DOCUMENTED BRIEFING

RAND

Velocity Management

An Approach for Improving the Responsiveness and Efficiency of Army Logistics Processes

John Dumond, Rick Eden, John Folkeson

Arroyo Center

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PREFACE

This briefing presents an executive-level overview prepared for the Army Deputy Chief of Staff for Logistics (DCSLOG) staff. The briefing describes an approach for improving the responsiveness and efficiency of the Army logistics system. The approach, called "velocity management," seeks to improve dramatically the speed and accuracy of logistic processes, thus reducing the need for logistics resources. The briefing justifies the need for this type of change, illustrates the key tasks involved in implementing it, and proposes an action plan for proceeding.

The briefing should be of wide interest in the Army because velocity management has the potential to affect many areas, both support organizations and their customers. Indeed, a major purpose of this briefing is to solicit broader participation and support for a pilot implementation. Because "velocity management" cuts across numerous functional lines, a senior-level coalition is likely to be needed for implementation. Probable members of this coalition would include the Army DCSLOG, Army Materiel Command, Combined Arms Support Command, appropriate Major Subordinate Command and Program Executive Office representatives, Forces Command—Logistics, U.S. Transportation Command, and Defense Logistics Agency. The briefing should also be of interest to readers generally concerned with business process reform. Comments and questions are welcome and should be directed to the authors.

The velocity management approach is being developed in a RAND research project entitled "Velocity Management: An Approach for Improving Logistics Responsiveness" sponsored by the Army DCSLOG. The research is being conducted in the Military Logistics Program of the Arroyo Center.

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SUMMARY

MORE RESPONSIVE, EFFICIENT SUPPORT

A logistics system should be able to respond quickly and accurately to meet the support needs of its customers. The sluggish and unreliable performance of the current Army logistics system in Operations Just Cause, Desert Storm, and Restore Hope—their military success notwithstanding—demonstrated that, despite its massive resources, it is unable to provide the desired levels of responsiveness and efficiency. The operational commanders who are the customers of the system have not been satisfied with the level of service, the responsiveness to evolving scenarios, and the mounting costs required to support the military capability that the commanders require.

The Army can dramatically improve the responsiveness and efficiency of its logistics system by applying three broad strategies.

- First, logistics managers should focus the entire system on meeting the customer's needs.
- Second, managers should design and redesign weapon systems to be more supportable—i.e., they should evolve the product to meet the customer's needs and to reduce the logistics burden.
- Third, managers should design and manage all logistics processes—i.e., reengineer them—to make them more responsive and efficient.

Velocity management is one approach that falls under the third strategy. This briefing describes velocity management and some of its benefits, illustrates the application of the concept to military logistics, and proposes a pilot implementation of the concept in the Army.

VELOCITY MANAGEMENT

Velocity management aims to substitute velocity and accuracy for mass in the logistics system. Reducing the cycle time of logistics processes promises the possibility of greater system responsiveness to the user's needs while permitting reductions in the size of safety stocks or the amount of days-of-supply that currently choke the system without adding much to achieved sustainment.

Commercial firms that have adopted this general approach of substituting velocity for mass have achieved substantial, sometimes order-of-magnitude, improvements both in cost and, more importantly, in effectiveness in meeting their customers' demands. What the commercial record leaves unanswered is whether the kind of process reform advocated by velocity management can be translated to the Army's situation.

The approach requires the analysis and reengineering of processes—e.g., order, repair, and ship processes—to eliminate non-value-adding activities and to continuously improve the productivity of value-adding activities. As each process is streamlined and made more productive, the flow—i.e., velocity—of material through the process improves. Importantly, a more responsive system must not only perform more quickly but also more reliably (i.e., with little variance in response time).

As processes improve in velocity, the mass of stocks needed declines because stockage policy is based on a ratio of expected demand over expected lead time. If we assume that expected demand does not change, as lead times shrink required stocks will shrink, too. Of course, stocks that have already been acquired represent sunk costs, but excess stocks can be shifted to war reserves, and annual stock replenishments (because of condemnations, etc.) will be reduced. In addition to considerations of lead time, it is widely recognized that buffer stocks today have also been expanded in an attempt to buffer against the unreliability of the logistics system. Units have large stocks not only because it takes a long time to receive requested materiel but also because they cannot count on the system to deliver at a planned time. As processes become more reliable under velocity management, and as customers build trust in the improved performance of the system, units will lose a strong motivation to hold excess stocks.

The potential benefits of velocity management to the Army logistics system fall into two major groups: (1) improved responsiveness and (2) lower total support costs. Improved responsiveness has at least four aspects, including increased robustness to uncertainty in demands for support, higher quality of services, improved flexibility and mobility, and better tailoring of services to customer needs. Lower total support costs come from reducing manpower and overall inventory needs.

A MILITARY EXAMPLE OF VELOCITY MANAGEMENT

A crucial question is whether such process reform has been demonstrated for any military system, and in particular, for a logistics system. A recent

Air Force exercise, Coronet Deuce, provides an example of process reform demonstrated for a military logistics system. The reform was undertaken to solve problems associated with supporting the radar system on the F-16A/B aircraft—specifically, 32 high value components for 400 aircraft worldwide. The Air Force needed to reduce costs, "blue-suit" manpower, and mobility footprint. The Air Force's immediate goal was to reduce dramatically the average repair cycle times for these radar components. Through a series of innovations, the Air Force cut the depot repair cycle times for these items from 32 days down to between 6 and 8 days. For these few items, the redesigned process saved over $10 million annually while maintaining weapon system availability levels. Moreover, the new component repair process was more robust to changes in anticipated demand rates.

A PILOT IMPLEMENTATION

We recommend that the Army move the velocity management concept from the development phase to a pilot implementation in an Army setting. Our discussions with key DCSLOG (Deputy Chief of Staff for Logistics) staff and senior Army leaders have led to the development of an initial action plan.

A pilot implementation is valuable for at least four reasons, in addition to the benefits in cost savings and increased responsiveness that accrue to the actual processes that are improved in the implementation. First, the implementation will demonstrate the applicability of the concept of velocity management to Army logistics in this changing military environment. Second, the implementation will provide the Army with empirical data on the costs and benefits of velocity management. Third, the implementation will help to identify barriers to process reform. Fourth, the implementation will help the Army to derive "lessons learned" that will facilitate the further implementation of velocity management throughout the Army.

We suggest that the pilot implementation should focus on reducing the cycle times on the ordering, repairing, and shipping processes. This focus on Class IX, spare parts, should permit measurable peacetime improvements that transition well to supporting power projection. Specifically, the Army should measure improvement in order-and-ship time (OST), repair cycle time, availability/readiness, and costs.

Applying velocity management to improve OST entails decomposing the OST cycle into its component processes and then examining each one individually to seek performance improvements. The first step must be a focused effort to reduce process variability. As a performance measure, OST goes a long way toward measuring the objectives of velocity management. However, its usefulness is seriously limited by the reporting of only average performance. The variability of system performance is just as important. A 30-day average OST in one segment of the system may mask remarkably wide variability in performance; indeed, the standard deviation may very well exceed the mean. The current practice of only tracking the average times for either the individual order-ship segments or the total OST provides insufficient information for managers to understand the quality of performance achieved by the system. For that reason, we recommend that the Army also begin to routinely track the variability of OSTs throughout the system. As variability is reduced, the mean performance value will naturally reduce toward the median value. If this new stabilized performance level is not yet good enough to meet the logistics customer's requirements, then further improvement in cycle time can proceed while maintaining the lower variability in performance.

When velocity management is applied to the OST cycle, repair processes must also be targeted for reform because of their potential impact on OST. A significant portion of the value of the total Class IX inventory is composed of reparable components. Because of the inherent value of these inventory items, a pilot implementation of velocity management should include emphasis on these repair cycle processes.

The pilot implementation of velocity management should focus on a few weapon systems, perhaps targeting key systems or components of those weapon systems. We suggest that the Army consider both aviation and ground systems as candidates. The critical mission importance of the Apache argues for the inclusion of the Target Acquisition Designation Sight/Pilot Night Vision Sensor mission equipment package and the T-700 series helicopter engine. The high value of these reparable components means that they are potentially high-leverage components with respect to both readiness and cost. With respect to ground systems, the mission criticality of the M1A1 tank and the support difficulties associated with low-density equipment such as the M9ACE (Armored Combat Earthmover) and key material handling equipment make them strong candidates for consideration. In the case of these suggested ground systems, the cost of the components will be less than that of the Apache components, but the potential for improving mission support may be even greater.

We believe that a senior-level coalition is needed to guide and support the implementation of velocity management, both during the pilot phase and later during full implementation. The process reform that takes place under velocity management will affect multiple functions (e.g., supply, maintenance, transportation) and span organizational boundaries (e.g., the U.S. Transportation Command, the Army Materiel Command, and the Defense Logistics Agency). As a result, the coordinated reform of these processes will require the unified support of the senior leadership involved. A senior coalition is needed to provide the leadership and vision for change, to set broad goals and guidelines, to help waive Army regulations and other official policies, and to interface and coordinate with other Department of Defense players, such as the U.S. Transportation Command and the Defense Logistics Agency, as well as with contractors.

The process of putting together a senior-level coalition to support a pilot implementation of velocity management is now (fall 1994) well under way. The pilot implementation strategy is being refined and made more specific. There remain some additional senior leaders who should be brought into the process. The next step is the preparation and distribution of a draft pilot implementation plan to each member of the senior-level coalition to provide them with an opportunity to improve the plan and build consensus for execution of that plan at the earliest opportunity.

ACKNOWLEDGMENTS

We are indebted to many individuals in the Army and at RAND for their contributions to the research reported here. Many senior Army logisticians were extremely supportive and helped guide the evolution of this approach for improving the Army logistics system. BG Wright challenged us to take our research and recommendations from the dusty book shelves and work with the Army to begin implementation. MG Robison, then the Assistant Deputy Chief of Staff for Logistics (DCSLOG), focused us on the need to develop a coalition of senior leaders within the Army with a common vision of the need for change and the commitment to span the inherent organizational functionalism essential to bring about that change.

The approach has continued to evolve as additional senior Army leaders have become involved. Mr. Keltz, Principal Deputy for Logistics, Army Materiel Command (AMC), and MG Henderson, AMC, were early supporters. MG Cowings, Commanding General, Aviation Troop Command, was eager to include aviation in the pilot implementation. MG Irby, Program Executive Officer, Aviation, is a very strong early supporter who helped us refine the customer focus of the implementation plan. MG Raffiani, then Commanding General, Tank and Automotive Command, reoriented our search for implementation candidate systems to the currently most-difficult-to-sustain ground systems, low-density equipment. LTG Wilson, Army DCSLOG, has been a big supporter for velocity management implementation and has increased the momentum for improvement. MG Cusick, DCSLOG-SM (Supply and Maintenance), and his staff have taken over the day-to-day leadership for this effort. COL Goodbody and LTC Glenn Harrold are the DCSLOG points of contact. They had already started several initiatives aimed at logistics process improvement and provided enthusiastic leadership and practical guidance during the early planning. Continuous refinements to these plans were provided by LTC Harrold and LTC Love, a senior DCSLOG staff member.

