Special Feature

Supply chain management (SCM) transformation is among the top initiatives for government and the private sector alike. The ultimate objective is an integrated supply chain which perfectly synchronizes supply and demand, so that the rate of supply matches the rate of demand along the entire supply chain.

logistics Supply Chains

Supply Chain Management: Analyzing Industry and Air Force Metrics
Global Logistics Support—The GLSC: Operational Supply Chain Management

The Air Force has embarked on a sustainment vision that transforms the purchasing and supply chain management functions to better support the warfighter. The task at hand is to provide world-class materiel support at the best possible price. To do this, most would agree that an overhaul of the supply chain management process is needed. In "Supply Chain Management: Analyzing Industry and Air Force Metrics" Mr Marshall presents a comparative analysis of industry and Air Force supply chain metrics along with an assessment of the measures to determine the effectiveness of Air Force SCM transformation. The assessment provides several recommendations to improve the current suite of metrics used to manage the Air Force supply chain. Supply chain management is a complex process and no single research effort will yield all of the answers to the suite of metrics that should be used. This article summarizes those best practices that seem to indicate successful SCM implementation and operation.

A major change in the world of Air Force supply is the Global Logistics Support Center (GLSC). The GLSC has three primary functions:

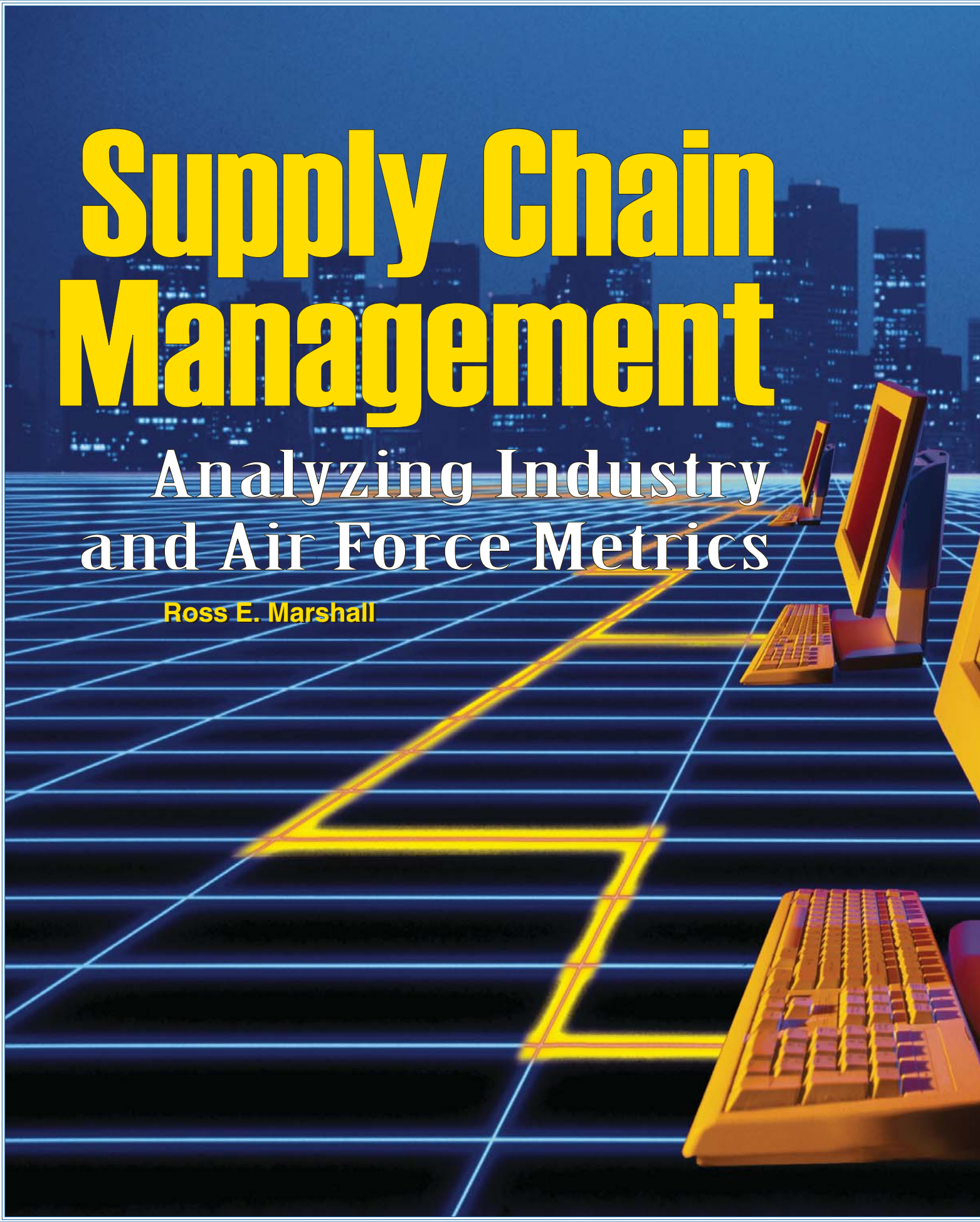
- Enterprise-wide planning of the Air Force supply chain, including planning for material, maintenance, and distribution.
- Providing a single point of contact for customers to resolve immediate logistics issues at the point of execution.
- Providing the single point of entry and authority for enterprise supply chain information management. This will include the management of business rules, processes and procedures, providing functional requirements for supply chain systems and measuring, assessing, and taking action to improve supply chain performance through enterprise metrics and analysis capabilities.

In "Global Logistics Support—The GLSC: Operational Supply Chain Management" Mr Reusser discusses the organizational structure and organizational locations of the GLSC.

Supply Chain Management

Analyzing Industry and Air Force Metrics

Ross E. Marshall



Introduction

Change, then, is part and parcel of today's logistics environment. But those who passively accept change instead of managing it often become its victim, losing control and influence over their environment or even losing their jobs, say the experts. Instead, logistics managers should become change leaders who motivate their organizations to seize the opportunities for improvements that change offers.[1]

—Toby B. Gooley

Special Feature

While current Air Force logistics processes have served us well, and provided unparalleled support since the end of the Cold War, the need to significantly reduce costs while improving weapons system availability is essential. Senior Air Force officials have stated that we've reached a point where our current way of doing the supply chain management (SCM) business, and the systems that support the current process, are limited in their ability to significantly improve readiness beyond the current levels.[2] The logistics doctrines, processes, and systems were developed when there was one large known enemy. Our policies, processes, and training were all optimized to support a major global war, not small-scale contingencies across the globe under widely different constraints.[3] Significant change in sustainment support to the warfighter is a key component in the overall transformation efforts and initiatives being pursued by the Air Force. It is estimated that the overhaul of the SCM system will take 7 years to fully implement.[4] Initially, the overarching goals of the Air Force transformation effort were to improve aircraft systems availability by 20 percent with 0 percent real growth in operating and supporting costs.[5] The goal was later modified, maintaining a 20 percent improvement in weapons system availability with a decrease of 10 percent in operating and supporting costs.[6]

There are several purposes of this article. The first, is to examine SCM processes used within the Air Force and private industry. This is important because a key purpose of the supply chain transformation initiative is for Department of Defense (DoD) logisticians to adopt commercial business practices in an effort to maintain their competitive edge in the rapidly changing global security arena.[7] A brief discussion of Air Force SCM processes will be presented, as well as industry methodologies for managing the supply chain in the private sector. The second purpose is to analyze and assess the usefulness of the metrics and measurements being used, again both within the private sector and the Air Force. These metrics will then be compared to see whether there is a correlation between the two methodologies, and recommendations made as to whether or not the right metrics are being looked at to assess SCM success within the Air Force. It is important for the DoD to have effective SCM because of its impact on military readiness and operations, and the substantial investment in inventory. While the DoD maintains military forces with unparalleled capabilities, timely supply support is critical to sustain them. Since 1990, the DoD's SCM processes have been on the Government Accountability Office's (GAO) list of high-risk areas needing urgent attention and fundamental transformation.[8]

The research methodology will be primarily a review of the existing writings by experts in the field of logistics and SCM, both in government and industry. Also, input from existing Air Force supply

Article Highlights

Despite the proliferation of SCM literature, finding an exact set of measurements which all of industry would agree upon is impossible.

