leadership, help design change management activities at individual sites, and take responsibility for implementing many of the change management deliverables. In turn, DLA provides templates and lessons learned from other BRAC sites, manages and monitors program deliverables, hosts teleconferences and face-to-face meetings with change management personnel across the Services, and works with DLA senior leadership to coordinate sponsorship events. Additionally, the DLA change management team provides communication products and vehicles, including brochures, videos, answers to frequently asked questions, employee access to a BRAC Website, and articles. This collaborative effort with the Services is an essential aspect of effectively implementing BRAC legislation and realizing BRAC objectives designed to enhance efficiencies and effectiveness within the DoD supply chain.

BRAC Change Management Challenges

The BRAC legislation states that decisions will be implemented by September 2011; however, achieving savings, efficiencies, and improvements will continue beyond the initial implementation. This extended timeframe creates challenges. Change management representatives from the Services are focused on many other initiatives in addition to BRAC. Many of these initiatives have a shorter project timeline, thus creating a greater sense of urgency and visibility.

It is important to remember that change management extends beyond the initial transfer of missions and resources to DLA. Leaders at DLA and the Services must take an active sponsorship role and serve as strong advocates throughout their organization, driving all of the changes required by BRAC law while maintaining the best interests of DoD.

A final challenge to BRAC change management efforts includes measuring success. While it is possible to measure the number of hits at a frequently asked questions Website, talking points developed and delivered to leadership, articles published, and brochures handed out at town halls, it could be argued that this does not reflect effectiveness. Ideally, if the goals of BRAC change management at DLA are to help ensure the successful transition of employees to DLA, prepare the workforce for the culture shift necessary to take on new mission, and help instill confidence in its customers, DLA metrics should measure these activities. Once appropriate metrics are defined, distilling change management efforts from other internal and external factors will be a challenge. Research has clearly shown that effective change management works, and so DLA officials will continue their attempts to define effectiveness, measure progress, and course correct as necessary.

For more information on the BRAC 2005 Supply and Storage decisions, please visit https://today.dla.mil/BRAC/default.asp.

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Retrograde Transit Normalization Study (RETRNS)—A Preliminary Investigation into Variance in Retrograde Processing

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Introduction

The speed with which carcass-constrained retrograde assets flow through the retrograde cycle (from base supply to the depot) matters. It matters because the Air Force's procurement and planning processes use the depot repair cycle time (DRCT) as a variable in worldwide buy and repair requirements. Our primary interest lies within a component of this large pipeline called reparable intransit (RIT).[1]

In 2006, Air Force Materiel Command, Supply and Engineering Requirements Division (AFMC/A4Y) ran a simulation using the Aircraft Availability Model (Logistics Management Institute) and the September 2005 D200A annual year (AY) data set to test the consequences of reducing reparable intransit time by 10 to 30 percent. At a 30 percent reduction in processing time, buy requirements would decline by $12.5M and repair requirements would decrease by $4.8M for a total savings of $17.3M.[2]

In February 2007, AFMC/A4YR ran this simulation on the September 2006 D200A annual year (AY). The simulation showed that a 30 percent reduction in retrograde cycle time would result in a reduced buy requirement of approximately $32M and a reduced repair requirement of about $11M. These estimates must be tempered by the fact that in an actual production run additional D200A business rules would come into play as well as a post-D200A process that completes the budget estimate.[3]

Whether faster shipping times would lead to cost savings has recently been called into question.[4] The essence of the argument is that while carcass-constrained assets should be expedited, other assets should be moved more slowly to save on transportation costs. Supporting this perspective is the fact that the Air Force employs a repair on demand (ROD) system for reparables—assets not in demand end up being stored at a depot until a specific repair request is made. In short, the point is made that it makes little sense to ship assets express (given the attendant costs) just to have them sit on a shelf waiting to be needed. The authors used a Monte Carlo simulation to demonstrate that at the 99.99 percent confidence level adding a couple days to shipping time does not increase back orders .

In the 2006 AFMC/A4YR simulation cited previously, 7,138 assets were implicated in the projected savings. At the time the simulation was performed, all of these assets were carcass constrained by definition because they were in a buy position.[5]

While it is true that D200A does not include depot storage time as a variable in DRCT, this fact does not invalidate the projected savings due to increased retrograde pipeline velocity. In effect, DRCT encapsulates storage time, but since the DRCT pipeline clock stops after the receipt of the asset at the depot and does not start again until a repair order is placed—storage time has no impact on its calculations. Hence, storage time is not relevant for the calculations. Another way of looking at it is that there is storage time associated with an asset only if the asset is not carcass constrained. Therefore, whether the ensconced model always reflects the reality of asset movement and repair demands is beside the point, because it is only changes in *model* parameters that affect buy and repair requirements. Whether a more suitable and responsive model can be developed is beyond the scope of this study but has been recently addressed by the RAND Corporation.[6] Perceived limitations in the current D200A model are discussed in that report.

Furthermore, since there appear to be two definitions of carcass constraint—the one used by D200A and the daily fluctuations tracked by EXPRESS[7]—even if some of the assets viewed as carcass constrained in the D200A simulation were not viewed as carcass constrained by EXPRESS, an alternative to slower shipping times is to decrease inventory levels (and hence buys), thus reducing the *slack* in the system. Masciulli et al.[8] discuss the tradeoff between transportation speed and inventory investment. Using the Aircraft Availability Model, they estimate that a 6-day increase in order and shipping time (O&ST)[9] time due to slower transportation will increase the spares requirement to the tune of $96M while that cost can be avoided by paying an additional $17M for faster transportation.

