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TECHNICAL REPORT

The Effects of Equipment Age on Spare Part Costs

A Study of M1 Tanks

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Prepared for the United States Army

RAND ARROYO CENTER

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Summary

M1 Abrams Tank Fleet Aging Is Prompting Concerns About Maintenance Costs

As the Army transitions to the Future Force, it will continue to rely on existing weapon systems, such as the M1 Abrams tank, until the Future Combat Systems (FCS) and companion systems are fully fielded. This has prompted concerns by Army officials who have argued that the increasing age of the Army's fleets is leading to lower readiness and higher costs. As a result, the Army has initiated programs such as recapitalization to selectively rebuild and upgrade systems.

Budget justifications for such programs have sometimes been difficult, because empirical studies have not demonstrated a convincing relationship between age and maintenance costs. For example, a recent RAND Arroyo Center study of M1 tanks found that although increased equipment age is associated with increased mission critical failures and thus likely affects readiness, little to no age effect is apparent among the high-cost parts that dominate M1 spare part expenditures.[1] Similarly, a recent Congressional Budget Office (CBO) study found no evidence of a link between M1 tank age and operating costs.[2]

However, such cost studies are hampered by a lack of data to effectively account for all maintenance costs. In this report, we discuss the data limitations as well as practices and behaviors within Army units that can obscure the effects

[1] Eric Peltz et al., *The Effects of Equipment Age on Mission Critical Failure Rates: A Study of M1 Tanks*, Santa Monica, CA: RAND Corporation, MR-1789-A, 2004, p. 27 (age-failure relationship) and p. 48 (high-cost parts).

[2] Congressional Budget Office, *The Effects of Aging on the Costs of Operating and Maintaining Military Equipment*, August 2001, p. 17.

of age on maintenance costs. Then we examine what the available data show about M1 age and spare part costs, and we also analyze whether part turn-in practices might obscure the effects of age on costs. We conclude with recommendations for improving the Army's data capture and business processes to enable better fleet analysis and management.

Mitigating Factors Can Hamper Studies of an Age-Cost Relationship

Cost Data Are Lacking in Key Areas

A critical factor hampering studies of an age-cost relationship is the lack of detailed maintenance-related data for all relevant Army budget accounts. By one estimate, field labor accounts for over half of the Army's cost of maintaining equipment (including depot maintenance).[3] However, age versus equipment operating cost studies have typically focused on the spare parts portion of Operation and Maintenance (O&M) accounts, because good maintenance labor hour data are lacking. The lack of labor data, as well as the failure to maintain life cycle part and labor histories at the end item level, makes it difficult to apply standard "economic useful life" models to estimate cost-effective replacement schedules. (Because data on maintenance costs for individual tanks are not available, this study relies on estimates of spare part costs at the brigade level.)

Spare Parts Budgeting Process Likely Dampens Spare Part Spending

Army budget analysts use a moving average of three years of spare part demand history, updated with current prices and credits, to determine a cost-per-mile factor for each end item variant. The factor is then multiplied by the number of each end item and the forecasted operating tempo (OPTEMPO) to determine the O&M spare parts budget allocation for each major command (MACOM), which distributes the funds to its subordinate units.

The budget determination process has no trend component to account for projected increases in part demands. Because a unit cannot spend beyond its budget, under normal circumstances, across all end items to be supported, its

[3] Eric Peltz, *Equipment Sustainment Requirements for the Transforming Army*, Santa Monica, CA: RAND Corporation, MR-1577-A, 2003, p. 14.

aggregate spares spending cannot "float" to meet increased needs. Nor does the Army systematically record and aggregate unmet maintenance needs at the tactical level. Even if units do find some ways to increase spare part spending, the moving average methodology without an additive trend component will not result in a higher forecast than that dictated by the most recent year of demand history. Indeed, the only ways for budgets to increase are an increase in OPTEMPO, an influx of additional cash during a year to meet apparent funding and maintenance shortfalls, a policy change, or an increase in part prices either from component repair costs or from supplier prices. Thus, hard budget constraints, the lack of a trend component in the Operation and Maintenance, Army (OMA) budget process, and the absence of unmet maintenance needs tracking likely combine to dampen the effect of any age-cost relationship.

