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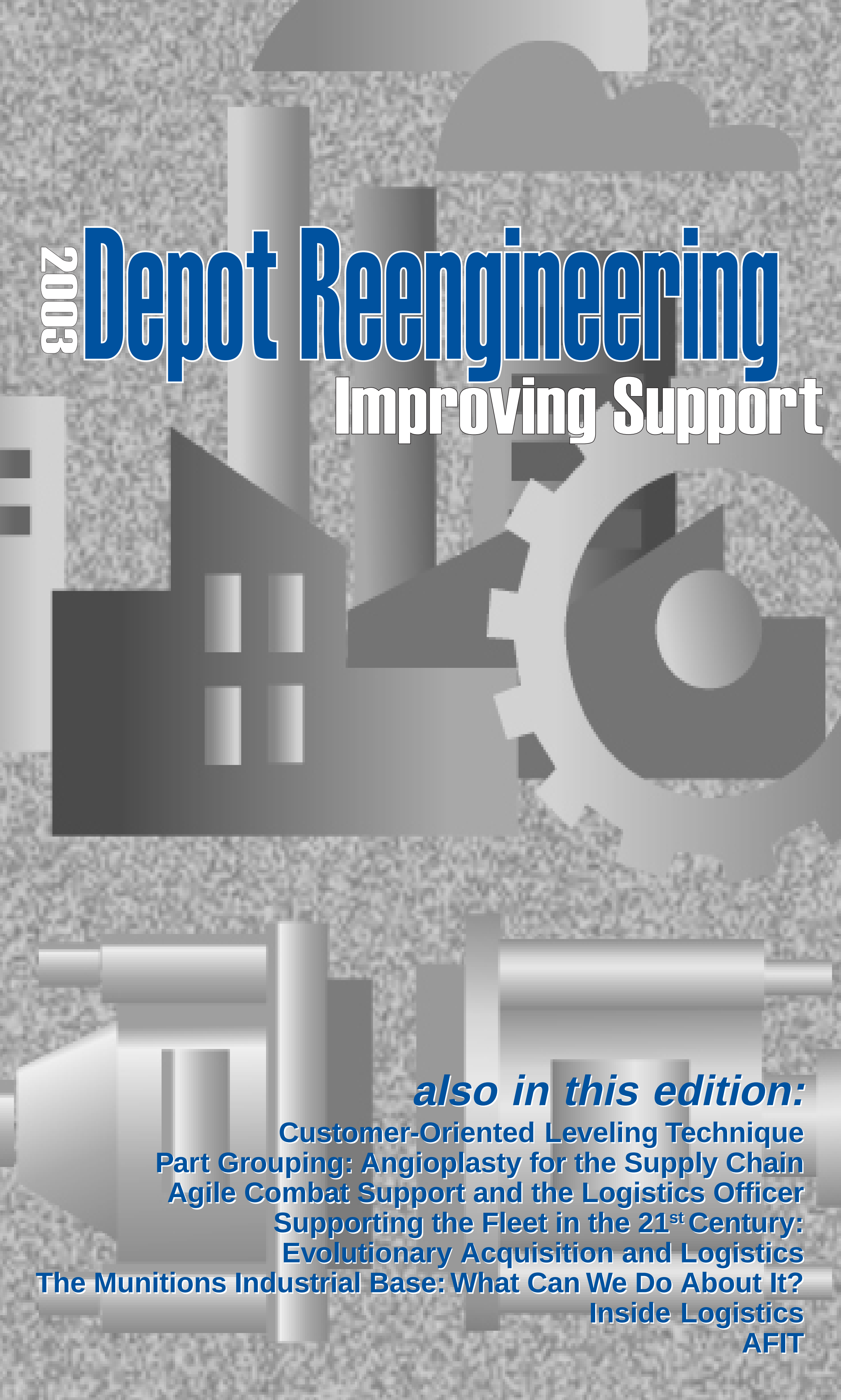

2003 Depot Reengineering

Improving Support

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Special Feature

DEPOT MAINTENANCE REENGINEERING

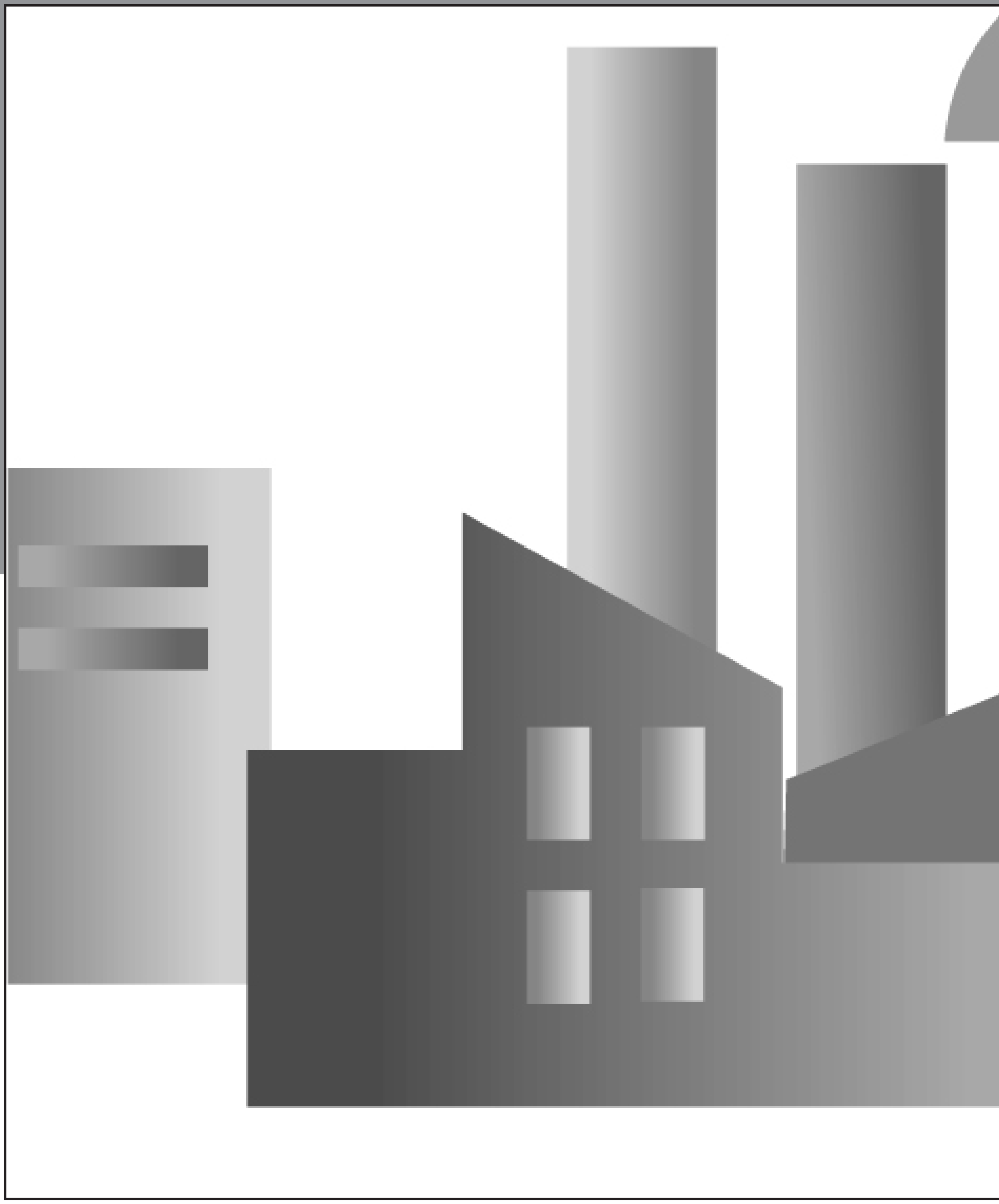
improving DEPOT support

Brigadier General Gary T. McCoy, USAF
Major Theresa B. Humphrey, USAF

DMRT has two clear objectives: improve support to the warfighter and improve financial performance. To fully support the warfighter, the depots must focus on reengineering processes to reduce flow times and increase production.

The team identified more than 300 depot maintenance performance inhibitors.

Over the years, the Air Force has made many efforts to improve depot maintenance performance and support to the warfighter. Financial management and productivity continue to be key elements of depot performance. To better focus their efforts, the Air Force leadership decided to take a more strategic and integrated approach toward improving depot maintenance. In July 2001, the Depot Maintenance Review Team (DMRT) was created with two overarching objectives: improve depot maintenance support to the warfighter and improve depot maintenance financial performance.



DMRT Has Two Clear Objectives

Sponsored by the Air Force Materiel Command (AFMC) Commander (General Lester Lyles) and Air Force Deputy Chief of Staff for Installations and Logistics (Lieutenant General Michael E. Zettler) and cochaired by the Principal Deputy Assistant Secretary of the Air Force for Installations, Environment, and Logistics (Ronald L. Orr, followed by Susan O'Neal) and AFMC Logistics Commander (Major General Paul L. Bielowicz, followed by Major General L. Terry Gabreski), the DMRT was made up of members from the Air Force Secretariat (SAF), Headquarters Air Force, AFMC, the air logistics centers (ALC), and other major commands (MAJCOM). A senior steering group—consisting of cosponsors, cochairs, SAF, Headquarters Air Force, and MAJCOM and AFMC representatives—provided valuable guidance to the team. Table 1 shows the members of the senior steering group and level of MAJCOM and Air Force involvement.

The team was initially structured into five separate focus areas: workload and production, workforce, materiel support, financial management, and infrastructure. Three more focus areas were added because of overwhelming concerns in information technology, organizational structure, and metrics, bringing the total number of focus areas to eight. Each of these focus areas

DEPOT MAINTENANCE REENGINEERING

was assigned a team of functional experts from Headquarters Air Force, AFMC, the air logistics centers, and the MAJCOMs. The teams' efforts were led and coordinated by an integrator (Colonel Robert McMahon, followed by then Colonel Gary McCoy), who also kept senior logistics leaders apprised of the teams' findings and recommendations. The depot customers (MAJCOMs) fully participated throughout the review and planning process. Their insights were incorporated into the development of the focus areas, and they took an active part in the site visits. Their input regarding the customers' perspective of depot maintenance performance and what improvements would best meet their needs and expectations helped the Review Team remain focused and effective.

From July through November 2001, the Review Team engaged in phase I of the DMRT effort, Problem Identification and Initial Solution Development. The team gathered data by visiting each of the three air logistics centers: Oklahoma City ALC (OC-ALC) at Tinker AFB, Oklahoma; Warner-Robins ALC (WR-ALC) at Robins AFB, Georgia; and Ogden ALC (OO-ALC) at Hill AFB, Utah. The team conducted forums with local stewards and members of the American Federation of Government Employees, depot maintenance managers, employees at all levels, military career *broadeners*, and company grade officers and outbriefed senior ALC leadership at the conclusion of each visit. The team identified more than 300 depot maintenance performance inhibitors, which were categorized into 38 major issues and then placed into the appropriate focus area.

In November 2001, after the reviews were complete and data categorized, the Air Force Secretary and Chief of Staff were briefed on the findings and recommendations and gave their authorization to proceed with the initiatives. The Depot Maintenance Review Team became Depot Maintenance Reengineering and Transformation (DMRT), signaling the beginning of phase II, Implementation Planning. Two implementation offices, one at Air Force Installations and Logistics and another at AFMC Logistics, were established to provide overall program management. Colonel McCoy led the implementation office at Air Force Installations and Logistics. Brigadier General Henry L. Taylor was the first to lead the implementation office at AFMC and was succeeded by Colonel Andrew E. Busch. These offices integrated major initiatives; served as a formal communication node; and ensured the appropriate reviews, coordination, and policies were in place to facilitate DMRT implementation.

The organizational chart details the leadership structure for DMRT (Figure 1). Throughout DMRT, it has been critically important to involve the right level of leadership to keep emphasis and momentum behind this effort. Leadership involvement begins with the AFMC Commander and Air Force Installations and Logistics and works down through the ALC executive directors.

DMRT has two clear objectives: improve support to the warfighter and improve financial performance. To fully support the warfighter, the depots must focus on reengineering processes that reduce flow times and increase production. Additionally, depots need to be responsive to warfighter requirements during peacetime as well as during wartime contingencies. The aging workforce issue also continues to plague the depots. Many employees are reaching retirement age and leaving in large numbers, taking with them valuable experience that cannot be easily or quickly replaced. The charge for the depots is to develop and train the existing and younger workforce to replace those who have retired. Financially, we need to develop an effective budgeting process and then execute it within established budgets to stop bringing bills to the table in the year of execution. We also need to put parts in the hands of mechanics when they need them and provide well-maintained equipment and facilities and the right kind of information technology systems to support their

Senior Steering Group	
Cosponsors Gen Lester L Lyles, Commander, Air Force Materiel Command (AFMC) Lt Gen Michael E. Zettler, Deputy Chief of Staff for Air Force Installations & Logistics (AF/IL)	**Cochairs** Ronald Orr, Asst Deputy Chief of Staff, AF/IL Maj Gen Paul L. Bielowicz, Dir of Logistics, AFMC
MAJCOM Reps Brig Gen Peter J. Hennessey, Dir of Logistics, Air Mobility Command (AMC) Brig Gen Donald J. Wetekam, Dir of Maintenance & Logistics, Air Combat Command (ACC) Col David Stringer, Dir, Air Education & Training Command (AETC) Dir of Logistics Col Larry Spencer, ACC/FM Barbara Westgate, Air Force Dir of Programs Maj Gen Michael C. McMahan, Air Force Personnel, (AF/DPF) Grover Dunn, Dir of Maintenance, Air Force Installations & Logistics (AF/ILS) Brig Gen Robert E. Mansfield, Jr, Special Asst for Supply Chain Integration & Logistics Transformation, AF/ILS	**AFMC Reps** Maj Gen I. Todd Stewart, AFMC Dir of Plans & Programs James Barone, AFMC Dir of Personnel Maj Gen Everett G. Odgers, AFMC Comptroller Tom Batterman, AFMC Dir of Logistics Maj Gen Charles L. Johnson II, Commander, Oklahoma Air Logistics Center (OC-ALC) Maj Gen Scott C. Bergren, Commander, Ogden Air Logistics Center (OO-ALC) Maj Gen Dennis G. Haines, Commander, Warner Robins Air Logistics Center (WR-ALC)
Secretary of the Air Force (SAF) Representatives	
Brig Gen Darryl A. Scott, SAF Acquisitions Gerry L. Freisthler, SAF Program Ex Office, Airlift & Trainers	Blaise Durante, SAF Acquisition Integration Robert D. Stuart, SAF Budget (SAF/FMB)
Focus Area Teams	
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Materiel Support Dejuana J. Howie, Lead, OC-ALC Logistics Management Dir (OC-ALC/LGS) Maj Tiger Hession, AF/ILSP Maj Anna Walters, SAF Contracting Mitch Mertz, AFAA/MS Capt Stephen D. Gray, ACC/LGS Matt Phillips, AFMC Agile Logistics Policy Br Debi F. Kirkpatrick, OC-ALC/LGS Marlene F. Wright, OO-ALC/LGS Jan McDaniel, WR-ALC/LGS Larry M. Chadwick, KPMG Silvia L. Czarnecki, AFMC Workload Br	**Financial Management** Edward Koenig, Lead, AF/ILSY Brenda Swain, SAF/FMB Michele Rachie, AF/ILSY Lt Col Vanessa Benn, Air Force Combat Support & Analysis Div (AF/XPPL) Maj Philip Greco (alt), AF/XPPL Jan M. Hebert, ACC Sustainment Br John McCants, AMC/LGXR Lt Col Jack E. Speake, Air Force Special Operations Command Financial Management & Comptroller Thomas G. Lopez, AFAA/MS
Infrastructure LaTrice Vaughn, OC-ALC Financial Management Comptroller Dir (OC-ALC/FM) Ron Baty, Lead, Depot Maintenance Div, AFMC/LG Paul W. Victorian (alt), OC-ALC/LGP Maj William Endres, AF/ILXI Ron T. Streeper, OO-ALC/LHYO Donald L Lucht, AFMC Modernization & Environmental Br Jerry Cook, WR-ALC/LGP Mary Aponte, AFMC Dir of Logistics Carl Dahlman, RAND Louis D. Zavakos, AFMC Program Development Jim McGinley (advisor), AFMC Financial Management Gene Kinslow, OC-ALC Plans & Programs Randy Young (advisor), OC-ALC/FM Michael W. Blasdel (alt), OC-ALC/LPPE Michael R. Williams, OO-ALC/XPX Wendy Johnston, WR-ALC/XPP	

Table 1. Depot Maintenance Review Team

Workload/Production	Standardized process improvement strategy
Financial	Correct disconnects in the financial requirements and determination process
Organizational Structure	Clear chain of authority, responsibility, and accountability
Workforce	Train and develop maintenance workers and leaders
Materiel	Responsive support to meet flexible workload requirements
Infrastructure	Recapitalize and invest based on maintenance strategy
Information Technology	Develop integrated information technology strategy
Metrics	Achieve a balanced focus on warfighter support and financial performance

Table 2. Eight Focus Areas

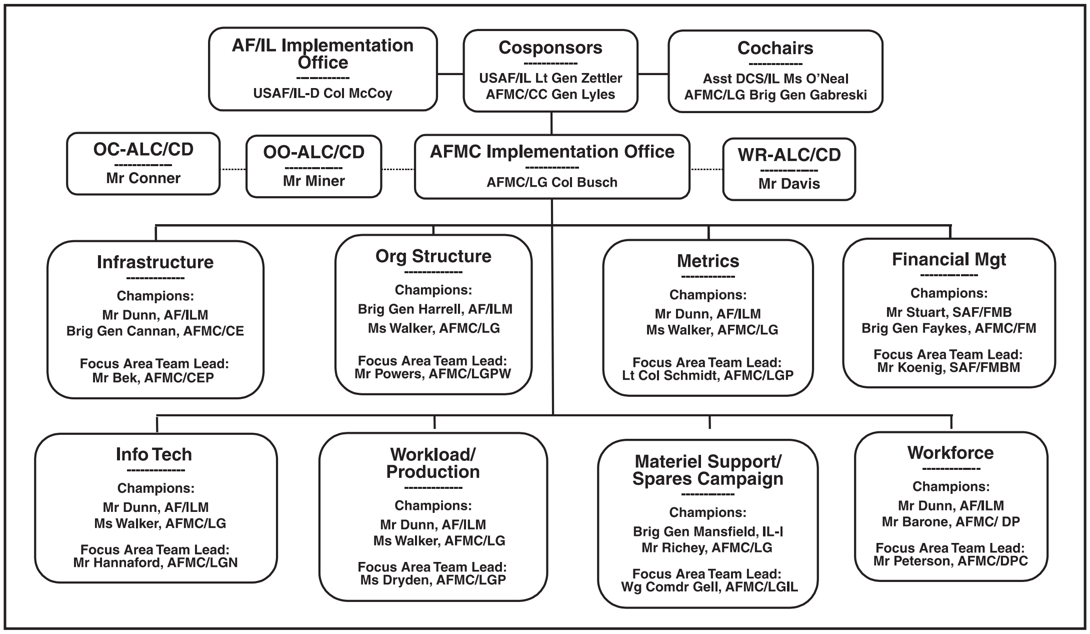

Figure 1. Organizational Chart

efforts. Finally, we must have the right organizational structure to manage the depot maintenance process and measure performance to drive the right behavior. These are the goals and challenges of DMRT. Depot Maintenance Reengineering and Transformation is a tremendous effort with bold actions to transform depot maintenance operations. The eight focus areas form the foundation for the 37+ initiatives that will ultimately improve support to the warfighter and financial performance. Focused efforts on every critical aspect of depot operations—people, parts, processes, financial management, information technology, infrastructure, and metrics—will result in modernized world-class depots. Senior Air Force leaders have committed their support to these efforts, and solutions are being implemented to drive DMRT toward its goals.

To ensure these efforts are on the right track, the Logistics Transformation Red Team was assembled in November 2002. The team included industry leaders, retired general officers and Senior Executive Service (SES) members with vast depot maintenance and leadership experience. The team's charter was to objectively assess logistics transformation efforts, identify problem and missing areas, and provide specific recommendations to lead to successful transformation. Some of the recommendations included focused change management, realignment of organizational roles and responsibilities, and integrating transformation efforts into a single, full-time program.

The team's recommendations were taken seriously—the Air Force Director of Installations and Logistics established the Directorate of Innovations and Transformation, led by an SES, to integrate the Air Force logistics transformation process. The DMRT offices at Headquarters Air Force and AFMC will be incorporated into the new directorate, along with the spares campaign and information technology integration. Ongoing logistics transformation initiatives will continue, and new efforts will be developed under the guidance of this Air Staff organization. One of the major undertakings for the directorate is to establish a clear mission, objectives, and desired outcomes. An important aspect of this task is to set overarching goals that will require the participation of all levels of logistics, including Headquarters Air Force, the MAJCOMs, and field units. The Directorate of Innovations and Transformation will shape overall policy, program the budget, and defend resources needed to support the logistics transformation effort, while the MAJCOMs will execute the initiatives. Finally, the directorate will take on the substantial and essential job of institutionalizing the change process inherent in transforming Air Force logistics, which is key to overall Air Force transformation.

The Air Force is transforming across the board and is well down the logistics transformation path. Success requires innovation, partnering with industry, and targeted investments and efforts such as the DMRT to provide direction and focus. It is a journey, but the goal remains world-class logistics operations for the air and space expeditionary force.

General McCoy is Director, Depot Maintenance Review Team, Installations and Logistics, Headquarters Air Force. Major Humphrey is Chief, Depot Maintenance Operations and Planning, Logistics Directorate, Office of the Assistant Secretary of the Air Force for Installations, Environment, and Logistics.

Special Feature

Workload and Production

Grover Dunn, Debra K. Walker
Sue A. Dryden

During the review phase of Depot Maintenance Reengineering and Transformation, the Workload and Production Team found depot maintenance lacked corporate strategy and a consistent approach for implementing process improvements. The team explored successful techniques from industry and proposed a standardized approach to depot maintenance process improvement. They also proposed standardized shop floor metrics that increase throughput, agility, and responsiveness to the customer. The shop floor metrics piece of this solution was transferred to the Metrics Focus Area Team.

The team selected a strategy that provided a common methodology for process improvement and captured the strategy in a concept of operations (CONOP) that incorporated a toolbox approach. The tools included benchmarking, *lean* depot repair, Six Sigma, and Modeling and Simulation. To validate this approach, the team conducted visits to various companies considered *best in class* in the repair and overhaul business sector. The visits confirmed that the toolbox approach is widely used by industry when they embark on process improvement initiatives, giving the various activities in the organization the latitude to select the technique that best fits their work environment. In addition to highlighting various techniques, the CONOPs also explains the critical role of leadership and the importance of formal training to fully understanding and applying the techniques. To formalize the process improvement, an Air Force Materiel Command (AFMC) instruction is being developed from the CONOPs.

Employee participation is a necessary ingredient in each of the process improvement tools. Realizing this, AFMC is making an investment to train and educate the workforce. It obtained the services of the American Productivity Quality Center, an internationally recognized resource for process and performance improvement, and is working with the Air Force Institute of Technology to develop and deliver long-term training requirements. Additionally, AFMC purchased and distributed training materials to the air logistics centers for in-house training.

Each of the process improvement techniques has features that enable the right application for the right environment. *Lean* is an innovative approach pioneered in the 1980s by Japanese automakers and focuses on eliminating *no value added* motions in work processes. Benchmarking, on the other hand, is a technique that involves comparing organizational, performance, financial, and other indicators to a best-in-class organization that performs similar processes. Another improvement method, Six Sigma, is a set of statistical and management tools that concentrates on eliminating defects and improving quality. Finally, Modeling and Simulation is the execution of a model of a certain operation or process to test the implications of a change. As the name implies, it is a simulation that allows a process to be tested without risk.

Process improvement initiatives are underway at all the air logistics centers. At the Oklahoma Air Logistics Center, Tinker AFB, Oklahoma, the F100 jet engine repair process was selected because of long and variable flow days. The Propulsion Production Division benchmarked with Pratt & Whitney to streamline the operation and discovered Pratt & Whitney accomplished the disassembly and assembly processes using a cellular concept, while the Propulsion Production Division used batch operations. This discovery drove the division's decision to expand the effort to include the *lean* depot repair methodology. After months of analysis, training, and planning, the F100 Inlet Fan Module (IFM) Lean Cell was created. The IFM Lean Cell incorporates basic manufacturing and *lean* repair principles and concepts.

The results of this project, depicted in Figure 1, are clear and measurable. Rearranging the shop floor layout opened up thousands of square feet and streamlined the process. Work in progress has been reduced by 30 percent, and flow days have been reduced by 25 percent with less flow-time variance. By continuing to find other opportunities to streamline the process, the shop is striving to achieve a 50-percent reduction in flow days.