"Supply Chain Management: Analyzing Industry and Air Force Metrics" examines supply chain management (SCM) processes used within the Air Force and private industry. A brief discussion of Air Force SCM processes is presented, as well as industry methodologies for managing the supply chain in the private sector. The article also analyzes and assesses the usefulness of the metrics and measurements being used, again both within the private sector and the Air Force. These metrics are then compared to see whether there is a correlation between the two methodologies, and recommendations made as to whether or not the right metrics are being looked at to assess SCM success within the Air Force.

The research methodology used is a review of the existing writings by experts in the field of logistics and SCM, both in government and industry. Input from existing Air Force supply chain managers was integrated into the analysis.

There have been several long standing discussions within the Air Force regarding how to measure the effectiveness of SCM. This article discusses some of those methods. It concludes with recommendations suggesting the use of specific metrics that will enhance the supply chain manager's ability to meet Air Force goals and more effectively manage the supply chain business.

Major recommendations presented in the article are as follows:

- Continue to use the Sustainment Business Process (SBPM) and Supply Chain Operations Reference Models
- Develop metrics that tie to strategic goals, are actionable, and are leading
- Continue to implement Lean and Six Sigma practices to improve the supply chain.
- Tie appraisal performance awards to successful management of SCM metrics

chain managers will be used. While it is recognized that each of the Services has slightly different approaches to SCM, the scope of this project (principally the government methodologies and recommendations) will be limited primarily to the Air Force.

Regarding performance measures, there have been several long standing discussions within the Air Force regarding how to measure the effectiveness of SCM. This article will discuss some of those methods. Recommendations will be made suggesting the use of specific metrics which will enhance the supply chain manager's ability to meet Air Force goals and more effectively manage the supply chain business.

Supply Chain Management

> *Whether push or pull, our current logistics are reactive. At best, unless we embrace a new paradigm, we will still be depending on the warfighters to tell the logisticians what they need, then trying to supply it as fast as they can. This amounts to an industrial age vendor struggling to satisfy an information age customer. Reactive logistics—the old logistics—will never be able to keep up with warfare as we know it.*[9]
>
> **—The Honorable Michael Wynne, Secretary of the Air Force**

SCM transformation is among the top initiatives for government and the private sector alike. The ultimate objective is an integrated supply chain which perfectly synchronizes supply and demand, so that the rate of supply matches the rate of demand along the entire supply chain.[10] While the principle sounds simple, actual implementation is very difficult. In fact, few businesses feel they really have control over their supply chains and the challenges to optimize such are substantial.[11]

In order to assess government and industry approaches to SCM, and the respective metrics used to measure the supply chain, one must first understand what SCM is, the policies that govern it, and the current processes and initiatives being implemented to improve it. There are numerous definitions of SCM, ranging from simple to complex, which can be found in books, journals, papers, and articles. The following are some common definitions taken from academia, industry, and government.

First, an SCM definition from academia: Dr John Mentzer, a noted expert, author, and professor of SCM at the University of Tennessee, has published numerous articles and written textbooks on supply chain fundamentals and is a leading consultant for many businesses. He defines the supply chain as: "a set of three or more companies directly linked by one or more of the upstream and downstream flows of products, services, finances, and information from a source to a customer.[12]

Mentzer continues to explain that SCM is then:

> …the systemic, strategic coordination of the traditional business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole.[13]

Within the private sector, the foremost industry authority on SCM is the Supply Chain Council (SCC). The SCC is comprised of nearly a thousand companies specializing in SCM and

logistics functions. They perform SCM studies and research, present conferences and workshops, provide training, accomplish case studies, and publish articles on SCM issues and best practices. The SCC is the author and developer of the Supply Chain Operations Reference (SCOR) Model, a proven methodology and the only cross-industry supply chain standard being accepted, which facilitates the blending of business objectives, strategy, process, and technology. The SCOR Model will be discussed in more detail later in this article. The SCC defines the supply chain as "the management of internal logistics functions and the relationships between the enterprise and its customers and suppliers."[14]

The DoD definition focuses on the primary mission of logistics—that of providing materiel and related services to the operational customer. The definition, as proposed in the *DoD Supply Chain Management Implementation Guide*, is as follows:

> DoD supply chain management is an integrated process that begins with planning the acquisition of customer-driven requirements for material and services and ends with the delivery of material to the operational customer, including the material returns segment of the process and the flow of required information in both directions among suppliers, logistics managers, and customers.[15]

Simply put, SCM is the management of all processes and functions that are necessary to satisfy a customer's order.

Within the DoD, numerous policies and procedures govern the SCM process. Joint Vision 2020 directs our forces to be faster, more lethal, and more precise through ongoing transformation in dominant maneuver, precision engagement, focused logistics, and full dimensional protection.[16] *The National Security Strategy of the United States of America* describes the pursuit of three priorities, one of which is to improve the capacity of the agencies to "execute responses."[17] This implies that we need to be more expeditionary and develop characteristics of stealth, speed, range, accuracy, lethality, agility, sustainability, reliability and superior intelligence. *The National Military Strategy of the United States of America* describes strategic principles which are imperative to contend with the characteristics of the security environment.[18] One such principle, that of agility, is described as the ability to rapidly deploy, employ, sustain, and redeploy capabilities. Additionally, the importance of mobility will necessitate more expeditionary logistics capabilities. Focused logistics provides the right personnel, equipment, and supplies in the right quantities and at the right place and time. Such focused logistics capabilities will place a premium on networking to create a seamless end-to-end logistics system that synchronizes all aspects of the deployment and distribution process.[19] *The 2006 Quadrennial Defense Review* (QDR) emphasizes the fact that the Department needs to focus on improving visibility into supply chain logistics and assess supply chain metrics.[20] Air Force SCM policies also tie to and conform to DoD's logistics strategies as outlined in the *Defense Logistics Strategic Plan*.[21] This plan sets the overall direction for the military logistics process for the 21st century. The DoD also provides SCM guidance through the *DoD Supply Chain Materiel Management Regulation*, published in May 2003.[22] This document provides guidance on the use of metrics to manage the supply process, as does Air Force Policy Directive 20-1, which states that "crucial logistics goals" must be developed.[23]

The *DoD Supply Chain Management Implementation Guide* is the bible for SCM implementation and improvement within DoD.

Article Highlights

- Focus on real-time training for Supply Chain Managers

While there appears to be no one, agreed-upon solution to the most successful SCM processes and measurements, there are some basic best practices. Mr Reusser concludes that Air Force SCM processes and metrics are not perfect, but, for the most part, they are on track. The use of the Supply Chain Operations Reference Model is having a significant impact in both the public and private sectors, which is evidenced by the numbers and types of organizations that are members of the Supply Chain Council. The Air Force Materiel Command has chosen a very complex process, the Sustainment Business Process Model (SBPM), to achieve SCM transformation. The SBPM should be worked in concert with the Air Force Global Logistic Support Center. Staying focused on the strategic goals of the Air Force, and developing actionable and leading metrics will be critical to the success of SCM improvement.