A later study by Masciulli,[10] found that saving $493K in transportation costs would result in a $7.68M increase in additional inventory. Furthermore, the author calculated that it would take the Air Force 15.67 years for the transportation savings to pay for the additional inventory.

Given the preceding, we posit that increasing retrograde pipeline celerity is indeed a generalized good to be sought by the Air Force. The Wall et al. model and the D200A simulations are not necessarily contradictory. However, if in practice pipeline celerity is increased and inventory levels decreased as a result, then when the repair on demand (ROD) model kicks in after the changes in inventory have taken place, increasing transportation time 2 days might well have a deleterious effect on expected back orders. Thus the purportedly benign feature of increasing transportation time would evaporate under a less slack asset distribution system. Modeling the above, however, is beyond the scope of this study. We turn now to an exploration of the factors that might explain the variance in reparable intransit pipeline times.

Analysis of Retrograde Pipeline Data

The simulations run by AFMC/A4YR show that the Air Force would reap savings by increasing the retrograde pipeline speed. The question is whether reducing pipeline time is a practicable and achievable goal. The short answer is yes, if similarly situated bases perform differentially. Since they do, increasing overall pipeline speed is largely contingent upon reducing the mean pipeline time for poor performers. We can broach this issue first by looking at the current performance vis-à-vis Air Force standards and second, by comparing performance among bases.

The Air Force cargo movement regulation stipulates standards ranging from 2 to 5 days depending upon origination and destination points. The pipeline referenced in these regulations runs from base supply to carrier delivery at a source of repair and

Article Acronyms

2LM – 2-Level Maintenance
AFB – Air Force Base
AFMC – Air Force Materiel Command
AMC – Air Mobility Command
ANG – Air National Guard
AOR – Area of Responsibility
AY – Annual Year
CMOS – Cargo Movement Operations System
CONUS – Continental United Sates
D6 – A receipt
D7 – Issue
D7x – This is a type of shipping document.
DDC – DLA Distribution Center
DIFM – Due-In From Maintenance
DoDAAC – Department of Defense Activity Address Code
DLA – Defense Logistics Agency
DRCT – Depot Repair Cycle Time
eLog21 – Expeditionary Logistics for the 21st Century
FSC – Flight Service Center
FY – Fiscal Year
GATES – Global Air Transportation Execution System
IREP – Intermediate Repair and Enhancement Program
IWSS – Integrated Weapon System Support System
MAJCOM – Major Command
MICAP – Mission Capable
NMCB - Not Mission Capable Both
NMCM – Not Mission Capable Maintenance
NMCP – Not Mission Capable because of Policy
NMCS - Not Mission Capable Supply
O&ST – Order and Shipping Time
OCONUS – Outside the Continental United States
REA – Retrograde Exception Analysis
REMIS – Reliability and Maintainability Information System
RETRNS – Retrograde Transit Normalization Study
RIMCS – Reparable Items Movement Control System
RIT – Reparable In-Transit
ROD – Repair on Demand
ROD – Report of Discrepancy
SBSS – Standard Base Supply System
SF – Standard Form
SHP – Shipping document
TMO – Transportation Management Office
TP – Transportation Priority

thus differs from RIT in that it does not include the time it takes to issue a receipt at a depot.[11] The Air Force cargo movement time standards are also based on agile logistics requirements which pertain only to air eligible transportation priority (TP) 1 and 2 assets.[12]

Defense Logistics Agency (DLA) distribution centers (DDCs) have a standard of 3 days from carrier delivery to the issuance of the receipt.[13] In combination, these standards equate with the RIT pipeline. Therefore, the maximum allowable time for TP1 and TP2 retrograde to move from base supply to the issuance of a receipt at a depot is 8 days. How does the Air Force current system fare? Table 1 shows the expected value versus the mean for the group, as well as the percent that meets the standard.

From an auditing standpoint, there are serious issues of noncompliance with promulgated retrograde shipment standards, with the Germany-United Kingdom to the continental United States (CONUS) group the most out of tolerance. However, our purpose here is performance improvement and while standards provide a reference point for current performance vis-à-vis expectations, they are not sufficient to determine what can be done in practice.

One approach is to compare the performance of similarly situated bases (mission, geography). An example based upon geographical location comparing non-reserve Air Force bases highlights the vast performance differentials. Table 2 compares two sets of bases in close geographical proximity, yet with highly divergent RIT days to 3 DDCs (Hill Air Force Base [AFB], Tinker AFB, and Warner Robins AFB). Note the consistent performance difference in each pairing irrespective of the ship-to address.

While this limited selection of base pairs proves nothing conclusively, it demonstrates in these cases that RIT is not simply correlated with geographical distance from an air logistics center. Given delivery guarantees from commercial carriers, this is not a surprise. The consistent performance differentials of the compared bases could, however, be indicative of operational factors in action.