BG Petrosky, the previous Assistant Division Commander, 101st ABN, and Mr. Mannion, then manager of the Aviation Branch of the Fort Campbell Directorate of Logistics (DOL), were very helpful in clarifying the customer's view early on in our efforts. Their innovations reinforced our expectations about the quality and commitment of the Army logistics work force. The successful implementation of velocity management and any other process improvements will be dependent upon the dedication of Army logisticians and their leaders.

From RAND's perspective, this effort represents the payoff for a stream of research that goes back many years. While improvements to logistics processes have occurred over the years, this project represents an attempt at a wide ranging improvement effort that integrates many earlier efforts. In recent years the efforts of senior colleagues such as Mort Berman, Hy Shulman, and Irv Cohen have motivated much of the current work. Ray Pyles and Jack Abell's parallel work with Project AIR FORCE (the Air Force's federally funded research and development center for studies and analyses that is located at RAND) pioneered many concepts found here. Marc Robbins' work on alternative logistics structures provides extensive documentation for improving the support of Army aviation. Nancy Moore's work on the Department of Defense distribution system and the need for reengineering that system is a key component of the current effort. Pat Boren and Lionel Galway have been critical members of the research team that has evolved the Weapon System Sustainment Management research stream that leads to this current implementation effort. John Halliday and Jim Quinlivan provided continuing intellectual support. Ken Girardini provided a thoughtful and challenging technical review.

Elizabeth Sullivan and Bari Whitbeck provided expert secretarial support.

GLOSSARY

AAD	Anniston Army Depot
AMC	Army Materiel Command
ASL	Authorized stockage list
ATCOM	Aviation Troop Command
AWM	Awaiting maintenance
AWP	Awaiting parts
CASCOM	Combined Arms Support Command
CCAD	Corpus Christi Army Depot
CINC	Commander in chief
CONUS	Continental United States
DCSLOG-SM	Deputy Chief of Staff for Logistics, Supply and Maintenance
DLA	Defense Logistics Agency
DoD	Department of Defense
DOL	Directorate of Logistics
DS	Direct support
EETF	Electronic Equipment Test Facility
FORSCOM	Forces Command
FORSCOM-G4	Forces Command—Logistics
ICP	Inventory control point
IOC	Industrial Operations Command
LIF	Logistics Information File
LRUs	Line replaceable units
MSC	Major Subordinate Command
NRTS	Not repairable at this station
OST	Order-and-ship time
PAT	Process action team
PEO	Program Executive Office(r)
PLL	Prescribed load list
PM	Program manager
POC	Point of contact
ppm	Parts per million
SD	Standard deviation
SFDLRs	Stock funding of depot-level reparables
SLC	Senior-level coalition
SRA	Special repair activity
SRU	Shop reparable unit
SSA	Supply services activity

TACOM	Tank and Automotive Command
TADS/PNVS	Target Acquisition Designation Sight/Pilot Night Vision Sensor
TRANSCOM	Transportation Command
VM	Velocity management

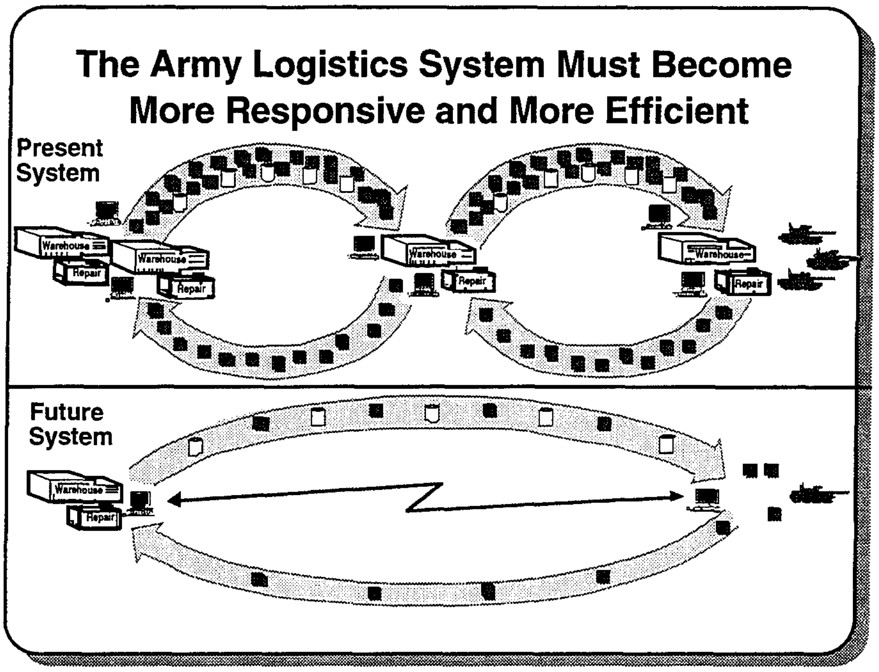
Velocity Management

An Approach for Improving the Responsiveness and Efficiency of Army Logistics Processes

Over the years RAND has done considerable research aimed at helping commanders understand and make reasonable judgments about their ability to support their forces during an operational mission, the ability both to successfully initiate *and* sustain a mission. This research has yielded several consistent themes, including (1) the need to accommodate the inherent *uncertainty* about operational customer requirements, (2) the power of *responsive* logistics support to overcome uncertainty, and (3) the potential for policies aimed at making logistics processes more responsive for *increased sustainment capability at reduced total system costs.*

We have organized these themes into a new approach for improving the responsiveness and efficiency of the Army logistics system. We call the concept "velocity management" because it seeks to improve the flow of materiel and information through the logistics processes to better satisfy the needs of Army customers.

This briefing is a relatively concise, executive-level introduction to velocity management. We describe velocity management and some of its benefits, describe a simple application of these concepts to military logistics, and sketch out an approach for a pilot implementation in the Army.



Let us begin by establishing the need for dramatically improving the responsiveness and efficiency of the current Army logistics system. As the U.S. national security environment changes, so do the needs of the customers of the Army's logistics system. This chart presents schematic views of the current logistics system and the logistics system that we envision to be appropriate for the new environment.

The current system, depicted in the top panel, is massive and expensive. A tremendous mass of logistics resources is ready to support any size force. The operational units have their own set of repair capability and stocks that are supported by a large distribution system. Another set of stocks and repair capability exists within the theater, and a third set remains in the continental United States (CONUS). A few numbers will help establish the massive scale of this system. As of the end of 1992, the Department of Defense (DoD) had over $150 billion in inventory, of which the Army logistics system had $40 billion, and one-third of that ($14 billion) was in spare parts.[1] Annually, the Army performed—prior to the

[1]*Washington Headquarters Services* (1992). The value of current inventories within each Service is now significantly less than it was just a few years ago, for two reasons. First, the Services have devalued their inventories several times. Second, some inventory has been shifted out of the Services as a result of the consolidation of supply depots within the DoD; however, within the Defense Logistics Agency (DLA), inventory levels have grown correspondingly.

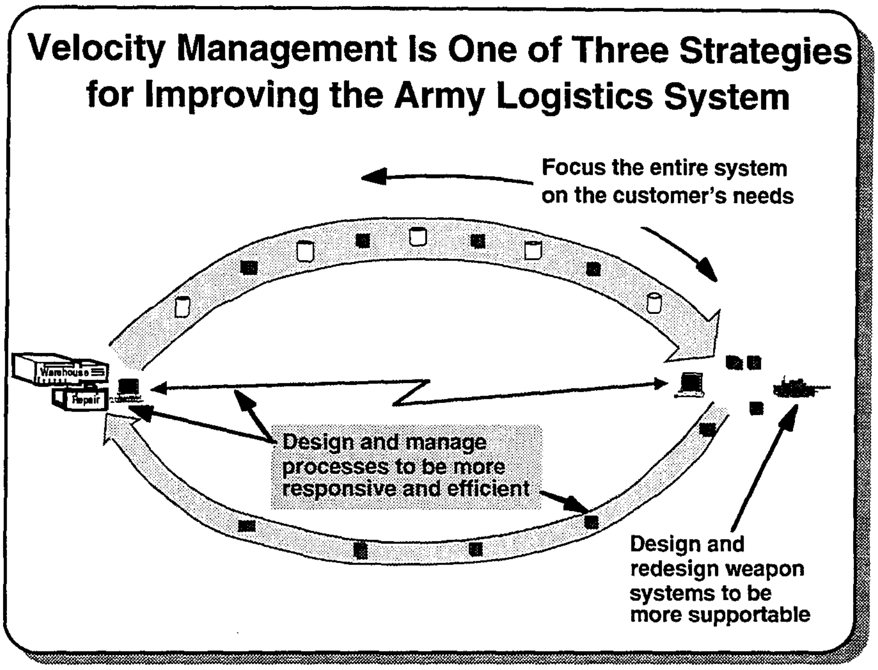
recent introduction of stock funding of depot-level reparables—almost one-half-million repairs and overhauls at its depots.

Unfortunately, the sluggish and unreliable performance of the current Army logistics system in Operations Just Cause, Desert Storm, and Restore Hope—their military success notwithstanding—demonstrated that, despite its massive resources, it is unable to provide the desired levels of responsiveness and efficiency. For example, repairs at Army depots take from three weeks to nine months to complete, and requests from Army customers generally take days to weeks to reach a source of wholesale supply. The operational commanders who are the customers of the system have not been satisfied with the level of service, the responsiveness to evolving scenarios, and the mounting costs required to support the military capability that the commanders require.

The United States has entered a national security environment in which it needs the capability to project CONUS-based forces worldwide to conduct a spectrum of missions. To meet the new power projection needs, the Army logistics system must become much leaner, more flexible, and more responsive. This is suggested by the bottom panel of the chart. The challenges of power projection include supporting deployed forces from afar, because the availability of a fully developed theater cannot be assumed. It is possible that echelons of support that have been doctrinal for major operations, such as the scenario of a major European land war, will be effectively eliminated. In its place will be a much leaner structure designed to provide support more rapidly and more accurately. The intermediate echelons of support will likely be more tailored to specific mission needs with an eye to minimizing the deployment burden while improving support.[2]

Such dramatic changes in the Army logistics system appear daunting; some might question whether they are even feasible. However, RAND research has identified and developed several promising approaches, including velocity management.

[2]Some have argued that, from the customer's perspective, the ideal logistics system would provide both massive resources and great responsiveness. However, this argument overlooks the facts that responsiveness reduces the need for massive resources while massive resources can slow responsiveness by "choking" logistics processes. And of course, massive resources cost a lot to acquire, manage, and move.



We have argued elsewhere that the Army can revolutionize its logistics system by applying three broad strategies.[3] First, logistics managers should focus the entire system on customer's needs. Second, managers should design and redesign weapon systems to be more supportable—i.e., they should evolve the product to meet the customer's needs and to reduce the logistics burden. Third, managers should design and manage all logistics processes—if necessary, reengineer them—to make them more responsive and efficient. Velocity management is one approach that falls under the third strategy.

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[3]For an overview of the three strategies, see Dumond, Eden, and Folkeson (1994); for an extended discussion of one approach under the second strategy (designing and redesigning weapon systems to be more supportable), see Dumond, Eden, McIver, and Shulman (1994).