Article Acronyms

AFMC – Air Force Materiel Command
AFLMA – Air Force Logistics Management Agency
ALC – Air Logistics Center
BSC – Balanced Scorecard
CCOR – Customer Chain Operations Reference
CRM – Customer Relationship Management
DCOR – Design Chain Operations Reference
DoD – Department of Defense
ECSS – Expeditionary Combat Support System
GAO – Government Accountability Office
GLSC – Global Logistics Support Center
IT – Information Technology
MC – Mission Capable
MICAP – Mission Capability
O&S – Operation and Support
SBPM – Sustainment Business Process Model
SCM – Supply Chain Management
SCC – Supply Chain Council
SCOR – Supply Chain Operations Reference
SKU – Stock Keeping Unit
TNMCS – Total Not Mission Capable Supply
TNMCM – Total Not Mission Capable Maintenance
UTC – Unit Type Code
WIP – Work in Process

It provides a roadmap for implementation and presents key principles and strategies for achieving progress toward fully incorporating SCM into the DoD logistics process. It was developed as a tool to assist DoD logisticians at all organizational levels who want to improve materiel support and service to customers.[24]

Within the Air Force Materiel Command (AFMC), the primary resource for SCM implementation is the Sustainment Business Process Model (SBPM). The SBPM describes nearly every element needed to implement a successful SCM process within the Air Force. It includes strategic, operational, and tactical level guidelines. The SBPM is an integrated end-to-end approach to SCM. It covers the range of supplier relationship management (SRM), SCM, and customer relationship management (CRM). SRM refers to collaboration with suppliers in design, sourcing, and buying. It involves contract performance, supplier risk analysis, and strategic process standardization. CRM involves satisfying customers by filling and managing orders more expeditiously and with better quality. SCM is the supply and demand planning bridge between SRM and CRM, and includes such elements as developing the demand forecast, conducting tactical planning and scheduling, managing assets, and performing inventory optimization analysis. The SBPM specifically describes nine critical elements that are needed for SCM implementation. They are:

- Strategic planning
- Managing customers
- Planning the supply chain
- Sourcing
- Make or repair
- Deliver
- Return
- Product sustainment
- Enabling

The SBPM is an expansion of the SCOR Model, which focuses primarily on the plan, source, make, deliver, and return portions of the process.

While the military logistics environment may differ somewhat from the private sector, much of what is currently being done to implement SCM transformation in the Air Force has been learned and patterned after industry practices. Within the private sector, each market or group of customers has a set of needs and the supply chain must be responsive to those needs. Decisions are made regarding how well the supply chain serves its market and how profitable it is for the supply chain participants.[25]

Linking policy and strategy to performance normally requires goals and objectives, as well as a complete measurement system to track progress. Getting the metrics right is critical in determining the success of SCM transformation and implementation. The measurement system cannot simply measure for the sake of measuring.[26] Measurements should drive recommendations and decisions that are actionable. This makes the choice of performance measurements one of the most critical challenges facing organizations. This is true because what gets measured, gets managed, gets fixed. In essence, what you measure is what you get.[27]

The following sections of this article will describe both industry and government SCM measurements, and the methodologies used to develop those measurements. A comparison of private sector and government metrics will then be done and recommendations made, based on best practices for measuring the supply chain.

Private Sector Supply Chain Management Metrics

Implementing a set of world-class logistics performance indicators is a prerequisite to any organization being able to achieve world-class logistics. The reason is simple: people behave based on the way they are measured. World-class measures lead to world-class behaviors.[28]

—Edward Frazelle

Despite the proliferation of SCM literature, finding an exact set of measurements which all of industry would agree upon is impossible. This is, in part, because of the past focus on areas such as customer service, cost reduction, and new technologies.[29] Also, little research has been conducted on performance measures that span the entire supply chain spectrum.[30] A major driver as well is the fact that performance measures should be driven by company goals and objectives, which differ significantly by company. While various supply chain experts recommend the use of different approaches and SCM metrics, there are some similarities. The following is a representative selection of SCM approaches to metrics development used in industry. These were selected because they are utilized by some of the most noted authors, experts, and organizations in the SCM arena.

Metrics	Reliability	Responsiveness	Flexibility	Cost	Assets
Perfect Order Fulfillment	X				
Order Fulfillment Cycle Time		X			
Upside Supply Chain Flexibility			X		
Upside Supply Chain Adaptability			X		
Downside Supply Chain Adaptability			X		
SCM Cost				X	
Cost of Goods Sold				X	
Cash-to-Cash Cycle Time					X
Return on Supply Chain Fixed Assets					X
Return on Working Capital					X

Table 1. SCOR Level 1 Metrics

Performance Categories	Customer Service (Measured by Fill Rate, On Time Delivery, and Product Returns)	Internal Efficiency (Measured by Inventory Turns, Return on Sales, and Cash-to-Cash)	Demand Flexibility (Measured by Cycle Times, Upside Flex, and Outside Flex)	Product Development (Measured by New Product Sales, Percent Revenue, and Cycle Time)
Business Operations				
Demand Forecast	X	X	X	
Product Pricing	X	X		
Inventory Management	X	X		
Procurement		X	X	
Credit and Collections	X	X		
Product Design	X			X
Production Scheduling		X	X	
Facility Management	X	X		
Order Management	X	X		X
Delivery Schedule	X	X		

Table 2. Strategic Business Performance Metrics

As previously mentioned, the SCC is recognized as an authority on SCM. It consists of nearly a thousand companies worldwide, many of which use the Council's services of training, research, and SCM implementation processes. The SCC is the author of the SCOR Model. The SCC created the SCOR Model as a way for companies to communicate their supply chain process. It establishes a framework for examining the supply chain, categorizing processes, and assigning metrics. Numerous commercial entities, including the aerospace and defense industry, as well as large consumer product manufacturers, helped to develop and implement the SCOR Model.[31] As previously mentioned, the SCOR Model combines and integrates the process elements of a business. The process is defined by the elements of plan, source, make, deliver, and return, and views the process across a full spectrum from the suppliers' supplier to the customers' customer. SCOR Model comprises measures in three levels. Each is a subprocess of the previous plan, source, make, deliver, and return process. SCOR performance measures include more than 100 different metrics which can be used. Changes are constantly being made to the model and metrics, as companies develop new best practices. Metrics have been streamlined and, in fact, metrics in the latest version of the SCOR Model, (SCOR Version 8.0), show level 2 processes with the addition of a cost metric.[32] Version 8.0 of the SCOR Model also describes the Design Chain Operations Reference (DCOR) Model and Customer Chain Operations Reference (CCOR) Model, which were recently announced. CCOR is a reference Model that integrates customer and supplier processes, such as reengineering, process measurement, and benchmarking activities for business transformation. DCOR identifies principal process elements found throughout the design chain and links them to performance attributes and metrics. DCOR and CCOR are product and industry neutral and are cross industry and cross functional.[33] Table 1 is an illustration of the level 1, or strategic level metrics, recommended in the SCOR Model.

Michael Hugos, a noted author and practitioner of SCM concepts, suggests that there is a basic pattern to the practice of SCM and the development of its measures.[34] He suggests that the supply chain consists of five major business drivers. These drivers are production, inventory, location, transportation, and information. Businesses must align their business strategies around these five drivers. Next, in gaining a high level understanding of these drivers, and how they relate to each other, Hugos recommends that the SCOR Model, developed by the SCC be used.[35] The plan, source, make, deliver, and return categories are the day-to-day operations that determine how well the supply chain works.

Hugos then argues that metrics must be developed in four performance categories. These are customer service, internal efficiency, demand flexibility, and product development.[36] It is at this point that he contends that companies can no longer survive by using lagging metrics (those metrics that are based purely on history), and that leading metrics must be used because the business environment is now characteristic of shorter product life cycles, smaller niche markets, new technologies, and new opportunities.[37] The SCOR Model presents data at three different levels of detail; strategic, tactical, and operational. Table 2 shows strategic level metrics, as recommended by Hugos, which would be used for the company as a whole. Table 3 shows tactical and operational level metrics displayed at the supply chain manager level where the work is actually performed.

These measures are used in some form by a variety of companies such as Dell, 7-Eleven, Wal-Mart, Perkins, Eastern Bag, and Proctor and Gamble.[38]

Another practitioner in supply chain strategy is Edward Frazelle. Frazelle suggests that all world-class logistics organizations are characterized by a number of things, one of which is the extensive use of logistics key performance and

financial indicators.[39] He recommends that a company's metrics be designed around four businesslike performance areas and five interdependent processes. The performance areas are financial, productivity, quality, and cycle time. The five processes are customer response, inventory planning and management, supply, transportation, and warehousing.[40] Table 4 illustrates the specific measures recommended by Frazelle and used by the companies for which he consults.