Retrograde Shipment from:	Base Processing and Transit Time Standard (days)	Mean (days)	N	Std Dev (days)	Percent Compliant
CONUS TO CONUS	2	3.45	52,672	4.2	50.5
Germany/UK to CONUS	3	5.73	2,194	4.3	29.9
Italy/Japan to CONUS	4	6.64	1,334	6.9	60.0
Korea/Southwest Asia and others to CONUS	5	5.06	4,744	4.1	72.3
Total		3.73	60,944	4.3	

Table 1. Retrograde Shipments versus Air Force Cargo Movement Standard by Group

	Distance To ALC1	RIT	Distance to ALC2	RIT	Distance to ALC3	RIT
Base 1a	2,130	17.6	950	14.6	319	11.8
Base 1b	2,237	4.4	1,156	5.2	320	4.7
Base 2a	846	10.2	1,018	11.9	1,971	9.5
Base 2b	961	5.0	1,044	4.0	1,842	6.3

Table 2. Comparison of Geographically Similar Bases

Aside from these base-to-base comparisons, what does the performance picture look like across all Air Force bases? Using a data set from the TRACKER database obtained from AFMC/LSO in 2006, the median RIT for an unserviceable asset moving back to a source of repair was 7 days with the modal occurrence being 6 days (see Table 3). Aggregation by base shows RIT averages ranging from slightly under 4 days to 33 days.

In March 2007, we obtained a second TRACKER dataset from AFMC/LSO covering fiscal year (FY) 2006. The mean time from the issuance of the D7x (shipping document)[14] to the acknowledged receipt at the depot was 9.47 days.

Decomposition into Pipeline Segments

Juxtaposing current retrograde performance to standards and comparing performance across bases helps illustrate the current state of processing unserviceable but reparable assets. But before we can address how to improve retrograde movement performance, it is necessary to disaggregate RIT into its constituent pipeline segments. From an enterprise view, the retrograde chain is comprised of three sequential functional arenas: base supply and transportation management office (TMO) processing, carrier possession, and the depot distribution centers.[15] Splitting RIT into its three functional components produces the following pipeline times:[16]

- Turn-in to carrier pickup takes an average 1.91 days
- Carrier possession time is 1.88 days
- Depot induction takes 3.32 days

The 2007 data was comparable.

Of the approximately 212,000 shipping documents obtained from the 2006 TRACKER dataset, 68,197 records had all of the constituent components of RIT. It is this subset which is used in the following analysis.

As previously indicated, average processing times vary considerably from base to base. Just looking at bases with 100 or more shipments during the period under consideration, the base supply to the TMO pickup segment ranges from less than 1 day to over 21 days. The period covering carrier delivery to the D6x (materiel receipt) at the depot ranges from 1.92 days to 6.3 days. While the former segment is due to base processes the latter is likely the result of both base and depot operational processes.

A visit to the DLA at Tinker AFB in 2005[17] indicated that the lag from carrier delivery to the issuance of a D6x was largely the result of discrepancies discovered during the receipting process (D6). A primary complaint was that the packages arrived from the base without proper documentation needed for identification. If these problems are representative

across the DDCs, then the delay in issuing a D6 could be attributable partially to practices in base processing.

Additionally, data quality issues on the base end of RIT have been identified by retrograde exception analysis (REA) audits.[18] Specifically identified were incorrect ship-to addresses, improper labeling, and an issue of timeliness with respect to DLA receiving the prepositioned materiel receipt documents before receipt of an asset.

The differential performance of base operational processes can only serve as part of the explanation for the variance seen in the pipeline segment covering depot receiving and issuance of the D6 receipt. When that period of time is disaggregated by the depot, there are statistically significant differences among the depots. The average time to process the D6 after delivery of the item was 2.11 days at Tinker, 3.57 days at Hill, and 4.42 days at Warner Robins (see Table 4). Using the 2007 data, receipts took almost 10 days to process at the Cryptologic Depot at Kelly AFB while the receipting process at Boeing for C-17 repairs took slightly more than 1 day on average. The 2007 data indicates that Warner Robins improved their performance to approximately 3.25 days. Hill and Tinker performances were comparable to what they did in 2006.

While Tinker has the best mean time to D6 receipt, it also had a larger variance in processing this receipt. This indicates that while it performs the best overall, it also has a larger number of shipments that are outliers. It is worth noting that Tinker is the only organic operation of the three. What explains these differences in processing time is as yet unknown. However, these differences in mean processing time show that depot processing practices cannot be ignored as a variable explaining the delay in issuing the D6.

To further explore the base and depot process variances we used regression analysis[19] to build a series of models to test various hypotheses. First, we explored what we call the Expected Regulatory Framework model. If the regulatory framework that guides retrograde processing fully governed the operational characteristics and permeated behavioral practices of base supply and TMO processing, then we would expect certain results to follow and we would expect that any variance could be largely explained by key regulatory variables. For example, assets shipped under TP1 should arrive more quickly on average than TP2 and TP2 before TP3. What we find is that TP1 has a mean of 8.8 days for RIT, while TP2 actually arrives faster at 8.4 days. True to expectations, TP3 comes in with the slowest transportation time with an average of 9.8 days.

If we plug transportation priority, MAJCOM (as a proxy for mission), number of shipments (to control for the fact that the shipping volume varies considerably among the bases and may create efficiency effects), weight and quantity of assets shipped, into a regression equation seeking to explain the variance in the base supply to the carrier pickup at the TMO, these variables account for only 6.3 percent of the variance (R^2).