Similar efforts are underway at Ogden Air Logistics Center (OO-ALC), Hill AFB, Utah. The aircraft brake repair process was targeted as a *lean* initiative because of high work in progress and lengthy flow times. The shop's goals are to reduce the number of brakes in work by 25 percent and flow days by 50 percent. The Lean Team accomplished a detailed analysis of the entire repair process and segmented it into three parts—disassembly, cleaning, and inspection. They focused their initial efforts on the first segment (disassembly) and found that batch processing was driving excessive wait times. Consequently, the team created a compact, efficient repair cell layout conducive to single-piece flow (as opposed to batch processing). Since implementing *lean*, the number of brakes in work has been reduced by 90 percent, and flow days have been reduced by 85 percent in the disassembly segment. As the Implementation Team shifts the same analysis to the two remaining segments, the cell will continue to evolve, and similar results are expected. When the entire process has been *leaned* out, efficiencies are expected to save $500K annually by fiscal year 2005.

The Warner Robins Air Logistics Center, Robins AFB, Georgia, also has embraced a thorough process improvement and combined *lean* and benchmarking to achieve impressive results. The Avionics Production Division embarked on a *lean* journey to improve production of ARC 164 ultra-high frequency radios. Shop personnel analyzed the repair process and developed a revised procedure thought to reduce flow time from an average of 14 days to 5 days. After implementing the new procedure, they found it did not yield the expected results because they had underestimated the amount of support shop work. As a result, the shop further refined and then implemented a second procedure. Four weeks after this second process was implemented, the shop reported a 50-percent increase in productivity. This, in turn, reduced customer back orders by 33 percent, and 8 weeks after implementation, all back orders for the ARC 164 were eliminated. Shop flow days actually have been cut from 14 to 3.5 days, a remarkable shop improvement.

The workload and production focus area has made great progress in implementing a standard process improvement strategy throughout AFMC. The three air logistics centers are taking on the challenge and implementing several initiatives using the toolbox approach provided in the process improvement CONOPs. They are beginning to see results and will see more progress with continued emphasis on these techniques. The depot maintenance community is absolutely committed to improving repair processes to provide world-class support to the warfighters.

Mr Dunn is Deputy Director, Installations and Logistics, Headquarters Air Force. Ms Walker is Deputy Director of Depot Maintenance, Directorate of Logistics, Air Force Materiel Command, Wright-Patterson AFB, Ohio. Ms Dryden is Deputy, Depot Maintenance Division, Directorate of Logistics, Air Force Materiel Command.

Lean Brake Team

One important feature of the process improvement technique is employee involvement. Technicians from the brake repair shop at OO-ALC participated in *lean* events to develop the repair cells. This photo shows the team working together to optimize the cell layout.

New process keeps first stage fan cases inside building 3001 and close to IFC lean cell. Repair process under one supervisor, improving workload prioritization and communication. Eliminated previous bottleneck area and decreased part travel distance.

Building 3001 Rubber Injection Facility

Old process sent first stage fan case to building 3221 for rubber injection. Workload done by different division (accessories) at a building more than a mile and a half away.

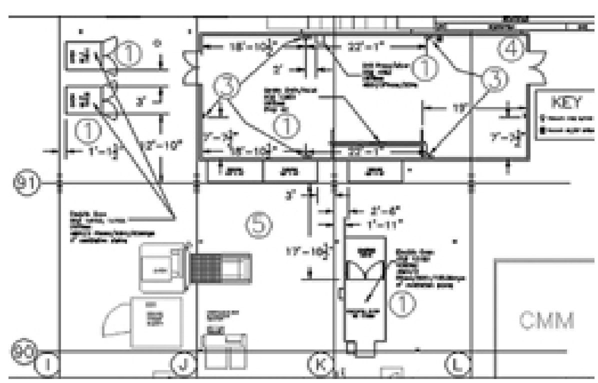

Figure 1. Inlet Fan Module Lean Cell

Financial

Edward Koenig; James Stuart; Brigadier General Frank R. Faykes, USAF

Over the last several years, most Air Force corporate discussions pertaining to depot maintenance have focused on critical reviews of the financial woes within the Depot Maintenance Activity Group (DMAG). The Depot Maintenance Reengineering and Transformation (DMRT) Financial Focus Team analyzed problems impacting Air Force depot maintenance financial processes. From that effort, implementation teams undertook seven initiatives to attack those problems, with the vision of improving depot maintenance financial processes at all levels.

Air Force depots endured a number of changes in the 1990s, to include decentralizing the depot maintenance organization at each of the five air logistics centers, divestiture of critical materiel control functions, and two air logistics center closures with associated depot workload transitions. While these events significantly impacted financial results, they created the baseline condition upon which DMRT improvements must operate. Accordingly, the Financial Focus Team focused analysis efforts on the systemic problems that transcended this period of adjustment and continue to hamper DMAG operations. The team began work in March 2002 on the initiatives outlined below, of which, the first two have already been completed.

- **Eliminate Depot Maintenance Quarterly Surcharge**. In 1998, the Office of the Secretary of Defense (OSD) directed that depot maintenance activities recoup losses during the year of execution if actual operating results varied more than $10M from budgeted projections. This proved a punitive measure when implemented via Program Budget Decision 437, effectively eliminating the ability of DMAG to act as a working capital fund. The Air Force was forced to pay significant execution-year shortfalls for the last 5 years as DMAG losses exceeded the $10M trigger level. Citing that level as an unrealistic variance for a $6B business area, the DMRT Financial Focus Team proposed a more realistic variance (2 percent of total DMAG expenses) that would account for normal fluctuations in the complex, highly diverse, depot maintenance workload environment. The OSD approved a greatly expanded variance, amounting to $88M for organic depot operations in fiscal year (FY) 2003. This change provides greater flexibility for the air logistics centers to manage operations within more realistic boundaries during the year of execution, with a payoff of eliminating corporate reimbursement of losses within the threshold.
- **Incorporate DMAG into the Air Force Corporate Program Objective Memorandum (POM) Process.** Depot maintenance cost growth has resulted primarily from baseline task increases on aging systems or price increases in the factors of production. These large changes previously were presented to the corporate structure as a must-pay bill during the budget estimate submission at a point in the process (after the POM) where the corporate structure had already allocated available dollars to all Air Force programs. However, during the FY04 POM (now called Program Budget Review [PBR]), a price change estimate was included for these programs in an attempt to incorporate those costs into MAJCOM depot maintenance programs. While the factors passed to the MAJCOMs proved understated, the DMAG PBR rate process itself was successfully implemented in the FY04 cycle. An improved process will be implemented in FY05 to achieve a closer estimated rate (passed to the MAJCOMs) with the ultimately computed rate in the late stages of the POM/PBR. The Air Force corporate structure will know the fully burdened cost of depot maintenance so corporate resources can be allocated properly for all competing programs.
- **Predictive Modeling.** Perhaps the single biggest financial complaint surrounding depot maintenance has been the inability to accurately budget for increased costs. Predictive modeling will harness modern information technologies and statistical techniques to capture historical data, normalize for known program changes, and forecast future costs by workload type for budgeting purposes. The model will also improve the synergy (and eliminating disconnects) between depot maintenance requirements and budget processes. A prototype version encompassing aircraft workloads will be developed and fielded in FY03 in time to assist in preparation of the FY06 POM. The production version, encompassing nonaircraft workloads, will be developed and online in FY04.
- **Contract DMAG Transition to Direct Cite.** Working capital funds are established to mirror business activities that possess visibility and control over operations and costs. Use of the working capital funds permits these activities to actively manage their workforce, budget, and workload, providing the customer with the best product in the most efficient manner. It was never designed, or intended, as a pass through for contractor payments (the current Air Force model) over which the Air Force has no management control and visibility. The transition of contract DMAG to direct citation of customer funds removes DMAG from its *middleman* position; separates the performance of the two distinct entities, organic and contract; and closes the financial gap between the customer and provider of contract depot maintenance. This significant business process change is being accomplished gradually over 2 years at logical contract breakpoints. FY03 transitions are focused on commodity contracts, which are funded by the Materiel Support Division (MSD). Larger contracts pertaining to weapon system overhaul workloads, including those complicated by government-furnished equipment and materials, will be the last to transition, beginning in FY04.
- **DMAG/MSD Integration.** This ambitious initiative has three goals. The first is to develop accurate and defensible prices by coordinating

the pricing activities of DMAG and MSD to allow for the best possible estimate of repair and supply costs during each price build cycle, beginning in FY04. The second goal is to better project the amount of materiel required for depot repair processes by improving the accuracy of repair bills of materiel. This improvement is a key to accurately forecasting the amount of materiel used during the repair process and setting the repair price. The final goal is to study options for a financial merger of DMAG and MSD into a single enterprise model. Currently, these two functionally independent businesses operate as financially independent entities as well, with the internal transactions between them complicating the requirements, budget, and execution processes. Options will address whether they could better operate as a single enterprise at the air logistics center or Air Force Materiel Command level, measured by a single set of warfighter support and financial performance metrics.

- **Workload Carryover Metric.** Depots are permitted a set amount of work to carry over from a funded year's requirements to the next year, facilitating efficient operations by leveling workload flows without regard to fiscal year boundaries. Until recently, the standard used by all Department of Defense (DoD) depots was an arbitrary 3 months applied to all workload types. This standard did little to fulfill the underlying purposes of carryover: workload management and efficient application of appropriated funds. A new OSD standard is pending, which will measure carryover commensurate with the outlay rates associated with depot maintenance source appropriations. Unfortunately, this standard does not address efficient depot loading either. The Air Force initiative will propose varied carryover standards in accordance with the production need of each major form of workload (aircraft overhaul, commodity repair, software development) The revised carryover standards will be proposed to a joint service and DoD oversight group as replacements to the current standards.
- **Revamp the Sustainment Process Board (SPB).** The Air Force lacked a clearinghouse entity that could review key processes and serve as a forum for developing and formalizing improved policies and procedures for the depot maintenance operations. The revamped SPB brings together key provider and customer stakeholders for regular reviews of depot policies and procedures, both current and those directed by the SPB as replacements. The goal of the SPB is consistent policy application across the depot community.

Collectively, these initiatives strike at the root of poor financial performance identified by the DMRT. When implemented, they will synergistically improve the financial performance of the DMAG and the Air Force as a whole.

Mr Koenig is Director for Budget Management and Execution, Office of the Deputy Assistant Secretary for Budget, Office of the Assistant Secretary of the Air Force for Financial Management and Comptroller. Mr Stuart is Deputy for Budget, Office of the Assistant Secretary of the Air Force for Financial Management and Comptroller. General Faykes is Director of Financial Management and Comptroller, Headquarters Air Force Materiel Command, Wright-Patterson AFB, Ohio.

Workforce

**Grover Dunn, Jim C. Barone,
Leif E. Peterson**

The workforce focus area was charged with the large task of uncovering issues hindering optimal depot maintenance performance. Over time, several events impacted the workforce, including reductions in force and closure of two depots. The average age of the workforce continued to rise, many experienced employees began retiring, and the younger workforce lacked experience and training. The Review Team uncovered several concerns during the review phase and developed initiatives to resolve them. Some of the major initiatives are highlighted below.

- **Maintenance Training Organization and Maintenance Orientation and Technical Training Plans.** The team identified that newly hired employees were not *maintenance ready technicians* when they reported for duty. Many lacked basic understanding of their role within the Air Force, Air Force Materiel Command (AFMC), and air logistics centers and were unfamiliar with core maintenance programs such as tool control, technical orders, safety, and foreign object damage prevention. As a result, they were unable to contribute to production in the shop until they fulfilled these basic requirements, and it could take several weeks before this happened. The team developed a two-part initiative to address this issue. The first part involved standing up a maintenance training organization within the maintenance directorates at the air logistics centers to serve as a centralized training entity for all depot maintenance-unique training. The second part is building maintenance orientation and technical training plans modeled after the highly successful military enlisted career-field education and training plans. A training plan will be developed for each skill and standardized to the maximum extent possible. Together, these two initiatives will reduce the time required to produce skilled technicians. A separate initiative focuses on developing senior military and civilian depot leaders.
- **First-Level Supervisory Training**. This initiative was driven by the discovery that new first-level supervisors were not prepared for managerial demands in the maintenance environment. In many cases, newly selected first-level supervisors are

turning wrenches one day and are supervisors the next with little or no preparation in how to deal with their new duties, making the transition from mechanic to manager very difficult. The solution was to initiate standardized first-level training courses that will be completed before people are selected for supervisory duties so they can *hit the ground running*. A standard course for those currently occupying a supervisory position is also being developed. Such training will provide new supervisors the tools to succeed ahead of time, mitigating the frustration of *learning as you go* while trying to manage day-to-day production demands.

A separate workforce initiative is examining ways to minimize daily distractions first-level supervisors face. This, along with proper training, will enable them to balance the competing demands of managing the personnel and technical aspects of their position.

- **Appraisals and Award System.** Due to the magnitude of this initiative, it was broken into two separate pieces, one that deals with the appraisal system and another that looks at the awards system. As the team conducted their site visits, several concerns arose over what was seen as an inflated appraisal system that also serves as the basis for the distribution of annual monetary awards. This initiative strives to establish performance plans and ratings that focus on cost, quality, and schedule to make the appraisal and award system less subjective. A group incentive award is being considered that will be based on team versus individual performance. Both the appraisal and awards initiatives are long-term in nature but, when implemented, will allow managers and supervisors at all levels to objectively evaluate and reward employees. These objective-rating criteria will enable the appraisal and award system to drive production; control cost; and ultimately, improve support to the warfighter.
- **Unresponsive Hiring Process.** One major concern for the depots was the amount of time required to fill vacant positions. In many cases, it took an average of 80 days to get through the hiring process. Additionally, implementation of a new personnel system at the air logistics centers impacted some internal processes. The focus of this initiative is to streamline hiring processes and increase hiring flexibility. The ultimate goal is to enable managers to fill vacancies quickly and minimize their impact on production.
- **Multiskills.** Multiskilled employees are certified to work in more than one technical area and can be moved, as workload requires, increasing productivity and reducing workflow disruptions. The Review Team discovered that depot maintenance employees are not *incentivized* to become multiskilled and supervisors are not well versed in how to fully employ multiskilled technicians. The search for a solution revealed a memorandum of agreement (MOA) between AFMC and the American Federation of Government Employees that lays out provisions for using multiskilled employees. This MOA will be *resurrected*, and AFMC will determine policy to encourage the use of multiskilling in specific work situations where the need exists.

The criticality of properly developing the workforce and providing them with the tools needed to effectively fulfill their duties cannot be underestimated. Refocusing on depot maintenance training and workforce development will produce a workforce to support world-class depot maintenance operations.

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Organizational Structure

Brigadier General Elizabeth Ann Harrell, USAF; Debra K. Walker; Michael J. Powers

The organizational structure of depot maintenance was not one of the original Depot Maintenance Reengineering and Transformation (DMRT) focus areas. During the review phase, several teams discovered the organizational structure was perceived as impacting depot performance. Feedback from people at various levels indicated the existing structure lacked a clear line of accountability, responsibility, and authority. Maintenance functions were dispersed in different directorates, resulting in what was seen as a general loss of focus on maintenance processes and lack of proper development of the maintenance workforce. A separate team was established to address this concern, especially since issues related to the depot maintenance organization spanned several focus areas.

The Organizational Structure Focus Team was established after the initial site visits during the review phase of DMRT. The team researched general organizational design concepts used in the private sector and reviewed Air Force organizational guidance to develop and evaluate several restructuring alternatives. The Commander, Air Force Materiel Command selected the centralized maintenance option, which consolidated depot maintenance functions into a single maintenance directorate. While each air logistics center (ALC) was given the flexibility to allow for some unique mission-driven characteristics, the overall structure is standardized throughout the three depots. All three air logistics centers reached full operational capability 1 October 2002.

The new organization retains the strengths of the current structure, including combined customer and product focus and enhanced lateral communication. The new structure also creates a clear chain of command focused on depot maintenance, facilitates rapid resource allocation and reallocation, and enables the consistent application of maintenance policies. While some personnel were relocated and select administrative functions were centralized, there were no reductions in force or grade directly associated with the new organization. The realignment is accountability-based with a majority of the moves occurring in the management areas and their respective reporting chains.

The following processes were also examined as part of the overall ALC transformation effort: acquisition product support, engineering, human resources, purchasing and supply chain management, financial management, information technology, and intelligence. While some of these reviews may result in reorganization, others may not. The evaluations are ongoing, and this phase of the ALC transformation is targeted for completion in October 2003.

Centralized maintenance functions focus on efficient, high-quality depot-level products to support the warfighters. The Maintenance Directorate restructuring fosters implementation of process-based improvements through other DMRT initiatives. It will be within those initiatives that real improvements in productivity and cost control will be accomplished. The new Director of Maintenance and the production workforce play a vital role in the overall success of DMRT.

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Infrastructure

David J. Bek; Louis D. Zavakos; Grover Dunn; Brigadier General David M. Cannan, USAF

The Air Force depot maintenance physical plant occupies more than 500 facilities and nearly 16 million square feet. With such a large concentration of facilities at three locations, facility and capital equipment (referred to as infrastructure) management is a vital component of the depot maintenance enterprise. Unfortunately, the Air Force depot physical plant aged as recapitalization investments stagnated. Similarly, facility configuration and space limitations often thwarted efforts to embrace changing technology necessary to modernize depot processes. To improve efficiency, increase throughput, and reduce cost, depots needed to approach infrastructure management from a strategic view.

During the review phase of Depot Maintenance Reengineering and Transformation (DMRT), the Infrastructure Focus Area Team identified key barriers limiting proper infrastructure management. Ten initiatives were formed against the backdrop of the mission statement: "provide well-maintained, environmentally compliant, efficiently configured, and properly equipped facilities to support assigned workloads." The initiatives fall under two main categories: long-term capital investment improvements and process improvements.

Long-Term Capital Investment Improvements

The infrastructure focus area assisted in the development of the Depot Maintenance Strategy and Depot Maintenance Master Plan. As a subset of the above documents, the Secretary of the Air Force approved a $150M Per Year Depot Plus-Up beginning in fiscal year 2004 that will be invested in DMRT initiatives, capital purchase program (CPP), and military construction (MILCON) transformational investments. The Depot Maintenance Strategy, Master Plan, and $150M Depot Plus-Up paved the way for infrastructure initiatives with far-reaching strategic impact.

- **Formalize the Depot Integrated Infrastructure Master Plan.** This first initiative is the cornerstone of all other infrastructure initiatives. Infrastructure management lacked a strategy and an institutionalized strategic planning process. Investment programs and decisions lacked a comprehensive, long-term strategy, weakening the depots' ability to obtain funding needed to sustain and improve the depot infrastructure. Insufficient investment funding led to maintenance, repair, and replacement backlogs, crisis-management funding, and an inability to support necessary technology and process changes. To formalize future strategy development,

Facility Configuration
Facility configuration constraints at the air logistics centers made it challenging to maximize efficiency or modernize processes. The Infrastructure Focus Area's objective is to alleviate these challenges.

work began to document existing depot infrastructure capacity, future workload requirements, and any subsequent delta between capacity and workload. Projects were identified and prioritized to meet these infrastructure gaps for MILCON and CPP, and a reasonable funding profile for maintenance and repair was defined. Furthermore, the Depot Integrated Infrastructure Master Plan will define and document infrastructure policy to institutionalize the strategic planning process. This will ensure changes in workload posture and new technologies are incorporated into future planning and ensure the right infrastructure investment requirements are identified in the planning, programming, budgeting, and execution processes.

- **Incentivize Infrastructure Investment in Maintenance and Repair**. Because of underfunding in many depot budget lines, vital infrastructure projects were postponed, and funding earned in the depot overhead rate structure for infrastructure requirements was used to finance noninfrastructure requirements. Also, pressure to keep depot overhead rates low led to delayed infrastructure investments. Both practices increased depot costs by increasing process delays caused by equipment failure. Using the Air Force Installation Readiness Report (IRR) and Air Force Materiel Command (AFMC) Infrastructure Condition Index (ICI) facilities metrics, the depot infrastructure condition can be assessed, and depot commanders can report progress as investments are made. While the IRR and ICI exist in more aggregate facility format, the metric tools are being adapted to provide valuable information for both facility and capital equipment by depot and technical repair center level. Figure 1 depicts AFMC IRR facility class ratings, while Figure 2 illustrates AFMC ICI relative to facility investment. The IRR tool lets the manager to identify, by facility class, the total funding levels required to eliminate C-3 and C-4 ratings by 2010 per Defense Planning Guidance. The ICI tool includes a linear regression model to predict future conditions, given a specific funding profile. Once fully developed, these tools will give depot commanders valuable infrastructure information needed to guide investment decisions. A reporting mechanism is being developed to provide the incentive of measuring progress over time.
- **Create Capital Investment Funding Appropriation Line.** New weapon system program managers forecast depot activation requirements. While some coordination with logisticians occurred, disconnects were common when the same programs made subsequent depot maintenance-impacting decisions but failed to properly coordinate them. When a depot was finally made aware of a change, there was too little time and insufficient funding to adequately prepare and provide the requested organic programmed depot maintenance. The weapon system-centric focus and real-world dynamics of acquisition programs do not provide incentives for system program managers to invest in organic depots. This initiative establishes a single capital investment appropriation line where all depot activation funding, programmed by the respective weapon system, could be positioned, allowing for better visibility, safeguards against funding disconnects, promotion of commonality, and optimization of depot infrastructure.
- **Provide Greater Flexibility for Implementing Workload Changes.** Structured MILCON and minor construction processes inhibit depot maintenance ability to reconfigure facilities to accommodate rapidly changing workload requirements. The time to plan, program, and acquire a MILCON requirement could average 4 to 5 years. This delay, along with the constraint of a minor construction threshold, hinders the flexibility of the depots to implement workload adjustments, which only have a 2- to 3-year lead time. To help alleviate the mission-capable (MC) threshold constraint, the Infrastructure Focus Area Team developed a legislative proposal to establish a Department of Defense Depot Maintenance Revitalization Demonstration Program (DDRDP). DDRDP will increase the MC threshold, allowing the depots to construct or modernize larger facilities without the time required to obtain a MILCON.
- **Add Surge Requirements to Infrastructure Planning and Programming.** Depots must have a surge capability to meet increased requirements associated with sustained periods of war or heightened mission deployment. However, providing for an eventual surge requires additional facility or capital equipment capacity. As depots focused on reducing costs by minimizing excess capacity, they became undersized to accommodate mobilization and surge capabilities. The focus team established a separate team to develop an approach to identify surge requirements; establish policy, guidance, and training; and then program for future infrastructure. These changes will encourage surge investments where needed most to support wartime and mobility depot maintenance requirements.

Installation	Maintenance and Production Facility Class		
	FY00	FY01	FY02
Hill AFB	C-3	C-3	C-4
Robins AFB	C-4	C-4	C-3
Tinker AFB	C-3	C-4	C-4
Plant Replacement Value (PRV) in $M	$2,166	$2,368	$2,599
Total Weighted Requirement (TWR) in $M	$744	$1,483	$1,829
TWR / PRV	34.4%	62.6%	70.4%
Overall AFMC Depot C-rating	C-3	C-4	C-4
Cost to C-2 in $M	$421	$1,013	$1,272

KEY:

C-rating = [TWR/PRV] * 100%

C-1	0 - 10%	Only minor deficiencies with neglible impact on capability to perform required missions.
C-2	> 10 - 20%	Some deficiencies with limited impact on capability to perform required mission.
C-3	> 20 - 40%	Significant deficiencies that prevent it from performing some missions.
C-4	> 40%	Major deficiencies that preclude satisfactory mission accomplishment.

Note: Eliminate C-3 and C-4 rated facility classes by 2010 per Defense Planning Guidance.

Figure 5. Installation Readiness Report

Process Improvements

The Infrastructure Focus Area Team also noted several critical processes that no longer fostered efficient depot infrastructure management. The following initiatives strive to vastly improve those critical processes to aid overall depot efficiency:

- **Improve the CPP Process. The** CPP process used to justify budget inputs was established to validate and prioritize requirements, yet the rigor incorporated into the process makes it unwieldy. The focus area is investigating ways to streamline the CPP process and ensure the program aligns with depot infrastructure strategic planning. Automation technology is also being considered to help prepare, submit, and manage required documents.
- **Train the Depot Workforce in the CPP and Economic Analysis Processes.** Extensive documentation is required to justify CPP budget inputs. Shop-level personnel prepare and submit requests independently, resulting in a wide range of formats that make comparisons and prioritization difficult. Often, the CPP submissions lacked a persuasive business case analysis to sell the project, requiring rework and wasting manpower and time. The focus area will develop a training program to ensure across-the-board understanding of the process, approval levels, and package format and content.
- **Improve Preventive and Predictive Maintenance Programs.** Because of budget constraints and concern for competitive depot overhead rates, equipment maintenance budgets and manpower were cut nearly 40 percent over the last 10 years. Equipment maintenance became reactive *run to failure* with a significant effect on process downtime because of equipment failure. A depot-level team collected and analyzed data concerning equipment downtime, backlog of maintenance, and overtime. The team recommended acquiring additional manpower to properly address predictive maintenance requirements at each depot and new predictive analysis tools such as online monitoring, infrared, and laser alignment equipment. Together, these recommendations will significantly increase equipment reliability and reduce process downtime.