Peter Bolstorff and Robert Rosenbaum are two additional experts in the field of SCM. They suggest that most companies do not have a good handle on their supply chains. They believe, however, that if one can define the organization's supply chain (which should not be hard to do), then it can certainly measure it. Once "...you begin to measure it, you'll find great opportunities to drive continuous process improvement to it."[41] Bolstorff and Rosenbaum are avid believers in the balanced scorecard (BSC), developed by Robert Kaplan and David Norton, and SCOR Model processes. Most private sector businesses today have been influenced by the BSC approach to developing business metrics. Kaplan and Norton's book, *The Balanced Scorecard: Translating Strategy into Action*, published in 1996, is

	Performance Metrics	Complexity Measures	Configuration Measures	Practice Measures
Plan	- Planning costs - Financing costs - Inventory days of supply	- % of order changes - # of SKU's carried - Production volume - Inventory carrying cost	- Product volume by channel - # Channels - # of supply chain locations	- Planning cycle time - Forecast accuracy - Obsolete inventory on hand
Source	- Material acquisition costs - Source cycle time - Raw material days of supply	- # of suppliers - % of purchasing spending by distance	- Purchased material by geography	- Supplier delivery performance - Payment period - % items purchased by lead times
Make	- # of defects - Make cycle time - Build order attainment - Product quality	- # of SKU's - Upside production flexibility	- Manufacturing process steps by geography - Capacity utilization	- Value add % - Build to order % - Build to stock % - % manufacturing order changes - WIP inventory
Deliver	- Fill rate - Order mgt costs - Order fulfillment lead times - Line item return rates	- # orders by channel - # line items - % of line items returned	- Delivery locations by geography - # of channels	- Published delivery lead times - % invoices with billing errors - Order entry methods

Table 3. Tactical and Operational Performance Measures

	Financial Indicators	Productivity Indicators	Quality Indicators	Response Time Indicators
Customer Response	- Total response time - Cost per customer	- Customer orders per person hour	- Order entry accuracy - Communication accuracy - Invoice accuracy	- Order entry time - Order process time
Inventory Planning and Management	- Total inventory cost - Inventory cost per SKU	- Inventory turns - SKU's per planner	- Fill rate - Forecast accuracy	
Supply	- Total supply cost - Supply cost per purchase order	- Purchase orders per person - SKU's per buyer	- Perfect purchase order %	- Purchase order cycle time
Transportation	- Total Transportation cost - Transportation cost per mile	- Stops per route - Fleet yield - Container capacity utilization	- On-time arrival % - Damage % - Miles between accidents	- In-transit time
Warehousing	- Total warehousing cost - Warehousing cost per piece - Warehousing cost per square foot	- Units per person - Storage density	- Inventory accuracy - Picking accuracy - Shipping accuracy - Damage % - Hours between accidents	- Warehouse order cycle time
Total Logistics	- Logistics expenses - Logistics profit - Logistics asset value - Logistics asset turnover - Logistics capital charges - Total logistics cost - Logistics cost-sales ratio - Return on logistics asset - Logistics value added	- Perfect orders per logistics full-time equivalent	- Perfect order %	-Total logistics cycle time

Table 4. Performance Measures

still one of the most popular texts used for developing measures for both private sector businesses and government entities. The BSC provides executives with a comprehensive framework that translates a company's vision and strategy into a coherent set of performance measures.[42] These measures are typically organized into four different perspectives: financial, customer, internal business processes, and learning and growth.[43] By using these four categories of measures, a company *balances* its approach to things most important across the spectrum of the business. The BSC is also a way to minimize information overload by limiting the number of measures used.[44] As will be seen in the next chapter, the BSC approach is specifically used by the Air Force. Bolstorff and Rosenbaum's consulting techniques include a session on developing a balanced set of supply chain metrics with an associated *SCORcard*.[45] The SCORcard is simply a format of SCOR metrics in which a company inserts its business measures. In a perfect world, the Bolstorff and Rosenbaum metrics would be simple—slice financial and customer data by product to come up with an infinite number of perfectly matched measures. Unfortunately, the large number of measures generated makes this nearly impossible. Hence, they suggest a *SCORcard* be developed and defined around customer, internal, and shareholder data and interests.[46] The SCORcard must be flexible in order to allow companies to make decisions on where to track certain measures. For example, a company may report the profitability measures at multiple layers of the organization and the balance sheet only at the corporate level; or it may track revenue by customer, but costs at the product group level. However, in the end, Bolstorff and Rosenbaum believe the SCOR Model is a proven methodology and provides the best practices in SCM, including metrics development, and therefore, should be used when developing a company's strategic, tactical, and operational measures. Table 5 depicts the set of metrics recommended by Bolstorff and Rosenbaum and is in harmony with the SCC's SCOR Model.

Dr Tom Mentzer, who chairs the Supply Chain Management Department at the University of Tennessee, is one of the most sought after authorities in the supply chain business. He is a noted author and consultant for numerous private companies.[47] His guidance has been used by many corporations in establishing supply chain processes and metrics.

Dr Mentzer suggests that to be successful in the SCM business, companies have implemented what he terms the *twelve drivers of SCM competitive advantage*.[48] The twelve drivers are described as follows:

- Coordinating the traditional business functions
- Collaborating with supply chain partners on noncore competency functions
- Looking for supply chain synergies
- Noting that all customers are not created equal
- Identifying and managing the supply chain flow cycles

Performance Category	Level 1 Metrics	Level 2 Metrics	Level 3 Metrics
Supply Chain Delivery	- Delivery performance - Fill rates - Perfect order fulfillment	- On-time delivery - Manufacturing schedule attainment - Warehouse on-time shipment - Transportation on-time delivery - Forecast accuracy - Supplier match % - Customer match %	- Customer orders delivered on time per total number orders - Customer lines delivered on time - Order shipping accuracy - Other metrics as determined by department
Supply Chain Responsiveness	- Order fulfillment lead time	- Order receipt to order entry - Order entry to order shipment - Order shipment to order receipt	- Delivery date of each order - Other metrics as determined by department
Supply Chain Flexibility	- Supply chain response time - Production flexibility	- Source lead time - Order fulfillment - Lead time for order items - Days required to change labor, material, or capacity	- Lead time for constraint items - Manufacturing cycle times - Order fulfillment times - Other metrics as determined by department
Supply Chain Cost	- Cost of goods - Total SCM costs - Selling, general, and administrative costs - Warranty and return costs	- Direct, indirect, material cost - Order manufacturing cost - Material acquisition costs - Information technology cost - Inventory carry cost - Returns cost	- Cost centers - Customer service cost - Warehouse cost - Transportation cost - Cost to support supply chain - Other metrics as determined by department
Supply Chain Asset Management	- Cash to cash cycle time - Inventory days of supply - Asset turns	- Days payable - Days WIP - Days inventory - Working capital fixed assets	- Accounts payable - Material costs - Accounts receivable - Other metrics as determined by department
Profitability	- Gross margin - Operating income - Net income	- Revenue - Cost of goods - Taxes	- Use level 2 metrics - Other metrics as determined by department
Effectiveness of Return	- Return on assets	- Revenue - Cost of goods - Taxes	- Net operating income - Other metrics as determined by department
Share	- Earnings per share	- Company specific	- Use company formula

Table 5. SCM Performance Measures

- Managing demand in the supply chain
- Substituting information for assets
- Recognizing that systems are templates to be laid over processes
- Realizing that not all products are created equal
- Making yourself easy to do business with
- Not letting tactics overshadow strategies
- Making sure your supply chain strategies and your reward structures are aligned

The last element is where Mentzer focuses attention on measurements. He writes," What gets measured gets rewarded, and what gets rewarded gets done."[49]

His methodology for developing the key logistics measurements starts with strategy formulation. Once the corporate strategy has been determined and is understood, planning should take place. Planning is defined as the deliberate process to produce a specific outcome. It includes the design of the logistics system, taking into account all of the elements needed to be both effective and efficient. Next the business must organize for success. There is not much literature found that identifies an ideal organization or structure for SCM. However, Mentzer suggests that understanding specifically what customers want and their resulting input expectations is fundamental to achieving customer satisfaction and therefore should drive the organizational structure.[50] Once the structure is in place, performance measurements can be developed. The key to the specific measures is to reward the company employees and supply chain partners who act in ways consistent with the business strategies. The performance dimensions should include measures of efficiency, effectiveness, quality, productivity, quality of life, innovation, profitability, and budgeting. Key measures include outbound freight cost, order fill rate, on-time delivery, customer complaints, inbound freight cost, order cycle time, forecast accuracy, invoice accuracy, and equipment downtime.[51] Dr Mentzer believes that there has been no firm evidence of the value of the SCOR approach.[52] He further believes that there is no one set of governing standards that define a business model.[53]

The approaches to SCM practices and measures of these notable authors and experts provide a good understanding of the supply chain techniques and metrics being used in the Air Force.