Purpose of the Briefing

- Describe Velocity Management and some of its benefits
- Describe an application of Velocity Management to military logistics processes
- Lay out an action plan for a Pilot Implementation

The purpose of this briefing is threefold. The briefing proceeds through three sections that address these purposes in turn. We begin by defining velocity management in more detail and explaining its benefits.

Velocity Management Aims to Substitute Velocity for Mass

- **Definition:**
  - **Velocity management is a concept that advocates improved flow of materials and information through the logistics processes**
- **The speed and accuracy of logistics processes can be improved**
- **The processes need to be reengineered to eliminate non-value-adding activities and continuously improve value-adding activities**

Very simply, velocity management aims to substitute velocity and accuracy for mass in the logistics system. Reducing the logistics process cycle time promises the possibility of greater system responsiveness to the user's needs while permitting reductions in the size of safety stocks or the amount of days-of-supply that currently choke the system without adding much to achieved sustainment.

The feasibility and potential benefits of this approach have been established in the commercial sector. As we will show, firms that have adopted this general approach of substituting velocity for mass have achieved substantial, sometimes order-of-magnitude, improvements both in cost and, more importantly, in effectiveness in meeting their customers' demands.

The approach requires the analysis and reengineering of processes—e.g., supply, repair, or transportation processes—to eliminate non-value-adding activities and to continuously improve the productivity of value-adding activities. As each process is streamlined and made more productive, the flow—i.e., velocity—of material and information through the process improves. The processes also become more reliable in the sense that variance in response time declines.[4]

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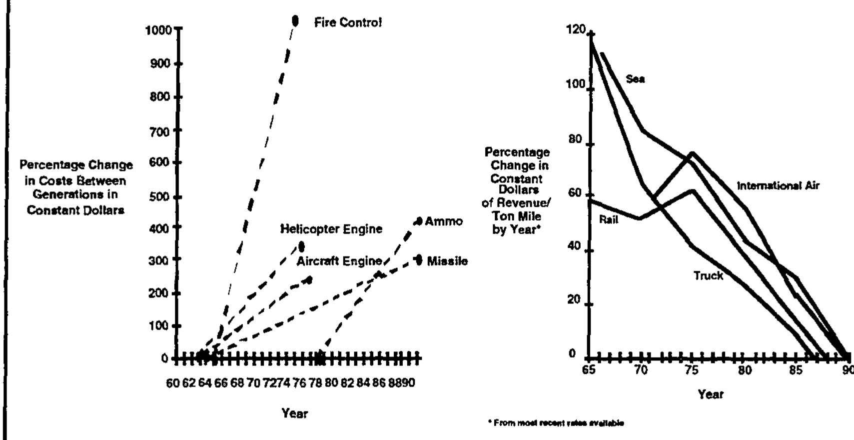
[4]Some readers may recognize the derivation of these techniques—and velocity management generally—from the so-called "quality" movement in management theory.

As processes improve in velocity, the mass of stocks needed declines because stockage policy is based on a ratio of expected demand over expected lead time. Assuming expected demand does not change, as lead times shrink, required stocks will shrink, too. Of course, stocks that have already been acquired represent sunk costs, but excess stocks can be shifted to war reserves, and annual stock replenishments will be reduced. In addition to considerations of lead time, it is widely recognized that buffer stocks today have also been expanded in an attempt to buffer against the unreliability of the logistics system. Units have large stocks not only because it takes a long time to receive requested materiel but also because they cannot count on the system delivering at a planned time. As processes become more reliable under velocity management, and as customers build trust in the improved performance of the system, units will lose a strong motivation to hold excess stocks.

For readers who are not familiar with quality management, a good introduction to its various strands is Dobyns and Crawford-Mason (1991).

Basic Assumptions Underlying Logistics Policy Have Changed Radically



A historical perspective can help illuminate why it is now even more important to shift from a reliance on massive logistics resources to a reliance on improved velocity of logistics processes. The Army's current logistics processes were designed in a period when materiel was relatively cheap and transportation relatively expensive. But, as this chart shows, the costs of acquiring major weapon system components have sharply increased over the past few decades, while the costs of transporting materiel have decreased sharply.[5] As a result, old assumptions no longer hold, and policies regarding when it is cost-effective to hold rather than move materiel, or when to use premium transportation, need to be revisited.

The panel on the left illustrates the trend in materiel costs for major weapon system components from one generation to the next. Over a 30-year period the United States has seen the fielding of a new generation of equipment to replace the functionality of the preceding generation. The new generation of equipment clearly performs much better than the earlier one, is often much more reliable, and incorporates advanced technology. However, while the helicopter engine for the UH-60, Blackhawk, provides the same functionality as the engine for the earlier UH-1, Huey, the newer engine is nearly 350 percent more expensive. If the logistics system to support the new helicopter is the same as the old,

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[5]We are indebted to our RAND colleagues John Halliday and Nancy Moore for this data.

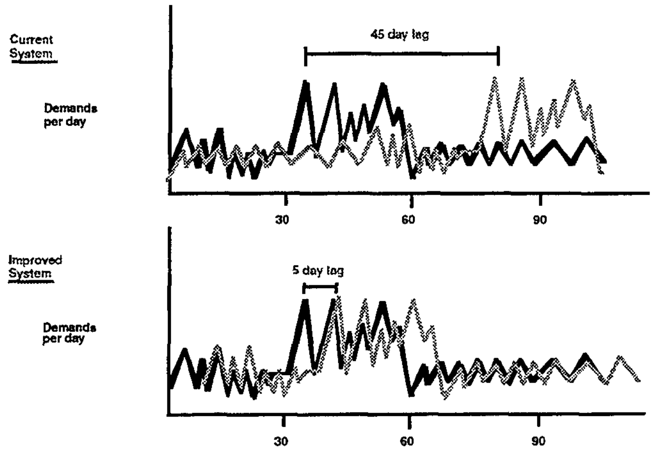
the investment for the same level of support, or sustained weapon system availability, will be higher with respect to spares. This is because the costs of the materiel have gone up while the order and repair cycle times have remained relatively constant. Spares provisioning levels are driven by equipment usage/failure rates, and the order and repair cycle times.

The panel on the right depicts a different but related trend, declining transportation costs. Over the past 30 years, based on constant-year dollars, the cost of transportation has been declining. In addition, transportation has become more reliable, rapid, intermodal, and available—i.e., transportation has become more responsive and reliable to user's needs.

There are two lessons here for the Army's logistics system. One is general: Logisticians need continuously to examine and challenge the assumptions underlying the system. The second is more specific: Today it makes sense for a logistics system to rely strongly upon the highly reliable and affordable transportation that is available worldwide. Faster administrative processes to support shipping can help create a system that is highly responsive to the needs of military customers and can keep up with their changing and uncertain requirements for support. Velocity management applies both of these lessons.

By way of caveat, let us note that this example's focus on the availability of improved transportation capabilities should not be mistaken for the sum of velocity management. Velocity management seeks improvement to *all* logistics processes—transportation, component repairs, procurement activities, weapon system design and development, ammunition production and distribution, etc.

Army Logistics Processes Must Be More Responsive to Uncertain Demands

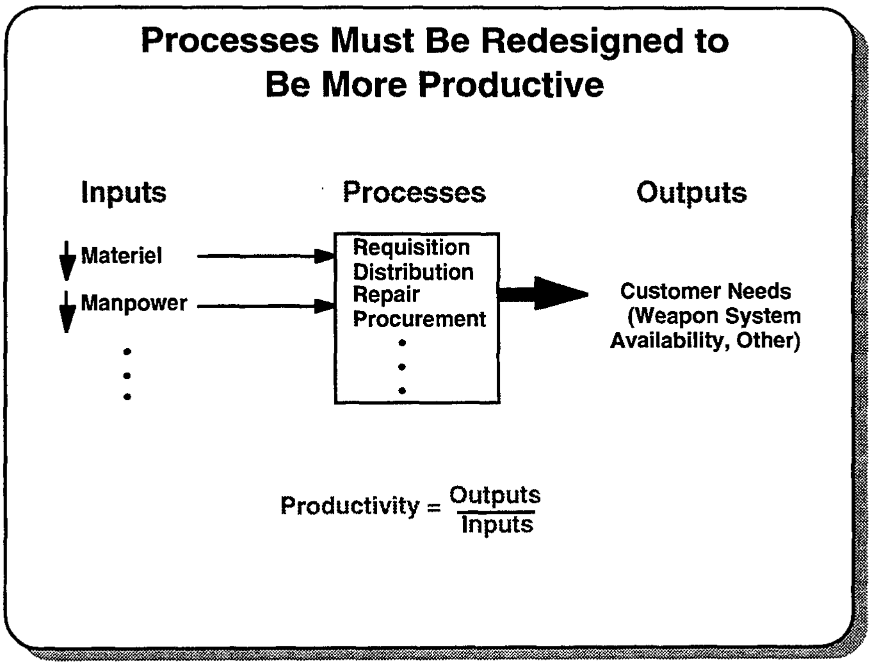


This chart illustrates the scale and impact of the improved velocity in logistics processes called for under velocity management.

Assume that the dark solid line represents an operational commander's demand for some type of support, say, resupply of spares. In the top case the arrival of those spares, indicated by the lighter (patterned) line, lags 45 days behind the actual demand. Demand is almost never smooth and constant in the real world. Between days 30 and 60 some activity causes a temporary increase in demand. (This hypothetical scenario is close to the reality experienced in Panama during Operation Just Cause.) The resupply cycle times for some critical items exceeded the duration of the contingency. The resulting lack of support argues for the commander to demand more days-of-supply if the process remains unchanged.

The bottom example assumes the same demand pattern, but with a five-day resupply cycle time. This dramatically more responsive system satisfies the commander's needs even when more radical demand shifts are encountered. Moreover, the needed days-of-supply are much reduced.

Importantly, a more responsive system must not only perform more quickly but also more reliably.



In addition to improving processes to make them more responsive to uncertain demands, it is also important to make those logistics processes more productive. This chart is meant to underscore the need for that increased productivity.

Like all systems, the Army logistics system is made up of inputs, processes, and outputs. In the current military environment, the Services are experiencing drawdowns in inputs (signified by the downward pointing arrows) as well as in the total output required (as measured by total number of sustained weapon systems). In some cases the inputs may have drawn down so sharply that the processes that they feed no longer function as well as designed.

The concern is that the level of readiness and sustainability inherent in the remaining forces be maintained or even improved in the face of declining inputs and potentially "broken" processes. If the inputs to the system are drawn down at a faster rate than the supported force structure (i.e., the desired outputs), the productivity of the system must increase to maintain the required support. Hence, velocity management focuses on improving the productivity of the logistics processes themselves. This focus is not the common simple injunction to "do more with less." Rather, velocity management calls for performing the processes differently—redesigning them—so as to make them more productive. Such process reform requires analyzing the assumptions and policies that shape current procedures and then developing and assessing alternatives.

The Services have demonstrated their capacity for process reform in the face of crisis. For example, during Operation Desert Storm, they quickly innovated the Desert Express priority airlift, deployed contractors into the theater, and found ways to reduce depot repair cycle times for key components—the list goes on. This type of process reform for productivity improvement is needed now on a continuing basis and larger scale.