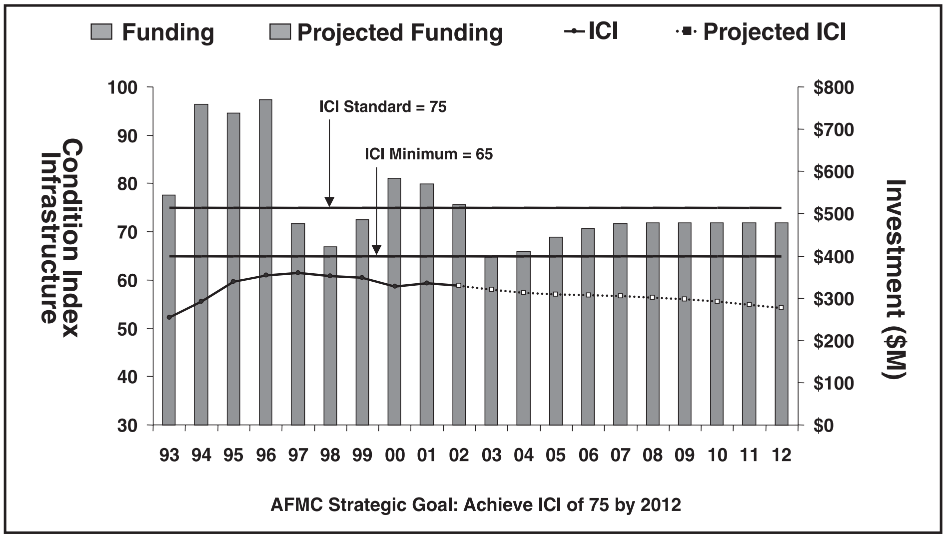

Figure 2. AFMC Infrastructure Condition Index (Facilities)

- **Remove Impediments to Broad Use of the Facility and Equipment Maintenance System.** Depots can use Facility and Equipment Maintenance System (FEMS) software to manage equipment maintenance data. Unfortunately, the software was not consistently used, frustrating proper equipment maintenance and reducing equipment reliability and depot throughput. A depot-level team realized guidance on FEMS use was lacking, and many maintainers were not properly trained. Standardized work instructions were formalized, and formal training is being developed. Radio-frequency scans have been purchased and used to update warehouse FEMS, and policy and guidance documentation is being developed to emphasize FEMS use. Finally, a software integration problem duplicated data entry, and the team is working to simplify the total system data-entry process. Aggregately, these changes should improve access, user capability, and the use of FEMS to enhance equipment maintenance.
- **Improve Maintenance and Repair Facility Project Delivery Process.** The Review Team found existing facility maintenance and repair processes constraining, leading to lengthy project development times and delaying critical facility improvements. A depot-level team found each air logistics center had independently developed facility definition and delivery processes and capabilities. The team is implementing several subinitiatives to minimize work and improve delivery times. Most of the subinitiatives have been completed and implemented across each depot, yielding a common *toolkit* of processes and schedules, contract vehicles, and points of contact.

In summary, the DMRT effort recognizes the impact infrastructure has on productivity and cost control. By providing sufficient facility and equipment capacity, capability, and configuration, depots will have the flexibility and reliability needed to implement change to reduce cost and increase throughput. The DMRT infrastructure focus area is aggressively working initiatives that will collectively pave the way for depot transformation and ultimately ensure depots provide superior support to the warfighter.

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Materiel Support

Brigadier General Robert E. Mansfield, Jr, USAF; Garry B. Richey; Wing Commander Andy Gell, RAAF

Air Force supply and maintenance functions operate under multiple layers of policy. These policies are critical to effective support to the warfighter: they identify standard processes and procedures, define reporting requirements, and serve as the institutional knowledge for how maintenance and repair operations should be performed across the Air Force logistics community. During the review phase of Depot Maintenance Reengineering and Transformation (DMRT), the Materiel Support Focus Area Team observed three broad issues that limited the effectiveness of policies designed to ensure parts supportability for depot operations.

First, the Review Team recognized that, over time, portions of the existing set of policies became counterproductive and were not driving desired performance. After identifying specific areas where policy was no longer up to date, the team established a process to review and revise Air Force Materiel Command materiel support policies to clearly reflect Air Force support objectives. Some of the areas addressed include management review codes, supply support requests, and local purchase policies. The compliance processes were emphasized to implement the guidance in a standardized fashion and produce consistent results across multiple maintenance and repair activities.

Many of the processes and systems developed to support air and space expeditionary force operations were not adequately addressed by existing guidance and required new policies for effective implementation. Examples include the interoperability of Air Force forecasting systems with the Defense Logistics Agency's (DLA) ongoing Business Systems Modernization effort, procedures for filling back orders when automated systems fail, and procedures for ordering parts for the Depot Maintenance Activity. In each case, the Focus Area Team developed and is implementing a process to ensure rapid development of consistent policy guidance and mechanisms for monitoring policy implementation and utilization.

Finally, the Review Team noted shortfalls in stockage policies that did not support depot operations, especially low-demand items. Levels for all types of items will not be increased, but an evaluation will be conducted to determine appropriate items and quantities required to best support depot maintenance activities. Low-demand items will be analyzed to determine if the investment to stock these items is justified. If so, a consistent stockage strategy will be implemented to ensure these items are available when required. Additionally, DLA stockage policy has been renegotiated to retain levels on some low- or no-demand parts required by depot maintenance activities.

In summary, the DMRT materiel support efforts will streamline processes and improve parts availability to improve depot throughput and productivity. By systematically reviewing policies across the board, the depot maintenance activities will ultimately receive better parts support.

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Information Technology

Grover Dunn, Debra K. Walker, Steve Hannaford

A simple physical inventory would reveal there is no shortage of information systems supporting depot maintenance. Unfortunately, these systems do not always provide timely or accurate data; do not always talk to each other; and in many cases, cannot be used to make sound management decisions. These limitations led to the creation of the Information Technology (IT) Focus Area Team during the review phase of Depot Maintenance Reengineering and Transformation. The IT Team is focused on integrating, managing, and optimizing information technology across depot maintenance in three main areas: IT Master Plan, Automatic Identification Technology, and Depot-X.

Information Technology Master Plan. Maps are useful to help ensure you arrive at the right place, at the right time. A map for information technology, the Air Force Materiel Command (AFMC) Logistics Information Technology Master Plan, is also necessary to guide the development, funding, and fielding of IT systems. The IT Master Plan is a living document that will be updated continually to guide IT planning, development, and implementation. The first edition, published in September 2002, is tactical and establishes a framework to align IT systems and initiatives with guidance set forth in the *USAF Installations and Logistics Information Systems Strategic Plan*. A second edition will integrate people, technology, business processes, data, and funding into a comprehensive strategy. As a whole, the plan focuses on the future vision for AFMC depot maintenance and supply management to steer efforts toward the right IT solutions.

Automated Information Technology. Improvement efforts within information technology have centered on application development and reengineering. Human interface issues were secondary, often making the systems nonuser friendly. Data input responsibilities fell to the technicians on the shop floor, taking them away from *turning wrenches* and reducing productivity. The primary objective of this initiative is to provide users with automated tools to make data collection transparent to the technicians, minimize shop floor disruptions, and improve overall productivity. Examples such as bar coding, automated tool dispensers, and *smart cards* decrease data-entry demands on the end users and make systems more user friendly. To date, capabilities planned for evaluation include the Automatic Tools Dispenser (Auto-Crib), parts numbering (serial numbering tracking) for maintenance data collection, and a single system sign-on for the technician and mechanic.

Depot-X. As the air logistics centers field IT systems, personnel often develop systems to help them better perform their jobs, especially when standard systems do not meet the local need. These systems are often built independently with minimal information sharing between the functional areas, leading to duplication of effort and unnecessary expenditure of resources. Depot-X is a rapid-assessment, development, integration, and fielding capability for enhanced processes, systems, and information technology. Depot-X provides a structured analysis process to evaluate information from a functional and technical perspective. This approach improves coordination with the user, developer, and tester communities across the depot maintenance and supply management functional areas. Depot-X will encourage innovative ideas at each of the air logistics centers, eliminate duplication of effort, and ensure the greatest benefit for the investment.

The IT Master Plan presents a comprehensive vision to manage information resources to improve warfighter support and financial management. Additionally, streamlined data collection and analysis will help alleviate administrative and nondirect labor burdens and improve productivity at the air logistics centers. Finally, full implementation of Depot X will remove duplicative applications while encouraging innovative system improvements throughout AFMC.

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Metrics

Grover Dunn, Debra K. Walker;
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The Metrics Focus Team was tasked to establish a standardized set of warfighter-focused performance measures to realign depot maintenance metrics with warfighter needs and tie the measures to supply chain management and major command (MAJCOM) metrics and targets. The metrics also must link vertically throughout the depot maintenance structure—shop floor to Air Force Materiel Command (AFMC) to Air Staff—with the ability to *drill down* through the organizational levels.

Customer input is key to successfully implementing this initiative. The team surveyed the warfighters on how depot maintenance does and should relate to their readiness and combat capability. Warfighter-centric metrics, being developed, directly address warfighter concerns and include throughput, schedule, cost, and quality. Shop-floor metrics are a subset of the overall metrics initiative and were initially a part of the workload and production focus area. These metrics will focus on production and also include cost, quality, schedule, and safety and will be visibly displayed in each shop. Keeping the workforce well informed of their performance will help drive the right behavior to keep the warfighter needs in focus. Tools such as the Object Czar Depot Maintenance Analysis System will automate these metrics to ease the burden of analyzing such a large amount of data. The final product will be an AFMC metrics manual that will fully define the key metrics used at each level of management. The manual will also direct the reporting process for the air logistics centers and the process of keeping the MAJCOMs informed on depot maintenance performance.

Establishing the right number and type of metrics to properly measure the impact of depot maintenance performance on warfighter support is no easy task. Clear, concise, and meaningful metrics are a key element in improved depot maintenance support to the warfighter and financial performance. The resulting metrics will provide the capability to demonstrate the impact of AFMC performance on warfighter support and ensure we are jointly working toward the same goals.

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Supply 2003

COLT uses a marginal analysis technique to achieve the best possible objective while satisfying constraints.

Captain Jason Vinson, USAF
Major Kevin Gaudette, USAF

Customer-Oriented Leveling Technique

We have probably all heard it (and maybe even said it once or twice): "I would have been able to produce if only I had the parts" or "It isn't my fault the aircraft isn't on schedule, supply is out of the washers I need, and the supplier is on back order as well." Oftentimes, these types of comments seem like finger pointing, but the numbers indicate they are rooted in truth. In May 2001, there were more than 32,000 consumable units back ordered against end items or higher assemblies in an awaiting parts status.[1] Examples are all too common in which relatively inexpensive consumable parts hold up the repair of an expensive reparable part. The Defense Logistics Agency (DLA) supplies upwards of 90 percent of the consumables used in aircraft programmed depot maintenance (PDM) and component repair, which takes place primarily at Air Force Materiel Command's (AFMC) three air logistics centers (ALC). Under contract by AFMC's Directorate of Logistics, Bearing Point (formerly KPMG Consulting) cited consumable-item support to depot maintenance in its Constraints Analysis Program study as one of the key limiting factors impacting the depots.[2]

The Customer-Oriented Leveling Technique (COLT) was developed by the Management Sciences Division of AFMC's Directorate of Plans and Programs in conjunction with the Supply Division of the AFMC Directorate of Logistics, with the goal of improving availability of consumable parts supplied by DLA. These parts allow maintainers at the air logistics centers to complete PDM on schedule and get reparable assets out to the field. This article outlines the history that led to the development of COLT, walks through the details of the model's algorithms, touches on some key paradigm shifts that had to occur prior to implementation, and highlights performance improvements already realized.

Background

Discussions and studies regarding how to treat consumable parts are nothing new. The article "Management of Air Force Depot Consumables: A Brief History and Taxonomy" goes into a more detailed description of how these parts have been treated over the last 10 years.[3] We, therefore, limit our discussion here to a summary of the major milestones that led to the development of COLT.

A traditional economic order quantity (EOQ) model was used until 1998 to determine the quantity of each part to be stocked at the retail echelon of supply and when orders should be placed to resupply those stocks. This approach took into account such factors as the historical demand rate and unit price for each item, as well as assumed values for ordering and holding costs. A 1998 study by the Air Force Logistics Management Agency (AFLMA) showed that, in some special cases, retail support for consumable parts could be improved by ordering more frequently from DLA than the EOQ approach would dictate.[4]

In response to the AFLMA study, AFMC changed its EOQ ordering approach to a new policy of one-for-one ordering on all DLA-managed consumable parts. This new policy called for the air logistics centers to order stock daily from DLA to resupply their shelves based on the number of assets consumed each day. The policy provided DLA with a more accurate picture of its customers' true demand streams, but it was not in line with the recommendations laid out in the AFLMA study, which defined specific criteria as to when the new policy should and should not be used. An added problem with one-for-one ordering was that, in execution, each of the air logistics centers had its own approach for calculating stock levels. All three used a *days of stock* approach to set these levels, but their criteria for determining the number of days were drastically different. One air logistics center set the same number of days on all stock numbers, whereas another used a certain number of days for all items under a set dollar value and a different number of days for all other parts. The third had yet another approach that looked at not only the cost of the items but also the number of requisitions each part had experienced. AFMC implemented one-for-one ordering simultaneously across the command, but in practice, there were three very different approaches being used for determining stock levels for consumable parts.

In 2000, an integrated product team (IPT)—led by the AFMC Directorate of Logistics and comprised of members from the AFMC Directorate of Plans and Programs, each of the air logistics centers, and DLA—was formed to improve consumable parts support to the depots. This team examined the effectiveness and shortcomings of each of the current practices and explored alternatives that might yield the desired improvement. Analysis showed each of the current approaches to be suboptimal and led to the development of COLT, a marginal analysis model that ties together funding, customer demand, and DLA supportability when setting stock levels.

COLT Basics

Like Air Force reparable supply systems, COLT uses a marginal analysis technique to achieve the best possible objective while satisfying constraints. In this case, the objective is to minimize customer wait time (CWT) for consumable parts, while the constraint is operating within set funding limits. As long as the model has money to spend, it will increase the stock level of the part that, relative to all other parts, will yield the largest return on investment. Simply put, it maximizes the *bang per buck*. The *buck* is simply the cost of the item in question, but the *bang* piece of the equation deserves a bit more explanation.

COLT is said to minimize CWT for ease of communication, but a more accurate statement is that the model minimizes the *demand weighted* CWT per dollar spent. This objective ensures the result of a COLT run is the minimum average CWT across a population of parts for a given level of inventory investment. The *bang*, then, is defined as the change in expected CWT, multiplied by the demand rate when the stock level is increased by one unit. Mathematically, this product of demand rate and expected CWT is equivalent in definition to time-weighted expected back orders (EBO).

$$EBO = CWT * DDR$$
$$\text{Where } DDR = \text{Daily Demand Rate}$$

At its core then, COLT's objective of minimizing demand-weighted CWT is identical to the goal of readiness-based leveling: to minimize expected back orders.

Assumptions and Inputs

COLT, in its evaluation of expected CWT, makes a series of assumptions regarding the behavior of consumable items. First, the demand during lead time is assumed to be distributed as a negative binomial random variable, as opposed to the more commonly used Poisson distribution. A study by Deemer and Kruse offers evidence that justifies the use of the negative binomial distribution in lieu of the Poisson, particularly in cases where the variance of demand exceeds the mean.[5] Second, variance in lead-time demand is assumed to be a function of not only the demand variability but also the variability in the lead time itself.[6]

In addition to making some new assumptions about the population of items when setting stock levels, COLT considers three new factors. All three are provided by DLA and relate to the level of support it expects to provide to its retail customers. The first factor is the expected stockage effectiveness, an estimate by stock number, of the percentage of time DLA expects to have an item available when it is requested. This estimate is based on the wholesale stock level, historical demand rates for the item, and expected resupply times. Second, DLA provides a historical average of the amount of time Air Force customers have had to wait for each part when back ordered, called the conditional delay. Last, DLA indicates the location where each item is stocked. Many items are stored onsite at the air logistics center, and in other cases, parts are stored at central inventory control points. Items stored onsite are assumed to have a shorter shipping time than those that must be delivered from offsite locations. Together, these three factors are used to compute the expected wholesale delay time or pipeline time. For the first time in the history of Air Force consumable support, the model that sets stock levels accounts for the fact each item receives a different level of performance from the wholesaler.

COLT uses these assumptions and factors in conjunction with the demand rates and unit prices from the ALC stock control system, D035K, to compute a *bang per buck* for each stock number. It then allocates a set inventory investment to minimize the expected CWT across all consumable items at the depot. At the completion of a run, COLT outputs a flat text file of level-change transactions fed into D035K to put the new stock levels into effect.

Essentially, COLT's approach identifies those parts that have good expected wholesale support, so their retail stock levels can be decreased without appreciably impacting the support felt by the maintenance customer. The savings from the reduction in these healthy retail stock levels are then reinvested in other items that yield a better overall return on the dollar in terms of CWT. In short, COLT reallocates levels so the right parts are ordered at the right times. This approach has a dramatic effect on customer support, as shown in Figure 1.

The triangle in the figure shows the actual AFMC-wide CWT prior to implementation of COLT (fiscal year [FY] 2000), while the square below it shows the COLT estimate of CWT given the stock levels at that time. A comparison between the FY00 CWT and the COLT-generated cost curve shows the effects of reallocating the stock levels using a marginal approach. With the same level of funding, the CWT could potentially be reduced from 10.89 days to about 1 day. In the real world, of course, the actual CWT would probably be slightly higher than the estimate. Still, even a CWT of 2 days would represent a reduction of nearly 82 percent or about 9 days per request. Similarly, the FY00 CWT of 10.89 days could be achieved with less than $30M in inventory, less than half the level at that time.

Setting Affordable Levels: A Paradigm Shift

There were two key challenges that had to be overcome during the sale and implementation of COLT. The first hurdle had nothing to do with the level-setting algorithm and everything to do with how much money the model was told to allocate. Prior to this new approach, D035K set stock levels for consumable parts independent of the General Support Division (GSD) budget. Oftentimes the result, as the air logistics centers approached the end of a fiscal year, was the discovery that the current rate of obligating funds could not be supported and some requisitions would have to be suppressed until the next fiscal year. In some cases, this merely delayed some stock replenishment. In many, however, parts needed immediately for repairs could not be ordered until the following year's funds became available.

In COLT, the integrated product team decided to take a different approach by only setting affordable stock levels. Simply stated, the model only allocates the available money in the General Support Division when it sets stock levels. The model is run at least quarterly, often monthly, to capture deviations from the expected rate of obligation. An obligation is the money used by the air logistics center to buy assets from DLA. When actual obligations exceed expectations, COLT decreases some stock levels to slow the future *burn rate*. A decreased level will result in the sale of an asset to the customer that does not have to be resupplied—no obligation. When the actual obligations come in under expectations, the model conversely increases stock levels, building additional inventory with the remaining obligation authority to further lower the expected CWT. The one caveat in the latter case is that COLT also ensures the allowed ratio of obligations to sales, or unit cost target, is met, which keeps the size of the inventory from growing out of control.

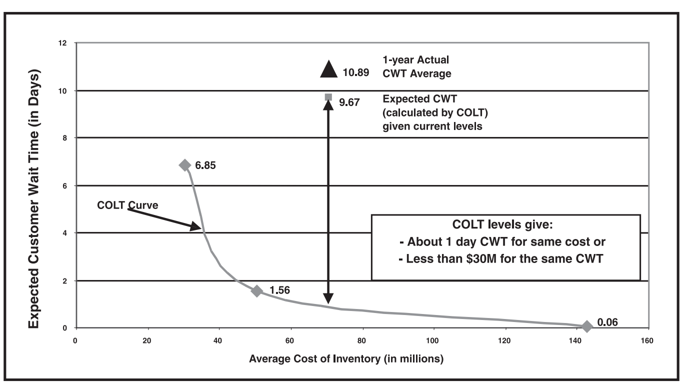


Figure 1. Effects of Inventory Investment on Customer Wait Time

The concept of only setting affordable levels is a significant departure from past practices but helps COLT maximize support to the customers. As stated in the previous paragraph, when COLT perceives that the current rate of obligations will overextend the budget, it decreases stock levels to get on track. This action prevents obligation authority from being used for stock replenishment that could be better used to minimize potential work stoppages due to the lack of needed consumable parts.

New Metric: CWT

The second hurdle to implementation of the model dealt with the metrics used to evaluate its success. To this point, the traditional supply metrics of issue effectiveness (IE) and stockage effectiveness have not been mentioned. Instead, we have focused on CWT. This point proved to be a major stumbling block for the decisionmakers at the air logistics centers, whose assessments are based, in part, on these traditional measures.

Issue effectiveness, by definition, is nothing more than a measure of the percentage of time depot supply has a part immediately available when it is requested by depot maintenance. The Integrated Product Team contended that this measure does not provide an accurate representation of depot supply's performance because it neglects to account for the duration of resulting back orders. To illustrate this point, it is useful to look at a simple example. Suppose we have a part for which, over its last ten requisitions, the assets were available in eight cases and the remaining two were back ordered. Issue effectiveness during this time was 80 percent. For the two back orders, let us assume that it took 10 days to get each from DLA. Now suppose, over the next ten requisitions, again, the assets were only available in eight cases so issue effectiveness remains at 80 percent. The difference in this case, however, is that, instead of taking 10 days to get the back-ordered assets, it now took 20 days each. Clearly, support has gotten worse on this part, but looking at issue effectiveness alone does not alert us that anything is wrong. In fact, from July 1999 to March 2001, the total number of AFMC back orders was reduced by 32 percent by focusing on issue effectiveness, while the total not-mission capable-supply rate remained relatively constant at about 12.9 percent (Figure 2). Clearly, focusing on issue effectiveness was not having the desired impact on the bottom line.

CWT, as defined by the integrated product team, takes care of this problem, without losing the information contained in the IE metric. All items immediately available are given a CWT of zero, and the back-order days are captured for all parts that have to be ordered. Thus, the equation for CWT looks like this:

$$CWT = [IE * 0 \text{ days}] + [(1 - IE) * (\# \text{ back-order days})]$$

Returning to our example, CWT over the first ten requisitions is:

*CWT = [80% * 0 days] + [20% * 10 days] = 2 days*

And over the second set of 10 requisitions:

*CWT = [80% * 0 days] + [20% * 20 days] = 4 days*

CWT alerts us something is wrong, while issue effectiveness alone misses the mark. Similarly, if the days on back order remain the same as CWT gets worse, we can infer that the percentage of immediate issues must be going down.

Alternate Applications

So far, we have discussed only the use of COLT from the perspective of setting retail stock levels for DLA-managed consumable parts, but there are two other key applications of the model that add value to the new approach—budgeting and allocation.

For the first time in the consumable parts arena, requests for additional funds can be justified using the COLT model. Specifically, the model indicates the expected level of support that will result from the current level of funding and quantifies the support improvements possible with additional funding. For example, an extra $3M in obligation authority will decrease the expected CWT by 30 percent. This ability to quantify the impact of additional GSD obligation authority, coupled with the success the model already has experienced, has made COLT an important tool in the budgeting process.

The next step, after money has been approved for the budget, is to determine how that money should be allocated to the air logistics centers. Historically, this step has been accomplished by looking at the past volume of work done by each air logistics center. COLT now optimally allocates these funds to minimize the expected CWT across the command, rather than just locally at each air logistics center.

Implementation Results

COLT was implemented across AFMC at the beginning of FY02 with CWT as the primary measure of success. Since that time, the average CWT across AFMC has decreased by 65 percent, from about 6.9 days to less than 2.5 days. Over the same time, issue effectiveness has fluctuated, but CWT has shown a constant improvement.