Unit Behaviors May Hide the Effects of Aging from the OMA Budget

Because a unit cannot spend beyond its budget, it may adopt certain coping behaviors to extend its purchasing power in an attempt to meet equipment readiness goals. However, these behaviors might obscure the effects of aging from the OMA OPTEMPO budget process. For example, a unit might go outside the standard supply system to obtain parts by directly asking a direct support (DS) mechanic to repair or rebuild a component carcass rather than turning in the carcass for credit and requisitioning a new part from the military supply system. This would be advantageous from a financial standpoint when the parts needed to complete the repair are less than the average repair cost at the national level (as military labor is not charged to units). Also, units might attempt to increase their cash flow by turning in serviceable—but currently unneeded—parts for credit. Such transactions will not be reflected in the OMA OPTEMPO budget process.

The Impact of Unit Turn-in Behavior Can Be Assessed

These dampening and obfuscating factors and data limitations hamper a thorough analysis of an age-cost relationship. However, we were able to assess the impact on costs of spare part turn-in practices using Corps/Theater Automated Data Processing Service Center (CTASC) document history files. We did this by analyzing the difference between two measures of a unit's spare part costs,

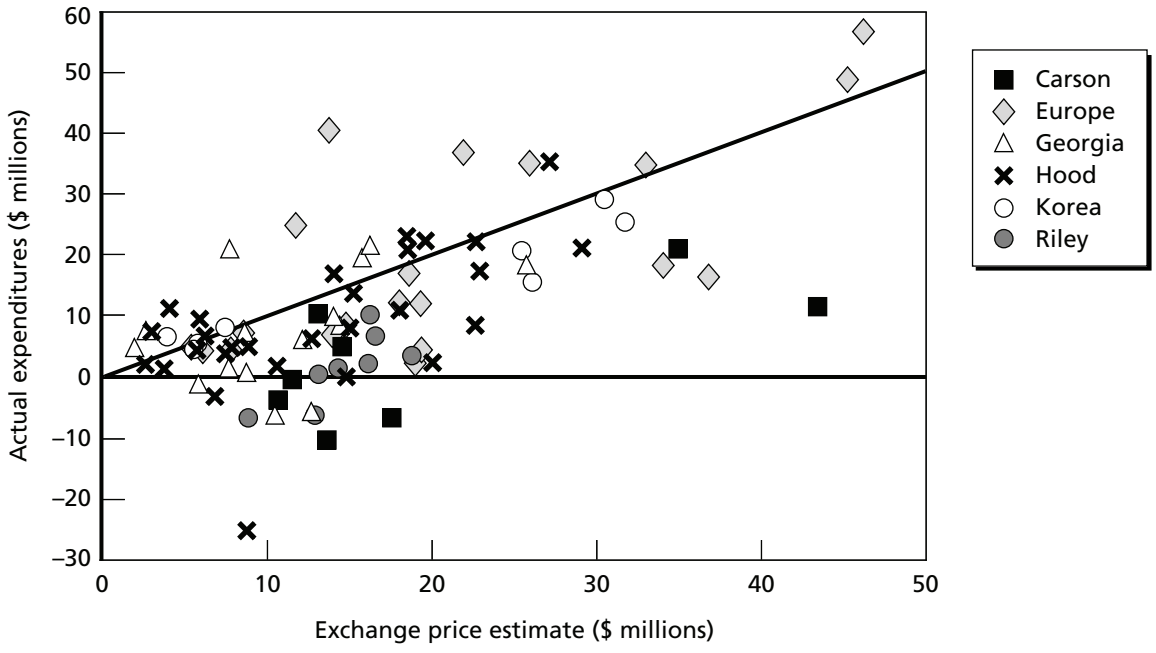
the "exchange price estimate" and "actual expenditures," and whether they have different relationships to tank age.

