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Logistics Analysis

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Introduction

The current focus in logistics analysis relies heavily on the use of averages. There are instances where predictive modeling is used; however, data requirements for predictive modeling to be accurate are often not being met by the logistics community.

Predictive modeling, probability management, and stochastics provide a backbone for data analysis requirements in tomorrow's Air Force logistics community. In order for these techniques to provide real benefit, data integrity must be maintained. The implementation of an Enterprise Resource Planning (ERP) system in the logistics enterprise allows for an integrated common database, alleviating errors and wait time in transferring data between logistics systems. In the logistics community of the Air Force, the ERP system, along with the demand planning and repair scheduling programs is called the Expeditionary Combat Support System (ECSS). As the logistics community moves to install ECSS, new analysis techniques can be used to more accurately predict future requirements for manpower, transportation, supply, maintenance, and other areas of agile combat support throughout the logistics enterprise.

Article Acronyms

ECSS - Expeditionary Combat Support System
ERP - Enterprise Resource Planning
LCOM - Logistics Composite Model
SEP - Shell Exploration and Production

Current State of Logistics Analysis

Throughout the logistics world, the Air Force uses averages in metrics and decision support. Examples include determining stock purchases by averaging pipeline transportation and repair times in conjunction with average demands, determining schedules of transportation assets based on average required capacity, and buying jet fuel at an average rate per year. The dangers associated with averages can be put into categories:[1]

- **The Family with 1.5 Children**. The average data does not take into consideration the actual population. When transportation times for items are entered into Air Force computer systems, such as the D200 Requirements Management System, average times are used. These averages do not often capture the reality of transportation times, as illustrated by the fact that they are used less than 35 percent of the time. These transportation times are used to determine pipeline length, and subsequently, purchase requirements. The danger of errors and poor data management results in significant back orders.[2]
- **Ignoring Restrictions.** When preparing for average demand, a certain amount of capacity is allocated to meet that demand. If demand exceeds capacity, demand is limited by capacity. If capacity exceeds demand, overcapacity exists. Using the average required capacity to schedule transportation assets for Air Mobility Command to be used by United States Transportation Command presents this danger. If the demand for assets is lower than the capacity, assets will be underutilized. Conversely, if demand is higher than the required capacity, throughput will be limited by the capacity of transportation assets. This problem becomes more evident when combining the weight, cube, and palletization of assets.[3]

- **Ignoring Optionality.** On a commodity with volatile prices and a constant demand, stockpiling during periods of low cost can offset the demand during periods of high cost. Using the projected average price on fuel, every fiscal year the fuel price for the Department of Defense, including jet fuel, is set as a fixed rate. This is a very different strategy than the established best practices in the airline industry. Southwest Airlines, the only profitable United States based airline, uses a process called fuel hedging. Hedging is the act of stockpiling fuel at periods of low cost, and not purchasing at periods of high cost. This act capitalizes on the volatility of fuel prices, and saves Southwest more than $150M per quarter.[4]

Additional categories, illustrated by notional examples, include:

- **Why Everything Is Behind Schedule**. Delivery of 10 parts is pending. The delivery time for one part is uncertain and independent, but known to average 1 week with a 50 percent chance of being over or under. It is tempting to estimate delivery as 1 week, but for that to happen, each part would have to arrive at or below the average delivery time. This is the same probability as flipping 10 sequential heads on a fair coin.
- **The Egg Basket**. Consider 10 mission critical parts being transported on the same convoy and the alternate case of one mission critical part on each of ten convoys. If there is a one-in-ten chance of losing any convoy, then either strategy results in an average of nine parts reaching their destination. However, the first strategy has a one-in-ten chance of losing every part, whereas the second strategy has a one-in-10 billion chance of losing all of the parts.
- **The Double Whammy**. Consider an inventory of perishable items. Here there is a spoilage cost associated with having too many of the items. There is also a back order cost associated with having too few of the items. The cost associated with the average demand is zero, since items are stocked to meet average demand. However, on average there will be a cost associated with stocking items, as forecasts are very rarely identical to demands.