COLT has also spread the levels more equitably, as mentioned in the previous section. Prior to implementation, the CWT at each of the three air logistics centers was drastically different. Performance at the Oklahoma City ALC was more than twice as strong as that of the Ogden ALC, and the Warner Robins ALC was even worse off than Ogden. Since implementation, performance has improved at all three, but the latter two have improved by a larger percentage. As a result, all three air logistics centers now have about the same expected CWT, less than 3 days on average. COLT achieved this by redistributing some of the funds from Oklahoma City to the air logistics centers that were hurting, at the same time improving the support at the Oklahoma City ALC, albeit by a smaller amount.

To date, COLT has been implemented only for depot consumables within AFMC, but the system is currently being tested for use in base-level supply by the Air Combat Command and Air Education and Training Command. Assuming the results are as encouraging as those at the depots, we may one day use COLT, or a system like it, for all Air Force consumable levels.

Conclusion

Improving consumable-item support has been a hot topic for many years. COLT was not the first model to deliver an improvement, and it will certainly not be the last. It is simply the next step in the evolution.

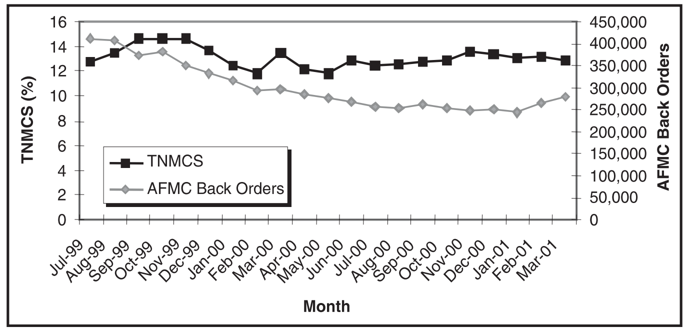
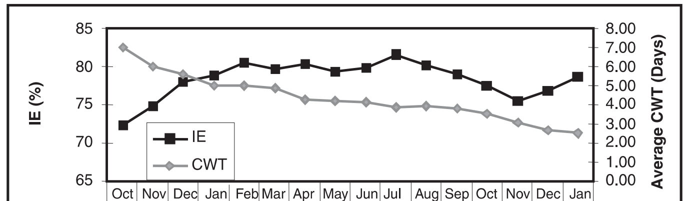


Figure 2. Comparison of AFMC Back Orders and Fleetwide TNMCS Supply Rates—July 1999 through March 2001



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
IE	72	75	78	79	81	80	80	79	80	82	80	79	77	76	77	79
CWT	6.9	5.9	5.5	4.9	4.9	4.8	4.3	4.1	4.1	3.8	3.9	3.7	3.5	3.0	2.6	2.4

Month

Figure 3. Comparison of AFMC Issue Effectiveness and CWT—October 2001 through January 2003

COLT has been an amazing success story for AFMC in the area of improving consumable parts support to the air logistics centers—an area that accounts for a relatively small percentage of the Air Force spare parts budget but can have an enormous impact on the ALCs' ability to get airplanes through PDM and repair end items for use in the field. COLT uses a marginal analysis technique to minimize the CWT for consumable spare parts and has achieved a 65-percent reduction in CWT across AFMC since implementation in October 2001. In addition, the tool has been used to generate optimal and defendable funding allocations across the air logistics centers, as well as justify the need for additional funding needed to deliver a continuous high level of warfighter support, such as in the case of depot surge operations in support of the war on terrorism.

COLT uses information about DLA support that is readily available, coupled with the new goal of minimizing CWT, to make smarter decisions about how the Air Force spends its limited GSD budget. These decisions have literally reshaped the entire consumable inventory to more efficiently buffer the level of support depot supply is able to deliver to its depot maintenance customers. It would obviously be great to have all the parts in the world available 100 percent of the time. But in the real world, COLT makes the tough decisions that minimize the amount of back-order time mechanics spend waiting for parts.

Notes

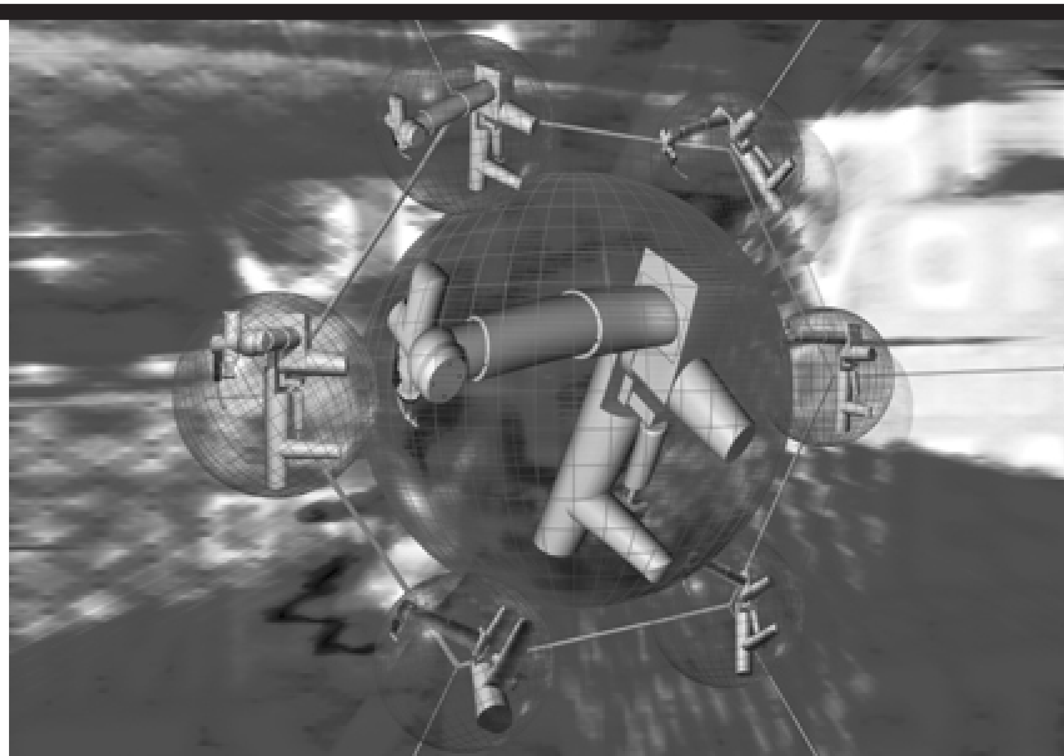
1. Ron Corbett, AWP Metrics presentation, AFMC/LGIL, Apr 02.
2. Kieren Keelty, "Supply Chain Management Constraints Analysis Program Update," AFMC Briefing, Sep 00.
3. Kevin Gaudette, Doug Blazer, and H. Kenneth Alcorn, "Management of Air Force Depot Consumables: A Brief History and Taxonomy," Under review, *Air Force Journal of Logistics*.

(Continued on page 46)

A part grouping system, however, effectively leverages a supply chain by arranging the production of individual items into groups that are based on common manufacturing processes.

Part Grouping

Angioplasty for the Supply Chain



Colonel Michael C. Yusi, USAF

Hey, *loggie* warfighter, your aged weapon systems are full of *tired iron*, you have diminishing manufacturing sources for mission critical spare parts, your industrial base is getting colder, and lead times are getting longer each day. Logistically, you have hardening of the arteries: no agility, no flexibility, and no options right? Well, there is angioplasty for your supply chain. This article analyzes how a supply chain part grouping system mitigates these types of problems and reopens supply chain blood flow for improved health. It defines this system, describes how this process begins, explains how rigor is put back into a cool industrial base, demonstrates how it smooths variations in demands and decreases production lead times, and shows how it improves availability and lowers costs of critical parts for end users. Examples from the Defense Logistics Agency (DLA) are used to elaborate some points even further. Finally, results of a part grouping concept demonstration between the Boeing Company and DLA are highlighted and reviewed.

Part Grouping Definition

A part grouping system relates to the idea of group technology (GT) but has a slightly different approach. Thomas E. Potok, Collaborative Technologies Research Center, Oak Ridge National Laboratory, states manufacturers view group technology "batching parts to take advantage of economies of scale," which usually will "be produced on a single manufacturing floor."[1] A part grouping system, however, effectively leverages a supply chain by "arranging the production of individual items into groups that are based on common manufacturing processes,"[2] as well as similar part materials or vendor capabilities. In addition, it is not fixed to just one manufacturing line or vendor. Instead, it takes advantage of using different vendors with processes and capabilities that can be applied to producing a group of parts. In a macroillustration, a part grouping system considers things like processing methods, steps, lines, and production capacities needed to make a group of parts. It considers similarity of part materials (metal, rubber, and carbon-fiber) and if the parts are in some type of general *family* such as machined, structural, or sheet metal. Continuing even further, if it is machined or has structural parts using similar types of materials, it considers things such as general form, shape, gauge thickness, and number of welding points these parts have. It considers the cost to make these parts per unit of measure, such as a range between $x.xx → $x.xx per foot. The point here is the variety of grouping options based on common manufacturing processes includes a wide number of factors. Expressed this way, a supplier who manages a variety of parts for many customers and missions achieves supply chain leverage using a part grouping system by partnering with a broad number of manufacturers possessing a range of capabilities with links to common manufacturing processes. This ensures greater depth and breadth of parts for the supplier when needed. This is in lieu of a supplier's depending (or

Agile Combat Support

being victim) on a few vendors or a single vendor with fixed capability making only one part. Another real possibility for a supplier is having no vendor available at all. This kind of scenario adversely impacts the mission capability of a customer's weapon system needing a *zero-balance* 35-five cent widget, grounding a fleet of F-16 jets or M1A1 Abrams tanks. With this in mind, improved supply chain agility, flexibility, and vigor (blood flow) using a part grouping system are possible.

Beginning the Supply Chain Angioplasty Process

Starting a part grouping system is the tough part; it is like *intrusive surgery*. It involves a supplier's collecting, organizing, and sharing large amounts of information on parts it manages and customers it supports to team with interested manufacturer and vendor groups. An interested manufacturer, in turn, must take the supplier data and assess its production base to link common manufacturing processes to part characteristics to determine what supply chain improvements it can offer in a part grouping system. This is much easier said than done; however, it is needed to pave a way through the supply chain arterial system for the supplier to get the high-ratio manufacturer partnerships to achieve part grouping system payoffs. For example, the DLA (as a supplier) provides Class IX spare parts for all military services. This includes managing more than 2.6 million national stock numbers (NSN) coded to more than 1,368 aerospace, land, and maritime weapon systems for the Air Force, Navy, Army, and Marine Corps.[3] This sheer number of NSNs, along with the range of warfighter customers and weapon systems supported, as well as the large number of manufacturers currently working with the DLA, makes starting a task daunting. This startup difficulty, however, can be mitigated for supplier and manufacturer. How? Well, they can decide to narrow the initial part grouping target based on a specific range of weapon systems or end items such as tracked armored vehicles, jet aircraft, instruments, or electrical systems. By doing so, focused leverage can be placed on certain weapon systems, which not only gets the process started but also can include the interests expressed by supply chain customers.

Certainly, a feasible startup process greatly benefits from a method or tool to help the potential manufacturer and supplier (willing to move into a part grouping arrangement) integrate necessary information with each other. Necessary information from the supplier includes basic things such as part nomenclature, part numbers, form, fit, function applications, past and present part manufacturer, monthly, quarterly, and annual customer demands, cost to procure, and current production lead times. Necessary information from the manufacturer includes basic things like part process characteristics (4 or 5-axis mill, turning, stamping), part family characteristics (wiring, sheet metal, tubing), producer qualifications, standard bill of materials, as well as administrative data such as production planning and quality control inspection steps.

An example of one prototype tool that can begin the angioplasty process is the Supplier Utilization Through Responsive Grouped Enterprises Part Grouping Tool. This decision support tool from DLA allows manufacturers to input indicative process data from their end and use them to bump against the indicative parts data managed by DLA into a broad range of grouped combinations consisting of simple → specialized → complex parts. Utilizing such a tool, both supplier and manufacturer can begin looking at part grouping options for consideration in a supply chain partnership. The tool can also weight part characteristics or the priority of processing stages to help manufacturers filter processing commonalities and fine tune initial group options even further.[4] Working in this manner, a variety of capabilities to facilitate the part grouping supply chain partnership are derived and ultimately begin opening the blood flow of the supply chain.

Putting Rigor Back into the Industrial Base

Edward Aldridge, Jr, Under Secretary of Defense for Acquisition, Technology, and Logistics, said, "If we are to deliver the best quality weapon systems for warfighting, then it's got to come from an industry that is competitive and innovative and healthy."[5] For a large military supplier like DLA, expanding its supply chain strategy for nearly 3 million weapon system spare parts from individual contracts to a part grouping system has potential for manufacturers (including second and third-tier business subsidiaries) to team and make a broader range of items, getting into more business markets. By doing so, these manufacturers share new markets not available for them individually, as well as profits that come with these markets. It is mutually beneficial (for the supply chain) for the manufacturers to work in a part grouping system, which also benefits the supplier partner, such as the DLA, in terms of having more part sources available to support its military service customers and aging weapon systems. John A. Tirpak said, "Today, over 41% of the USAF aircraft inventory is more than 24 years old" and also noted the B-52H is "almost 40 years old."[6] Not-mission-capable-supply cause-code *A*, first-time demands for Air Force weapon system spare parts are as high as 37-40 percent.[7] In a supply chain environment with weapon systems exceeding life-cycles and consuming more nonmarket ready parts, a part grouping system is a *win win* for participants.

By working in a part grouping system, a small business (that may depend entirely on a defense contract) struggling with cash-flow, since it produces only a few items with low demand density, has an opportunity to broaden its production of items; increase its density of demand; and subsequently, increase its cash-flow. This makes even further sense if this low demand density company has additional production capacity it is not able to fully optimize because of its limited business profile; therefore, risk of entering into a more dynamic part grouping system is even less compared to the potential payoffs in profits. In addition, by leveraging common manufacturing processes through multiple manufacturers, smaller businesses that have some additional and unique manufacturing capability critical to the Department of Defense (DoD) have opportunities to break into and thrive in a competitive supply chain. This is in lieu of just getting by because of their previously limited market share. Peter J. Higgins, a logistics management specialist at the Army Logistics Management College states, "As a result of fewer and smaller DoD contracts, some vital production capabilities unique to the defense industry are in jeopardy. For corporations to remain viable, their individual components must be profitable, or they will be shut down."[8] A part grouping system sweetens the business pot for a supply chain to have more diverse manufacturers, keeps special capabilities that may be unique to support aged weapon systems alive and well, provides more reliable sources of supply for the supplier, and puts vigor back into a cool industrial base.

In 1999, the Pentagon chartered the Defense Science Board (DSB) to look at the health of the defense industrial base. The

DSB task force stated, “Unless action is taken soon, the US defense industry will likely be less competitive and financially viable in 5-10 years.”[9] One of the recommendations from the DSB was to structure DoD programs to preserve a competitive industrial base.[10] With a $15.2B (in annual sales) supplier like DLA, cash incentives and broader opportunities, using a part grouping system, become exponential and can strategically influence and preserve the industrial base from a national perspective.[11] As a result, hardening of the supply chain arteries can be slowed, stopped, or even reversed.

Smoothing Demand Variability and Reducing Production Lead Times

Figures 1 and 2 show the difference in demand variability between parts managed individually versus by part grouping system.[12]

Why is this important? For a manufacturer, more demand variability with individually managed items (Figure 1) means more opportunity to be in an out-of-stock position if demands unexpectedly spike or if interruptions occur. This is because demand variability is tough to anticipate in a highly dynamic supply chain environment, such as what exists today with aging weapon systems incurring more first time demands for spare parts exceeding life-cycles. So if a manufacturer is managing parts individually, it can attempt to mitigate demand spikes by carrying more inventory, holding reserve production capacity to meet needs as they occur, or producing parts with more shift work (if possible) when demands increase. If it is not able or is unwilling to do any of these actions, a supplier and its customers are immediately a production lead time (PLT) away from getting the part needed once inventory echelons are consumed. This cannot be overstated since PLT, especially for aviation weapon system spares, can average from 6 to 8 or easily exceed a year.[13] The bottom line is a supply chain equation not conducive to agile support in the warfighting business: Nonagile Combat Support (***fx***)[↑manufacturer demand variability] * [↑PLT] * [↑deferred deliveries to the supplier] * [↑passed on costs] * [↑customer back orders]. Results of this kind of algorithm stifle mission capability for warfighters. For a large supplier like DLA, this situation may occur frequently since it supports highly dynamic customers (military services) subject to no-notice and high operations tempo missions. This drives unexpected demand variability into its supply chain, attempting to support more than 1,350 weapon systems.

On the other hand, smoothing demand variability through a part grouping system (Figure 2) between supplier and manufacturer allows better production planning from the very start across broad groups of items instead of just piecemeal. In this type supply chain, more demand predictability is gained, and production efficiency is achieved based on this predictability. This production efficiency in a dynamic supply chain results in optimum production capacity utilization and reduces PLT since items are produced with less impact because of demand spikes or interruptions. The bottom line is a supply chain equation that is conducive to agile support in the warfighting business: Agile Combat Support (***fx***)[↓ manufacturer demand variability] * [↓PLT] * [↑steady deliveries to supplier] * [↓inventory costs] * [↓customer back orders]. Results of this kind of algorithm are enhanced mission capability for warfighters. In addition, the more done across a broad part grouping supply chain, the more strategic leverage in efficiencies is achieved.

After 11 September 2001, John Rapp, senior vice president of operations for the US Postal Service stated, “Every organization with a supply chain should have contingency plans that help deal with demand surges and interruptions.”[14] The part grouping supply chain can actually build in contingency planning by systemically smoothing demand surges or interruptions created by unplanned operations tempo increases in weapon system flying hours, steam time, or tank miles. In doing so, it creates inherent production efficiencies and reduces PLT overall. This is not unlike smoothing blood flow with angioplasty, improving efficiency of the cardiovascular system, and reducing high blood-pressure levels.

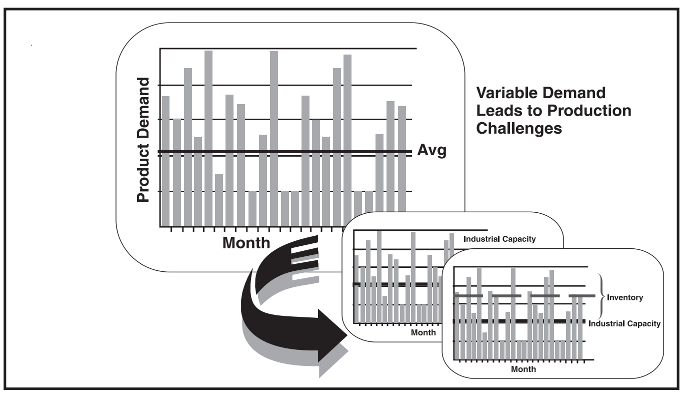


Figure 1. Variable Demand

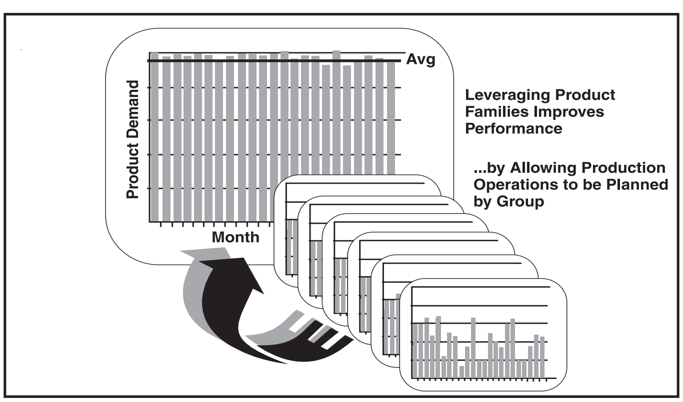


Figure 2. Leveraging Product Families

Improve Parts Availability and Lower Costs

With improved production efficiency and subsequent reduction in PLT, availability of parts (to include previously hard-to-get parts for aged weapon systems), across a broad part grouping system, remains consistently higher. By doing so, it lowers the need for the supplier and manufacturer to maintain higher inventories of safety level stocks, lowering holding costs on their end of the supply chain. There are less out-of-stock opportunities since part throughput is more assured, given optimization using common manufacturing processes among supply chain partners. Also, with higher efficiencies lowering PLT, the unit cost of parts is sustained and even reduced. Why? Less production schedule disruptions mean overall reduction in queue time buildup. With this achieved, materiel production setup times are economized because of efficiencies gained within the common processes used. This drives reduction in machine and production floor setup changes, leading to more efficient use of shift work and less overtime needs, especially during periods of unplanned demand spikes. Overall, the effectiveness in improved parts availability, cost savings achieved with lower holding costs based on less buffer stocks, and lower unit costs because of production efficiencies can be passed on to an end user such as the warfighter. The patient begins to experience the benefits of the angioplasty procedure and is back on the road to good health.

Part Grouping Concept Demonstration Results

A part grouping concept demonstration between DLA and Boeing provides an opportunity to study some results.[15] DLA entered into a part grouping supply chain arrangement in 1999 with Boeing to improve its support for spare parts that were low demand density with long PLT. Typically for DLA, these are aircraft weapon system parts. With this premise, Boeing initiated work on its end, focusing on three weapon systems used by the Air Force, Navy, and Marine Corps as a first phase test. These were the F-15 Eagle, F/A-18 Hornet, and AV-8B Harrier II. As part of this new part grouping partnership, DLA provided Boeing a large amount of indicative data on the spare parts coded to systems it managed. Boeing, in turn, studied its manufacturing processes strategically for these weapon systems based on parts families such as wire bundles, sheet metal, machined parts, and tubing.[16] The next steps, as described earlier, were the most demanding. The first cut for these three platforms totaled approximately 340,000 items. From this, Boeing assessed its own manufacturing and associated second- and third-tier vendor bases for common process capabilities. Then, it linked this to the parts data it possessed and data provided by DLA to focus down to a reasonable number for testing in a grouping system. By doing so, Boeing brought the group of items down considerably, to approximately 3,500 total.[17] Next, it calculated the probable demands of these individual items (based on historical demand requirements as provided by DLA indicative data) to optimize smoothing demand variability for the overall group being considered. It also needed to ensure production capacity for the group was executable from the participating vendor base. Concurrent with all this, Boeing needed to assess, interest, and work with its target vendor base to ensure the quality and feedback to give this innovative part grouping system a good opportunity to perform as envisioned. It found, for example, that it should allow its vendors to submit bids on portions of groupings that best fit their particular processing niche instead of attempting to get an all-inclusive grouping solution. Doing this, Boeing actually ensured a wider competitive base for vendors that could be expanded into a larger part grouping system in the future.[18] This also was a good method to mitigate associated risk for interested vendors because it provided a way to increase its cash-flow without jeopardizing product quality or stretching beyond production capacities, as was mentioned earlier.

The first deliverable of this part grouping system between DLA and Boeing was provided in 2001 and showed positive results. For example, under the category of tubing manufacturing processes, a part group of 84 hydraulic tubes supporting the F-15, F/A-18, and AV-8B realized an overall reduction in PLT of 60 percent, from 345 to 141 days. Overall price reduction across the group was from 8 to 10 percent. Results of specific items within this group were even more impressive. For example, the hydraulic tube shown in Figure 3 and used on the three subject weapon systems had an original PLT of 508 days. Under the DLA and Boeing part grouping supply chain, PLT was reduced by 75 percent to 129 days.[19]

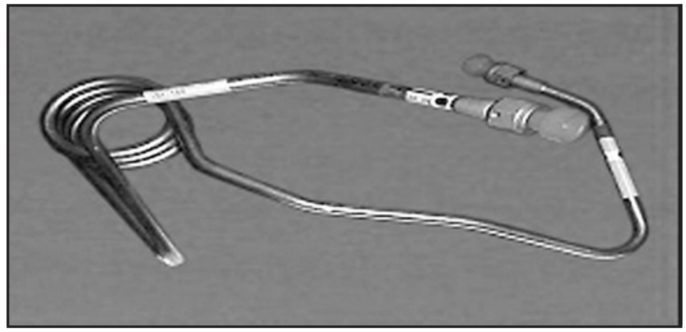


Figure 3. Hydraulic Tube

The unit cost of this item was also reduced by 30 percent. Over this same period, the efficiencies gained by this part group were able to mitigate an unanticipated spike in demands of 1,000 percent and still deliver to the new PLTs without any increase in cost.[20] Another benefit from this part grouping supply chain partnership was a huge reduction in supplier (DLA) back orders. The rate of back orders for items prior to the concept demonstration was about 38 percent overall. Even with the unanticipated spike in demands during this period under the part grouping system, back orders steadily decreased to about 7 percent overall. What this means is part availability remained consistently high to mitigate increased demands; with the added value of lower PLTs dropping (in aggregate) 60 percent, any newly established back orders now took 204 days less to deliver than it originally did when the parts were individually managed. For the example cited in Figure 3, any newly established back order now took 379 days less to deliver; this is a remarkable 1-year improvement for a critical weapon system part. Other direct benefits to DLA based on this part grouping supply chain were in its F-15 Virtual Prime Vendor[21] support contract, with more assured direct vendor deliveries for those parts included in the part grouping concept demonstration. In fact, any procurement method such as corporate, long-term, and prime vendor contracts would benefit if its line items touch this part grouping arrangement.