Commercial Firms Have Dramatically Improved Their Processes

Measure	Before	After	Firm
Inventory	$173,000,000	$22,000,000	Cummins Diesel
Safety Stock	30 days	5 days	Detroit Diesel Reman
On-Time Delivery	15%	80%	Titeflex
Production Lead Time	several weeks	3 days	Titeflex
Production Lead Time	months	days	FMC
Inventory Turnover	1.9	4.0	FMC
Standard Hours	87	39	HP
Quality	5000 ppm	100 ppm	HP

As part of our research effort, we have examined process reform efforts in the commercial sector and found a growing number of instances in which commercial firms have dramatically improved their processes.

American industry has been successfully pursuing dramatic improvements to meet the challenges of their increasingly competitive environment. For example, we found order-of-magnitude improvements with regard to reductions of inventory. The service parts division of Cummins Diesel reduced its average inventory on the floor from $173 million to $22 million.[6] Detroit Diesel Remanufacturing has been able to reduce its safety stock from 30 days to 5 days by reengineering its operations.[7]

On-time delivery performance can be greatly improved also. Titeflex, a small firm that manufactures high-pressure hoses and connectors, had secured a niche with the U.S. government.[8] In the late 1980s, competition for the market developed and Titeflex needed to make changes. Within two years it moved from 15 percent on-time delivery performance to over 80 percent, and it reduced the production lead time from weeks to days. FMC, the manufacturer of the Bradley Fighting Vehicle and an extensive line of automotive components, reduced its production lead time for a

[6]Discussion with managers at Cummins, March 1993.

[7]American Production and Inventory Control Society (1992).

[8]Blaxill and Hout (1991).

non-DoD product from months to days and reduced its inventory to the extent that the yearly turnover of inventory went from 1.9 times to 4.0 times.[9] (Generally, inventory turnover in DoD is near 0.5 times today.) Hewlett-Packard (Computer Systems Division) was under pressure to improve the productivity of its production process. It was able to reduce the standard hours required from 87 hours to 39 hours, while simultaneously reducing the defect rate of the process from 5000 parts per million (ppm) to 100 ppm.[10]

These examples and similar ones for other processes in various firms demonstrate that very substantial improvements in process performance are feasible. What the commercial record leaves unanswered is whether the kind of process reform advocated by velocity management can be translated to the Army's situation.

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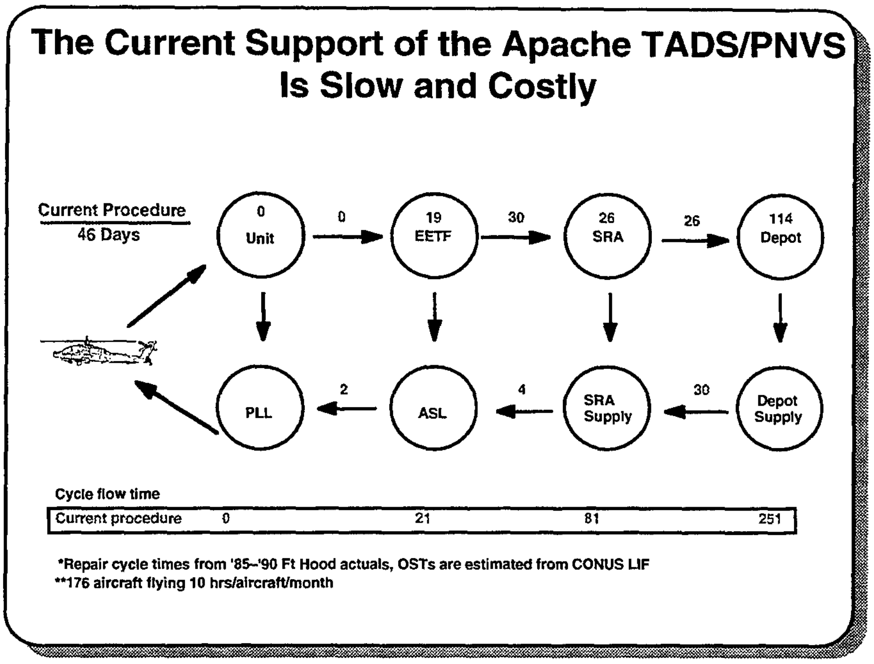
[9]Suzaki (1985).

[10]Ibid.



To this point in the briefing we have discussed velocity management and its benefits chiefly in conceptual terms. While the velocity management concept should be applied across the logistics system in support of all weapon systems, here we illustrate notionally how the concept would be applied to a specific set of Army logistics processes in support of a specific Army weapon system.

This chart depicts schematically the support structure for the Apache attack helicopter and, more specifically, the TADS/PNVS subsystem (i.e., the Target Acquisition Designation Sight/Pilot Night Vision Sensor system is the mission equipment package, the high-technology key to this helicopter's warfighting power). The TADS/PNVS is useful for our purposes because a great deal of data are available, permitting us to offer a relatively accurate description of the associated repair processes.

This illustration will be developed around the 176 Apache aircraft assigned to Fort Hood, Texas. The example uses repair cycle times that were documented there in the 1985–1990 time period. The actual transportation linkage between the echelon of repair and stockage nodes was estimated from the CONUS LIF (Logistics Information File) data.[11]

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[11]It is very important to point out that these segment cycle times are typically expressed as averages. Unpublished ongoing research by John Halliday, Nancy Moore, and others at RAND has shown that for the requisition-to-receipt processes (i.e., order-and-ship times [OSTs]), the variability for nonbackordered transactions was very high and

Overall, this gives us a relatively rich and reasonably accurate picture of how things looked during that period.[12]

The set of circles portrays the repair and supply nodes for the 27 different TADS/PNVS line replaceable units (LRUs) that are repaired at the different echelons in the logistics system. Moving from left to right, items are removed from the helicopter at the unit. The TADS/PNVS is a highly complex electronic system, and the removed LRUs cannot be repaired by the unit personnel. They merely remove and replace defective components from the aircraft. The components are then moved back to an intermediate-level repair activity, the EETF (Electronic Equipment Test Facility). Items that cannot be repaired at the EETF move back to the next echelon, the contractor-operated special repair activity (SRA). This activity is generally located outside of an installation as a regional repair activity. One is not located outside of every installation, but in the case of Fort Hood, there is one outside the gate in the town of Killeen, Texas. Those items that cannot be repaired at the SRA are moved to the depot repair activity. In this case, that is the Martin-Marietta factory facility in Orlando, Florida.

The numbers appearing at the tops of the activity circles and above the movement arrows indicate the average number of days that are involved in performing those activities or tasks. For example, the zeros at the unit repair activity (or circle) and on the arrow to the right of the unit activity indicate that, because repair is not done at that level, the items flow directly to the EETF.[13] When these items reach the EETF, items spend, on average, 19 days in that repair activity before they are returned serviceable to the authorized stockage list (ASL). If they are in the ASL and are available, it typically takes two days to respond to a requisition from the flightline and to issue the serviceable item from the ASL. Therefore, for items that are repaired at the EETF level and cycled through the EETF to the ASL and returned to the aircraft, the cycle time is 21 days on average,

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dramatically skewed by many transactions that were more than two and three times the achieved average. Hence, a reduction in process variability is at least as important as the reduction in average process cycle times.

[12]We are aware that since 1990, there have been initiatives throughout the Army and specifically at Fort Hood that have resulted in improvements to OSTs. There have also been some adaptations of repair processes instituted in response to the stock funding of depot-level reparables (SFDLRs) that will change and modify these numbers somewhat. We are currently in the process of updating these data. However, preliminary indications are that the new data will have little impact on the underlying message.

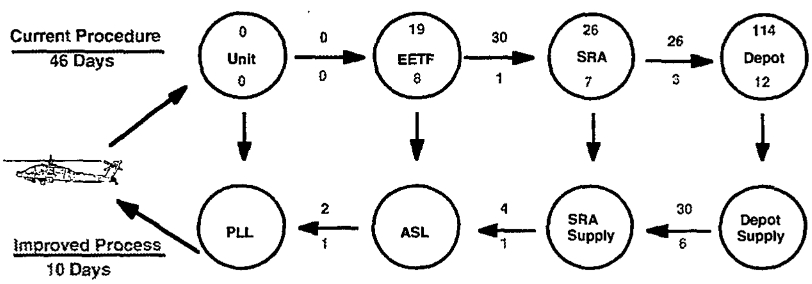
[13]We recognize that in actual practice a nonzero time would usually be a more accurate characterization. However, we have no data to support an "average" figure, and this lack does not diminish the value of our example.

shown at the bottom of the figure in the cycle time display. Likewise, for items repaired at the SRA, the typical cycle time is 81 days, and for items that are returned to the depot, it is 251 days. The good news is that only a very small percentage (on the order of two percent) of the items are sent to the depot for repair. The majority of items are repaired at the EETF and SRA levels. Overall, the current procedures result in a weighted average repair time of 46 days.

A slow and unreliable support structure is necessarily a costly one. It is difficult to determine accurately just how costly a poorly performing logistics system is, but some costs are readily evident. For example, every day of repair cycle time is a day of resupply lead time in the inventory requirements. Additionally, if a customer does not get an order on time and feels the need to reorder or to hoard stock against future needs, such actions drive up system costs. If a process can be accelerated and made reliable, the lead time decreases, safety stock requirements decline, and customers stop engaging in actions such as hoarding to protect themselves from poor performance. Ultimately, warehouse requirements and other holding costs decline.

With this picture of the current system performance in mind, let us now look at a higher-velocity system.

Improvement Results from Reducing Time in Each Segment of the Logistics Pipeline



Cycle flow time

Current procedure	0	21	81	251
Improved process	0	9	18	39

*Repair cycle times from '85–'90 Ft Hood actuals, OSTs are estimated from CONUS LIF
**176 aircraft flying 10 hrs/aircraft/month

This chart illustrates a notionally improved system of Apache support processes designed to reduce the repair cycle times, thereby improving logistics responsiveness. To construct this chart, we have not conducted a detailed engineering analysis, nor have we formed a process action team (PAT) of functional experts to prescribe changes. Rather, we have merely reviewed the process with the aim of developing a first-cut goal for improvement.

Velocity management calls for comprehensive process reform to achieve its full potential benefits. By comprehensive, we mean that the implementation of velocity management requires looking across all segments of the logistics process and dealing with the whole system, not just selected activities. Therefore, as we discuss this chart, we will begin with the improvements in the times in each segment of the logistics pipeline, and then discuss the cycle time improvements in the bottom panel.

In the chart a second set of numbers representing process goals appears below the numbers representing actual performance (from the preceding chart). These numbers represent improvement goals that might be possible during the repair of the Apache TADS/PNVS components. For example, we found that actual on-bench repair times at the EETF are typically measured in terms of minutes or hours, certainly not in days. Technologically, there appears to be no reason that the repair times could not be dramatically reduced. Reasons for longer times have to do with the availability of manpower to work the test equipment, the availability of the test equipment itself, and the availability of piece parts to repair the individual LRU components. So, we have specified eight days as a reasonable initial repair goal for this activity. In an actual implementation of velocity management, as the Army proceeds with the improvement process, it might very well find that it could do better than that. However, these numbers are not engineering study results; rather, they are only initial goals for significant improvement.