These examples illustrate the dangers associated with using averages. Use of averages is widespread in the Air Force and can limit the ability of logisticians to make informed decisions.

Future State of Logistics Analysis

Logistics in the modern era is driven by uncertainties that create a significant number of interdependent risks. If the underlying statistical relationships of the uncertainties driving these risks are captured during the planning process, they can be exploited to find the optimal risk-based tradeoff for increased logistics performance. A shift in information management that captures the statistical relationships of uncertainties is essential to management of risk, real options, and enterprise level logistics.[5]

As is seen in several programs throughout the Air Force, most notably the Logistics Composite Model (LCOM), the use of predictive management in making manpower decisions is essential to future operations. LCOM is a Monte Carlo simulation that uses simulated flying schedules to predict maintenance requirements. LCOM uses historical data, including the mean time between failures and the mean time to repair, to determine how many personnel and of what levels are required in each shop to handle the typical work flow. Given available data in current maintenance systems, LCOM is the best tool to predict this manpower requirement.[6] If data becomes more accurate and more available in the future, then all Air Force logistics functions can take advantage of predictive modeling and simulation to make manpower decisions. In the future state of logistics, additional factors in predictive management such as aircraft availability, spares packaging, spares leveling, and manpower decisions throughout logistics will need to be considered as the Air Force has to perform its mission more effectively with fewer people.

The adequacy of a simulation is limited by the availability of data and modeling of tradeoffs between variables. As is the case in many simulation applications, the oversimplification of data into averages inadequately accounts for uncertainty and risk. Often values of input such as time, manpower, and failure rates are simplified into mean, average, or *base case* values which serve as inputs and outputs from the model. The previous example of mean times taken from the D200 Requirements Determination System to simulate pipeline times in readiness-based leveling (RBL) computations[7] illustrates this point. The current data accuracy, availability, and timeline does not support predictive analysis and simulation to aid logistics decisionmaking. A mature ERP system, however, can provide the logistics community with the data required to obtain underlying data trends required to perform predictive analysis.

ERP Defined

Gartner defines ERP as "a set of applications software that brings manufacturing, financials, distribution, and other business functions into balance."[8] In other words, an ERP is one system used to manage all operations within a business enterprise. ERP systems provide an organization with a database backbone. All data is fed into the backbone and updated to the rest of the enterprise in real time. With organizational systems' barriers removed, business processes can focus on reducing the time wasted on handoffs between functional areas (the most common point of waste in most companies).[9] In addition, most ERP systems are built and installed with industry-wide best practices for data management.[10] This does not necessarily remove a competitive advantage that a company has; it does allow companies to model their enterprise processes around an industry proven process.

ERP systems have both risks and benefits associated with them. Some of the benefits are common data, real-time information and asset visibility, and enablement of business process reengineering. Some of the risks associated with ERP systems (specifically in their implementation) are that gaps can occur between the current state and future state capabilities, implementations frequently run over budget and behind schedule, and very little real cost benefits will be seen without major process modifications supporting the changing business data structure.[11]

In order for the Air Force to meet the goals set by logistics enterprise architecture (LogEA) initiatives—20 percent increase in aircraft availability and 10 percent cost reduction[12]—and manpower cuts in the Program Budget Decision 720,[13] major change is needed in both process management and system functionality. The legacy computer systems in the Air Force logistics enterprise are not capable of meeting the faster-paced communication capabilities required by today's suppliers and

customers in the end-to-end supply chain of Air Force logistics.[14] Much like the commercial world is driven by outside pressures to a new information technology (IT) system that can handle the increased communication and flexibility requirements of their suppliers and customers, the Air Force logistics enterprise must change to meet the increasing demand on our systems. ERP will be the Air Force's tool of the future to facilitate these business changes.[15]

The implementation of an ERP system within the Air Force logistics enterprise will allow for an integrated common database. This instantaneous availability of data allows for new tools to be more readily applied to data analysis. Instead of using averages, which have been shown to oversimplify variability when dealing with uncertain behavior, logisticians can use probability management to predict some uncertain behaviors.