What other improvements can be potentially envisioned and realized? Some examples could be a reduction in part cannibalization actions, less working capital fund surcharge fluctuations because of lower cost recovery rates, improved scheduled maintenance (operational and depot) based on more precise time-definite deliveries, and increased operational readiness based on reductions in not-mission-capable-supply and maintenance rates. In the context of strategically improving the health of the supply chain for the benefit of the patient (customer), the results seen in this part grouping concept demonstration hold excellent promise.

Conclusion

Reopening supply chain blood flow using *part grouping angioplasty* is colloquially expressed. It can, however, mitigate problems by putting rigor back into a cold industrial base, smoothing variations in part demands, reducing long production lead times, improving availability, and lowering costs of critical weapon system parts. Although much effort is required to enter into this type process, demonstrable improvement in agility of supplier and manufacturer supply chain partnerships can be

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Logistics is as crucial to the mission as the operator is to the weapon system.

Agile Combat Support and the Logistics Officer

Career Progression

Lieutenant Colonel Penny H. Bailey, USAF

Logistics is not inherently glamorous.[1] Commercials, promotions, movies, and so on are not made about logistics; they are made about the fighter pilot in a state-of-the-art aircraft, dropping bombs on target. However, logistics is an absolute necessity for the success of any military mission. Picture the fighter pilot without logistics. The pilot is sitting on the runway in a beautiful new jet with the best technology available. However, the pilot cannot get off the ground because there is no fuel to fly, no oxygen to breathe, no hydraulic fluid for the aircraft, and no munitions to drop—these are supplied through the logistics system. But before we can even get to this point, the flight suit and helmet the pilot is wearing are all part of the supply system, which is a part of logistics; therefore, those items are not available either. Wait, did I say the pilot was in a beautiful, high-tech aircraft? That is not possible either, because research and development, contracting, and acquisition officers, all part of the logistics group, are the ones who worked tirelessly in acquiring the state-of-the-art aircraft, so the pilot does not even have an airplane to fly. Additionally, the runway the pilot is now standing on is not possible either, because the civil engineers developed and built it, and they are part of the logistics career field as well. Now, we have a highly trained and well-paid pilot standing alone in an empty field. So how is the commercial or movie possible without the logistics officer? It is not. Though it may not be glamorous, logistics is as crucial to the mission as the operator is to the weapon system.

Though not glamorous, logistics is vital to America's defense, and it is the foundation of combat power.[2] Lessons from previous conflicts have shown this to be true for any military conflict. Therefore, this article includes a review of logistics and training for the logistics officer and a short discussion of probable future conflicts.

History

If one studies history, it becomes obvious lessons concerning logistics have been learned and relearned. As far back as Sun Tzu, the importance of sustaining an army has been stressed. In his work *On War*, Sun Tzu states, "An army which lacks heavy equipment, fodder, food, and stores will be lost."[3] This is logistics; it ensures the right equipment and supplies are at the right place at the right time. Logistics allows the warfighters to accomplish their jobs and win the war. However, in the Vietnam War, once again, America's forces had to relearn the significance of logistics. One example occurred in the first months of the conflict, when the 173d Airborne Brigade received *push* packages that had been developed and tailored based on World War II and the Korean conflict. When the troops arrived at the Tan Son Nhut Airport to secure the area, they found they were using ammunition at a faster rate than the packages were designed to support. Additionally, some of the ammunition was for weapon systems that had been retired from the inventory. Emergency requisitions were made and received for more than 225 tons of ammunition before

Agile Combat Support

the airport could be secured. The operation used every transport aircraft available in the theater for 7 days.[4]

Again, in the Gulf War, America found itself putting *tooth before tail* (operations before logistics). It took Iraqi forces less than 24 hours to secure their invasion of Kuwait. The world was uncertain whether Iraq would stop at Kuwait or try to move into Saudi Arabia. America immediately sent the warfighter overseas but sent no logistics support or sustainment cargo. Fortunately, Iraq did not progress into Saudi Arabia, and the commander of Central Command, General Norman H. Schwarzkopf, who had studied military history, knew the significance of logistics. He was afforded the luxury of almost 6 months in which to build up logistical support, and large quantities of supplies and equipment were sent to the Middle East prior to taking any further military action.[5]

However, America's more recent conflicts have not been on a large scale. And it is this type of conflict for which the Air Force needs to prepare. America has entered a time of change—in adversaries, force structure, force projection, and technology. To adjust to these changes, Joint Vision 2020 highlights five operational concepts with *Focused Logistics* being one of them. The Air Force has responded to *Focused Logistics* with Agile Combat Support (ACS), which establishes the role of logistics and combat support. Agile Combat Support will redesign the Air Force's support system into a more mobile, technologically superior, robust, responsive, flexible system, fully integrated with operations.[6]

Operations like those in Panama, Grenada, Bosnia, and Afghanistan are examples of agile combat. These are seemingly smaller, in-and-out operations that cannot afford a large logistics footprint or a long lead time for buildup. Who is going to engineer new logistics support for agile combat? Who needs to be properly trained to develop plans in support of this new type of conflict? Who will be expected to ensure the right equipment is at the right place, at the right time, in sufficient quantities? Of course, it will be the logistics officer. But how are the logistics officers going to be able to do this? Other than initial training in their functional area, there is no further logistics training, no broad logistical instruction.

Logistics Careers

To understand what logistics officers can provide to the warfighting commander, a detailed look should be made of the specific career fields. The Air Force has combined a number of careers into one area called operations support, sometimes referred to as mission support. In this area, there are 17 career fields. There is the *Officer Career Path Guide* for each career field available online at the Officer Assignments Web page.[7] This guide is supposed to provide specific information of what is expected of the Air Force officer in each career field and what the officers can expect to accomplish in their career. Figure 1 provides this information in an easy-to-read and comparative format.

The career fields are listed on the left in the figure. The competencies found in the *Career Path Guide* are listed across the top. The figures in the blocks are the number of times competency was mentioned as a requirement for that career field. The Opportunity/Goal on the far right is what the guide mentions as a possible position or the highest level one can attain at the end of a career. However, further research showed there are some positions the officer can attain, which were not mentioned in the *Career Path Guide*. These opportunities or jobs are indicated in parentheses. Also, I have provided the present rank of the officer in the highest position mentioned.

After reviewing the information, it is interesting to note the overwhelming requirement is for the officer to have a depth of knowledge—to know a significant amount of technical information. The second most desirable competency is breadth of knowledge—knowing other areas within a specific career field. Experience or ability, the ability to apply technical knowledge to a specific job, came in as the third most desirable competency. It is significant to note the breadth of knowledge referred to in the *Career Path Guide* was not usually a breadth of logistics knowledge but a broad knowledge of the officer's functional career field. For example, in supply, it was recommended that the officer be assigned to the various branches within supply to get a breadth of knowledge. However, each career path did mention one assignment into one of the accession areas, such as the Reserve Officer Training Corps or Officer Training School, would provide the officer a breadth of experience.

What is disappointing is that leadership, management, and decisionmaking are mentioned very little in the *Career Path Guide* as requirements for the officer. Ironically, though depth and technical knowledge are at the top of the requirements list, training is either barely mentioned or not mentioned at all. This could be because the career managers expect officers will attend initial training schools. However, becoming as proficient as the Air Force indicates it wants and needs logisticians to be requires more than a few weeks of school at the beginning of a career. Additionally, preparing for agile combat is going to require specialized training for this new type of support.

As seen in the figure, almost anyone who does not operate a weapon system or maintain it is clumped into logistics and will be a group within a wing. With these vast areas of responsibility, having a depth of knowledge in all 17 areas is next to impossible, and it will not provide the Air Force the ACS officer needed for future engagements.

Additionally, career progression for most logistics officers is limited at best and is nonexistent in some of the logistical career fields. This comes from the desire to transform the strongest military in the world into a corporation. Whereas this is a topic for another day, making the military reflect corporate America is the answer to budget constraints, but it is not the right answer to keeping America militarily strong. The Air Force must have well-trained and experienced logistics officers at every level. It has often been said, "There is no substitute for experience." This is true for logistics officers as well. The only way to ensure America's security in the future is to train the warfighter and put that same focus on the logistician.

The logistics officer must be experienced and well trained; there must be a progression for the logistics officer that teaches through experience as well as the classroom. This progression will ensure the right person is at the right location to make the right decisions, and these decisions will be based on the best teacher in the world—experience. For example, through proper training and assignments, the senior logistics officer would be at the Joint or Air Staff level directing what, where, how, and when to send people, equipment, and supplies in support of the warfighter. The midlevel logistics officer would be on the front line or at forward operating locations, receiving supplies, people, and equipment; setting priorities; and ensuring proper distribution. The young logistics officer would be at the home base sending out items to the midlevel logistician, while gaining the knowledge and experience needed to move to the next level.

History has taught, time and again, that you can usually get the warfighter to a location, but without logistics, you cannot sustain the mission. If you cannot sustain the mission, you will

	Leadership	Depth/Tech Knowledge	Manage/ Decisionmaking	Training	Experience/ Ability	Breadth	Expert	Opportunity/ Goal
Log Plans	1	3	1	1	7	5	1	Installations and Logistics Dir—3 star
Supply	3	8	0	0	4	6	0	Dir of Supply—2 star
Mun & Missile MX	2	8	0	0	3	7	2	Wing CC—1 star
Transportation	2	6	0	0	4	5	0	Dir of Transportation—1 star
Acquisitions	3	9	0	0	4	5	0	Sys Prog Dir (Asst Sec AF for Acq)—3 star
Science & Research	3	10	0	0	4	6	0	**None provided**—No ideal path
Developmental Engineer	2	11	5	0	2	8	0	**None provided**—Recommend crossflow (AF CE)—2 star
Finance	4	7	0	0	3	6	0	Dep Asst Sec for Budget—2 star
Contracting	4	5	1	0	2	3	0	Dep Asst Sec for Contracting—1 star
Civil Engineer	0	7	0	0	2	3	0	CE of the AF—2 star
Communications	3	6	0	0	2	3	0	**None provided**—Senior Ldrshp (Dep Ch of Staff for AF Comm)—3 star
Personnel	8	7	1	0	3	3	0	MSS/CC—Colonel
Manpower	2	4	1	0	3	2	0	DCS for Personnel—3 star
Security	3	9	1	0	6	2	0	AF Security Dir—1 star
Office of Special Investigations	2	7	0	0	1	3	0	**None provided**—exceptional career
Public Affairs	3	7	0	0	5	4	0	Director of PA—1 star
Services	6	3	2	2	9	2	0	None provided—not only one career path

Table 1. Officer Career-Field Progression

not win. Experienced, well-trained, and committed logistics officers will provide the plans and support necessary to meet wartime requirements because they have made the greatest investment—their lives' work.

Future Requirements

As previously mentioned, the smaller in-and-out conflicts of the recent past are what can be expected for future combat, and those situations will require Agile Combat Support. Agile Combat Support will provide logistical support across the entire spectrum of operations. These forces must be light, lean, and lethal. The support for them must be scaled down to provide a smaller footprint, responsive to support sustainment and sufficient to fulfill requirements.[8]

But what exactly is Agile Combat Support? There are a number of publications that refer to agile combat and discuss the support necessary for this type mission. However, I developed a simplified definition by breaking down each word: agile—quick and light in movement; combat—a battle or skirmish; support—to sustain without giving way.[9] Therefore, Agile Combat Support, for the purpose of this article, is defined as "The quick and light movement of personnel, supplies, and equipment necessary to sustain military operations."

The movement of people, supplies, and equipment is obviously the first stage. This will require extraordinary planning because no one knows exactly what will be needed for each mission or where that mission might take place. Proper logistics planning will reduce the need for taking emergency measures, which are usually expensive and can have an adverse effect on the overall mission.[10] Therefore, it is essential for the logistics officer to be not only familiar with the equipment needed to sustain each weapon system but also aware of the transportation requirements for movement. General Henry H. Shelton, Chairman of the Joint Chiefs of Staff, acknowledged this when he stated, "The route of sustainment is the lifeblood of combat power."[11]

A look at common items would be a good place to start the planning process. For example, food and shelter are basic requirements for personnel, and fuel is usually a common necessity for equipment. Once a determination of common items is made, a good look at how these items are packaged would be beneficial. Is there a better way to package these items? Are there ways to lighten the load? These questions—and more—need to be asked, evaluated, and answered to ensure our present and future support is not packaged for the large masses from the Cold War mentality but for the *light and lean* conflicts of the future. It is the logistics officer who will be required to answer these questions.

So what is needed to support and plan for future agile combat—logistics officers who have received sufficient training and the experience necessary to allow them to properly plan and support these types of future conflicts. General John P. Jumper already has recognized this is necessary for the maintenance officer. And steps have been taken to ensure these officers are afforded every opportunity to learn and experience most, if not all, maintenance aspects so they can become knowledgeable leaders in their field.[12] This is a step in the right direction, but it must not stop there. Our senior leaders deserve to have the same confidence

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Agile Combat Support

Supporting the Fleet in the 21st Century

Evolutionary Acquisition and Logistics

Mike E. Farmer, PMP
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EA Challenges

The New Mentality—Reality-Based and Evolutionary Acquisition

The Air Force acquisition world has been turned upside down. The traditional, bureaucratic rules have been tossed aside, and a new *if it isn't against the law* mentality rode into town. Does this environment portend a return to the days of the Wild West and a scenario where every program does as it darn well pleases? Of course not. But, in a recent policy letter, Dr Marvin R. Sambur, Assistant Secretary of the Air Force, tried to instill a sense of urgency and innovation from the acquisition community with a battle cry for ushering in a new emphasis on Reality-Based Acquisition. Under his vision, there are two overarching goals: "to shorten acquisition cycle time and to gain credibility within and outside the acquisition community." Toward that end, a list of commander's intent statements accompanied these goals, the first of which stated, "Program managers will ensure full compliance with the law; however, overrestrictive implementation that goes beyond what is required in statute must be challenged." Dr Sambur's policy letter also prescribes Evolutionary Acquisition (EA) as the "preferred strategy for achieving the commander's intent."[1]

At its core, Evolutionary Acquisition is strategy based on the delivery of needed requirements by providing successive increments of increasing capability. Its bottom line is to shorten the acquisition cycle by incorporating mature, quickly garnered technologies to produce an initial capability, then increasing the system's capabilities in subsequent increments over time. It provides the warfighter an improved capability, at a much quicker pace. In addition, it enables the United States to continue striving for the best, in increments, without depending solely on aging systems and outmoded technologies while waiting for a quantum leap or *big bang* (Figure 1). The process that builds this capability within each increment is called spiral development. The overall goal is to decrease acquisition response time in a 4:1 ratio by delivering new warfighting capabilities in about 5 years.

Taken together, the incremental deliveries under an EA strategy, coupled with the spiral development process, are designed to deliver useful and supportable technology to the warfighter faster and more reliably than the traditional single-step-to-full-capability acquisition approach.

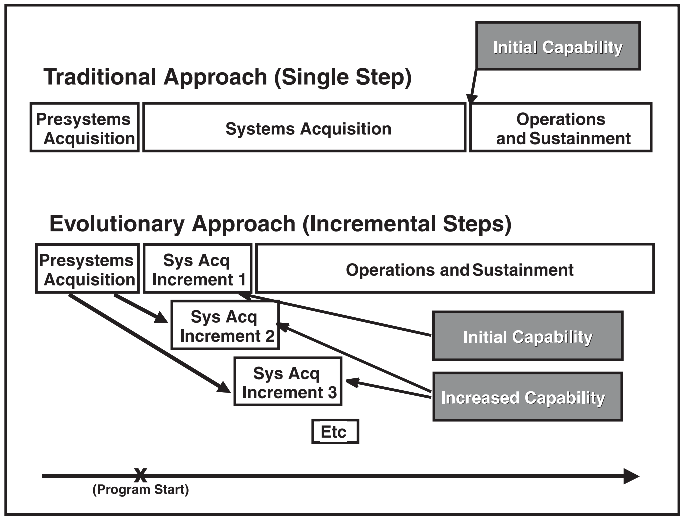

Figure 1. Traditional Versus Evolutionary Approach

Impact on the Support Community

Does this new mentality impact product support, logistics, and sustainment?[2] You bet. In some very important respects though, basic requirements are still the same for the sustainment community. Anytime a weapon system or product is delivered to the field, it must be fully supportable, as if it were the final delivery of the system. It does not matter if it was the result of a faster acquisition process. Nor does the fact it is being delivered in increments, rather than a full-up final version, change this dynamic. A weapon system delivered to the field without support capability is little more than a static display. Lieutenant General Michael Zettler reinforced this necessity during a panel session at a recent conference:

> I have no trouble with the program manager who is out there with a product put together to deliver a capability and to break a lot of paradigms along that path. I have a lot of trouble, though, when we just say throw out all the rules because I've got to make sure that what you field is supportable at Khandahar and Bagram and other places around the world like that. Or even at places like Seeb, where we've been operating a few years, or Prince Sultan Air Base. And it has got to be operated by a young man or woman with a high school education and 6 weeks of basic training, and 20 weeks of technical training, and 4 weeks of field training on that specific platform. And it has got to be worked. And he's got to have books to work it by. And he's got to understand it. And yes, we'll put some technical assistance out there in the form of contractor experts. And that's fine for platforms that are in very small numbers, but when you start to develop and field multiple systems and multiple squadrons of those systems, that's got to be supportable. It's got to work within the system. We've got to have the capability to have young men and women take care of it. And it's got to be reliable enough that the warfighter when he says go do it, it goes and does it.[3]

While some basic truths never change, Evolutionary Acquisition does, at the same time, pose major new and unique challenges for the support community. Planning can be more complex when attempting to support multiple increments, rather than one final delivery. The issues of configuration control and interoperability rise rapidly to the forefront of the planning effort, as incremental introduction of warfighting capability increases the chances of multiple versions of weapon systems being in use simultaneously. Proper planning should allow for a much more structured approach to configuration management, which should, in turn, mitigate the risks associated with multiple versions and interoperability. Ensuring full-up support capability is garnered more rapidly to match the quicker delivery of a weapon system operational capability is also among the most basic of those challenges. For these reasons, thorough logistics support planning and finely tuned, integrated, and coordinated support execution are even more important than in the past.

Taking on the Challenges of Evolutionary Acquisition

How does the support community approach and overcome these challenges? More specifically, what can the support planner do to ensure each increment can be immediately and fully supported, despite greater complexity? The bad news is there has been little official guidance offered to this point on supportability planning for Evolutionary Acquisition. The good news is that the lack of official guidance leaves plenty of room for innovation and flexibility. Further good news is that logisticians already have been preaching and practicing a basic framework for years, which can enable success, even in this changed acquisition environment.

Logisticians have always understood that up-front sustainer involvement enhances an acquisition program. When brought in early enough, support planners can offer design recommendations that ensure a weapon system is more easily supportable at a reduced total life-cycle cost. Unfortunately, in the pre-EA days, early and active sustainer involvement was not always a priority, as there often seemed to be more pressing needs. After all, in the old paradigm, the need to support the system was still many years away. Under EA's quicker delivery of systems, however, early sustainer involvement becomes imperative. If the weapon system is to be operated and supported sooner, then detailed support planning must be integrated with overall system planning at the earliest stages—even in the first initial capabilities documents and capabilities development documents developed by the warfighter.

To offer the best advice to the warfighter, the product support planners must keep attuned to the latest support concepts, technology advances, and availability. A good support planner will be aware of products already on the market or included in other weapon systems that can be integrated quickly to enhance the support of the proposed weapon system. They will also comprehend the status of logistics and product support research in the Air Force Research Laboratory, as well as the latest policy initiatives in Air Force Materiel Command, Air Staff, and Department of Defense (DoD) logistics. Based on this knowledge, the support planner must be able to provide the warfighter with advice on what can be procured quickly from the support perspective and what the impact will be on the warfighter. There may be products readily available that can reduce or obviate the need for some traditional support but require a larger initial investment. The warfighter needs to be provided with those options. On the reverse side, it is possible a system can be delivered rapidly under Evolutionary Acquisition, but the supply chain cannot be made ready to support it soon enough. Again, the warfighter must be informed of the constraints and tradeoffs, along with feasible alternatives. In any case, the product support professional must balance the need for agile acquisition with the absolute requirement of Agile Combat Support at the operational base or the deployed environment, because systems procured quickly are not worth the effort if they cannot be supported.[4]

The decisions made, actions planned, impacts anticipated, and costs projected should ultimately be spelled out clearly in a product support management plan (PSMP)[5] and appropriately included in the Single Acquisition Management Plan (SAMP) for the weapon system. Only by doing so, can milestone decision authorities, acquisition strategy panels, and Air Force corporate review panels adequately assess the proposed system of systems to ensure the warfighter can be satisfactorily supported before approving progression into subsequent phases of the acquisition process. The PSMP should be reviewed, updated, and approved at program decision reviews for increments that change significantly from the approved baseline.[6]

ILS Elements and Evolutionary Acquisition

Another traditional framework—Integrated Logistics Support (ILS)—remains very useful for ensuring the full range of support is considered and included, especially in the more complex EA environment. The ten ILS elements separate the logistics chain into manageable chunks. Maintenance planning; supply support; design interface; packaging, handling, storage, and transportation; manpower and personnel; support equipment; technical data; training and training support; facilities; and computer resources support comprise those elements, as depicted in Figure 2. The process of ensuring a weapon system is fully supportable includes appropriately addressing, integrating, and balancing each of these elements. In the following paragraphs, we will examine each of the ILS elements individually and briefly consider their unique impacts on a program using an EA strategy. These characterizations will not be exhaustive or comprehensive; instead, they will be a summation of some of the key points for actual program teams to consider in developing alternative support strategies in an EA environment.

Maintenance Planning is the process of describing requirements and tasks to be accomplished for achieving, restoring, or maintaining the operational capability of a system, equipment, or facility. The maintenance concept employed under Evolutionary Acquisition is not limited to any predetermined subset of those available to traditional acquisition programs. However, with the planned, methodical progression from the first increment to the last, the selection of two versus three levels of maintenance, the provider of base-level maintenance services for new and peculiar items, and the Source of Repair Assignment Process (SORAP) recommendation for the provision of depot-level maintenance take on added elements of complexity. Alternatives range from interim contractor support (ICS) for short periods, contractor logistics support (CLS) for longer periods, organic support, or public and private partnerships, whichever combination makes the most economical and mission support sense. It is important to recognize that the complexities of multiple increments do not necessarily drive the default decision toward using a contractor as the maintenance provider. Any potential contractor must face the same complexities, and as such, it may prove to be cost prohibitive to contract for such services. That said, only after a thorough repair level analysis (RLA) is completed will it be clear whether the maturity, stability, and complexity of the system design is appropriate for a contractor-provided maintenance scenario over that of an organic source.

Supply Support planning is used to acquire, catalog, receive, store, transfer, issue, and dispose of items to meet the user's peacetime and wartime requirements. In an EA environment, a supply support for the initial increment is likely to be provided through an ICS structure, without necessarily putting all the required supply management data interfaces in place. After the initial increment, the single manager will need to consider whether the priority of the mission, mission requirements, and date the increments need to be in operation can be met through normal organic provisioning processes, further interim contractor logistics support (using the Reformed Supply Support Process), or permanent contractor logistics support. Supply support may become more standardized and organically provided as the program moves to subsequent increments, the design stabilizes, and operational usage increases. Unique processes should be minimized with subsequent increments.