A second regression model replaced MAJCOM with variables specific to the weapon system type and number found on each base.[20] This was viewed as a more precise representation of mission as well as the regulatory and contractual realities related to specific weapon systems. This model allows us to explain 11.6 percent of the variance.

Our third model adds a dummy variable for each base. These variables serve as proxies for the operational characteristics that

N	Valid Missing	136,856 76,170
Mean		8.69
Median		7.00
Mode		6
Std Deviation		8.633
Minimum		0
Maximum		371

Table 3. Reparable Intransit Descriptive Statistics

DDC	Mean	N	Std Deviation
Hill	3.57	24,448	3.292
Tinker	2.07	23,067	5.008
Warner Robins	4.41	20,682	3.722
Total	3.32	68,197	4.181

Table 4. Carrier Delivery to D6 Receipt

define each base's retrograde activities. The explanatory power of this model is 37.2 percent. Hence, without being able to know what characteristics about base supply and TMO processing matter, we can assert that they exist and bear further investigation.

Turning now to that pipeline segment that runs from carrier delivery at the depot to issuance of the D6x (receipt), we find that a model that includes the depots as proxies for operational practices, bases, weight and quantity, and transportation priority explains 7 percent of the variance. The variables with the largest explanatory power are the dummy variables representing the three DDCs indicating that even controlling for the aforementioned variables, depot processes have the largest impact on receipt processing time. Furthermore, with Hill serving as the baseline, Tinker's beta coefficient for the regression equation indicates that a shipment to that depot was processed 1.4 days more quickly than average while a shipment to Warner Robins took 0.9 days longer.

Thus we reach the crux of the reason for the study. While the foregoing data analysis identified a wide performance range, we were not able to explain a satisfactory amount of the variance in our two pipeline segments of interest. The stark performance differentials among bases strongly hint that obtaining greater understanding of this performance variance can best be gleaned from analyzing the processes and systems that are reflected in the pipeline segments. The primary goal of this study is to begin to elucidate the factors that explain the variance in base supply and TMO processing. We will also investigate to a much more limited degree the carrier delivery to issuance of the D6x segment to probe whether DDC processing of the D6x is primarily affected by depot- or base-level processes. We will not investigate carrier possession time.

RETRNS Research Design and Analytic Framework

We are interested in learning what factors or characteristics account for the efficient and effective functioning of base supply and TMO operations. By efficient we mean faster movement from turn-in until a shipment is made ready for carrier pickup. By effectiveness, we recognize that speed should not create a situation where the state of the package received by the depot

(or an intermediate facility like a port) creates delays because of incomplete or missing documentation. Therefore, base operational practices impact both the immediate pipeline segment that captures their performance as well as that segment which putatively reflects depot performance.

In order to obtain a fuller understanding, we selected six bases and one depot to study retrograde shipment and reception processes.[21] Sites selected include outside the continental United States (OCONUS) and CONUS bases. Since we are studying the reverse logistics and supply chain of bases both outside and within the United States, it is essential to understand and make transparent the nature of the challenges each faces.

The case study should allow for the emergence of differences in procedures, data input practice, personnel staffing and training factors, technology, as well as incentive structures that function to create priorities for those working within the processes.

This study comports with the Expeditionary Logistics for the 21st Century (eLog21) initiative which places process reengineering at the core of that transformation.[22] Being able to articulate best retrograde practices will set the stage for future process reengineering.

RETRNS Study Methodology

Our intention for the case study was to document retrograde practices as-is. We were not there as auditors asserting how something ought to be. Instead, we were interested in capturing how work was actually performed and then to take insights from those observations and relate them back to the data, as well as conceptualize possible next steps.

There were four members of our team. Each visit utilized the same qualitative method whereby we started with a number of conceptual categories that we hypothesized might be relevant for performance differences. Each member took notes with those categories in mind, as well as actively listening to our hosts articulate their processes and what they experienced from their perspective. One team member created a number of process maps to capture the flow of both retrograde and personnel. As there were similarities in these flows, we did not map each site.
After each visit, observations and conversations were triangulated to produce a consensus about what we saw and heard, and what appeared to be the primary factors of interest. When there were different interpretations among team members clarification was sought via phone calls and e-mails with our hosts.

The research method used by the team was both exploratory and organic as the insights that emerged from each site visit were then incorporated into the knowledge frame we took to the next visit. In essence, the team practiced a form of abductive reasoning whereby the collective *facts* of the retrograde operations we viewed were then used to create hypotheses about the relevant evidence.[23]

Findings and Process Constructs of Interest

Any actual process is contingent upon certain determining inputs. A number are pertinent here: local practice, policies and regulations, local incentives and leadership, training and staffing levels, physical layout and work environment, and data systems and technology. We discuss pertinent findings within each below.