As we move to the right in the chart, notice that the time of 30 days for movement from the EETF to the SRA has been reduced to only 1 day. Those 30 days were how long, on average, it took to process and move an item from the EETF to the SRA, only a matter of a few miles. Many standardized procedures and much batching of paperwork and deliveries cause it to average 30 days. We estimate a reasonable movement time to be 1 day from the time EETF personnel decide they cannot fix it until it arrives at the SRA. Similarly, we have proposed reducing the processing time at the SRA from 25 days to 7 days. At this echelon, the test equipment is rather generic, and the skill level of the personnel who man the SRA tends to be higher. The personnel are more highly trained, and they are dedicated (in terms of their time) to repair. We therefore suggest a goal that is somewhat faster than the suggested goal for the EETF. Next, because of the high cost of these components and the availability of priority transportation like that used in Desert Express, we suggest that processing and moving time could be reduced from 26 days to 3 days. Likewise, an improvement at the depot is a further possibility.

The improved process cycle times appear at the bottom of the chart. For example, for items repaired at the EETF level, the improvement is from a cycle time of 21 days down to a cycle time of 9 days. Similar improvements are seen as you read across for the cycles through the SRA and the depot. The weighted average of the improved process, given similar levels of repair, is expected to drop from the current 46 days to 10 days. These dramatic improvements could be made using current technologies and information systems.

Velocity Management Has Higher Payoffs When Reparables Are Expensive

- **Stock reductions can follow improved velocity**

TADS/PNVS Availability	Current System	Improved System	Potential Savings	
85%	$22M	$4M	$18M	(per 176 a/c)
90%	$30M	$8M	$22M	
95%	$46M	$15M	$31M	

- **Other benefits of improved logistics responsiveness and reduced costs still apply**

The Army will receive a number of benefits from achieving such dramatic cycle time reductions. In the case of the TADS/PNVS, the Army is dealing with very expensive reparables and the potential for savings from stock reductions is quite large, as the chart here shows. These savings are illustrative of very expensive items.

Other benefits follow as well. In the case of the Apache, the Army's availability goal is 75 percent. To achieve that level of availability of the weapon system, the TADS/PNVS needs to be available and supported at a higher rate. Generally, our analyses indicate that if the Army could achieve an 85 percent availability for TADS/PNVS systems, it could probably achieve 75 percent availability for the Apache weapon system. Therefore, with an 85 percent availability goal for the TADS/PNVS, we used Dyna-METRIC to calculate what spares investment would be required, based on current logistics process times.[14] A $22 million investment in spare parts is needed to support the current repair processes (top left cell of the chart).

The analysis using the improved system with reduced repair cycle times indicates that only a $4 million investment of TADS/PNVS spare parts is needed to support the improved system, giving a considerable savings for this 176-aircraft fleet (top middle cell of the chart). However, the cost and

[14]Given a specific weapon system availability goal, Dyna-METRIC Version 4 can calculate the level of stock necessary to achieve the goal. See Isaacson et al. (1988).

operational value of the Apache suggest that the 75 percent availability standard may become unacceptable as the commanders in chief (CINCs) consider a broader range of missions for this weapon system.

In anticipation of an increased demand for the Apache, we analyzed the effects on cost of increasing the expected availability rates of the TADS/PNVS from 85 percent to 90 and 95 percent, respectively (the second and third rows of the table). For example, at a 95 percent availability of TADS/PNVS spares, with the current support system, the Army would require a $46 million spare parts investment.[15] At the same 95 percent level, with the improved system cycle times, the inventory investment required drops to $15 million. What is interesting to note here is that a $15 million investment and the improved system can dramatically increase the availability of the Apache helicopter while saving money over the current system at today's inventory levels ($22 million for 176 aircraft).

While these inventory savings are mostly one-time savings, there are benefits associated with the improved support system that are even more significant.[16]

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[15]This $46 million reflects, as does the $22 million computed above, a full cannibalization or controlled substitution policy. If the Army were to invoke an alternative policy that prohibits any controlled substitution, then the inventory requirement would go up dramatically.

[16]The Army has already invested in this inventory, and so the actual savings is going to represent the cost avoidance of the replacement of inventory associated with maintaining stock levels at the new lower levels. This would probably range between 10 and 20 percent of the associated inventory per year.

Velocity Management Aims to Improve Responsiveness and Lower Costs

- **Improved logistics responsiveness**
  - More robust to uncertainty in demands
  - More tailored to customer needs
  - Higher quality of services
  - Improved flexibility and mobility
- **Lower total support costs**
  - Free-up or reduce manpower
  - Reduce inventory needs

The potential benefits to the Army logistics system are many, though they fall into two major groups: (1) improved responsiveness of the logistics system, and (2) lower total support costs.

There are at least four aspects to improved responsiveness. First, it will result in a logistics system that is more robust in meeting uncertain demands, regardless of how they arise—for example, uncertainty about what mission the Army will be called upon to perform, uncertainty about the failure rates of various system components, or uncertainty about the performance of the distribution system.

Second, improved responsiveness will permit the Army to tailor its various logistics services and activities more closely to their customers' needs. If the Army logistics system was truly customer driven, then the system's culture could change and adapt more easily to the continuing changes in the national military environment.

Third, improved responsiveness can help improve the quality of service provided by its logistics processes by reducing the time between the performance of an activity and the time when the customer receives the resulting service or product. When the cycle time is reduced in that way, more clear and precise feedback on that service or product is possible, and quality improvement is more practicable.

Finally, a more responsive logistics system will enable the Army to respond to various scenarios in a very efficient and effective way. With the notional examples presented in this briefing, we intend to illustrate the improved flexibility and mobility of the fighting forces.

The second group of benefits relates to cost savings. The implementation of velocity management will result in lower manpower costs. Manpower that is currently performing non-value-adding activities will be freed up for assignment to other activities. Through continuing improvement, we hope to reduce total manpower required.

Stockage costs will also be reduced. As the activity cycle times are reduced throughout the entire system and the processes are made more reliable, the need for buffer stocks and safety stocks for materiel throughout the system will be reduced. After the improved responsiveness has been achieved and demonstrated to customers, inventories can be reduced. At first these may appear to be one-time savings of inventory investment, but a closer look will reveal that the amount of "churn" in the typical materiel inventory can run as high as 20 percent.[17] In one sense this helps define how quickly the one-time savings will be realized, but it also highlights the continuing impact that the lower inventory basis will have as a result of the continuing churn effects.

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[17]*Churn* can be defined as the sum total of all changes in the requirements database from one point in time to the next: the appearance of new items, the disappearance of items formerly in the database, and changes in item characteristics, e.g., demand rates, repair times, and NRTS (not-repairable-at-this-station) rates (Abell, et al., [1993]).

Outline of the Briefing

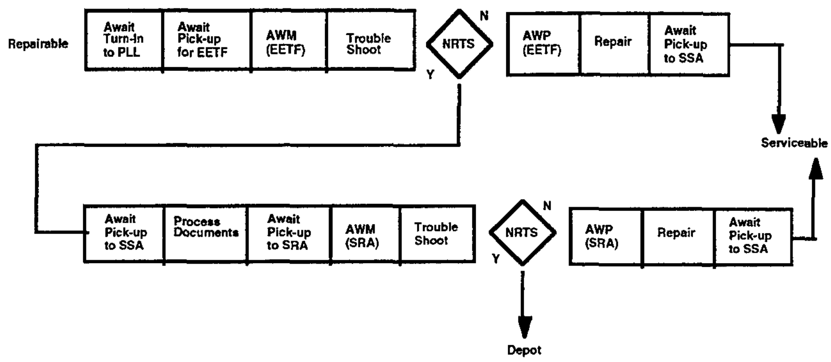
- **Describe Velocity Management and some of its benefits**
- ➡ **Describe an application of Velocity Management to military logistics processes**
- **Lay out an action plan for a Pilot Implementation**

To this point in the briefing we have described velocity management and its benefits conceptually and illustrated both the concept and benefits in an Army setting.

Now we are going to describe in more detail the process improvement approach advocated by velocity management and describe an actual DoD case in which a very similar approach has been applied successfully.

Implementation of Velocity Management in the Military Requires Improvement to Processes

Sample: Reparable Process

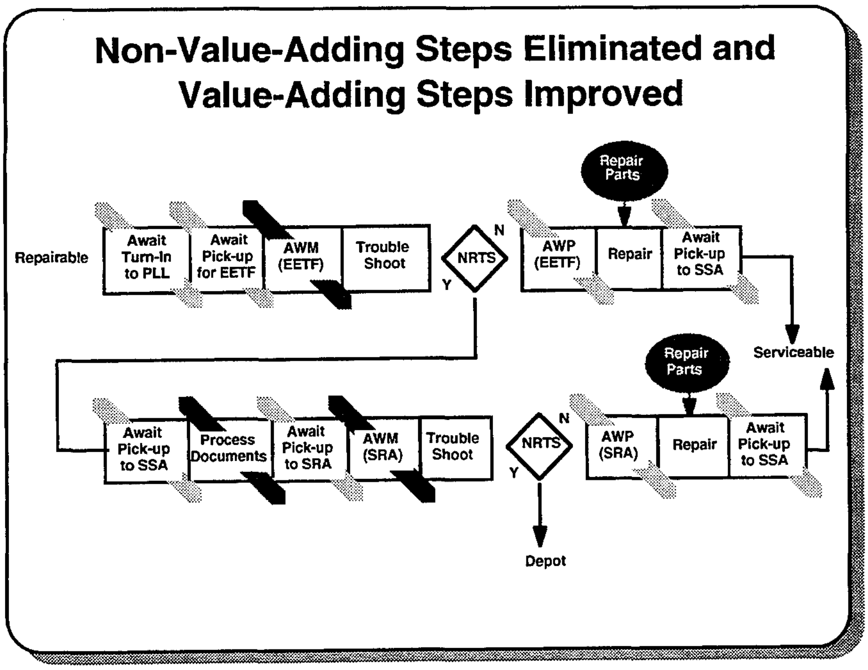


In our conceptual description of velocity management, we indicated that it requires analyzing processes to identify and eliminate non-value-adding activities and to continuously improve value-adding activities. In our notional Army example we showed the potential for dramatic improvements in the repair cycle times for the TADS/PNVS components. But thus far we have not shown in detail how processes must be analyzed and redesigned to achieve such dramatic improvements. That is the purpose of this and the next chart.

Above we depict a sequence of activities involved in a typical repair process. This narrow focus on a single process is intended to be illustrative: As we have said, velocity management applies to all logistics processes—not just repair processes, but also inventory control processes, warehousing processes, transportation processes, and more. In addition, full implementation of velocity management applies not only to the support of Class IX (i.e., spare parts) components, but to other classes as well, including ammunition, medical supplies, etc.

To provide continuity with the preceding section, we are going to use this example to talk about the repair processes associated with the Apache TADS/PNVS. In this chart we have decomposed the repair processes at the EETF and SRA levels into some of their component steps. (This is designed to be illustrative of process analysis, rather than a definitive engineering analysis.) Reading from left to right and from top to bottom, a reparable component carcass is ready to be given to the prescribed load list (PLL) clerk for further processing and movement to the EETF for repair. The component will then be stored at the EETF until a technician is available to work on it. The technician will then troubleshoot it and, based on the troubleshooting results, will either repair it at the EETF, place it in an AWP (awaiting parts) status, or declare it NRTS (not repairable at this station). In the AWP case, the component typically waits for the parts that were discovered to be defective during troubleshooting. When those parts are finally available, a repair takes place. Then the component is made available for pickup for return to the supply services activity (SSA), where it becomes part of the serviceable inventory again. For those NRTS items that proceed to the SRA (in the lower row), a similar parallel process takes place, including awaiting maintenance (AWM). Again, some of the items are declared NRTS from there and go to the depot for repair.