Air Force Supply Chain Management Metrics

From the MAJCOM perspective, there is an expectation that all kits remain full and back orders be driven to zero. From the Air Staff perspective, it would seemingly be that the Net Operating Result is realized and that metrics do not get any worse. From the AFMC perspective, the expectation should be that the logistics system achieves the level of performance that is consistent with its funding level.[54]

—AFMC Supply Chain Metrics Guide

The challenge facing the Air Force logistics community is to provide the best possible material and services support to the operational warfighter at the lowest possible price.[55] However, the Air Force logistics pipeline is a very complex system of interrelated functions, organizations, and processes, responsible for processing millions of dollars of consumable and reparable assets per day.[56] Effective SCM ultimately relies upon the ability to transform a seemingly limitless amount of information into meaningful and useful measurements to guide the sustainment operations. Properly doing so will optimize Air Force supply chain performance.[57]

Over the years, there have been several recommended approaches to Air Force supply chain metrics. Within the Air Force Materiel Command (AFMC), the Directorate of Logistics (HQ AFMC/A4) is responsible for Air Force-managed depot-level reparable spare parts and Air Force-managed consumable spares. In an effort to determine the right metrics to track, research initiatives were implemented and many different approaches emerged. In 1999, the Logistics Management Institute (LMI) was contracted to study SCM metrics and make recommendations. It recommended applying a balanced scorecard approach to basic industry-oriented performance and cost measures as documented in the SCOR Model.[58] The study specifically recommended a set of performance measures tailored for DoD use.[59] This plan identified a total of 110 metrics at the enterprise, functional, and process level.[60] SCM implementers were encouraged to use these measures when selecting the suite of logistics metrics for the future supply chain environment.[61] In 2001, at the request of the Air Force Deputy Chief of Staff for Installations and Logistics, the Air Force Logistics Management Agency (AFLMA) developed a set of measures. The AFLMA set of metrics consisted of 23 measures in 6 segments of the supply process.[62] In 2003, DoD published DoD Regulation 4140.1-R outlining the requirements and procedures for DoD managers working with the supply system. The regulation directs DoD components to use metrics to evaluate the performance and cost of the supply chain operations.[63] The regulation also directs DoD entities to use the SCOR Model.[64] In November 2003, the AFMC Supply Chain Management Division published the *AFMC Supply Chain Metric Guide*, recommending the most recent supply metrics to be used to manage the supply chain.[65] The *AFMC Supply Chain Metric Guide* highlights 10 metrics, 4 of which are performance measures and 6 of which are process oriented.[66]

Through these several initiatives, significant strides have been made to develop supply chain metrics for DoD activities. Based on what has been considered industry best practices, and highly influenced by the SCC, DoD recommended the BSC and the SCOR Model as the approach to SCM metrics.[67] DoD has actually been investigating the SCOR Model since 1997, and since that time, every branch of service has applied the SCOR Model in some way.[68] The Marine Corps is using it to help consolidate their information systems, the Navy has used it to help benchmark their process performance, the Army has studied its best commercial practices, and according to Air Force supply chain managers, the Air Force has incorporated it in its overall SBPM. The SBPM is the current Air Force initiative to transform the entire SCM process and develop its metrics. So, while the current metrics may not overlay completely with the SCOR metrics, that is certainly the intent for the future.

In the meantime, the Air Force Materiel Command (AFMC) has embraced the BSC as its approach to metrics development. Each air logistics center (ALC) and product center has been directed to develop a BSC which feeds into the Command Scorecard. See Figure 1 for an example of AFMC's balanced scorecard, and Figure 2 for an example of Ogden ALC's balanced scorecard.

Operational level and tactical level metrics are reported at the various levels of management within the organization. These measures reflect a level of indenture below the strategic metrics. Operational measures include weapon system mission capable (MC) rates, total not mission capable for supply (TNMCS), total not mission capable for maintenance (TNMCM), weapon system availability, and operation and sustainment costs. The MC rate is a reflection of the percent of the time the weapon is capable and ready to perform its mission. TNMCS and TNMCM are indicators of the percent of time a weapon system is unavailable because of waiting for parts or a maintenance action. Weapon system availability is a measurement of the number of items (aircraft) that are available and mission capable. Lower level metrics are managed by the respective supply chain managers and tend to blend with operational metrics.

As can be seen, a significant challenge is keeping the metrics simple and to a minimum number, yet making them meaningful such that they provide a picture of the health of the supply chain. Table 6 summarizes the metrics currently used by ALCs.

Comparative Analysis

The Air Force is different from other enterprises in many ways, but not in the most essential ones: You coordinate the work of many people to create products and services that you deliver to customers whose expectations are rising faster than your resources.[69]