Design Interface integrates logistics-related readiness, combat capability, and supportability design parameters into system and equipment design.[7] This element is often an overlooked element, yet it is far and away the most powerful one. By leveraging support considerations into system design, the greatest influence is made on logistics support, life-cycle cost, and the ability to carry out sustained warfighting missions. If spares and support equipment are to be more common, the system must be designed that way. If the new components are to be more reliable than their predecessors, they must be designed that way. If maintenance is to be simplified, the system must be designed that way. Evolutionary Acquisition provides greater opportunity for driving weapon system capability improvement into designs, as the system design is programmed for change more often. If not planned properly, however, the potential for significantly greater life-cycle costs exists, if each increment drives costly changes to the existing logistical infrastructure. Historically accepted estimates tell us that, once designed, as much as 70-80 percent of a system's total life-cycle cost is predetermined. To accommodate multiple increments under Evolutionary Acquisition, the initial design should, therefore, be as reliable, flexible, adaptable, scalable, supportable, and transportable as current technology allows. Under an EA strategy, the opportunity to improve reliability on a fielded system happens much sooner and more often in a program as design changes with each

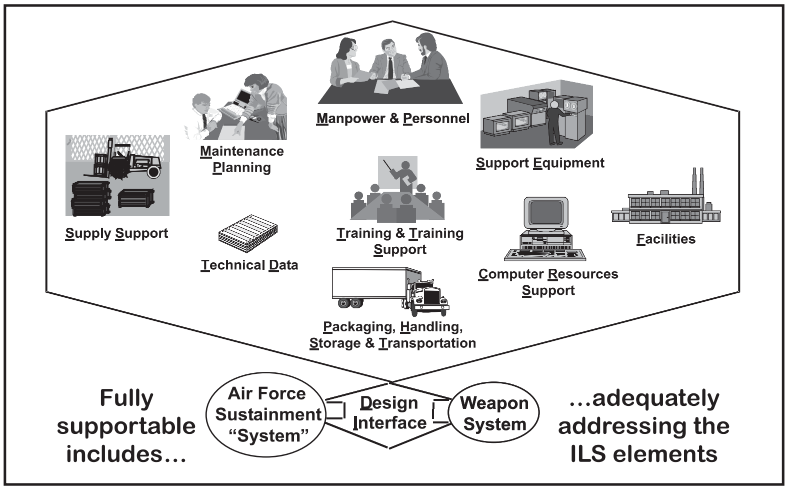

Figure 2. Then Ten ILS Elements

increment could lower total ownership costs, as well as improve operational performance.

Packaging, Handling, Storage, and Transportation (PHS&T) planning determines environmental, preservation, storage, and transportability requirements and methods to ensure elimination or minimization of damage to the system or support infrastructure. Transportability is a design consideration to ensure all system equipment and support items can be delivered to the battlefield or the point of operational use effectively, efficiently, and safely. Under Evolutionary Acquisition, earlier delivery necessitates earlier transportability analysis. Operational delivery and use of the system in the earlier phases of development, combined with the greater likelihood of contractor inventory control points and other support infrastructure differences, impact transportation decisions. As a result, the program office must contact and work with its center's transportation specialist much earlier in the program, long before any operational use or movement is considered. In addition, PHS&T requirements will need to be reevaluated for each increment to determine if any new or unique needs must be met. Numerous configuration changes (physical, weight, dimensions, hazardous material, security classification or item fragility changes), possibly resulting in new national stock numbers, will also impact PHS&T and transportability analysis. With multiple configurations possible, the number of container and packaging designs and the importance of clear label marking and total asset visibility increase significantly. Since sound PHS&T elements are vital in both peacetime and contingency operations, system designs should specify maximum mobility footprint parameters.

Manpower and Personnel planning identifies and acquires military and civilian personnel with skills and grades required to operate and support the system over its planned lifetime in both peace and war. The needed manpower and personnel (the numbers, skills mix, and grade levels) are influenced by decisions made in other ILS element considerations. As a system evolves through the increments, continuing efforts to simplify man and machine interfaces and utilization of built-in test and fault isolation devices can reduce, at least at the organizational level of maintenance, the skill levels required of personnel who operate and maintain those systems. Accomplishing the logistics support mission in the most efficient and economical way should be a primary focus in determining manpower requirements for each increment.

Support Equipment (SE) is all the equipment required to support the operation and maintenance of weapon systems. To the extent possible, support equipment and the systems they support should be designed such that the planned, future system increments under Evolutionary Acquisition do not drive extensive changes to the equipment needed to keep said items applicable and operational. There is a compelling benefit to having common aerospace ground equipment, munitions equipment, test equipment, and so forth. Thus, support planners and single managers should look across systems for common SE opportunities. In cases where a system change is needed, the ideal scenario would include simultaneous upgrades to all fielded systems and related support and test equipment. This reality also tends to suggest an extensive use of support equipment with modularity and scalable capacity such that upgrades are easier to execute.

Technical Data includes recorded scientific or technical information. Providing access to technical data can often be expensive and is, therefore, often considered a ripe opportunity for cost savings in new programs. However, the high cost is driven by its high value, and this decision should not be taken casually. While it may seem expensive, if access to data is not acquired when the design becomes stable, the production of spares in the future may not be competitive, and organic repair may not be possible. If the government's right to access technical data is a stipulation in the award of the basic weapon system contract, many sustainment problems can be precluded. Therefore, access to the full range of technical data should, at the very least, be priced and made available for government consideration and purchase. The decisions for each increment should be a result of the support concept and not vice versa, and clearly, the data costs will be a key consideration in that decision.

Training and Training Support planning considers processes, procedures, curricula, techniques, training devices, simulators, and other equipment needed to train personnel to operate and maintain a weapon system. Training needs should be considered and integrated with any program's flow from the first increment through the last increment. As systems progress from one increment to the next, training needs must be identified, funded, and initiated a lead time away from implementation to avoid negative impacts on operational capability. Ideally, if all systems and associated equipment are retrofitted or replaced in concert with the introduction of the new increment, the training (both operator and logistics) should be completed prior to initial operating capability of the new increment.

Facilities as an ILS element ensure that planners define necessary facilities or facility improvements for new acquisitions and determine locations, space, utilities, environmental, real estate, and equipment needs. The facility requirements associated with fielding new systems or associated future increments warrant considerable analysis and planning. Fairly unique to this element are the type of funding and lead times associated with constructing new facilities or renovating existing facilities to support system beddown. Normally, military construction (MILCON) funding (3300 appropriation) is used for facility construction. These funds are planned and programmed for by the MAJCOM acquiring the new system, with support from the system program office. MILCON funds are authorized and appropriated apart from acquisition program dollars. In addition, the calendar time it may take to get new facilities constructed can be years in the making. The lead time required to budget, design, and construct facilities, while system requirements may not yet have been fully defined, further complicates the rapid modification of this logistics support element from one EA increment to the next. Given these facts, minimizing the need for new facilities to support system beddown and the need for adequate lead time for MILCON budget requirements should be given additional weight in early program planning and design selection activities.

Computer Resources Support (CRS) encompasses the facilities, hardware, software, documentation, manpower, and personnel needed to operate and support mission-critical computer hardware and software systems. CRS is a critical enabler in most, if not all, military systems. Whether embedded in the fielded system and needing support or external to the weapon system (for example, part of the data management system or support equipment for supporting the fleet), computer resources can make or break the ability of the system to reach its operational potential. It is common knowledge that computer technologies often face a generational change every 18-24 months, so systems, especially those using an EA acquisition approach, must give significant consideration to planning for these changes. Whether systems are significantly upgraded or replaced entirely, the logistics support plan needs the flexibility and preparedness to deal with these coming changes. Design considerations in this area include, but are not limited to, such items as sufficient spare memory, reserved physical space, weight allowances, cooling capability, modularity, open systems architectures, and training and training support.

Other Important Support Considerations for Evolutionary Acquisition

The facility requirements associated with fielding new systems or associated future increments warrant considerable analysis and planning. There are other related considerations. Configuration management (CM), for instance, is not one of the ILS elements but is another crucial consideration, especially so under an EA scenario. It is one that touches several, if not all, ILS elements.

In the traditional approach, configuration management is already an important issue, and there can be multiple configurations of weapon systems in the field. Evolutionary management magnifies this version issue, making good configuration management even more important and requiring a more structured management approach. As the system progresses though the increments, the process by which the changes are planned, documented, executed, monitored, and communicated (that is, the CM process) is critical to the success of the overall program. If done properly, it will allow for orderly implementation of improvements to a weapon system over time. Therefore, some of the challenges with interoperability and multiple versions at a single location could be better managed and mitigated. Some unique provisions should be considered in the CM plan. Planners may or may not decide to retrofit previous versions, but they must consider and account for all support implications. The Configuration Control Board (CCB) probably should be stood up earlier in the acquisition process. System and functional reviews will happen earlier, so the CCB should be in place earlier to support them. There is likely much more activity in the CCB under Evolutionary Acquisition than in a single-step approach. The CCB's membership probably should be broader than under a single-step approach to address the orderly upgrade of the system through the increments. Consideration also should be given to making the CCB a relatively permanent, standing body. As such, it would provide more consistency throughout the program, from one increment to the next. With at least the core members of the CCB formed as a standing body, assumptions, analyses, and decisions previously made would need to be revisited less often, and a consistent plan would be more likely to be executable through to the final increment.

Corporate reviews remain an essential consideration: Evolutionary Acquisition does not eliminate them, even though many feel some of these reviews are burdensome and could slow down an EA process. Such reviews are necessary for many reasons:

- To comply with laws, policies, and strategies (for example, core, 50/50, depot-maintenance strategy, public-private partnerships).
- Because linkages between weapon systems are becoming greater. Many systems will be designed to work as systems of systems in the near future, so changing a system or its support structure could have significant impacts on other systems.
- To adequately assess the impact of each increment on the entire supply chain supporting the weapon system. Though the supply chain was capable of supporting a previous increment, it may not be capable of supporting future increments without additional planning. There is potential for different bottlenecks or gaps to surface in the supply chain with each new increment.
- To enhance leveraging in the purchase of goods and services involved with each increment. As one example, the strategic sourcing initiative has demonstrated, when government organizations and programs join forces to manage suppliers, there is potential for leveraging buying power to reduce delivery times, improve product performance, and decrease or stabilize prices.

Thus, system program offices, single managers, and logistics specialists cannot become individual stovepipes, fiefdoms, or silos under Evolutionary Acquisition and Reality-Based Acquisition. Corporate reviews help preclude this and look at the enterprise-wide picture. While corporate reviews may not be eliminated, they could always benefit from becoming more agile and streamlined under Evolutionary Acquisition.

One final consideration is also worthy of mention. In many respects, the performance-based logistics (PBL) initiative goes hand in hand with Evolutionary Acquisition. Performance-based logistics is already DoD's preferred approach for implementing product support. Under performance-based logistics, product support professionals negotiate logistics performance agreements with the operational customers and then build incentive-based performance agreements with commercial and organic providers, allowing them flexibility to build, accomplish, and improve support in a timely fashion. The goal of performance-based logistics is to create a reliable support system that reduces the need for and cost of logistics. It also tries to develop a maintainable system that reduces the need for resources, such as manpower, equipment, and spares required to support operational performance. Performance-based logistics attempts to reduce not only the resource requirements for logistics but also the requirement for logistics itself.[8]

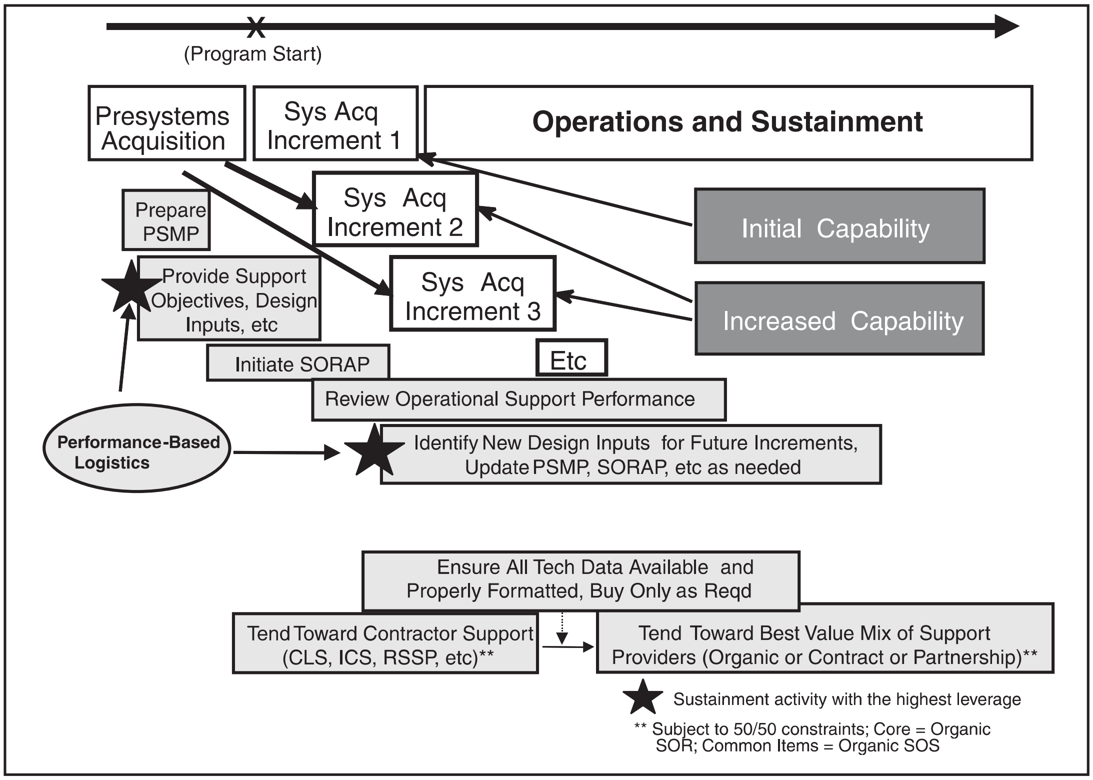

Figure 3. Summary—Sustainment for Evolutionary Acquisition

Conclusion

Evolutionary Acquisition is a strategy to provide the warfighter with improved, militarily useful capabilities delivered more rapidly. The strategy is an essential part of Dr Sambur's Reality-Based Acquisition policy that focuses on shortening acquisition time and increasing credibility to the warfighter. Though the acquisition environment has changed, the basic support framework probably has not changed much. With the faster fielding of successive increments, however, support complexity has certainly increased. Configuration management deserves increased attention, as Evolutionary Acquisition is likely to create multiple versions of the same system. At the same time, each increment must be fully supportable in an affordable manner. There should be no doubt that early logistics planning in an EA environment is more important than ever. Early development and continuous assessment of the Product Support Management Plan enhances this planning, as do corporate reviews. PBL strategies help give incentive to contractors to provide innovative logistics solutions, and the ILS elements continue to provide a useful framework to plan a robust range of support over a program's life cycle. Figure 3 overlays some of the key support activities on a generic program life cycle. Any member of the acquisition and sustainment communities would do well to understand these relationships and stay tuned to the evolving policies in this area over the coming years.

Notes

1. Marvin R. Sambur, Assistant Secretary of the Air Force (Acquisition), "Reality-Based Acquisition System Policy for all Programs" memorandum for MIDAs, FADs, PEAs, and DACEs, 4 Jun 02.
2. For the purposes of this article, product support, logistics, and sustainment are considered relatively synonymous. It can be defined as "the entire package of support functions necessary to maintain the readiness of and operational capability of weapon systems, subsystems, end items, and support systems" throughout the life cycle of a weapon system, Air Force Regulation 63-107, 29 May 01.
3. Lt Gen Michael Zettler remarks during panel discussions at the Acquisition and Logistics Excellence Week seminar at Wright-Patterson AFB, Ohio, 21 Oct 02.
4. Some concepts and products that could enhance faster support capability for new weapon systems include prognostics, increased reliability and maintainability, common support equipment, and open systems architecture.
5. Reference Air Force Instruction 63-107, section A2.4 for further information. At the time of this writing, there has been some debate on whether a PSMP should continue to be required by regulation under Reality-Based Acquisition. It is the opinion of the authors, however, whether required or not, a big picture, long-term support strategy is extremely beneficial for the sustainment of a weapon system, and the PSMP provides a good avenue for that.
6. At the time of this writing, there has been some debate on whether a PSMP should continue to be required by regulation under Reality-Based Acquisition. It is the opinion of the authors, however, whether required or not, a big picture, long-term support strategy is extremely beneficial for the sustainment of a weapon system, and the PSMP provides a good avenue for documenting those plans.
7. There are many parameters: reliability, maintainability, and deployability, sustainability, standardization and interoperability, fuel, utility, and energy management, testability, dependability, transportability, durability, availability, survivability, integrated diagnostics effectiveness, transportability, accessibility, spares support, mission effectiveness, serviceability, software reprogramability, level of repair, industrial support base, support equipment, inspections, human factors, corrosion, physical obsolescence, hazardous material management, software speed and efficiency, calibration, revised tactics, training, manpower, system safety, nondestructive inspection, changes in the environment, mobility. Design interface parameters are expressed in operational terms rather than as inherent values.
8. Further guidance on PBL can be found in the DoD publication *Product Support: A Program Manager's Guide to Buying Performance*, Oct 01.

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Agile Combat Support

The Munitions Industrial Base

What Can We Do About It?

The Air Force must change its contracting strategy.

Lieutenant Colonel Charles Webb III, USAF

In the budget world, most people think if you throw enough money at a problem it will go away. After years of neglect, the munitions industrial base is one area where simply *throwing money* at it will not be enough.

The munitions industrial base is a relatively small but critical component of the Agile Combat Support (ACS) concept. The ACS concept is formulated around seven core principles designed to "create a combat support force that is highly flexible and able to respond to the specific needs of the combatant commander."[1] Six master processes and 21 logistics tasks further define the concept. One of these logistics tasks is the industrial base, which is assigned to integrate the capabilities of industry to improve supplier performance and accountability.[2] Munitions is only one segment of the industrial base but demands immediate attention to ensure the force is ready.

Overview

Since the close of the Cold War, procurement of ammunition funding has dropped significantly. With less funding spread across the munitions industrial base, this led to a diminishing contractor base. With the sudden insurgence in munitions funding following recent incidents, the munitions industrial base is struggling to meet the higher production demands in a timely manner. Solutions to the dilemma are numerous and complex, but the following two approaches will help the struggling munitions industrial base. First, multiple-year contracting, as opposed to the normal single-year contract, can bring stability to the production capability and workforce. Second, changing the perspective on advocating funding from strictly a requirements-driven approach to an industry-based approach will ensure an adequate contractor base well into the future.

What Happened to the Munitions Industrial Base?

The Air Force ended the Cold War with a substantial stockpile of conventional weapons. As programs were cut to pay for the ensuing *peace dividend*, the Air Force severely cut procurement of ammunition. This situation naturally led to the shrinking of the contractor base, which compounds the problem now faced—too much money flooding the industry, literally choking the munitions industrial base.

Procurement of Ammunition Funding

Procurement of ammunition funding suffered through a steady decline from the end of the Cold War until just recently. Funding in the mid-1980s averaged about $750M, while funding in the mid-1990s bottomed out at about $300M.[3] With large war reserve materiel (WRM) stockpiles of munitions from the Cold War, the necessary test and training munitions were no longer procured, rather the WRM munitions were used for testing and training. This led to a decreasing stockpile of WRM with very little funding for replenishment. Funding for procurement of ammunition continued to drop until the shortfall for WRM and test and training munitions reached $2B in fiscal year (FY) 2001.[4] With Congress having not thought of threat of a major war, finding adequate funding for WRM was difficult. However, through intense advocacy by the Procurement of Ammunition Appropriation Managers and Headquarters Air Force Requirements Directorate, test and training munitions began receiving increased funding in the FY01 President’s budget. Through supplemental funding in FY01, $73M was added to the Procurement of Ammunition appropriation for test and training munitions.[5] Likewise, in FY02, $182M supplemental funding was appropriated for test and training munitions.[6] By February 2002, when the FY03 President’s budget was submitted, test and training munitions were fully funded. The budget for procurement of ammunition went from President William Clinton’s projected FY02 budget of $654M to President George Bush’s FY03 budget of $1.1B.[7] Even though this funding was desperately needed to replenish the munitions stockpile, it was too late to save the munitions industrial base.

Diminishing Contractor Base

With a decade of decreased funding for ammunition procurement, there was no way for all the munitions contractors to stay in business. Most contractors in the munitions industrial base had only defense contracts to compete for with severely limited civilian application. Bomb bodies, flares, and fuses are a few of the munitions industrial base sectors hit the hardest. For example, since 1992, there has been a sole source for forged steel bomb bodies used in the Mk-80 series bombs.[8] This not only eliminates competition and any attempt to reduce unit costs but also limits the production capability to one manufacturer. There is also the threat of a single incident (safety, tornado, or even terrorist) completely stopping bomb body production. In similar fashion, the magnesium-Teflon flare industry is currently down to one supplier. A second vendor is going through requalification after having its production line shut down for more than a year following the third incident in 2 years. The last accident was significant enough to involve a fatality. The flare production process is an intricate and highly dangerous procedure, which has resulted in several mishaps with all the vendors involved. These circumstances have led to substantial backlogs in flare production and a 40-percent increase in unit costs. Likewise, fuse vendors dropped from 32 in 1987 to only 8 today.[9] As a result, it is difficult to find vendors capable of producing more technologically advanced fuses. Production of the new joint programmable fuse has been delayed more than 2 years because of technical deficiencies with the vendor. The Air Force is seeking its third vendor in an effort to find someone to produce a joint programmable fuse capable of working in all required parameters.

Several other commodities have been challenged with the diminishing contractor base. There is only one vendor producing laser-guided bomb (LGB) tail kits and guidance control units. These components are attached to the general-purpose bomb body to make a complete LGB, giving the bomb precision capability. A second vendor has been attempting to qualify for more than 2 years now but has yet to produce an LGB for the Air Force.[10] The preferred munition going into Operation Enduring Freedom was the joint direct attack munition (JDAM). Like the LGB, the JDAM uses a general-purpose bomb body but attaches a GPS-guided tail kit to provide a near-precision capability. These tail kits also are produced by a single vendor, which had an extremely limited production capability going into Operation Enduring Freedom. Probably the most devastating predicament to the munitions industrial base is in the production of trinitrotoluene or TNT, which is the major component of the explosive fill used in Air Force bombs. TNT has not been produced in this country since 1986, and the stockpile will be exhausted completely after filling the bombs from the FY01 buy.[11] Even more discouraging, with the many environmental constraints to production of TNT, there may not be a vendor in the United States. That leaves us with the options of reclaiming TNT from bombs currently awaiting demilitarization or buying it from an overseas source. There are problems inherent with both options. There is obviously a limited supply of TNT available to reclaim. Plus, the Air Force Research Laboratory still needs to approve the TNT reclaim process. The other option, purchasing TNT overseas, has political ramifications with identifying a weakness in the production capability to the world and relying on a foreign source for something as critical as an explosive fill for bombs. These considerations make it even more critical to develop a production capability in the United States.

The overall diminishing contractor base limits production capability, decreases competition, increases unit cost, and leaves virtually no surge capability. These observations were proven all too true with the wave of munitions funding in the FY03 President’s budget.

Current Dilemma

For the last 5 years, the procurement of ammunition appropriation has averaged $570M a year.[12] The next 5 years forecast an average of $1.05B, almost doubling the previous 5 years. With the current budget process, the only quantities that can be purchased are what the contractor can produce in a 12-month period. In theory, the quantities the contractor produces in the 13th and subsequent months should actually be funded in the next year’s budget. As a result, the money for anything more than a 12-month production capability is actually needed next year, not now, so the money disappears. Increasing the contractor’s 12-month production capability takes money to *facilitize*. This is a risky business for the contractor because there is no guarantee beyond the current year’s funding. If the Air Force decides to use its own money to *facilitize* a vendor, it limits competition between vendors in the outyears. The Air Force recently chose this option with the JDAM. As the preferred munition in Operation Enduring Freedom, hampered with severely limited production, the Air Force spent $47M to enhance the Boeing facility used to make JDAM tail kits. In addition, the Air Force programmed more than $1B for JDAM production over the next 5 years. [13] Even with this concerted effort on a priority munition, JDAM tail-kit production will not meet the target production rate until August 2004—almost 3 years from the start of Operation Enduring Freedom. So we have to ask ourselves, is Agile Combat Support working? Are we readying the force? How do we best execute this sudden influx of money to the munitions industrial base?

Is There a Better Way?

Munitions industrial base leaders agree on one short-term solution to stabilize the base. They have told the Air Force to change its contracting strategy. However, this change alone will not be enough, but with a new look at advocating funding for munitions, coupled with the change in contracting strategy, the Air Force can stabilize the munitions industrial base and ready the force.

Change the Contracting Strategy

The contracting strategy for munitions has traditionally been to solicit bids for a single-year contract. Sometimes, the contract would have option years attached to the contract, but the only guarantee to the contractor was for the single year. This strategy does not allow for the contractor to plan beyond a single year. Full two-shift production in the plant one year may be followed with severe layoffs and only a half-shift of production the next or, worse yet, no production at all. This leads to difficulty in maintaining a fully trained, stable workforce. Likewise, there is no incentive to upgrade facilities to improve production capability with no guarantee for the next year. To alleviate this situation, senior leaders in the munitions industry presented their recommendations to the Air Armament Summit in March 2002. The continuing theme throughout the summit was clear: to stabilize the munitions industrial base, the current contracting strategy must be changed to one that incorporates a multiple-year contract.[14] This would offer the contractor several distinct advantages. The contractor could plan for production beyond the first year, procure long lead-time items, purchase bits and pieces in bulk for reduced costs, better use a fully trained workforce, and actually lower unit costs to the government.