Examples of Probability Management

Shell Exploration and Production (SEP) illustrates the use of probability management. In order to meet the demands of global uncertainties, SEP engaged in reorganizing into a global operating model engaged in the upstream activities of acquiring, exploiting, developing and producing oil and gas.[16] This involved the combining of local and regional activities into a single, centralized business organization managing a large portfolio of venture opportunities, with data management at its core.[17]

Shell typically used a bottom-up assembly of exploration ventures into a business planning function. That is to say, each regional business section of Shell would develop and rank possible business ventures based on perceived risks and rewards. Shell made a transition to a top-down capital allocation approach that involved the use of stochastics. Shell developed a stochastic library involving factors such as hydrocarbon volumes, drilling and developmental costs, volumetric distributions, and economic values of exploration.[18] SEP insured the libraries were simple to understand and easy to apply but detailed enough to be credible. Shell included individual libraries for global scenarios so that each venture could be assessed on the impact to the global environment. What Shell created was not a simple risk and reward tradeoff curve—instead the potential tradeoffs between several pairs of metrics could be seen. Management at Shell could open the graphic user interface and select or deselect investment projects with a click of the mouse. This action created a profile, driven through Excel formulas, where repetitions were driven by precalculated Monte-Carlo trials within the stochastic library. Because the simulations were not taking place at the mouse click, existing trials were being used, the statistical properties of the profile were immediately apparent.[19]

With this approach, management could now see various investment levels through group interactions within the model. The reward was that managers now were forced to focus on big picture issues, and the impact of their organization within the business enterprise.[20]

The Shell approach is applicable for Air Force logistics. The current bottom-up approach involving the manipulation of wing level metrics can become a top-down assessment of how each wing can benefit or hurt the Air Force logistics enterprise. In order to accomplish this top-down approach, data integrity and availability must be ensured at the highest levels of planning.

Another example of an ERP implementation is Sloan Valve. Sloan Valve is a small company that is approximately 100 years old and has always remained privately owned. They manufacture bathroom equipment; in fact, they have 80 percent of the market on hands free bathroom fixtures in America. In 1998, Sloan Valve installed an ERP system but saw little initial return on investment from their system. They frequently undertook incremental investments that attempted to refine processes, what the Air Force calls continuous improvement. As Dr Michael Hammer describes this phenomenon of low return on investment, "chronic 'good enough' incremental investments deteriorate long-term market position."[21] Seeing a need for dramatic change, Sloan used the ERP system as a catalyst to develop end-to-end business processes that focused on what, where, and when work needed to be done.[22]

Another successful ERP implementation is Welch's. Evolving customer needs dictated a need to change, and management needed better visibility through the order management process. Welch's committed to an ERP system which involved business process reengineering at its core. The benefits they have seen from their ERP system include a decrease in total customer deductions for mistaken orders and missed contract deadlines. Deductions as a percentage of net sales dropped from 1.2 to 0.5 percent in a 2-year period. In addition, their days on hand of inventory and cash dropped from 25 days to less than three days, reducing the financial and logistics footprint of their business enterprise.[23]

A common factor in the implementation strategies of Sloan Valve and Welch's involved changing their business processes to take advantage of data availability in ERP systems. These changes impact the throughput and efficiency throughout the business enterprise. The Air Force can expect similar, drastic changes to their business processes as ECSS is implemented. While dealing with the uncertainties of changes facing Air Force logistics, predictive analysis will provide the decisionmakers with the information needed to understand the tradeoffs of decisions. Predictive analysis allows for modeling and stochastic analysis of decisions before they are made, providing a decision support tool for agile combat support.

Conclusion

In order to meet the uncertainty of real world logistics situations, a predictive modeling technique for logistics analysis is required in the Air Force. Predictive modeling, probability management, and stochastics can be used in tandem to meet logistics analysis and data analysis needs of tomorrow's Air Force logistics community. Data requirements for this type of analysis are not being met by current logistics systems. The implementation of ECSS, the Air Force's ERP system, and the integrated database feature associated with the system, will meet the data requirements of this future state of logistics analysis.