—M. Michael Hammer

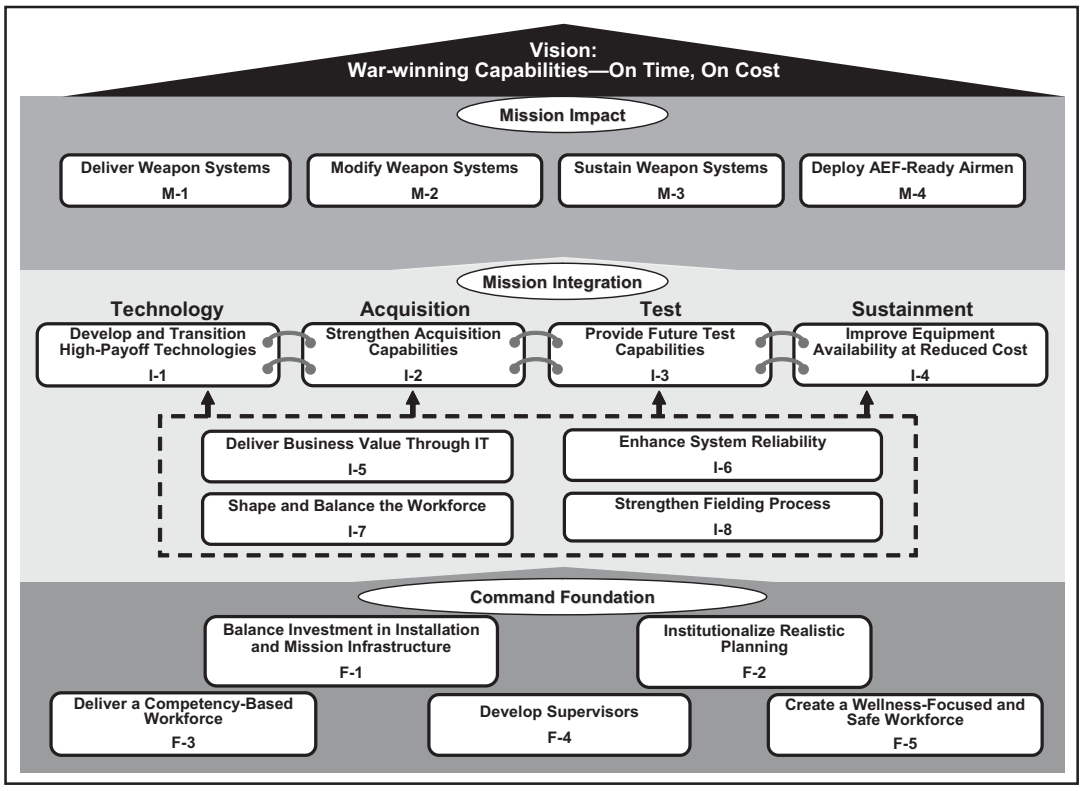


Figure 1 – AFMC Balanced Scorecard

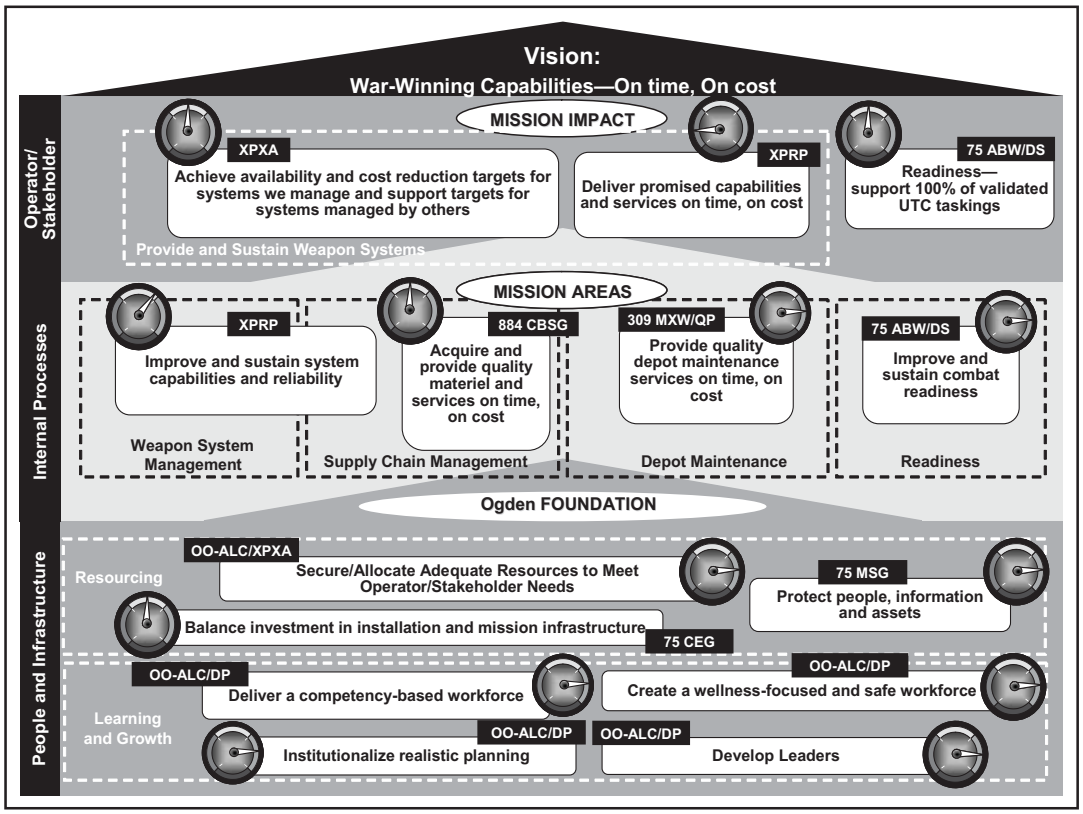


Figure 2. Ogden Air Logistic Center Balanced Scorecard

In order to provide Air Force supply chain managers with valid suggestions on how to manage supply chain performance, a comparison of metrics used by private industry and the Air Force is necessary. While significant differences exist between industry and DoD approaches, there are many similarities as well.[70] The GAO has been assessing and reporting on logistics and supply chain efficiency for several years. In a March 2001 report, it stated that the DoD needs to make more use of supply chain best management practices similar to those used in the private sector to help cut costs and improve customer support, and employ various methods to speed up the flow of parts through the logistics pipeline.[71] Again in 2005, the GAO reported that SCM transformation was an essential element of DoD's business and critical to the success of the department.[72] The report validates that the department is on track with some of its performance metrics, including level of back orders, customer wait time, and orders on time. However, more attention needs to be paid to cost and the implementation of other industry best practices.[73]

Table 7 compares the metrics being used by the Air Force and those being used by several private sector companies. Because of the sensitivity of the private sector data, company names have not been used. Rather, they have been designated by the letters A, B, C, and so forth. The companies represent a wide range of the industry sector, from major aircraft manufacturing companies to household consumer product suppliers and transportation companies. The measures compared are primarily strategic and operational level metrics, and are those most commonly used by several companies. Some companies use slightly different names for the same basic metric. In that case, the most commonly used measure name was used. Since several of the companies are members of the SCC, and their metrics are influenced by the SCOR Model, the SCOR metrics were listed even if not used by a particular company. The data was obtained from a variety of sources. In some cases, data was received informally from company contacts. In other cases, data was obtained from research done by others; however the disclosure of specific company names was not allowed. Some companies' data was received through a third party and therefore inappropriate to release. Again, for these reasons, specific company names are not used.

The data in Table 7 indicates that several organizations, including the Air Force, use similar measures to manage their supply chains. While companies associated with the SCC tend to use the SCOR Model metrics, even they are not consistent in using all of the SCOR recommended metrics. Most companies are very focused on cost and supplier quality. They also are quite focused on tracking downside adaptability, which is an indication of cost when requirements are reduced. Upside flexibility and adaptability are not being used by many supply chain managers, which is surprising since this is a reflection of their suppliers' abilities to meet changing demands, and would seem to be another critical element needing to be managed within the supply chain. Also, few companies seem to be overly interested in the success of their customers, as indicated in both the customer success metric and the availability metric. In an optimal SCM operation, concern would be given for the success of both one's suppliers and one's customers. This trend may change with the growing interest in partnering. Partnerships seem to drive a closer relationship in business aspects of the partners. The data also indicates that little attention is being paid to demand forecasting, another critical element in managing the supply chain. This may not be true. It could simply be that demand forecasting has been difficult to accomplish. Good demand forecasts would enable less supplier adaptability since there would be less variability in the customer orders. Much is being done in the way of systems development to aid in this regard.

Conclusions and Recommendations

Defense logistics is at the heart of all military operations, from supplying the troops with everything from weapons to food items, logistics is an essential tool for the survivability of the forces. In a changing military landscape where military are transforming the way they fight and what their operational needs will be, the need to become more efficient and effective in the way that operations are supported has led nations to transform the way that material readiness and logistics support is delivered.[74]

—Dr James Finley, Deputy Undersecretary of Defense Acquisition and Technology

Upside flexibility and adaptability are not being used by many supply chain managers, which is surprising since this is a reflection of their suppliers' abilities to meet changing demands, and would seem to be another critical element needing to be managed within the supply chain.

Simply put, SCM is the management of all processes and functions necessary to satisfy a customer's order. While the precise metrics needed to measure the supply chain continue to be debated, no one will argue that good measurements are critical in order to successfully implement SCM in the Air Force. In fact, the *DoD Supply Chain Management Implementation Guidebook* specifically calls for "enterprise-wide performance measures" to successfully implement SCM in DoD organizations.[75] The following recommendations are made to further enhance Air Force SCM measurement development:

Recommendation Number 1: Continue to use the SBPM and SCOR

The Air Force has obviously benefited from the work done in the private sector. The current effort underway to shape the SCM

process using the SBPM is a result of the SCC's influence. The Air Force fully intends to proceed with the SCOR Model as it maps out the supply chain processes and further defines its metrics. The Air Force should proceed with the use of SCOR through the SBPM process, but should try to accelerate process completion, since history has shown that long, drawn out systems and process solutions rarely succeed. Continued participation in the SCC is also recommended. The SCC offers numerous benefits to the Air Force by providing information on industry best practices, access to leading experts in SCM, and consulting authorities. A study of the companies on the Forbes Magazine's Fortune 1000 list reflected a significant difference in the profitability of companies that are members of the SCC versus those that are not. The bottom line results were nearly two and a half times higher for SCC members than nonmembers.[76]

Recommendation Number 2: Develop metrics that tie to strategic goals, are actionable, and are leading

Metrics should always be tied to strategic goals. The Air Force has done a good job advertising that its strategic goals are to increase weapon system availability and reduce cost. The Air Force needs to stay focused on these goals. Operational goals need to tie to the strategic goals. For example, mission capability hours and customer wait time directly relate to weapon system availability. These measures are actionable but somewhat lagging. Once they go *red*, it is difficult to reverse the trend.