Base Supply and TMO Processing

- The current retrograde processes in themselves varied from base to base. The majority of operations had the following asset flow: Maintenance turn-in to supply (either picked up by supply, or delivered by maintenance, or both), item checked against documentation, shipping document cut (TRIC SHP), asset transferred to TMO, then in-checked, packaged, and carrier selected.
- Certain bases had multiple process flows as a result of shipments into the area of responsibility (AOR) as well as base originating retrograde. At one base the second retrograde flow had no interface with the flight service center (FSC), except to exchange improperly addressed packages. This second flow was contractor-run with one contractor serving as both a source of supply and repair. This contractor also utilized subcontractors for repair depending upon the weapon system.[24]
- AOR shipments were generally viewed as the most error-laden. AOR shipments were often missing documentation or contained incomplete or erroneous documentation that required the receiving bases to research to correct the uncertainties. Another time-consuming delay was when midstream receiving destinations (such as ports) had to repack an asset before forwarding to the DDC.
- There was no standard procedure for how retrograde moved from the maintenance backshops to supply. Some bases had supply make regularly scheduled runs to pick up parts. Others had maintenance deliver parts to supply. Still others allowed both. Maintenance-to-supply deliveries of retrograde were considered at one base to interfere with maintenance activities because maintainers had to stop what they were doing and deliver parts to supply.
- We obtained a report of discrepancy report (ROD) from DLA for the last 9 months of FY06. Table 5 shows the discrepancies as indicated by the three Air Force depots. Curiously, slightly less than 97 percent of these discrepancies

Discrepancy Category	Discrepancy Type	Discrepancy Count	Percent of Total
C	Condition other than indicated	170	3%
D	Documentation missing/incomplete	487	9%
M	Misdirected assets	69	1%
O	Overage	9	<1%
P	Packaging	3455	65%
S	Shortage	36	1%
T	Technical Data Missing/Incomplete	279	5%
W	Wrong Item	742	14%
Z	Other	35	<1%
		5282	100.00%

Table 5. Discrepancy by Category

were reported by Warner Robins. Do personnel at the Warner Robins DDC notate discrepancies with greater regularity? Tinker's lack of discrepancy data conflicts with the anecdotal comments previously received from personnel at that DDC about the many problems with incoming assets.

- Packaging was the largest problem representing approximately 70 percent of the discrepancies for that period. Other notable problems included the depot receiving the wrong items indicated on the supply documentation (14 percent) and missing or incomplete supply documentation (9 percent).[25] Table 5 contains a breakdown by discrepancy category.
- These discrepancies cause delays at the depot by frustrating the issuance of the receipt acknowledgment (D6). This won't matter much for reparables that have no demand, but for those that do, the impact is to directly reduce aircraft availability. Table 6 shows the net effect for the four primary discrepancy categories using Warner Robins data only. With no other factors considered, a retrograde shipment will take 7.1 days from carrier pickup to issuance of the D6 receipt at the depot (herewith named TransDays). Missing or incomplete documentation adds about 3.5 days to processing. Packing issues and wrong items add approximately 1.5 days. When technical data (inspection or serviceability information) is missing or incomplete, the discrepancy adds almost 9 days to processing. While the number of discrepancies is small relative to total retrograde shipments, when they exist they cause statistically significant delays in processing at the depot.
- Besides causing delays in retrograde processing at the receiving facilities, discrepancies create additional processing costs because they necessitate an SF-364 (report of discrepancy) being filled out as well as followup actions on both ends of the transaction. In general, discrepancies are indicative of the effectiveness of base operations and as such provide an additional perspective to complement base supply and TMO efficiency metrics pertaining to retrograde processing. For bases with at least 120 shipments during the period studied, the percent discrepant ranged from a low of 2.7 percent to approximately 31 percent.
- Improper packaging appeared to be propagated throughout the system as bases sometimes received serviceable assets from the depot in improper packaging.
- AMC had only one flight out of Aviano a week.
- Non-express items can sit on the truck at the loading dock for up to 72 hours over the weekend waiting for a full truck load.
- Customs officials will sometimes pull assets even after a truck has been ordered, thus delaying departure.

Policies and Regulations

Policies, regulations, and contract specifications create defining process features. These features or artifacts create the rules framework within which individuals function. Process improvement then would entail more than efficiency adjustments. It would require review of policy obligations as to their importance in light of the goals of the process and a determination whether the rules impede or accelerate movement toward the goals. Sometimes there is no leverage with respect to policy obligations—they must be observed. Other rules and practices are nothing more than bureaucratic residue without present validity. Opportunities exist in this conceptual space.

Certain inefficiencies resulted due to operational structures arising from contracts. One subcontractor stated that they regularly received improperly documented retrograde from the AOR. Researching the asset required not only researching databases such as Reliability and Maintainability Information System (REMIS) but also contacting the FSC. This subcontractor used to have direct access to the FSC but now under their new Integrated Weapon System Support System (IWSS) contract they had to funnel requests through the prime contractor. This created delays in processing the retrograde.

Discrepancies	Processing Days Added
(Constant)	7.1
Documentation	3.6
Packing	1.6
Technical Data	8.9
Wrong Item	1.7

Table 6. Primary Retrograde Discrepancies and Impact on Processing of the D6

The standard reasons tracked for why an aircraft is not mission capable are:

- Not Mission Capable Maintenance (NMCM)
- Not Mission Capable Supply (NMCS)
- Not Mission Capable Both (NMCB)

There apparently exist instances where there is another cause of an aircraft being not mission capable. It appears that depots operating under the Repair on Demand system will wait until they reach a quota with respect to certain parts requests. One base we visited had a recurring problem with a depot, because unserviceable items were held until a quota was reached before spare parts were ordered, thus prolonging the *hole in the plane*. This appears to be an example of *NMCP*, (not mission capable because of policy). While this particular policy feature will not impact retrograde cycle time, it may have a significant impact on aircraft availability and MICAP hours.