Process improvement requires a detailed analysis of the current process and, in particular, a detailed understanding of the value-adding steps. Improvements in cost and responsiveness will be the result of the elimination of non-value-adding activities and the continuous improvement of value-adding activities.



This chart illustrates the elimination of non-value-adding steps and the improvement of value-adding steps that follows process analysis.

The analysis of our notional repair process has resulted in a focus on eliminating all waiting or queuing (e.g., awaiting turn-in to the PLL clerk or awaiting pickup to EETF). We are looking for a way to convert that repairable to a serviceable as quickly as possible. Value-adding activities are movement of the repairable to a maintenance facility for diagnosis, repair, and return to serviceable condition. Whenever the component is in a non-value-adding activity (e.g., awaiting turn-in or awaiting parts), we consider process changes to eliminate that activity. In fact, at the AWM point, procedures to start work as soon as the repairable arrives need to be developed. This may mean that maintenance artisans are principally dedicated to maintenance activities.

When the artisan completes troubleshooting, we would aim to complete the repair by replacing bad parts immediately and eliminate the awaiting parts delay. The Army could do that by making repair parts available in an expanded repair parts inventory readily available to the repair technician. The overall goal remains to reduce costs and overall inventories; however, buffer inventories of cheap parts may need to be maintained. These buffer inventories will let the Army move the more expensive components through the processes more rapidly.

It is important at this point to understand that an analysis of the current process is only the first step in a process-improvement effort.

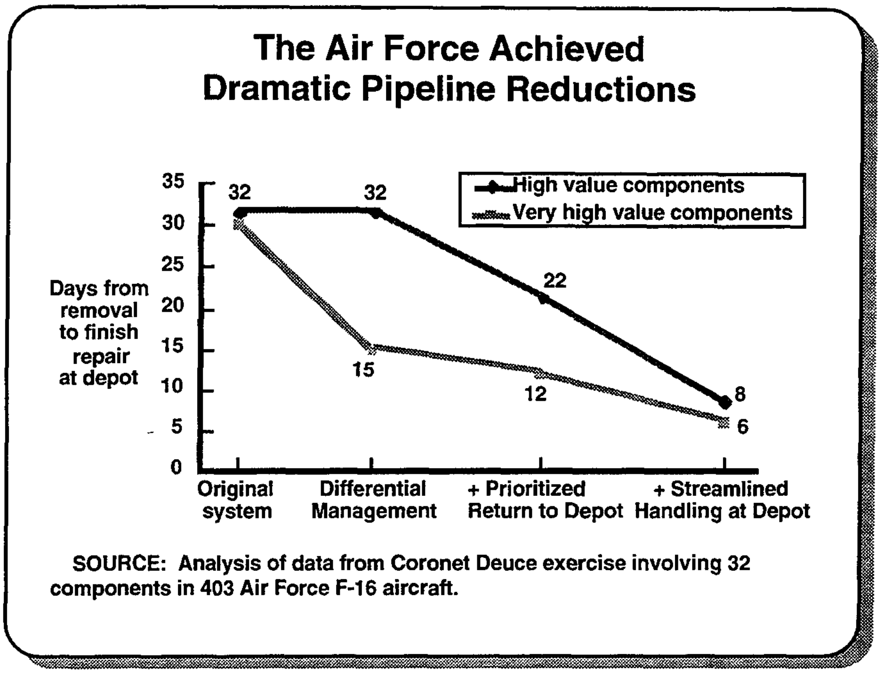
Fundamentally, if you continue to perform a given process in the same way, then your possibilities for improvement are limited. In such a case the improvement will likely be limited to the reduction of queuing times and the reduction in variability of task performance. If some policies and rules are not changed, even this improvement will not be possible. If you continue to perform the processes in the same way, then you will continue to get the same performance results. Process change requires a willingness to step back and challenge the assumptions that guide the current procedures. Furthermore, the goals for improvement must be driven by the needs of the customers of the process. You must be willing to question even the need to perform this specific activity in the first place. Maybe an aspect of the current process activity is needed, but it does not need to be done at this location by these people. Maybe information transactions need to occur, but the information and the materiel do not need to be traveling together, or parallel processing of information and materiel could occur. Process improvement is a creative process of change within an organization.

The Air Force Has Recently Implemented Elements of Velocity Management

- **Coronet Deuce Exercise**
  - Support of radar system on F-16A/B
- **Customers demanded improved performance from logistics system**
  - Manpower reductions were also required
- **Leadership coalition directed action**
- **Process analysis goal: dramatically reduce repair cycle time**

The preceding Army example, though detailed, was still notional. So it is reasonable for the skeptical reader to ask whether such process reform has been demonstrated for any military system, and in particular, for a logistics system. We address that concern by presenting a recent Air Force example of process reform that incorporated elements of the velocity management approach.

The example occurred during an exercise called Coronet Deuce, during which the Air Force focused on the problem of supporting the radar system on the F-16A/B aircraft. In addition to the high cost of these components, there were pressures for manpower reductions within the Air Force maintenance system and for improved mobility. Therefore, the Air Force needed both to improve the performance of its logistics system and, at the same time, to reduce costs, manpower, and mobility footprint. (In this case, the Air Force's immediate goal was to reduce dramatically the average repair cycle times for these radar components.) To make this happen, the Air Force discovered (as the Army is discovering) that the logistics processes crossed several functional agencies. To span those functional boundaries and bring about true change, a leadership coalition was required to make the implementation actions possible.



This chart shows the dramatic improvements that the Air Force was able to achieve through a series of actions to improve the processes for repairing 32 high value radar components for 403 F-16 aircraft deployed worldwide (Abell and Shulman, 1992).

The vertical axis shows the number of days from the removal of a particular radar system LRU from the aircraft on the flightline until it has finished being repaired at the depot. Prior to this process improvement action, the Air Force had taken 32 days on average to complete the repair cycle for these items.

For the 403 aircraft, the Air Force divided the 32 components into two categories: high value and very high value components. The seven very high value components have a pipeline value per day in excess of $300,000 each. The 25 remaining high value components have a pipeline value per day of less than $75,000 each. The Air Force provided premium transportation (overnight delivery) of those very high value items from the unit to the depot. Because of the consistent overnight delivery of these components, the Air Force was able to cut its pipeline times by more than one-half. Based on that success, the Air Force started providing similar service to all 32 components. The Air Force then focused on streamlining procedures to accelerate on-base processing from the flightline mechanic to the transportation departure. Ultimately, all of the supply processing and transportation processing at the unit level were streamlined and expedited. Non-value-adding activities were eliminated.[18]

After working the unit-level processes, the Air Force then focused on the depot level of the component repair process. Originally, the items were delivered by Federal Express to the depot transportation and supply office that processed them into the warehouse. Then, the items were processed out of the warehouse to the depot repair technicians. The streamlining indicated on this chart focused on the depot supply and transportation handling, eliminating unneeded delays. The result of all these improvements was to cut the repair times from 32 days to between 6 and 8 days, depending on the value of the items.

Note that this dramatic increase in velocity (from 32 to 6-8 days) is of roughly the same scale that we suggested that the Army should be able to achieve by redesigning its support process for the Apache TADS/PNVS (from 46 to 10 days). The Air Force experience in Coronet Deuce provides a convenient benchmark for the Army pilot implementation of velocity management that we propose in the final section of this briefing.

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[18]To capitalize on the improved processes, the Air Force also changed its inventory mix, ending up with a slight net reduction in total inventory requirements: The numbers of bit pieces and the shop reparable units (SRUs) needed to repair the LRUs at the unit were reduced. The Air Force did not need to buy any more LRUs because it had already acquired enough to fill the larger pipelines. Further, because the improved processes permitted the consolidation of repair activities without reduced weapon system availability, the Air Force was able to relocate intermediate-level repair to the depot and eliminate that repair echelon. By moving to a two-level structure, the Air Force achieved its goals of substantial improvements in mobility and reductions in maintenance manpower.

With Dramatic Velocity Improvement the Air Force Gained Many Benefits

- **Improved responsiveness**
  - Faster and more reliable repair cycle
  - Maintained worldwide availability goal
  - More robust to changing scenarios
  - Reduced deployment airlift burden
- **Lower total cost**
  - Increased priority transportation
  - Reduced manpower
  - Less total inventory
    - More LRUs

These dramatic velocity improvements gave the Air Force a number of important benefits. In the first place, they improved the component repair system's responsiveness. The Air Force got faster, more reliable repair activities. The system is very consistent at these faster times and supports worldwide basing. (Some of the 403 aircraft are stationed in Japan, some in Germany, and the rest in the United States.) Not only was the Air Force able to dramatically shorten the depot repair cycle times, but the worldwide aircraft availability goals were maintained. In fact, this new component repair process has proven to be very robust to changes in scenarios and continues to be responsive to various missions.

This increased responsiveness and velocity of the depot repair process has shown the Air Force that a two-level maintenance solution works for this weapon system. The Air Force also reduced the deployment airlift burden because it is no longer necessary to move the intermediate test equipment and the manpower to operate it. Only spare parts are moved now.

Remarkably, while achieving improved responsiveness, the Air Force also lowered support costs. The Air Force now has lower costs for the processes involved, even though the costs for premium transportation rose. The total costs are lower because the Air Force was able to reduce manpower costs by cutting some 60 percent of the intermediate-level maintenance technician manning.

The Air Force Also Gained Valuable Experience

- **Dramatic improvements are built from many small steps**
  - Defining an improvement goal is relatively easy
  - Defining a complete strategy for successful implementation is much more difficult
  - Continuous movement toward the goal is a key concept
- **Barriers to change will emerge**
  - Some are imagined or based on "custom"
  - Some are "official" and senior coalition support is key
- **Derived "lessons learned"**
  - Piece parts to support repair processes cause delays
  - Commercial shippers provide more than just transport

The Air Force also gained considerable experience in how to implement process change during the Coronet Deuce exercise. First, it discovered that dramatic improvements are achieved as a result of many small steps. Defining an improvement goal was relatively easy. However, defining a complete strategy for successful implementation is a much more difficult task, and continuous movement toward the goal is the key concept.

Second, the Air Force discovered that a number of barriers to change emerge as an organization starts changing its way of doing business. Although some of the barriers are imagined or based on custom or the culture of the organization, others are official barriers and require a senior coalition's support to overcome.

Third, the Air Force derived a number of lessons learned. For example, it discovered that a total system view is needed. Although the goals were to reduce manpower and mobility footprint, it found that these were best achieved by improvements at the repair depot when coupled with responsive transportation for both repairable and serviceable components.

Outline of the Briefing

- Describe Velocity Management and some of its benefits
- Describe an application of Velocity Management to military logistics processes
- → Lay out an action plan for a Pilot Implementation

To this point, we have explained what velocity management is, what its potential benefits are, how it is accomplished, and how elements of the concept have been implemented successfully in one military logistics system. Now we turn to the third part of the briefing, in which we recommend that the Army move the concept from the development phase to a pilot implementation in an Army setting. The action plan that we propose is intended as a starting point for discussions leading to the final plan.