Additional metrics, such as perfect order fulfillment, demand forecast, inventory, and upside and downside flexibility should be incorporated in the Air Force suite of metrics. These metrics would be actionable and provide supply chain managers better information to manage the logistics business. A common complaint from supply chain managers is that it is difficult to predict or forecast material usage and therefore a faulty plan becomes the major impediment for successful supply chain implementation. The implementation of the Expeditionary Combat Support System (ECSS) will incorporate the necessary software to better forecast requirements. However, supply chain managers cannot afford to wait until the implementation of ECSS. Industry uses buffers as well as upside and downside supply chain flexibility and adaptability metrics to compensate for fluctuations in requirements. The Air Force should incorporate these metrics and continue with corporate contracts and commodity councils to measure and track changes in demand.

Recommendation Number 3: Continue to implement Lean and Six Sigma practices to improve the supply chain.

Implementation of Lean and Six Sigma practices are a proven technique to improving processes. Many seem to believe that Lean practices only work in an industrial area, however, there are numerous examples of Lean successes in administrative and other areas. In fact, at the Ogden Air Logistics Center, a Lean team was established to attack the highest driver impacting the F-16 MICAP, the radar antenna. The team consisted of maintenance personnel, facilities and process engineers, production planning and scheduling technicians, supply technicians, and the supply chain manager. Prior to the establishment of the team, there were 105 radar antenna MICAPs, 180 back orders, production flow times were at 28 days, and work in process (WIP) was 67. In less than a year, the team had reduced MICAPs and back orders to zero, flow times had been reduced by 90 percent, and work in process was down to just 6 items. The supply chain manager was instrumental in implementing initiatives to provide the production line with needed parts, as well as making other changes which improved the mean time between failure by 36 percent, causing the antenna to remain in use longer before needing overhaul. The SCC recognizes the value of Lean and now hosts a SCOR/Six Sigma/Lean Convergence Forum which is designed to help attendees

Performance Metrics	Level 1 (Strategic)	Level 2 (Operational)	Level 3 (Tactical)
Net Operating Results	X		
Deficiency Report	X		
MICAP Hours	X		
Customer Wait Time	X		X
MC Rates		X	X
TNMCS		X	X
TNMCM		X	X
System Availability	X	X	X
O&S Costs	X	X	X
Issue Effectiveness			X
Demand Forecast			X
Back Order Age			X
Cost of Goods Sold		X	X

Table 6. Air Force SCM Performance Measures

Organization	AF	A	B	C	D	E	F	G	H	I	J	K	L
Measurement													
Perfect Order Fulfillment		X	X								X		X
Order Cycle Time	X	X	X	X	X	X	X	X	X	X			X
SCM Cost	X	X	X	X	X	X	X	X	X	X	X	X	X
Cost of Goods Sold	X	X	X	X	X	X	X	X	X	X	X	X	X
Demand Forecast		X									X		X
Issue Effectiveness	X	X	X	X	X	X	X	X	X	X			X
Fill Rates	X	X	X	X	X	X	X	X	X	X	X		X
Back Order Average Age	X	X	X	X	X	X	X	X	X	X	X		
Inventory Turns		X	X									X	X
Supplier Quality	X	X	X	X	X	X	X	X	X	X		X	X
Supplier On Time Delivery		X	X									X	X
Customer Success and MC	X		X									X	
Upside Supply Chain Flexibility													X
Upside Supply Chain Adaptability													
Downside Supply Chain Adaptability		X	X	X	X	X	X	X	X	X		X	X
Inventory Days of Supply		X											X
Cash-to-Cash Cycle Time											X	X	X
Availability	X		X										
Member of Supply Chain Council	X	X	X				X	X	X			X	X

Table 7. Comparisons of Metric Usage

understand how SCOR, used in conjunction with Lean and Six Sigma techniques, can assist managers in getting better results across the entire supply chain. The Air Force should implement Lean techniques within the supply chain to get quick successes. While the SBPM, PSCM, and ECSS offer the opportunity for long term transformational gains, Lean offers a methodology for significant improvements in both the short run and long run, and supports the Air Force Smart Operations for the 21st Century initiative.

Recommendation Number 4: Tie appraisal performance awards to successful management of SCM metrics

While it may be difficult to do, appraisal awards should be tied specifically to supply chain performance. Because of the many variables which affect supply chain performance, leaders are hesitant to specifically tie awards to performance of the supply chain. Typically, individuals are rewarded for working hard and doing an apparently good job, regardless of how the supply chain reacts. A more focused effort should be made to tie the two together. The National Security Personnel System should also have a positive impact linking pay to performance.

Recommendation Number 5: Focus on real-time training for Supply Chain Managers

Supply chain managers have complained that training is not real time. The Air Force invested a significant amount of money in training those involved in the supply chain business, but the value of the training was minimized because the systems, processes, and methodologies were not in place to implement the training received. The Air Force should develop training modules that coincide with supply chain transformation implementation efforts. This would enable supply chain managers to immediately implement the efforts being fielded.

Conclusion

In summary, there are numerous definitions of SCM, but simply put, it is the management of all processes and functions necessary to satisfy a customer's order. While there appears to be no one, agreed-upon solution to the most successful SCM processes and measurements, there are some basic best practices. Air Force SCM processes and metrics are not perfect, but, for the most part, they are on track. The use of SCOR is having a significant impact in both the public and private sectors, which is evidenced by the numbers and types or organizations that are members of the SCC. The Air Force Materiel Command has chosen a very complex process, the SBPM, to achieve SCM transformation. The SBPM should be worked in concert with the Air Force Global Logistics Support Center (GLSC). Staying focused on the strategic goals of the Air Force, and developing actionable and leading metrics will be critical to the success of SCM improvement.

Future Research

During this study, a number of potential research opportunities came to light. The following are a few that may be considered:

- The impact of supply chain software in producing positive results for companies with successful supply chains. There is a need to investigate whether the improvement in supply chain performance is worth the investment cost of the system software.
- Expanded studies on the specific metrics used by successful companies in the supply chain business. This should include the factors influencing the success or failure of attempts to implement measurement systems for supply chains.
- An assessment of the characteristics of companies with successful supply chains, including their best practices. From this, draw out the qualities needed for companies to be successful in the future.
- Assess the effectiveness of current Air Force initiatives, such as the GLSC and the SBPM. Since both are new, their success is unknown at the present time.