Local Incentives and Retrograde Leadership

The importance of organizational culture was made apparent on our first visit and resonated throughout the project. The high priority of retrograde processing was evidenced at that base by *constant communication*, weekly due-in from maintenance (DIFM) monitors meetings, a How Goes It Supply Meeting, a monthly IREP (Intermediate Repair and Enhancement Program)[26] meeting that brought supply and maintenance personnel together to discuss 2LM timeliness and processing time metrics, and periodic meetings to allow supply and maintenance personnel to understand each other's needs. This latter meeting provided a forum for interfacing areas of responsibility to discuss issues of relevance to both. There was also some cross training exercises. Furthermore, TMO procedures for in-checking into the cargo movement operations system (CMOS) were posted on the wall above the computer stations. This made knowledge available for quick reference (efficiency) to all (lessens the learning curve).

Such leadership and prioritization of retrograde movement was glaring in its absence at some other bases. In general, the observed organizational culture correlated with the objective performance of retrograde processing both in terms of efficiency and effectiveness (fewer discrepancies at the depot).

Training and Staffing Levels

When asked about what made their operation function well, one response was that a high volume of retrograde had forced them to get it right. Practice makes perfect. At another base, they stated that high volume overcame their ability to process retrograde smoothly. This apparent contradiction was then tested with the data. Shipping volume was correlated with base supply and TMO processing time for each MAJCOM. With the exception of AFMC and ANG, the other MAJCOMs saw an increase in pipeline speed as shipping volume increased. Air Education and Training Command's (AETC) correlation was not significant. This result may call into question the importance of minimum staffing levels. Table 7 shows the correlation of MAJCOM with base supply and TMO processing time as well as the corresponding significance level and the number of shipments.

Deployments were often considered to be problematic. The civilian force was generally viewed as a stabilizing force given the deployments. However, since the knowledge and experience level of the civilian personnel varied, the tradeoff was not always equivalent. Some of the civilian personnel were temporary federal employees. With lower pay and uncertain futures, more experienced and capable individuals would not be attracted to such a position. Given the incentives such a classification creates, the military personnel often had greater command of the work that needed to be performed. Hence deployments could, depending upon the replacements available, create process inefficiencies.

ANG	
Pearson Correlation	.070(**)
Sig (2-tailed)	0.000
Shipments	16,991
AFRC	
Pearson Correlation	-.136(**)
Sig (2-tailed)	0.000
Shipments	2,206
ACC	
Pearson Correlation	-.120(**)
Sig (2-tailed)	0.000
Shipments	16,176
AETC	
Pearson Correlation	d
Sig (2-tailed)	0.073
Shipments	11,877
AFMC	
Pearson Correlation	.148(**)
Sig (2-tailed)	0.000
Shipments	5,504
AFSPC	
Pearson Correlation	-.331(**)
Sig (2-tailed)	0.000
Shipments	509
AMC	
Pearson Correlation	-.125(**)
Sig (2-tailed)	0.000
Shipments	6,156
USAFE	
Pearson Correlation	-.287(**)
Sig (2-tailed)	0.000
Shipments	3,076
PACAF	
Pearson Correlation	-.129 (**)
Sig (2-tailed)	0.000
Shipments	4,884
** Correlation is significant at the 0.01 level (2-tailed).	

Table 7. Correlation of Base and TMO Processing Time with Shipments (by Selected MAJCOM)

Physical Layout and Environment

Flight service centers collocated with TMOs created process efficiencies as well as a collaborative work environment. The relative importance of collocation is not known.

Clean and organized workspaces were the norm with one exception. This exception also had the worst processing time among the bases we visited.

Data Systems and Technology

The use of SATS (Supply Asset and Tracking System) varied by base. Use ranged from not at all to being employed by base supply only to use by both supply as well as maintenance back shops. Funding limitations appear to be one reason why certain bases did not have the technology.

One consistent complaint was that RIMCS (Reparable Item Movement Control System) data was not being updated frequently enough. Another problem with RIMCS was that Department of Defense activity address codes (DoDAAC) apparently were being overwritten by shippers resulting in misrouted shipments. Why this occurred is not known.

We received complaints about GATES (Global Air Transportation Execution System) interfacing with CMOS and data system disconnects between SBSS and CMOS.

Conclusions and Recommendations

RETRNS was born in the realization that there was a vast gulf in performance among bases in the processing of retrograde. Various analyses seeking to explain the variance in performance found significant factors but most of these were proxy variables that crudely represented base and depot processes. The goal of this study was to begin to peer beneath the data and to attempt to ascertain through observation and conversation what factors may truly provide an explanation for the differential performance that the data conclusively showed existed. Over the course of the study we obtained valuable insights about the why. In effect, we now have a much clearer understanding about the likely factors that appear to matter most for pipeline celerity.

Given the multidimensionality and multi-organizational nature of the retrograde system, it stands to reason that what needs to be done to improve the current system would not be monochromatic. Primary constructs of interest that warrant further investigation include: the importance of organizational culture, data system interface limitations and the need for further data integration, variable quality control on retrograde shipments especially from the AOR, the perceived negative effect of deployments on operational functioning, and the impact of staffing levels on processing efficiency and effectiveness. These factors appear to be important contributors to: efficient and effective base supply and TMO operations, the operational efficiency and manpower costs of intermediate bases such as ports, and the processing of retrograde at the depot.