Taking a look at bomb body production, from start to finish, it takes an average of 25 months to receive a bomb.[15] The contract allows the vendor 12 months to obtain the materials to produce the bombs before the manufacturing process begins. The bulk of this time is consumed with the procurement of steel. Since the company only is assured of the single-year contract, it only buys steel for that particular year. Those months in the production lead time must be absorbed each year, and without purchasing additional steel, there is no surge capability. By using a multiple-year contract and advance procuring steel, the contractor could reduce long production lead times and provide a surge capability currently nonexistent. The flare community would particularly welcome the stability to the workforce. In such a hazardous environment, a fully trained, experienced workforce would lead to a safer production line. This would allow the contractor to increase production capability and reduce the current backlog. In the case of the TNT shortfall, a multiple-year contract may be the only way TNT can be purchased from a US vendor. As mentioned earlier, a single-year contract offers little incentive to *facilitize* production capability. Estimates from industry to develop a production capability for TNT range anywhere from $15M to $35M.[16] However, there is no way any company would invest this amount of money with only a single-year guarantee for production. With a multiple-year contract, a company could spread the up-front investment costs across the total length of the contract and provide an acceptable unit cost to the government with a profit margin worth the investment. Without the multiple-year contract, reclaimed TNT must be used, or TNT must be purchased overseas.

There are, of course, drawbacks to a multiple-year contract, the major one being it puts the risk on the government. If the agreed-upon minimum quantities are not purchased in each year of the contract, the government will pay substantial penalties for breaking the contract. In a world of changing funding priorities, no one has wanted to take that risk. In the Air Force corporate structure, if higher funding priorities arise, the remaining programs absorb the cut in funding. If a program is supported with a multiple-year contract, the Air Force corporate structure would be less likely to take money from that program because of the financial penalties involved. This would lead to larger cuts in the other programs and, in effect, surrender some of the Air Force corporate structure's flexibility. However, in light of recent events, it seems more certain than ever the Air Force will need munitions to meet its political objectives and the munitions funding line will remain stable. Now would be the time to take industry up on its recommendation and pursue a multiple-year contracting strategy.

New Look at Advocating Funding

Procurement of ammunition funding is driven by requirements. Each year, the Air Staff's Requirements Directorate receives requirement inputs from the combatant commanders and major commands. These inputs go into a model that develops the Nonnuclear Conventional Ammunition Analysis report, which establishes the munitions requirement each year. With this validated requirement, advocacy begins for funding. Like most programs, the requirements are not completely funded, so a prioritized funding list goes forward. The only consideration to the munitions industrial base is whether or not industry can support that year's buy, not what should be bought to keep the production line open. Industry provides a minimum sustainable rate for each commodity, but that minimum quantity is used only to determine the minimum amount required to buy *if* that particular commodity is going to be bought. Many times, the Air Force chooses not to buy a particular commodity in a given year. To provide stability to the munitions industrial base, the minimum quantity for each required commodity should be bought to ensure the production capability remains intact. The Air Force must look beyond the immediate operational requirement and purchase the minimum quantity required to sustain the munitions industrial base. The bulk of funding cannot be put in one particular preferred munition at the neglect of others and there be a contractor ready to support Air Force needs a year or two later. The Air Force needs to work with industry to validate the minimum quantity required to keep the production lines warm and negotiate an affordable arrangement. Too many times when an attempt is made to procure a munition currently out of production, but with a valid requirement, the production capability no longer exists. This is particularly true with the volatile flare community. Finding a vendor to revive that

(Continued on page 47)

AFIT Takes Students Back to the Basics with Its Applied Maintenance Management Concepts Course

Lieutenant Colonel Donald S. Metscher, USAF
Captain David P. Collette, USAF

What Is AFIT?

The Air Force Institute of Technology (AFIT) has two schools available for the traditional logistics career fields. One is the Graduate School of Engineering and Management in which officers, civilian equivalents, and noncommissioned officers can attend an 18-month program and earn a master's degree. More information can be located at the AFIT Web site: www.afit.edu. The other is the School of Systems and Logistics.

What Is the School of Systems and Logistics?

The School of Systems and Logistics, where the authors are currently assigned, provides professional continuing education to military and Department of Defense employees. The school has an administrative department and three education departments. The department offers 12 courses to the logistics field, one of which is the Applied Maintenance Management Concepts, WLOG 262, and is recommended for undergraduate credit. Students who complete WLOG 262 earn 5 quarter hours of upper-level undergraduate management. More information can be located at the School of Systems and Logistics Web site: www.ls.afit.edu

What Is Applied Maintenance Management Concepts?

The Applied Maintenance Management Concepts course gives logistics managers and supervisors an array of executive skills. Of the executive skills taught, 80 percent originate from the field of Production and Operations Management, 10 percent from Psychology, and 10 percent from Base Environmental Management. All topics are directly applicable to military management functions supporting base-level operational units. The course exposes students to the latest policies and initiatives and challenges them to apply both theory and techniques to current management problems confronting base-level logistics managers. In addition, the application of statistical concepts, statistical process control, and reliability and maintainability measures are illustrated through practical exercises. During the last year, WLOG 262 was offered 11 times. AFIT hosted five offerings during the calendar year, while six other onsite offerings were hosted by the United States Air Forces in Europe, Pacific Air Forces (PACAF), Air Mobility Command, and Air Education and Training Command. To request this course at your base, coordinate with your major command (MAJCOM) training functional manager. When instructors are teaching in the field, they solicit research topics from the group-level maintenance leaders. Teams of four to six students apply course concepts to current concerns and experience the academic problem-solving process. Sometimes these group projects evolve into follow-on consulting projects that may be worked after the end of an onsite course.

Rediscovering Metrics and Statistical Process Control to Analyze the Health of the Fleet

In a recent class conducted in the field by the course director, Major Gary Nogrady, and an instructor, Captain David Collette, a student team, headed up by Captain Chris Melcher, responded to a group commander's concern over the rising not-mission capable-for -maintenance (NMCM) rates in the local F-16 fleet, resulting in decreasing aircraft availability. The study utilized statistical process control techniques to identify work unit codes (WUC) that may be out of control and driving the high NMCM rate. The goals were to identify and isolate which WUCs were driving the high NMCM rate and then recommend areas for further analysis. Out of control does not mean the process is broken, rather the process is no longer behaving the same when compared to historical data. When a process is out of control, managers should identify why the process is behaving the way it is and determine which management decisions to make, if any, to return the process to an in-control state.

Mechanics of the Analysis

Historical Data

Historical data were gathered from the wing's PACAF RCS 7211 Monthly Maintenance Summary. This information is available through the analysis section within each maintenance complex and may be available in electronic format through the MAJCOM. In the case of this particular study, 5 years of data were available at the base. The data were in a monthly average format and unavailable as daily data. Daily data could have provided a stronger statistical evaluation by highlighting all the variation in the data. Monthly averages tend to hide the natural variations that occur in any manufacturing process.

Assumptions

In any analysis, certain assumptions must be made. In this case, we assumed the Core Automated Maintenance data are complete and accurate. The findings and recommendations are limited to the techniques taught in LOG262 and the short time allotted to study the problem.

Data Issues

Data issues included the analysis based on a limited data set (only 5 years of data). The data were divided into two piles: recent and historical. The most recent 12 months of data were plotted on the control charts, and everything else was labeled historical. The historical data were used to estimate the mean and standard deviation. And finally, the historical data were assumed to be in control to create statistically valid estimates of the mean and standard deviation

Statistical Process Control

Statistical Process Control (SPC) and Pareto charts are tools from the quality arena and can be used to make fact-based decisions. In the *Air Force Process Improvement Guide*, there are eight rules used to determine if a process is in or out of control. These rules identify situations or departures from the norm that have such a low probability of occurring randomly we use them to identify a process change. In the context of the course, three of these rules are taught. However, for this study, the analysts used all eight rules. Remember, identifying a process as out of control does not mean the process is broken. Out of control simply means the variation is no longer random, and management should be able to find out why the variation is no longer random. Some of the more common reasons for a maintenance process to be out of control could include experience of the technician, quality of the repair job, quality of the needed parts (benchstock, -21 equipment, reparable assets), weather (heat, cold, rain, and so forth), manning authorizations and allocations, number of cannibalizations, local maintenance policies, and the maintenance philosophy.

The technique of Statistical Process Control has been around since King William I and was developed further by Walter Shewart in the Bell Labs before Bell Labs became known as AT&T. Statistical Process Control is a tool that can be used to monitor a process and compares what is happening with the process to how the process has performed over a historical period of time.

Applying SPC Rules

The control charts combine statistics with historical data to provide a decisionmaking tool. This tool is a good starting point for managers to determine where management effort is required. If a process is *in control*, then we should not pursue specific peaks and valleys; improvement efforts should focus on refining the process. The rules used in this study are as follows: Rule 1, are 5 or more consecutive points above or below the average line? Rule 2, is there a single point either above or below the control limits? If either rule 1 or 2 applies, then the process is out of control, and the variation is not random. If neither rule applies, then we fall into rule 3. Rule 3 states if all points are within the control limits and no more than 4 points in a row are above or below the average line then the process is in control and exhibits random variation.

Initial SPC Analysis

The analysts first looked at the wing NMCM data to determine if further evaluation was required. This information is shown in Figure 1. The control chart in Figure 1 violates rule 1 as 12 points in a row are above the average or mean. For the months of November, April, and June, we verified the data points were above. Therefore, further investigation is justified, and a separate SPC chart was developed for 28 different WUCs to determine which ones were out of control. Of the 28 WUCs investigated, 18 of 28 were out of control.

Pareto Analysis

A Pareto analysis is based on the Pareto principle; that is, 80 percent of the impact is caused by 20 percent of the problems. The Pareto (80/20) analysis was used to identify problem areas by rank ordering WUCs by total NMCM hours. In this particular study, the top six WUCs (20 percent) contributed to 65.8 percent of the total NMCM hours. The WUCs included look phase inspections, airframe, turbofan powerplant, crew station, special inspections, and landing gear. Interestingly, four of these six WUCs are out of control (Figure 2).

Phase Inspections

After identifying the look phase as the largest contributor of time, we built an SPC chart to determine how time spent this year compared to time spent in the previous 5 years. We discovered the time spent in phase is statistically out of control (Figure 3).

Final Analysis

The class observed two areas during the final analysis. First, random variation in the overall NMCM rate was achieved by

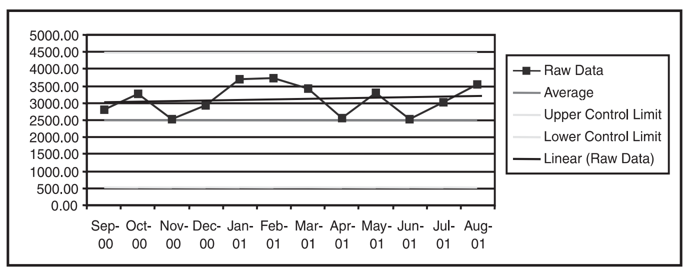

Figure 1. Wing NMCM Hours

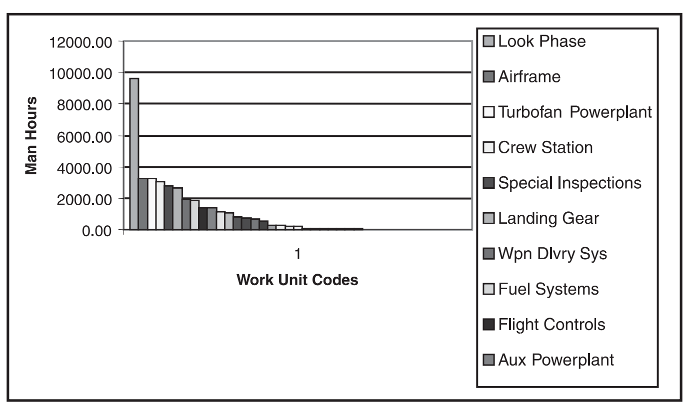

Figure 2. Pareto Chart

removing the largest contributor in terms of NMCM time (look phase inspections). When random variation is achieved, we stop removing data streams. After removing this plotted data, we recalculated the average line and upper and lower control limits (Figure 4).

Second, the top four of six WUC contributors to total NMCM hours were out of control and, therefore, have assignable variation. The process exhibits random variation when the top contributor (look phase) is removed from the data pile, and the analysts recommend looking at this area. However, the other three WUC areas, which are also out of control, should not be excluded. As these three are in the top 20 percent, it is prudent for management to also evaluate 11XXX—Airframe, 04XXX—Special Inspections, and 13XXX—Landing Gear.

One Step Further

The analysts wondered if the maintenance hours in phase were climbing as a result of more flying at the wing. We plotted the last 5 years of flying and phase hours and discovered the flying hours slightly decreased, while the maintenance time reported in look phase almost doubled (Figure 5).

Therefore, the climbing time in phase is not attributable to more flying hours, and we can confidently look within the maintenance complex for an explanation. This base changed from the 200-flight-hour phase concept to the 300-flight-hour phase concept in April or May 2000. However, it does not look like this change had any significant impact on the process.

Why Did the Study Stop in August 2001?

In September 2001, the base changed the way data were reported to the MAJCOM. The reports from September 2001 to the current time only include the top five drivers for repair. Sometimes these drivers are the top six reported in this study, sometimes not. As the data reporting process changed, we cannot include partial information in this study. Therefore, August 2001 is the last month with complete information and the last month we can reliably use in this study.

Conclusions

The original research question of "Why is the NMCM time climbing?" can be answered in generic form. The time reported during the look phase inspection process is statistically out of control. When this data stream is removed from the data pile, the process returns to an in-control state, further cementing that the look phase inspection process is an area to investigate further. Maintenance leadership at the base now has a specific area to explore. Specifically, the class recommended further analysis of WUCs 03XXX—Look Phase Inspections for explanations of out-of-control data and further isolating the NMCM hours into three- or four-digit WUCs. *Drilling down* or *peeling the onion* management may identify specific areas for improvement, thereby reducing the average NMCM time. In addition, we recommended that the wing continue to monitor the NMCM hours with Statistical Process Control and Pareto analysis techniques to determine if management decisions have any impact on these processes. What are the long-term implications? Airframes are aging. This results in longer phase inspections and tougher repairs. As a result of this increasing workload, the models used to determine manpower, for inspections, airframe repairs, and spare parts should be reevaluated.

As result of this class project, the base analysis section conducted its own analysis of WUC 03 to highlight the areas driving the NMCM time.

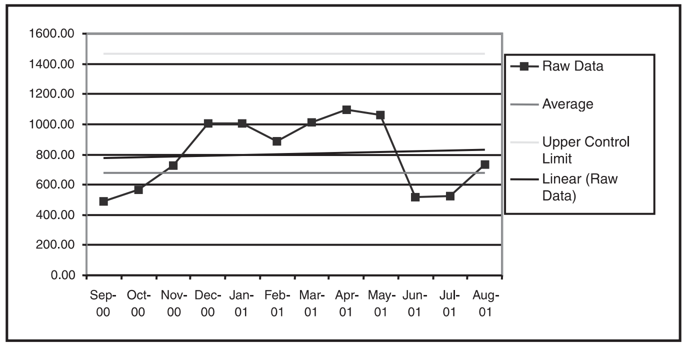

Figure 3. 0XXX—Look Phase Inspections

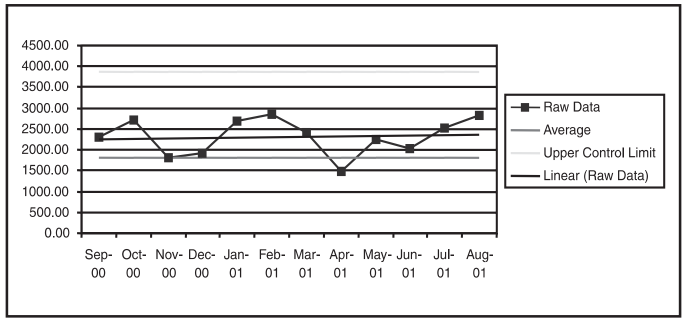

Figure 4. Wing NMCM Hours with WUC 03 Removed

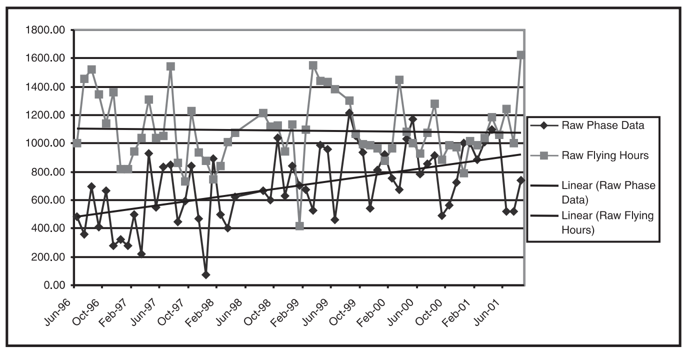

Figure 5. Raw Phase Flying-Hour Data

Colonel Metscher is course director for LOG 131, Industrial Maintenance Management, and LOG 132 Production Maintenance Management, Department of Materiel Management, School of Systems and Logistics, Air Force Institute of Technology, Wright-Patterson AFB, Ohio. At the time of the writing of this article, Captain Collette was assigned to the Air Force Institute of Technology.

notable quotes

Appeasement—surrender on the installment plan.

—Arthur H. Vandenberg

EXPLORING THE HEART OF LOGISTICS

Is Your Green Light Really Red? Get the *Real* Story from Your Mission Indicators

Major Kenneth R. Theriot, USAF

You know how it is. You get the same report every month, showing you a green light. Then suddenly one month, you get a red light, and everybody starts looking under rocks for an answer to where you went wrong this month. The problem is, you may have gone wrong 6 months ago, and you are just finding out about it now.

A fighter squadron I worked with a few years ago reported monthly mission-capable (MC) rates on a bar chart. For 4 consecutive months, its rates measured better than the command standard. Then in August, the MC rate busted (failed to meet) the standard. Answers were sought as to what happened in August to cause the problem. But when a different kind of chart, a control chart, was used to analyze the same data, it revealed the cause of the problem did not occur in August but was a culmination of several factors in the way aircraft maintenance had been accomplished and reported for many months. The inevitable failure would have been detectable and correctable months earlier had control charts been used. Instead, each time the rate met the standard, everyone assumed all was well. They gave the MC rate a green light for each *good* month, based on the recently popular *traffic light* chart. That was because they did not hear what the numbers were trying to tell them.

If you base decisions regarding mission indicators on charts that use the traffic light method or the ubiquitous bar or line chart, it is likely you are not getting all the information you need. When we look at charts that measure the results of the same process at fixed intervals, like MC rates by month, we glean huge amounts of information from the movement of data points, but most of us do not know how to extract that information. So we do the easy stuff, comparing the most recent month against a command standard, comparing this month against last month, and trying to make sense of trends and spikes. So how do we fix this? The good news is there is an easy-to-learn method for reading deeper into the chart. The bad news is it involves the word *statistical*. Statistical process control (SPC) is a cheap and easy way to use data already collected to improve command and control. Its use can literally allow us to predict performance months in advance and can provide decisionmaking guidelines for correcting or improving performance. This article looks at the deficiencies inherent in current methodologies, describes the use of control charts, and highlights how an Air National Guard (ANG) fighter wing used SPC to improve F-16 MC rates.

What Is the Problem?

Why did I say bar charts or traffic light charts do not give all the information needed? First, let me qualify this statement. There are situations where these charts are appropriate. You can use traffic-light charts for actual *go* or *no go* information. For example, availability of personnel (you need ten, and you have ten) or whether something is broken or not would be the correct use of traffic lights. Likewise, an appropriate use of bar charts would be to compare report cards of different areas in the same period (each bar represents a different base, organization, or weapon system). But sometimes, we try to force readiness information not truly *go* or *no go* in nature to fit our charts. The MC rate is one such animal. These rates are highly changeable; they are measured on a periodic basis (daily, weekly, or monthly) and compared to a standard. Traffic-light and bar charts are not a good fit for these kinds of measurements. These charts use a series of static snapshots to describe a continually changing number. They only allow us to compare two numbers or guess at patterns that seem to appear when the numbers move up and down. For example, we know when the number for this period is higher or lower than a command standard or some other number on the chart, like last month's result. We are either better or worse, right? We either meet the standard or do not. Is that not all we need to know? If we are meeting the standard this month, we must be okay. Maybe, maybe not. While there is no arguing the truth of whether one number is higher or lower than another, that information only tells a portion of the tale. In my story about the fighter squadron, it had four consecutive *green light* months. But we found out later the process was not healthy. It was just that none of the symptoms were showing when the circles were colored green. How can the Air Force give green lights to sick processes? The answer is variation.

Every repeatable process contains some difference in the measured result from period to period—variation. Vital information is contained in the movement patterns of numbers on the charts, which we typically ignore or attempt to interpret using inaccurate guesswork. If MC rates are used on a monthly basis, you are likely to see the number fluctuate each month. Some months, there may be only a 1- or 2-percent shift, while other months, the rate jumps by 5 or 6 percent. But *some* variation in a repeatedly measured result is inevitable. If we do not know the scope of that variation because it was not measured, we would never know if we had a system, like the fighter squadron mentioned, that meets the standard today but is still guaranteed to bust the standard at some point during the year.

We already know, on some level, that every repeatable process has variation. Think of how suspicious you would be if the MC rate never fluctuated and measured 86.3 percent for 24 consecutive months. If we accept there will be some change each period, the question becomes, how much change does there have to be before we think there is something out of the ordinary happening? How steep does the trend have to be? How high (or low) does the spike have to be? Ask a dozen people, and you will get a dozen answers. There is no standard for what constitutes a true trend or spike. We have to go by gut feeling about whether the ups and downs are significant. Sometimes, we even guess right. The problem with trying to use guesswork to analyze the patterns or compare two numbers, as discussed earlier, is all these numbers are subject to some system variation and virtually guaranteed to be different. So their mere difference tells you precisely nothing. The information so crucial to command and control lies both in the numerical value and movement of numbers. The use of control charts gives a way to tell the difference between a significant change in the pattern and a random change that does not indicate a shift (for better or worse) in the system. SPC gives not only practical rules that can be quickly applied to tell *signals* (real departures from the norm) from *noise* (expected, inevitable system variation) but also guidelines on what to do about it and predicts future performance levels. Now that is useful information.

What is the Solution?

Unlike many suggestions for change in the Air Force, this one is cheap and fast. If you have monthly (or any other periodic) data and a spreadsheet program, you can begin after you finish reading this article. The finished project should look something like Figure 1. You will notice a few unfamiliar lines on an otherwise simple line chart. The dotted lines represent the limits of the window of inevitable variation. These are called control limits. This means the system will inevitably generate numbers between these lines (assuming the system is stable). The wider the lines, the larger the change in numbers expected from month to month. Knowing this has already put you ahead of the game. If you have a command standard somewhere between these limit lines, you already know the system is *guaranteed* to generate numbers on the wrong side of that standard. The other line in Figure 1, not normally found on the charts, is the center line. This is the average performance level. This line gives the context for other ways to interpret the data (again, assuming the system is stable). It will allow us to tell whether the changes in the numbers are part of the inevitable system variation (noise) or caused by specific, significant, out-of-the ordinary events (signals).

Stable is neither good nor bad. All *stable* means is that the system has proven it operates predictably and stably around some average level. How do we know if we have a stable process? See Figure 2. If, after we calculate the center line and control limits, the last of the three conditions in Figure 2 is present (a point is outside one of the control limits), the system is not stable. We need to get the process under control before we can proceed. If the system is stable, this still does not mean *good*. Remember that stable means predictable, and the stable process may simply be predictably bad. This could mean the performance level is not where you want it. But it could also mean there is too much variation in the system, and performance levels will fluctuate too much.

So how do we go about creating a control chart? Warning! A small amount of potentially mind-numbing statistical jargon follows. There are several different types of control charts, the discussion of which is beyond the scope of this article. The one we want to use is called the *individual and moving range chart* (x/mR).[1] As the name implies, it is actually two charts in one. But we will only be looking at the performance (individual) portion (Figure 1). We still need the moving range information for our calculations.

First, gather at least 5 consecutive data points (20 is better if you have historical data to draw from, but 5 is the minimum for a useful chart) for your calculation. Take the average and plot that line horizontally on a line chart.