Purpose of the Pilot Implementation

- Demonstrate applicability of velocity management to Army logistics
- Acquire empirical data on costs and benefits
- Identify implementation barriers
- Derive "lessons learned" for further implementation

A pilot implementation is valuable for at least four reasons (these are in addition to the benefits in cost savings and increased responsiveness that accrue to the actual processes that are improved in the implementation). The primary reason is that the implementation will demonstrate the applicability of the concept of velocity management to Army logistics in this changing military environment. The second reason is that the implementation will provide the Army with empirical data on costs and benefits. The third reason is that the implementation will help to identify barriers to process reform. The fourth reason is that the implementation will help the Army to derive lessons learned that will facilitate the further implementation of velocity management through the Army.

Based on Feedback, We Have Developed a Pilot Implementation Plan

Objective: **Improve readiness at lower cost.**

Strategy:

1. Use velocity management paradigm to improve process performance.
2. Use senior-level coalition (SLC) to resolve/remove barriers to progress.
3. Focus initially on improving the ordering, repairing, and shipping processes.
   - Measure improvement in OST and repair cycle time
   - Measure improvements in availability/readiness
   - Measure cost savings
4. Start with: Apache TADS/PNVS and T-700 jet engine
   M1A1 and low-density items (e.g., M9ACE)
5. Apply lessons learned and extend implementation.

Our discussions with key DCSLOG staff and senior Army leaders have helped us to develop the initial action plan proposed here.

The overall objective of velocity management is to make the Army logistics system more responsive and efficient. Responsiveness will be measured primarily by sustained weapon system availability; total support cost per available weapon system will be the primary measure of efficiency. Hence, the objective of velocity management can be achieved for the pilot implementation, improving sustained readiness at lower cost.

The strategy for achieving that goal is to apply the velocity management paradigm to improve the performance of the individual logistics processes. Because the traditional management of these different logistics processes involves several different logistics functional groups (e.g., supply, maintenance, transportation) and spans organizational boundaries (e.g., the Forces Command, the Army Materiel Command, and the DLA), the implementation of change to these processes will require the support of the senior leadership involved.

We suggest that the initial focus of the improvement efforts should be on reducing the cycle times for the ordering, repairing, and shipping processes. This focus on Class IX, spare parts, should permit measurable peacetime improvements that transition well to supporting power projection. Specifically, the Army should be able to measure improvement in OST, repair cycle time, availability/readiness, and costs.

It is important to measure progress and to concentrate management attention. It is also important to understand that many of the actions taken to improve processes will also improve those common processes for other items that were not the initial focus of the pilot implementation. Such synergy is a planned by-product and benefit of this implementation approach.

To open the discussion, we suggest that the Army consider both aviation and ground systems as candidates for the pilot implementation of velocity management. (It may be prudent to begin the improvement efforts by further focusing on a few weapon systems, perhaps targeting key systems or components of those weapon systems.) The critical mission importance of the Apache leads us to the suggestion of including the TADS/PNVS mission equipment package and the T-700 series helicopter engine. The high value of these reparable components means that they are potentially high-leverage components with respect to both readiness and cost. With respect to ground systems, the mission criticality of the M1A1 tank and the support difficulties associated with low-density equipment such as the Armored Combat Earthmover (M9ACE) and key material handling equipment make them strong candidates for consideration. In the case of these suggested ground systems, the cost of the components will be less than the Apache components, but the potential for improving mission support may be even greater. The resulting comparisons of costs to benefits for aviation and ground systems may be useful for decisions regarding how to expand the initial implementation.

The final point with respect to this proposed plan for implementation is that the Army must prepare from the outset to apply the lessons learned and to look for ways to extend and expand the implementation as the benefits of velocity management are demonstrated and documented.

With this overview of the action plan in place, let us now turn in more detail to two specific points: first, the focus on improving OST, about which several Army leaders have expressed a strong interest to us; and second, the need for a senior-level coalition to sponsor the pilot implementation.

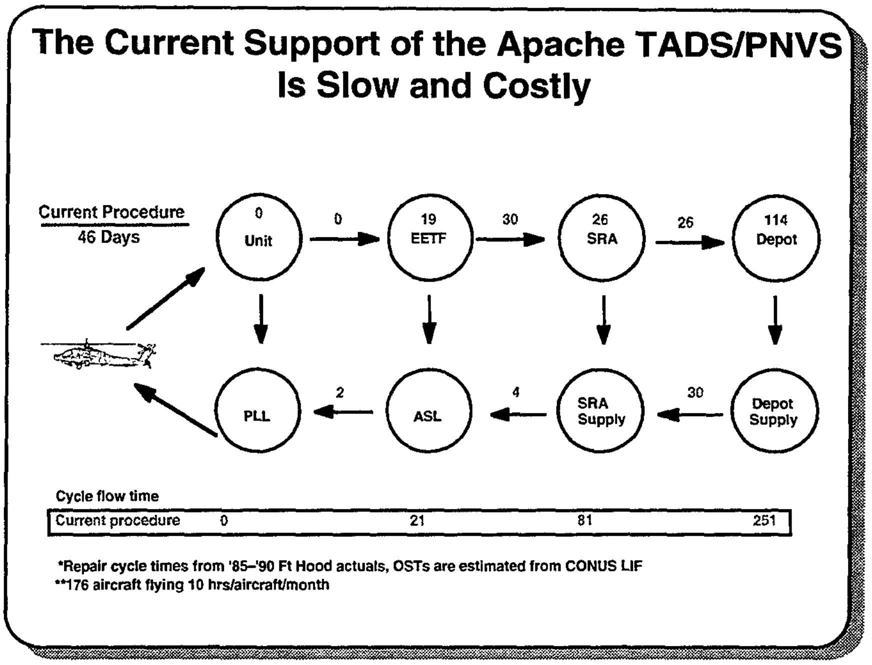
A Focus On OST Goes a Long Way Toward the Objectives of Velocity Management

- **OST directly affects customer readiness**
- **OST captures the effects of sluggish ordering and shipping processes**
  - **Installation processing of orders and shipments**
  - **Supply depot processing of orders and shipments**
  - **Item manager processing of orders**
  - **Transportation processes**
- **OST is usually reported as the average performance for a pipeline segment.**

Our discussions with Army leaders have uncovered a strong interest in improving OST. We concur with this proposed focus. OST is an important existing system performance measure that goes a long way toward measuring the objectives of velocity management. OST relates directly to the ordering and shipping processes. Management reporting has typically been in terms of the average days to transit the various segments of the system. OST's accuracy as a performance measure is limited by the data reporting discipline of the various transaction nodes within the system. Its usefulness as a performance measure is somewhat degraded by the reporting of only average performance. The variability of system performance is just as important. Nevertheless, OSTs strongly correlate with equipment readiness rates, and we hypothesize that reductions in the variation and duration of OSTs will have a positive impact on sustaining customer readiness.

Because OST can be tracked across the individual process segments, it is a useful measure to help target improvement efforts and to monitor performance over time and for various scenarios. In short, OST is a useful measure for all Class IX materiel.

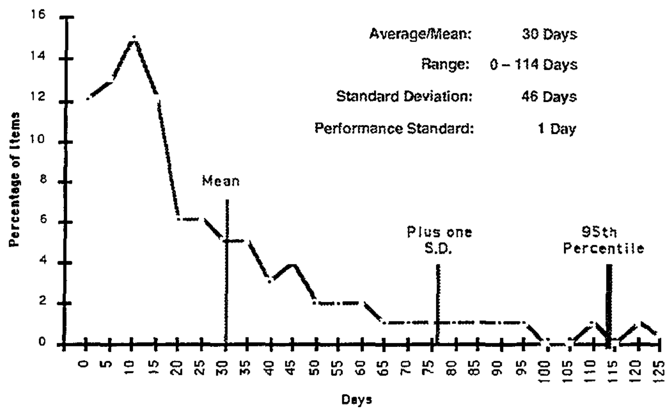
However, the current practice of tracking only the average times for either the individual order-ship segments or the total OST provides insufficient information for managers to understand the quality of performance achieved by the system. For that reason, we recommend that the Army also begin to routinely track the variability of OSTs throughout the system.



To illustrate the importance of tracking variability as well as average performance, let us return to the Apache TADS/PNVS component repair example that was discussed earlier. The reader will remember that on average it took 30 days to get from the EETF to the SRA. Obviously, the reparable component was not traveling that whole time. In fact, virtually all of those 30 days were spent processing and/or waiting. Thus, the statement that the segment time averaged 30 days is uninformative and potentially actually very misleading.

Average Pipeline Segment Performance Does Not Provide Enough Information

Distribution of retrograde times to the SRA:



This chart graphs the performance distribution that lies behind the 30-day mean. It is based on some 2000 component transactions over a five-year period. The vertical (or "Y") axis plots the percentage of the total transactions that were completed in some number of days ("X" axis). For example, 12 percent of the time the components move in 24 hours or less; 13 percent of the time the components take between one and five days to move; and so on. As the shape of the curve suggests, the segment times are highly variable and very skewed. If we cumulate these data, we find that 50 percent of the components moved in 15 days or less (i.e., the median is 15 days). The mean of 30 days reflects the many incidents of long movement times in the right-hand tail of the curve. There were 100 transactions that took longer than 114 days; the longest time documented was 552 days.

On our chart we have noted the point at which 95 percent of the transactions occurred, 114 days. We have chosen this 95th percentile point to define a reasonable "range" for the transactions observed (i.e., 0–114 days). We have also computed the standard deviation for the full sample size to be 46 days. Therefore, the mean value (i.e., 30 days) plus one standard deviation (i.e., 46 days) should include 90 percent of the transactions, and it does. The size of the standard deviation (SD) tells us how skewed to the right the distribution of our process times is. The higher the SD, the higher the variability from the process mean time. Furthermore, the lower the SD, the closer the process mean will approach the process median.

Imagine, by contrast, an OST segment with very little variability that always took 30 days, plus or minus one day. Thirty days may or may not be too long, but at least the user could plan on it. The consistency of the 30-day performance in this example is valuable in itself. Now compare this imaginary case to the reality in the case above. The reality is a segment that takes 30 days, plus 46 and sometimes even more days. The variability is so large that this segment of the repair cycle process can be fairly classified as out of control. The value of the SD is over 150 percent of the mean value.

The first step in improving the Army logistics system must be a focused effort to reduce process variability. To accomplish this objective, variability must be reported as a performance indicator that is as important as the current average process performance measures. As the process performance variability is reduced, the mean performance value will naturally reduce toward the median value. (That is, the mean performance value will decline from 30 days toward the 15-day median value as a result of the reduction in variability alone.) If this new stabilized performance level is not yet good enough to meet the logistics customer's requirements, then further improvement in cycle time can proceed while maintaining the lower variability in performance.

The reader will remember that we earlier contrasted the current performance for these TADS/PNVS component repair activities with a notional improvement goal. The notional goal for this segment was movement of a reparable component from the EETF to the nearby SRA in 24 hours or less. On this chart we have displayed this as an example of an improved performance standard of one day. This chart then could be viewed as an exemplar for how similar data might be reported to appropriate management personnel who are responsible for the segments of the process of concern. However, those at higher levels of management may need a summarized view.