The following recommendations are those that would appear to provide the greatest impact on retrograde as a system.

- Discrepancies in retrograde shipments received at the depots inhibit processing at the depot. If these discrepancies are holding up carcass-constrained items, then these delays are directly impacting aircraft availability. Another impact is

more widespread. Since all discrepancies require the filing of an SF364, resources are being wasted in resolving them. Further training may resolve these problems. We suggest widespread dissemination of a set of efficiency and effectiveness metrics: base supply and TMO processing time, DDC processing of the D6 after carrier delivery of the asset, and a discrepancy ratio (total shipments – perfect shipments/ total shipments) or alternatively a perfect shipment ratio (total shipments-total discrepancies/total shipments).

- Projected savings from increasing retrograde pipeline speed range from $17.3M to $43M. Retrograde processing needs to be reduced approximately 3 days to effectuate these savings. Two years of data have shown that it takes approximately 3 days from the delivery of the asset at the depot to its being receipted. Two-thirds of these projected savings could be realized if that process can be reduced to 1 day.
- As business rules are written for the Expeditionary Combat Support System, the existing interoperability problems between GATES and CMOS as well as between SBSS and CMOS should be addressed.
- All bases that we visited that served as intermediate or final shipment points for retrograde expressed displeasure with AOR shipments. How can these processes be improved given the exigencies that AOR bases face? A process improvement study to explore this in more detail is warranted.
- Organizational culture undoubtedly contributes to the processing variations that the data exhibits. A census of base supply and TMO operations may contribute to our understanding of best practices.
- Deployments of experienced personnel were viewed as a problem. How can base supply and TMO operations best maintain their operational capabilities given these demands? Investigating how the need to train military personnel in their chosen fields can be balanced with the need for operational efficiency deserves further attention.
- There are two distinct enterprise issues with retrograde movement in the Air Force. The first involves assets that are not carcass constrained. Because of the ROD system, carcasses sit at the depot until a demand is made. It is this fact that leads some to suggest the slower movement of reparables. Instead, we view this as an inventory control problem best addressed by reducing inventory levels.
- The second enterprise level issue pertains to carcass-constrained assets. How to improve the attendant policies and processes such that MICAP hours are reduced and aircraft availability enhanced becomes the crucial question. It is the subset of all retrograde that have MICAP hours accruing while they are also carcass-constrained that should arguably receive the future focus in studying the impact of retrograde asset movement. Such carcass constrained assets are delayed by at least two causes. The first is the speed with which needed carcasses move through the relevant processes and pipeline segments. Second, are those instances when a repairer is put on hold because the depot is waiting to meet its quota before parts will be ordered or repairs performed. This is effectively a policy limitation which we call NMCP, or not mission capable because of policy.

Whatever specific courses of action are chosen, it is imperative for the Air Force to continue to study how the flow of reparable, unserviceable assets can be improved. Improvements to the various interfacing operations and systems by any of the aforementioned means may work towards the enhancement of aircraft availability and provide cost savings irrespective of whether that is through inventory reduction or increased pipeline velocity and its attendant reductions in buy and repair requirements.

Notes

1. Retrograde Cycle Time is comprised of three supply chain segments: base and transportation management processing, carrier possession time, and depot possession time that encompasses receipt from carrier to issuance of the D6 transaction.
2. Bob McCormick, "Requirements Analysis – Reparable Intransit Pipeline Changes," 21 April 2006.
3. Bob McCormick, "Requirements Analysis – Reparable Intransit Pipeline Changes," 20 February 2007.
4. Captain David Wall and Major Edward Snow, "Analysis of the Repair Cycle," AFLMA Final Report LS200511600, Air Force Logistics Management Agency, Maxwell AFB, Gunter Annex, Alabama, June 2006.
5. *Logistics System Training Program, Secondary Items for D200A, Student Study Guide,* May 2003. Also see AFMCMAN 23-1, "Requirements for Secondary Items," [Online] Available: http://www.e-publishing.af.mil/shared/media/epubs/AFMCMAN23-1.pdf. The buy position is defined as the smaller of the third short position (after applying depot repairs) at the buy period or the termination period.
6. Richard Hillestad, Robert Kerchner, Louis W. Miller, Adam Resnick, and Hyman L. Shulman, *The Closed-Loop Planning System for Weapon System Readiness*, RAND Corporation, [Online] Available: http://rand.org/pubs/monographs/2006/RAND_MG434.pdf, 2006.
7. See AFMC Instruction 23-120, 2.4.1.1 for definition of carcass availability used by Express.
8. Captain Jason L. Masciulli, Captain Christopher A. Boone, and Major David L. Lyle, "Premium Transportation: An Analysis of the Air Force Usage," *Air Force Journal of Logistics*, XXVI, No 2, 2-7.
9. AFMCMAN 23-1, Chapter 9.4.1.1. Base OS&T days are the time that elapses between request for a serviceable item and receipt.
10. Captain Jason L. Masciulli, "Looking at the Best Way to Get There: Comparing the Cost Effectiveness of Two Means in Moving Aircraft Spares," *Air Force Journal of Logistics*, XXIX, No 3/4, .35.
11. AFI 24-201, Attachment 2, "Table of Air Force Pipeline Time Standards," 10 March 2005. Confusingly, the Air Force has another set of retrograde movement standards (UMMIPS) AFMAN 23-110, Vol. 1, Part 1, Chapter 23, Attachment 24D-1, "USAF Retrograde Material Movement Pipeline Guidelines." Under these guidelines virtually all retrograde shipments in this dataset were compliant as the standards range from 8 days in CONUS for TP1 to 30 days for TP3. Area 4 (hard lift areas) standards range from 21 days to 93 days. Areas 1-3 range from 16 to 83 days.
12. AFI 24-201, *Agile Logistics and Contingency Operations*, 10 March 2005.
13. See DLA Distribution Center Website. [Online] Available: http://www.ddc.dla.mil/.
14. There are various D7 and D6 transactions. The use of just D7 or D6 is meant to be inclusive.
15. In terms of transactions, RIT encompasses the following supply chain segments: it starts when a ship document (D7) is issued by base supply; continues at the transportation management office after pickup or delivery; in-checked where a YRO is generated; packaged; carrier selection made; picked up by the commercial carrier at the base (YLN generated); delivered to the depot by the carrier; and ends when the depot issues a D6 receipt.
16. Data is from the TRACKER database. N=68,197, May 2005 – May 2006. A data subset was created that covers shipments to the Warner Robins, Hill, and Tinker depots only.
17. Visit in December 2005 involved personnel from AFMC, DLA, and the OK DDC.
18. These audits are performed by AFMC/A4W.
19. These predictive models take the following linear regression form: $Y=a=bx_1+bx_2+\ldots bx_n=e$.
20. Variables were created such that for every weapon system each base was assigned a number which represented the percentage that each weapon system's comprised of the base's total contingent of aircraft. The default was 1 (no aircraft of that type), so that a base that had