End Notes

1. Toby G. Gooley, "Take Charge of Change," *Logistics Management and Distribution Report*, August, 1999, 2.
2. Grover Dunn, "Air Force Logistics Transformation," briefing Supply Chain Management Conference, Dayton, Ohio, April 2003.
3. Michael E. Zettler, "A View from the Top," eLog 21: Bringing AF Logistics into the 21st Century, 24 November 2003.
4. Air Force Materiel Command. "PSCM Frequently Asked Questions," [Online] Available: https://www.ripit.wpafb.af.mil/PSCM/PSCM.html, 1 Nov 2003, 1.
5. Air Force Deputy Chief of Staff for Installations and Logistics, "PSCM Concept of Operations," August 2005, 4-8.
6. Air Force Deputy Chief of Staff for Installations and Logistics, "eLOG21 Concept of Operations," 9.
7. Cheryl D. Mann, "Leverage Industry to Enhance DoD Logistics," research thesis, Army War College, Carlisle Barracks, Pennsylvania, 7 April 2003, 1.
8. General Accounting Office, "DoD's High-Risk Areas: High-Level Commitment and Oversight Needed for DoD Supply Chain Plan to Succeed," GAO-06-113T, Washington, DC: Government Printing Office, 2005, 1.
9. Michael Wynne, "Thinking about 21st Century Logistics," *Air Force Journal of Logistics*, XXIX, No 3/4, Fall/Winter 2005, 8.
10. Air Force Deputy Chief of Staff for Installations and Logistics, "PSCM Concept of Operations," 3-1.
11. Peter Bolstorff and Robert Rosenbaum, *Supply Chain Excellence,* New York, NY: Amacom, 2003.
12. John T. Mentzer, *Supply Chain Management,* Thousand Oaks, CA: Sage Publications, Inc., 2001, 5.
13. Mentzer, *Supply Chain Management,* 441.
14. Supply Chain Council, [Online] Available: www.supply-chain.org, tools and resources.
15. Department of Defense, Deputy Under Secretary of Defense (Logistics and Materiel Readiness). *DoD Supply Chain Management Implementation Guide*. McLean, VA: Logistics Management Institute, 2000, 14.
16. Department of Defense, Chairman of the Joint Chiefs of Staff, *Joint Vision 2020*, Washington, DC:. Government Printing Office, June 2000, 2.
17. United States, *The National Security Strategy of the United States of America*, Washington, DC: Government Printing Office, 2006, 45.
18. United States, *The National Military Strategy of the United States of America*, Washington, DC: Government Printing Office, 2004, 7.
19. *The National Military Strategy of the United States of America*, 17.
20. Department of Defense. *Quadrennial Defense Review Report,* Washington, DC: Government Printing Office, 2000, 72.
21. Department of Defense, *DoD Logistics Strategic Plan,* Washington, DC: Deputy Under Secretary of Defense (Logistics and Materiel Readiness), 2000 edition, 1999, 1.
22. Department of Defense Regulation DoD 4140.1-R, *DoD Supply Chain Materiel Management Regulation*. 23 May 2003, 1.
23. Air Force Policy Directive (AFPD) 20-1, *Logistics Strategic Planning*, 22 April 1993, 1.
24. Department of Defense, Deputy Under Secretary of Defense (Logistics and Materiel Readiness). *DoD Supply Chain Management Implementation Guide*. McLean, VA: Logistics Management Institute, 2000, vii.

25. Michael Hugos, *Essentials of Supply Chain Management.* Hoboken, NJ: John Wiley & Sons, 2003, 17.
26. Bob Frost, *Measuring Performance: Using the New Metrics to Deploy Strategy and Improve Performance*, Dallas, TX: Measurement International, 2000, 28.
27. Robert S. Kaplan and David P. Norton, "The Balanced Scorecard - Measures that Drive Performance." *Harvard Business Review,* Vol 70, No 2, January-February 1992, 71.
28. Edward Frazelle, *Supply Chain Strategy: The Logistics of Supply Chain Management.* New York, NY: McGraw-Hill, 2002, 58.
29. Jerry R. Turner, "Integrating Supply Chain Management: What's Wrong With This Picture," *Industrial Engineering*, December 1993, Vol 25, No 12, 52.
30. Mentzer, *Supply Chain Management*, 413.
31. Bolstorff, *Supply Chain Excellence*, 2.
32. SCOR level 1 metrics are strategic level measures and are shown in Table 1. Level 2 and level 3 metrics are operational and tactical level measures respectively.
33. Supply Chain Council. "Supply Chain – Letter," [Online] Available: www.supply-chain.org, September 2004, 1.
34. Hugos, *Essentials of Supply Chain Management*, 5.
35. Hugos, *Essentials of Supply Chain Management*, 44.
36. Hugos, *Essentials of Supply Chain Management*, 149.
37. Hugos, *Essentials of Supply Chain Management*, 155.
38. Hugos, *Essentials of Supply Chain Management*, 31.
39. Frazelle, *Supply Chain Strategy*, 21.
40. Frazelle, *Supply Chain Strategy*, 40.
41. Bolstorff, *Supply Chain Excellence*, Intro.
42. Kaplan, "The Balanced Scorecard," 24.
43. Kaplan, "The Balanced Scorecard," 147.
44. Kaplan, "The Balanced Scorecard," 72.
45. Bolstorff, *Supply Chain Excellence*, 47.
46. Bolstorff, *Supply Chain Excellence*, 49.
47. University of Tennessee, Faculty website, [Online] Available: http://bus.utk.edu/ivc/supplychain/faculty/Faculty_bios/mentzer.htm, Accessed 12 October 2006.
48. Mentzer, *Fundamentals of Supply Chain Management*, 22.
49. Mentzer, *Fundamentals of Supply Chain Management*, 27.
50. Mentzer, *Supply Chain Management,* 424.
51. Mentzer, *Supply Chain Management*, 417
52. John Mentzer, personal email, 25 October 2006.
53. Mentzer, *Fundamentals of Supply Chain Management*, 243.
54. Air Force Materiel Command, *Supply Chain Metrics Guide*, 5.
55. Department of Defense, *DoD Supply Chain Management Implementation Guide*, 1.
56. Heinz H. Huester, "Improving Performance Analysis of the Distribution Segment of the Air Force Logistics Pipeline" graduate thesis, Air Force Institute of Technology, Wright Patterson AFB, Ohio, March 2002, 7.
57. Air Force Materiel Command. *Supply Chain Metrics Guide,* Wright-Patterson AFB, Dayton, Ohio, 25 November 2003, 4.
58. Department of Defense, *DoD Supply Chain Management Implementation Guide*, 70.
59. Larry S. Klapper, et al., *Supply Chain Management: A Recommended Performance Measurement Scorecard,* McLean, VA: Logistics Management Institute, June 1999, iii.
60. Marcia Leonard, "Air Force Materiel Command: A Survey of Performance Measures." research paper, Wright-Patterson AFB, Ohio: Air Force Institute of Technology, March 2004, 58.
61. Department of Defense, *DoD Supply Chain Management Implementation Guide*, 72.
62. Robert K. Ohnemus, "Measuring the Health of USAF Supply," AFLMA Final Report LS199929101, Air Force Logistics Management Agency, Maxwell AFB Gunter Annex, Alabama, January 2001, 6.
63. Department of Defense Regulation, DoD 4140.1-R, 16.
64. Department of Defense Regulation, DoD 4140.1-R., 19.
65. Air Force Materiel Command, *Supply Chain Metrics Guide*, 5.
66. Air Force Materiel Command, *Supply Chain Metrics Guide*, 9.
67. Department of Defense, *DoD Supply Chain Management Implementation Guide*, 69.
68. Supply Chain Council. "Supply Chain – Letter." [Online] Available: www.supply-chain.org, May 2001, 1.
69. Ogden Air Logistics Center, "Balanced Scorecard Metrics," 13 February 2006,
70. Michael Hammer, "AFMC Supply Chain Management Working Level Course," Lecture, Wright-Patterson AFB, Ohio. 20-29 July 2004, 9.
71. Department of Defense, *DoD Supply Chain Management Implementation Guide*, 15.
72. General Accounting Office. *Major Management Challenges and Program Risks – Department of Defense*, Report No. GAO-01-244, Washington, DC: Government Printing Office, 2001, 71.
73. General Accounting Office, *DoD's High-Risk Areas*, 1.
74. General Accounting Office, *DoD's High-Risk Areas*, 10.
75. James Finley, Deputy Undersecretary of Defense. "Defense Logistics Support: Tactical Focused Logistics for Streamlined Deployment, Distribution and Sustainment," Lecture, Defense Logistics Conference, Washington, DC, 2 October 2006, Event Summary.
76. Department of Defense, *DoD Supply Chain Management Implementation Guide*, 5.
77. Supply Chain Council, "Supply Chain – Letter," [Online] Available: www.supply-chain.org, October 2002, 2.

Ross Marshall is the Director of the 84th Combat Sustainment Wing, Hill Air Force Base, Utah. During the time of the writing of this article, he was a student at the Air War College, Maxwell Air Force Base, Alabama.

Supply chains cannot tolerate even 24 hours of disruption. So if you lose your place in the supply chain because of wild behavior you could lose a lot. It would be like pouring cement down one of your oil wells.

—Thomas L. Friedman

Cannibalization is a quality-of-life issue.

—Lt Gen Michael E. Zettler

Bringing supply chain integration to reality will transform Air Force supply management.

—Brig Gen Robert Mansfield,

Visit the *Journal* online at: http://www.aflma.hq.af.mil/lgj/Afjlhome.html