Multiple Measures Are Needed to Understand and Improve Process Performance

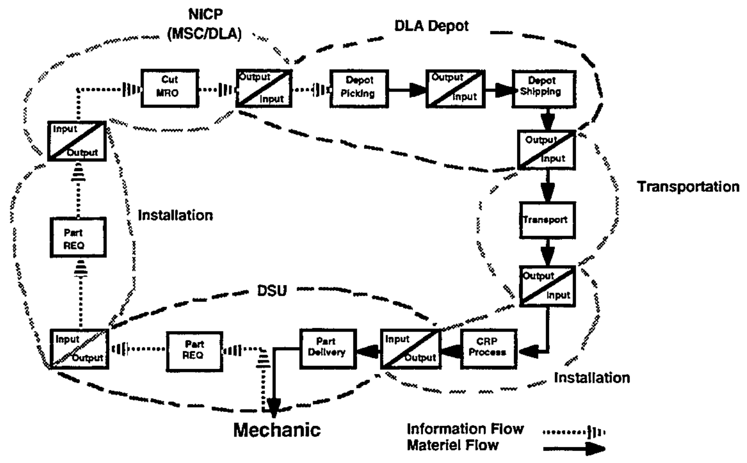
TADS/PNVS component repair times (days):

Pipeline Segment/Activity	Mean	95% Range	Standard Deviation	System Performance Standard
Retrograde to EETF	?	?	?	?
EETF Repair Time	19	0 – 80	33	?
Retrograde to SRA	30	0 –114	46	?
SRA Repair Time	26	0 – 94	36	?
Retrograde to Depot	26	1 –109	55	?
Depot Repair Time	114	0 –319	99	?

This chart refers to the same TADS/PNVS component repair example. In this case all the repair cycle segments are listed in order. The example discussed just above is the third entry, which is labeled "Retrograde to SRA." In this expanded view of the repair cycle process, you will note that the initial retrograde to EETF segment cycle times are unknown. In this case, a different data system tracks the turn-in of the defective component from the user to the direct support (DS) repair activity, the EETF. To successfully manage the repair cycle times for these high value components, these data will need to be captured and tracked just as with the other segments. (In discussions with representatives from other field units, it was reported that this initial segment of the sequence is at least as much of a problem as the other segments in the process.)

The chart reports the average or mean performance and SD for each segment. It also reports the 95 percentile range for observed performance, which can be useful for managers to interpret that performance. We have also included a column for the segment's system performance standard, even though initial targets for these have not been determined. As the process analysis proceeds during the improvement process, one would expect these standards to be refined. Ultimately, these standards must be driven by the needs of the logistics systems customers, and the standards will change over time. While today most managers think about these system standards in terms of days, we believe that the Army needs to plan now to begin measuring this performance by segment in terms of hours.

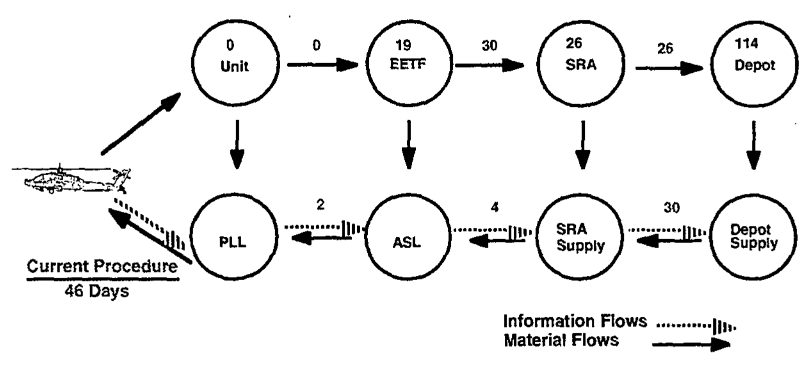
Each Segment Needs the Capabilities to Improve Processes and Coordinate with Its Customers and Providers



Applying the velocity management paradigm to improve OST entails decomposing the OST cycle into its component processes and then attacking each one individually to seek performance improvements. This chart illustrates conceptually the order and ship cycle for typical Class IX materiel. The order and ship processes form a closed cycle that begins and ends with the customer; in this case that customer is a mechanic.

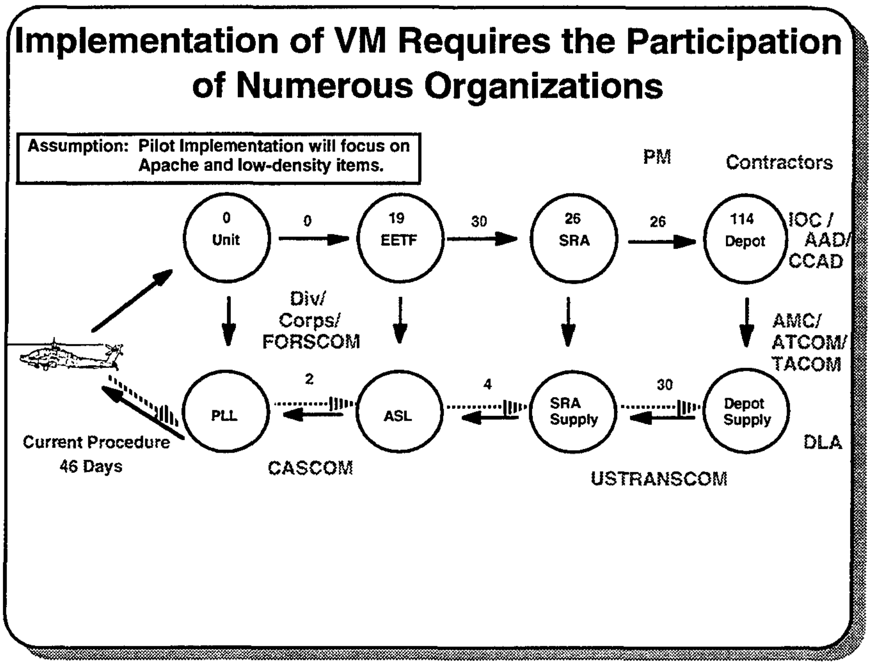
Each segment in the chain is depicted as a process having an input and an output. The output of each process is an input to the subsequent process. The inputs and outputs can be either materiel or information flows. For example, if the mechanic does not order the correct part number or stock number, then the supply depot will have no chance of shipping the needed item. Speed and accuracy aimed at satisfying a need that will sustain mission performance increase the value of the logistics services to the customer. Because so many echelons and functional activities become involved in ultimately satisfying such needs, improvement will take coordination and communication. As the chart indicates, many organizations are involved in this cycle, including non-Army organizations.

OST Improvements Could Be Constrained by Sluggish Repair Processes



Before we turn to the need for a senior-level coalition to coordinate the pilot implementation across these many organizations, let us make one final point regarding the OST cycle.

This chart shows that when velocity management is applied to the OST cycle, repair processes must also be targeted for reform because of their potential impact on OSTs. The order and ship processes, while displayed differently than in the preceding chart, are embodied in the lower half of this chart. Requisitions flow back from the helicopter to the appropriate echelon of supply, and the materiel is then shipped forward to satisfy the demand. However, a significant portion of the value of the total Class IX inventory is composed of reparable components. These are items that are repaired and restored to serviceable condition, and then returned to inventory for issue to a future customer demand. Over time, reparable items are available for issue from supply channels because of the repair cycle processes. Because of the inherent value of these inventory items, we feel that a pilot implementation of velocity management should include emphasis on these repair cycle processes. The need to include these processes further expands the number of organizations and activities that need to be represented in the pilot implementation.



This chart identifies some of the key participants we suggest are needed for a successful pilot implementation of velocity management (VM). Progress would be possible with less than full support, but we believe that implementation success depends on a strong Armywide commitment. Based on our experience, the logisticians want to do the right thing for their customers. This program will permit them to follow through with improvements to their processes that they have already identified as needing improvement and for which they were looking for convenient avenues for coordination.

The key aspect to bringing about such wide-ranging participation is the development of a leadership coalition dedicated to facilitating and coordinating improvements across activities. One of the intents of this briefing is to build such a coalition of senior leaders. The specific actions to be taken by the participants have not yet been defined, but the need for improvement has now been widely acknowledged. A number of senior leaders (as indicated in the preface) have expressed interest in pursuing a pilot implementation of velocity management as a promising step toward improving the logistics system.

The Role of the Senior-Level Coalition Is Very Important

- **Provide senior leadership and vision for change**
- **Decide scope and rate of change**
- **Maintain support and pressure to carry through with change**
- **Waive Army regulations and policy for Pilot Implementation**
- **Interface and coordinate with other DoD players**
  - **e.g., TRANSCOM, DLA, contractors**
- **Pursue status as "Reinvention Laboratory" to waive non-DoD constraints**

We believe that a senior-level coalition is needed to guide and support the implementation, both during the pilot phase and later during full implementation. It is required to provide the leadership and vision for change and to provide a united front signifying that, in fact, change is required. The coalition members must help decide the scope and rate of change. With regard to scope, a weapon system focus may be an appropriate way to begin, even though, as we have indicated, the Army may focus on specific components of a complex weapon system. The scope might include all units or initially be limited to a given installation, quickly moving up the echelons to involve the depot and inventory control point (ICP) and other echelons of repair that are along the way. We believe that the window of opportunity is small and that aggressive timetables are required. We would argue that the senior-level coalition should be pushing for setting specific milestones, broad goals, and broad guidelines. Individual milestones can be set by the work teams. The senior-level coalition is also in a position to help waive Army regulations and other official policy and can serve to interface and coordinate with other DoD players, such as U.S. TRANSCOM, DLA, and even contractors.

Obviously, developing and maintaining a broad senior-level coalition are very demanding prerequisites to success. To help make clear why we nevertheless consider such a coalition to be essential, let us briefly mention just one specific issue that we believe could hamper the success of the pilot implementation unless senior leadership understands the complex incentives at work. This issue is the impact of the DoD and the

Army's policies of stock funding of depot-level reparables (SFDLRs). As stock funding has spread beyond the depot industrial funds to involve installations and operational units, economic incentives have become increasingly powerful motivators of behavior throughout the system. While the issue of stock funding does not need to be ultimately rationalized and resolved for a velocity management implementation to be successful, it will be important to understand how and why conflicting incentives can impede desirable behavior. The coalition may be an appropriate forum for developing alternatives for improvement in a process quite separate from the velocity management implementation.

To Implement VM, Each Coalition Participant Needs Several Capabilities

- **An understanding of how their activities fit into the larger logistics system**
  - What is their product or output?
  - What are their inputs?
  - What transformations are required?
- **Experts (velocity action teams?) who can incrementally analyze, simplify, and streamline activities and flows**
- **A change agent to coordinate, interface, and integrate**

Coalition participants would be expected to ensure a clear understanding of the outputs, inputs, and the transformations performed by their activities. This would likely require the appointment of internal velocity action teams to incrementally analyze, simplify, and streamline their process activities and flows. Those local experts are generally the most knowledgeable and already have ideas about how to improve processes. Because of the cross-functional nature of Army logistics, the coalition member could expect to provide clear goals for improvement and appoint an empowered change agent to coordinate, interface, and integrate the organization's improvement activities.

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