F-15s that comprised 75 percent of their total aircraft was assigned 1.75 for the F-15 variable.

21. The following criteria were used to select bases to visit:
    a. MAJCOM has REA representative. This eliminates AETC and AFRC.
    b. One OCONUS base shipping to US port
    c. One CONUS base (port) receiving from OCONUS
    d. Two other, US continental bases from regular Air Force.
    e. Two bases from ANG.
    f. A mix of bases in particular those who have consistently better or worse performance in shipments to all ALCs.
    g. Minimum 1000 shipments per year for regular Air Force. Minimum 400 shipments per year for ANG.
22. See eLOG21 Overview.pdf, Air Force Portal Website, 4 August 2004, 5.
23. Uwe Wirth, *What is Abductive Inference*, [Online] Available: http://user.uni-frankfurt.de/~wirth/inferenc.htm
24. Various process flow maps were constructed and are available.
25. Data received from DLA on 15 February 2007. See DLAI 4140.55 for the regulation concerning the reporting of supply discrepancies and attendant discrepancy codes, [Online] Available: http://www.dla.mil/dlaps/dlai/i4140.55.htm#REPORTING_OF_SUPPLY. SF364 is used to report discrepancies.
26. AFI 21-101, *Aircraft and Equipment Maintenance Management*," [Online] Available: http://www.e-publishing.af.mil/shared/media/epubs/AFI21-101.pdf, 29 June 2006.

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Historical Perspective

The battle is fought and decided by the quartermasters before the shooting begins.

—Field Marshal Erwin Rommel

No matter their nationality or specific service, military logisticians throughout history have understood the absolute truth represented in the above quote. Whether they were charged with supplying food for soldiers, fodder for horses or the sinews of modern war—petroleum, oil, and lubricants (POL), they have understood that victory is impossible without them—even if, sometimes, it seemed their vital contributions were forgotten or ignored. None of the great military captains of history were ignorant of logistics. From Frederick the Great to Napoleon to Patton, they all understood the link between their operations and logistics. The great captains also have all understood that history had much to teach them about the nature of the military profession. Yet, military logisticians do not often spend time studying the history of military logistics.

There are at least three general lessons from history that might prove of some use in understanding how best to prepare for the future. The first of these is the best case operationally is often the worst case logistically. The second is promises to eliminate friction and uncertainty have never come to fruition. And the third is technological change must be accompanied by organizational and intellectual change to take full advantage of new capabilities. While these lessons are not exclusive to logistics, when applied to the understanding and practice of military logistics, they provide a framework for understanding the past and planning for the future.

Colonel Karen S. Wilhelm, USAF (Ret)

Concentration and Logistics

To win in battle we must concentrate combat power in time and space. Strategy and tactics are concerned with the questions of what time and what place; these are the ends, not the means. The means of victory is concentration and that process is our focus here. There are only four key factors to think about if we seek success in concentration. This is not a simple task. Although few in number, their impact, dynamics and interdependencies are hard to grasp. This is a problem as much of perspective as of substance. It concerns the way we think, as much as what we are looking at. The factors are not functions, objects or even processes. They are best regarded as conditions representing the nature of what we are dealing with in seeking concentration. They are as follows. Logistics is not independent. It exists only as one half of a partnership needed to achieve concentration. Why is understanding this so important? Logistics governs the tempo and power of operations. For us, and for our enemy. We have to think about the partnership of operations and logistics because it is a target. A target for us, and for our enemy. Like any target, we need to fully understand its importance, vulnerabilities and critical elements to make sure we know what to defend and what to attack. All military commanders, at all levels of command, rely on the success of this partnership. How well they understand it will make a big difference concerning how well it works for them and how well they work for it.

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