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Logistics and Warfare

General Mathew B. Ridgway, of World War II fame, once observed, "What throws you in combat is rarely the fact that your tactical scheme was wrong … but that you failed to think through the hard cold facts of logistics." Logistics is the key element in warfare, more so in the 21st century than ever before. Success on the modern battlefield is dictated by how well the commander manages available logistical support. Victories by the United States in major wars (and several minor wars or conflicts) in the 20th century are linked more directly to the ability to mobilize and bring to bear economic and industrial power than any level of strategic or tactical design. The Gulf War and operations to liberate Iraq further illustrate this point. Long before the Allied offensive could start, professional logisticians had to gather and transport men and materiel and provide for the sustained flow of supplies and equipment that throughout history has made possible the conduct of war. Commanders and their staffs inventoried their stocks, essayed the kind and quantities of equipment and supplies required for operations in the severe desert climate, and coordinated their movement plans with national and international logistics networks. *"The first victory in the Persian Gulf War was getting the forces there and making certain they had what they required to fight* [Emphasis added]. Then and only then, would commanders initiate offensive operations."[1] The same may be said of lightning quick victory in Iraq, although without the massive stockpile of inventory seen during the Gulf War.

In 1904, Secretary of War Elihu Root warned, "Our trouble will never be in raising soldiers. Our trouble will always be the limit of possibility in transporting, clothing, arming, feeding, and caring for our soldiers.…"[2] Unfortunately, the historical tendency of both the political and military leadership to neglect logistics activities in peacetime and expand and improve them hastily once conflict has broken out may not be so possible in the future as it has in the past. A declining industrial base, flat or declining defense budgets, force drawdowns, and base closures have all contributed to eliminating or restricting the infrastructure that made rapid expansion possible. Regardless, modern warfare demands huge quantities of fuel, ammunition, food, clothing, and equipment. All these commodities must be produced, purchased, transported, and distributed to military forces. And of course, the means to do this must be sustained.

Notes

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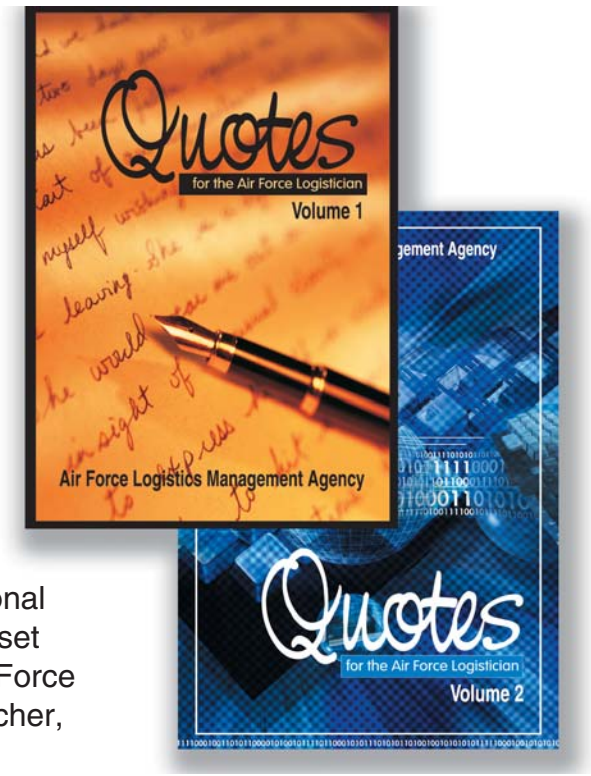

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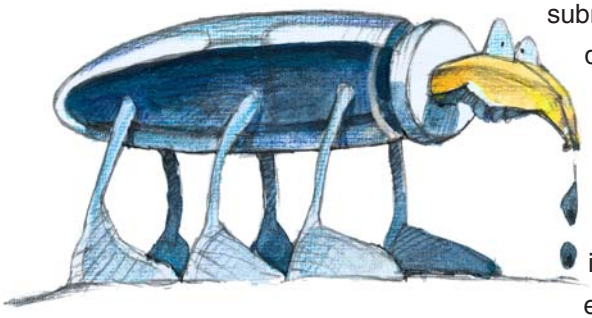
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