Second, find the average moving range. For this, you need a list of moving ranges, which you get from the differences between the data points used in the first step. For example, if you used 82, 80, 79, 83, and 81 (five consecutive performance results from your system), the first moving range would be the difference between the first 2 points. In this case, that would be 2 (difference between 82 and 80). The next number would be 1 (difference between 80 and 79) and so on until you have all the moving

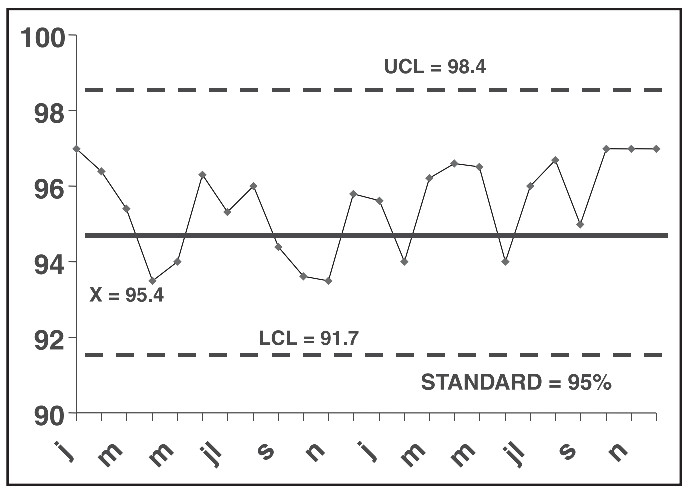

Figure 1. Performance Result

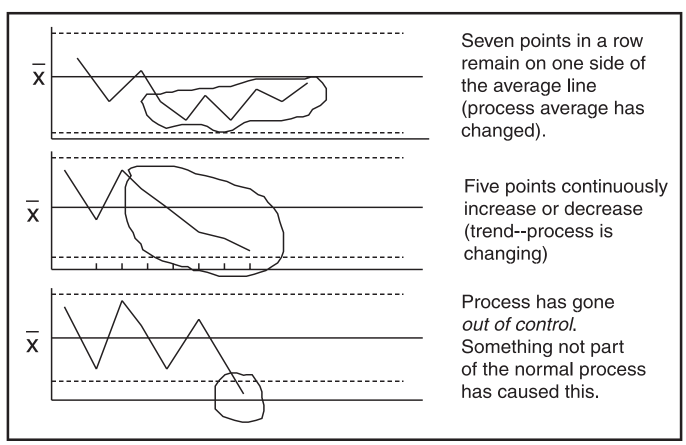

Figure 2. Control Chart Interpretation

ranges available from baseline data. Then, just take an average of these moving ranges. At this point, you should have an average performance of 81 and an average moving range of 2.25 (mean of 2, 1, 4, and 2). We are almost there.

Third, calculate the control limits. The formula for the upper control limit is the performance average + (2.66 times the average moving range). The figure 2.66 is a constant used for this kind of chart. In this case, that would be 81 + (2.66x2.25) = 87. We use the same numbers for the formula for the lower control limit, except that we subtract. So the lower control limit would be 81 – (2.66x2.25)=75. Now, the chart looks something like Figure 3. This is a stable process. Note that the lines were extended into the future. We are going to plot all subsequent performance on this chart and use these lines to interpret the performance. Do not recalculate unless there is evidence of a shift in the system (as indicated by the first and second *signal* below).

Now all you have to do is apply the rules in Figure 2 to interpret the health of the system. The figure shows types of results that signal something out of the ordinary:

- Seven points in a row remain on one side of the average line.
- Five points continuously increase or decrease (trend).
- A single point falls outside the control limits.

If you see a signal like this, it means something has changed. That change might even be positive, evidence improvement efforts are paying off. These signals also can serve to get your attention when something goes wrong so you can eliminate the problem. I mentioned earlier that SPC can give us guidance as to actions to take. Here are those guidelines:

- If signals are present (significant change in system):
  - Action = focus (perhaps corrective action) on when the signal occurred. Take corrective action if necessary.
- If signals are not present but the result is negative (a *red* condition), the problem does not lie in the month the red condition occurred but is a symptom of a system that allows either too much variation or operates too close to the standard. In either case:
  - Action = correct the system. Analyze and correct the multiple inputs and sources of variation throughout the system. The goal is to improve the average performance, tighten the window of inevitable fluctuation, or both.
- If signals are not present and there are no negative results but a standard value is between the control limits.
  - Action = correct the system as above. It is inevitable that you will bust the standard at some point; we can predict future poor performance.

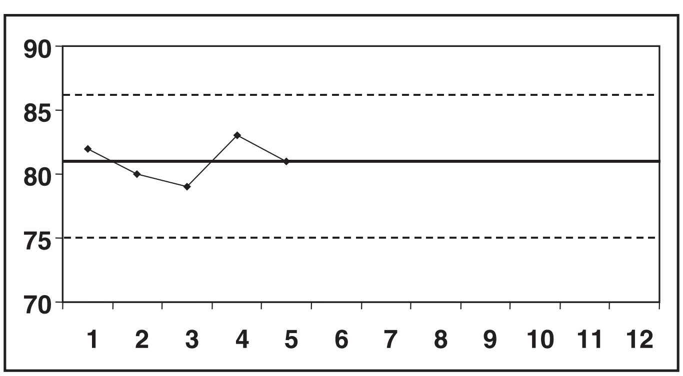

Figure 3. Control Chart

The hard part for most of us is what to do if none of these signals are present and we still have poor performance. For example, on the new control chart (Figure 3), there is a command standard of 80 (up is good). We met it for the first 2 months (green lights), busted it in month 3 (red light), and met it again the final 2 months. What would most of us have done when month 3 went red? We would have looked for reasons in month 3. This is the wrong approach. As stated above, the problem lives in the design of the system, the multiple inputs that factor into it daily. If we tried to focus on month 3, we would likely end up changing something to try to correct the symptom rather than the actual problem. This approach will fail to solve the problem and could make things worse. We probably would have taken no action in months 1 and 2 because we were *green*. But we had evidence of impending failure. The standard of 80 is between the control limits of 75 and 87. In a situation like this, we were bound to fail to meet the standard and knew this even when we were *green*. This knowledge allows us to take action prior to the actual manifestation of the problem.

This is why and how to put SPC to use in your unit. Now let us take a look at one example of SPC in action.

140th Fighter Wing Puts SPC to Work

Colorado ANG's 140th Fighter Wing at Buckley AFB began using SPC to analyze its fleet MC rates in October 1998. The logistics commander, Colonel George Clark, spearheaded the effort to derive as much information as possible from the system and focus efforts on improving the ailing health of the F-16 fleet. When they started, the average fully mission-capable (FMC) rate was 50.78 percent. They could not get a grip on the numbers, which fluctuated randomly from a low of 36 percent to a high of 70 percent. Colonel Clark's initial goal was to use control charts to "let the process measure itself," rather than relying on guesswork and conjecture from multiple parties. Up to that point, they had been using bar charts, with 2 years overlapped into one chart, which makes it virtually impossible to derive all the useful information from the system. Once everyone could see the large amount of variation in the system and that the problems were system-wide, maintenance and supply personnel began to search for ways to tighten up the system, paying attention to all the inputs and processes used to derive the FMC rate (Figure 4). We can see this system is stable, since none of the signals from Figure 2 are present. This means the system was guaranteed to give them results at an average of 50.78 percent (far below the standard of 62 percent), with inevitable and random fluctuations between the control limits of 17 and 85 percent. They continued to plot subsequent FMC rates into this chart. Early in FY00, their first signal appeared. A run of 7 points stayed above the mean. This was evidence the process had changed for the better. When the process stabilized, they recalculated new control limits and a new average line. By February 2002, their chart looked like Figure 5. The new mean jumped from 50.78 to 67.48, a 33-percent increase, pushing the average performance well above the standard of 62 percent. Equally (perhaps more) important was the decrease in variability, yielding a much more tightly controlled system.

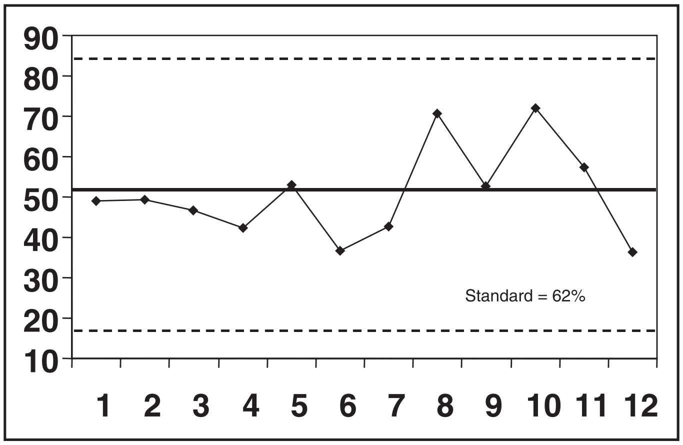

Figure 4. 140 FW FMC Rate in FY99

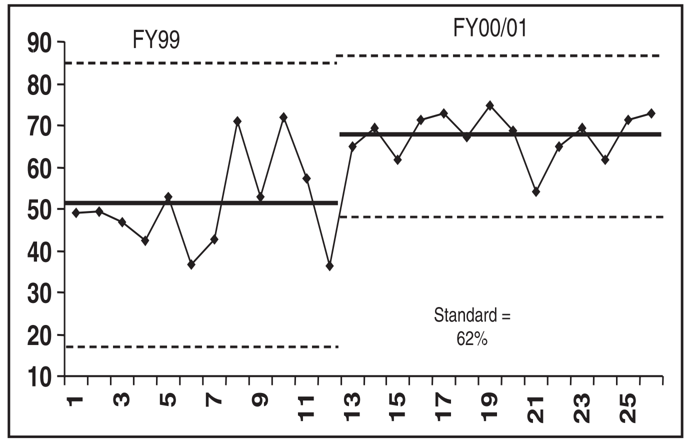

Figure 5. 140 FW FMC Rate Improvement

The FMC rate remains at the same level of performance and variation as in FY03. Colonel Clark and his logistics team continue to use SPC in 2003 to analyze and improve mission capability.

Bottom Line

Commanders and supervisors at all levels need to know most of the charts currently used do not give all the information needed and are frequently misleading. An understanding of variation and use of control charts can give immediate and penetrating insight into the systems. This insight gives the power to more accurately diagnose actual system health, change the focus of efforts from putting out fires to preventing them, and accurately predict future performance levels.

Much has been written about SPC, but I highly recommend a book by Donald J. Wheeler *Understanding Variation: the Key to Managing Chaos*. More indepth mechanics of SPC are spelled out in this book, which is entertaining and a relatively short read but is not a huge tome on statistical theory.

Notes

1. Donald J. Wheeler, *Understanding Variation: The Key to Managing Chaos*, SPC Press Inc, Knoxville, Tennessee, 1994.

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Transforming the Way the Air Force Plans, Deploys, and Sustains Robust, Global Communications for the Warfighter

Lieutenant Colonel Kimberly Crider, USAF

Transformation is not a buzzword—it is a core philosophy, a penchant for innovation that has been a hallmark of Air Force tradition since the Wright brothers first took flight over Kitty Hawk. Even so, the tragic events of 11 September 2001 and the ensuing global war on terrorism have made the need to transform the way the Air Force plans, organizes, equips, and executes air and space capabilities more critical than ever. We now find ourselves in a highly unpredictable environment, requiring our military to adapt and respond rapidly to a variety of potential threats and scenarios. Success in this new environment relies on integrated planning and execution, robust capability, and decision-quality information to deliver specific warfighting at the right time and right place.

Getting decision-quality information into the hands of the warfighter in today's operational environment depends on a robust, worldwide communications capability. The Directorate of Communications Operations, under the Deputy Chief of Staff, Installations and Logistics, is committed to ensuring Air Force communications and information (C&I) professionals are organized, trained, and equipped to provide that capability, whenever and wherever needed. This commitment is reflected in a family of transformational initiatives for Air Force communications operations captured in the Directorate of Communications Operations Strategic Plan. The initiatives promise to advance C&I effectiveness over the next 5 to 10 years and, ultimately, act as a key enabler to increased warfighter capability throughout the full spectrum of operations. This article highlights four important initiatives in the Air Force Installations

and Logistics plan—Unit Code (UTC) Transformation, Theater Deployable Communications (TDC), Operations Tempo Improvements, and Network Optimization—describing how each will contribute to the availability of robust, global C&I capability to support expeditionary aerospace force (EAF) requirements in today's dynamic operational environment.

Communications and Information UTC Transformation

The Directorate of Communications Operations recently chartered a working group, with representatives from all Air Force communications and information specialties, to review and reshape C&I UTCs, transforming them from large, mission-based UTCs to smaller, more flexible, capabilities-based packages designed to support air expeditionary force (AEF) operations. Thus far, more than 200 UTCs have been validated with significant findings for improvement: 12 percent will be revised to ensure appropriate, scalable packages are available to support full spectrum operations, and more than 38 percent have been recommended for deletion, eliminating redundancy and obsolete needs. Top-line changes are already underway and will be implemented in upcoming AEF cycles. The next steps include updating policy and concepts of operations, as well as ongoing revalidation. Major command (MAJCOM) planners applaud the results, stating, "It was a long time coming!"

Theater Deployable Communications

In joint and combined operations, the Joint Task Force (JTF) commander must have access to the status of subordinate forces from all involved services. This requires communications interoperability among all Air Force elements, the JTF commander, the forces of the other services, and continental United States and theater command and control centers. To meet this need, the Air Force is developing and fielding TDC: a lightweight, modular, high-capacity, integrated, deployable communications capability includes switching, multiplexing, network management, super high-frequency satellite terminals, and multiband and multichannel satellite systems. TDC packs a robust set of communications in a small package. Built on open standards and designed specifically to allow commanders to take what they need, TDC provides a highly flexible capability to help make deployed AEFs lighter, leaner, and more lethal. System fielding is well underway, with 50 of 122 suites delivered, and will continue through fiscal year (FY) 2008.

EAF Operations Tempo Improvements

Today, 65 percent of the Air Force combat communications capability and 90 percent of its engineering and installation capability are provided by the Air Reserve Component. Increased requirements to support ongoing deployments have resulted in partial mobilizations and extended tour lengths for reservists and guardsmen, which puts an additional strain on combat operations planning. The Directorate of Communications Operations is looking hard at this problem and has initiated a bottom-up review to find ways to reduce extensive mobilization to satisfy ongoing mission needs or popup crisis operations. The review will be completed in May 2003 and will result in a set of recommendations for ways to meet EAF requirements while decreasing overreliance on mobilizations and extended tour lengths. The study will also be available to other functional communities to help them manage their combat support and sustainment force planning.

Network Optimization

The Directorate of Communications Operations has set off a series of initiatives to optimize Air Force network operations, maintenance, and readiness. These initiatives include partnering with the Air Force Communications Agency to tie Scope Network field knowledge directly back into Combat Information Transport System (CITS) modernization planning, certify and accredit all Air Force *Unclassified but Sensitive Internet Protocol Router Network* circuits, and fully automate system and network compliance management. Additionally, the Directorate of Communications Operations is coordinating with the MAJCOMs and other Air Staff and Department of Defense agencies to implement a Global Information Grid-Bandwidth Expansion capability across 31 Air Force bases by FY04. The selected bases will mark the first step in transforming the Defense Information System Network into a global, robust, trusted, high-speed terrestrial network. Third, the Directorate of Communications Operations is working to normalize Network Operations and Security Center (NOSC) operations via a standard set of processes, equipment, and tactics, techniques, and procedures. The CITS program will provide a standard tool suite to the NOSCs and this year will provide remote management, firewall upgrades, mail relay, and an automated and enhanced C4 status page. Equipment standardization will be complemented by publication of revisions to Air Force Instruction 33-115, Volume 1, *Network Management*, and Volume 2, *Licensing Network Users and Certifying Network Professionals*. Additionally, standard NOSC tactics, techniques, and procedures will be vetted at the Black Demon exercise in March 2003 and published next summer for distribution Air Force-wide.

These efforts are just a sample of the transformational initiatives included in the Directorate of Communications Operations' strategic vision. Others include transformation of Air Force postal operations, C&I integration at Silver Flag, Defense Automated Publishing System implementation, ePubs expansion, strategic sourcing of Air Force Pentagon Communications Agency, information technology asset management, and satellite communications operations optimization. These initiatives are representative of the total commitment by Air Force Installations and Logistics and the Directorate of Communications Operations to provide the Air Force with the best in robust communications and information capability—anytime, anywhere—to meet the challenges of today and tomorrow. For additional information on the Communications Operations Strategic Plan and Transformational Initiatives, please contact Lieutenant Colonel Kimberly Crider, DSN 478-1737, kimberly.crider@pentagon.af.mil.

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(Customer-Oriented Leveling Technique continued from page 21)

4. Buddy Berry, Brad Anderson, Douglas Blazer, John Dietz, and Severine Colborg. "Harmonization of Air Force and DLA EOQ Policies," AFLMA, Maxwell AFB, Gunter Annex, Alabama, Oct 98.
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(Part Grouping continued from page 25)

significant, as seen in the DLA and Boeing part grouping concept demonstration. The end result for the warfighter is improved supply chain health reflected in increased mission capability and readiness.

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15. DLA, Supply Chain Council Awards for Excellence in Supply Chain Operations and Management, 2-2 to 2-12.
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17. Supply Chain Council Awards for Excellence in Supply Chain Operations and Management, 2-5.
18. Supply Chain Council Awards for Excellence in Supply Chain Operations and Management, 2-8
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21. *Supply Chain Council Awards for Excellence in Supply Chain Operations and Management*, 2-11.

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(Agile Combat Support and the Logistics Officer continued from page 29)

concerning logistics. They need the same type of expertise in the logistics arena as they have in operations and maintenance. Commanders cannot count on having the same opportunity General Norman Schwarzkopf did before he felt comfortable in initiating his operation during Desert Storm. With proper training and a true breadth of logistical knowledge and experience, it is possible to have the same confidence in logistics as there is in operations and maintenance.

Recommendations

As mentioned previously, logistics seems to be a catchall, but in reality, it is a very real arena. Therefore, the realignment of logistics should be considered. When a commander, either at a base or headquarters, needs information on logistics, there should be one expert who can provide that information. However, with the vast array of career fields in logistics, having one expert is impossible. One consideration could be to take research and development, acquisitions, and developmental engineering out from under the logistics umbrella and make them their own area of expertise. This would greatly benefit the Air Force, as its future is dependent on these officers and the new technology they develop. Having military officers in these career fields with good career progression will ensure a healthy relationship between the operator and developer as well as ownership—the military member will not have conflicting loyalties.

Another recommendation would be to include munitions and missile maintenance in the maintenance career field, as senior leaders will expect to have one maintenance expert and not maintainers in the logistics field. Yes, this type maintenance is different from aircraft maintenance just as contracting is different from supply in the logistics arena. However, it is important at this point to remember officers are not expected to be the technical experts but managers who ensure the mission is accomplished in the most efficient manner possible. It is the senior noncommissioned officers who are the experts, and the officers should rely on them for indepth and technical information. The officer is expected to manage resources, evaluate situations, and lead the way—not direct which wrench to use or which bolt to tighten.

With these adjustments, a viable logistics officer is possible, with the exception of civil engineering. This area could stay under the logistics group at the base level, which would allow the Air Force to grow very effective engineers, as they understand the tactical requirements of effective base operations and mission support. Young engineering officers will acquire an understanding of the military mission at the base level. They will learn what needs to be developed and how it all comes together to support the greatest military on earth. Then, at the middle and senior level, military engineers will have the expertise needed to support agile combat whenever the occasion arises, whether from a research lab where they develop *light and lean* equipment or on the front line supporting the mission.

If these changes are made, proper training of the logistics officer can begin. In technical school, officers should first get a good working knowledge of the logistics group. The first block of study should be learning the various missions of logistics, then comes a deeper study of the logistics area they will be assigned to first. After 3 years, when the logistics officers are reassigned, they can return to school for specialty training required for their next assignment. There is already a precedence for this type of cross training or breadth of experience as operators do this every time they go into a new weapon system.

Conclusion

We must train as we fight. Agile Combat Support seems to be the way of the future. There may be other occasions where we will be afforded the opportunity to build up our masses before entering into a conflict; however, we cannot count on it. Plans for massive buildups already exist, but America's Armed Forces need to take a deeper look into what is needed for future short-term conflicts. In both instances, the trained logistics officer is invaluable. Logisticians will be the first to go in. They will investigate the security of the area, observe resources available for personnel and equipment, assess what additional supplies are needed, and ensure these items arrive in the quantities needed and when needed.

The pilot will no longer be alone in the empty field but will be flying high because of the combat support provided by the well-trained logistics officer. Who knows, this could be a great plot for a commercial or movie someday.

Notes

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(The Munitions Industrial Base continued from page 37)

capability is expensive and time-consuming. An industry-based approach to advocating funding will ensure the production capability remains for all required commodities in the munitions industrial base. Without this approach, only preferred and highly visible munitions will continue to receive funding with no guarantee of the other, equally as important, commodities maintaining a production capability.

Conclusion

The munitions industrial base has been selected for several years now. Inadequate funding has led to a diminishing contractor base. When a strong industrial base was needed to pull the Air Force through in recent events, it found limited capacity with an even less surge capability. With a change in contracting strategy toward multiple-year contracting, the munitions industrial base can stabilize its workforce and increase production. The funding to do this can come with a new look at advocating munitions funding. If the Air Force moves past the traditional requirements-based funding and looks toward an industry-based approach where it continually purchases commodities at the negotiated minimum sustainable rates for industry, it can ensure a strong munitions industrial base.

One of the six master processes of the Agile Combat Support concept is to *ready the force*. If the Air Force does not take the steps necessary to stabilize the munitions industrial base, Agile Combat Support will fail in its requirement to *ready the force*, and logisticians will have failed.

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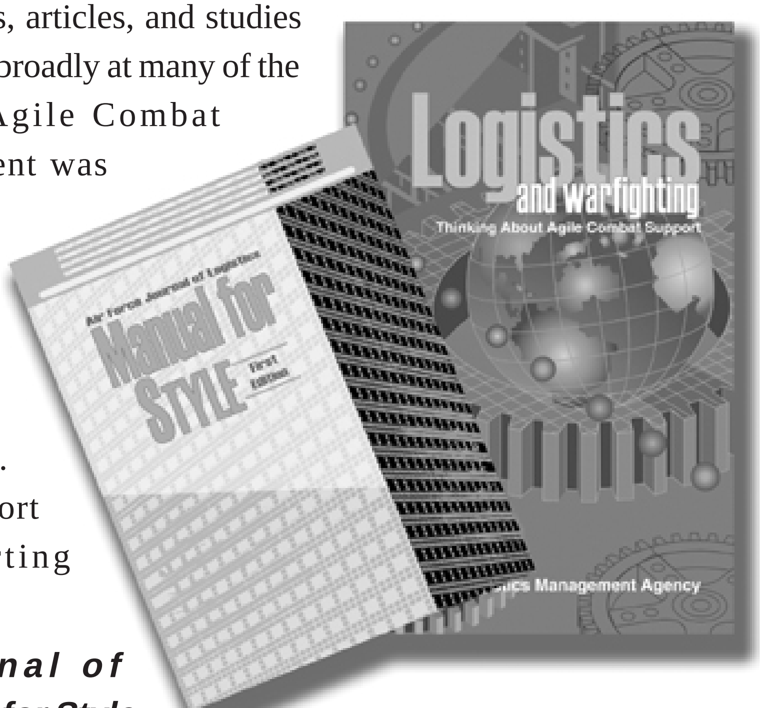

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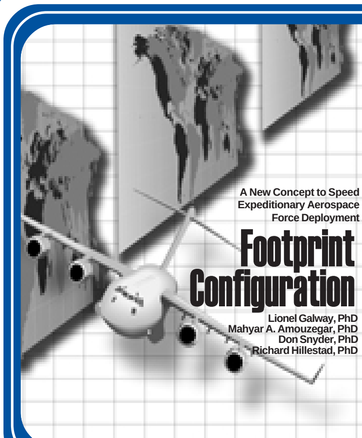

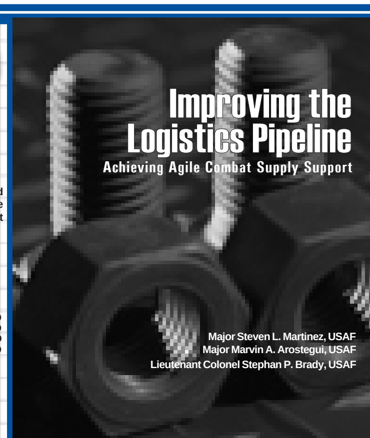

The Editorial Advisory Board selected "Footprint Configuration"—written by Lionel Galway, Mahyar A. Amouzegar, Don Snyder, and Richard Hillestad—along with "Improving the Logistics Pipeline"—written by Major Steven L. Martinez, Major Marvin A. Arostegui, and Lieutenant Colonel Stephan P. Brady—as the most significant articles to appear in the *Air Force Journal of Logistics*, Vol XXVI, No 4.