The exchange price valuation ignores variations in turn-in behavior and is an estimate of the economic value of a unit's part requests. The exchange price estimate assumes that whenever a unit submits a request for a reparable part, it turns in an unserviceable carcass for credit; the estimate also ignores serviceable turn-ins. In contrast, the actual expenditures estimate simply represents total estimated outlays minus total credits based upon actual issues and turn-ins.

Unit Turn-In Behavior Affects Spare Parts Spending

If a unit's actual expenditures are significantly lower than its exchange price estimate, this indicates that the unit may have used turn-ins to stretch its budget. Our analysis found that the relationship between actual expenditures and the exchange price valuation of spare part costs varies substantially. Figure S.1 compares exchange price estimates and actual expenditures for units in six locations. The exchange price estimate is shown on the horizontal axis, while actual

Figure S.1
Unit Turn-in Behavior Affects Spare Part Spending



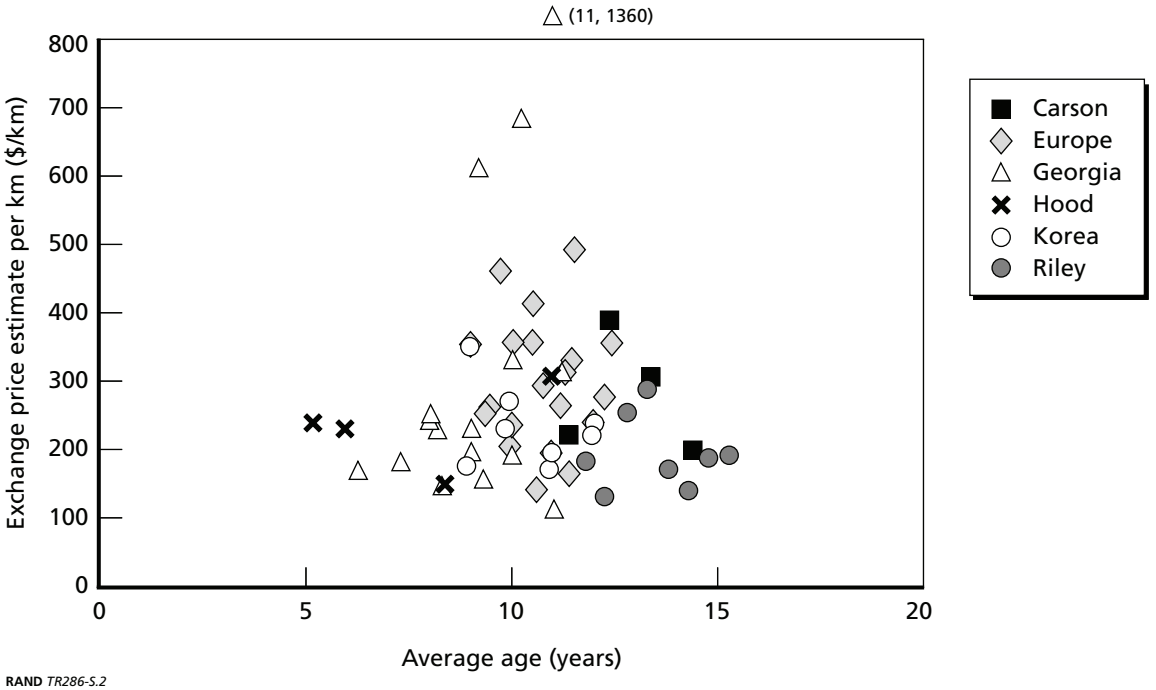
RAND *TR286-S.1*

expenditures are on the vertical axis. Points lying "below" the diagonal line indicate brigade-year observations whose actual expenditures are lower than their exchange price estimates. These results suggest that some units, particularly those at Forts Riley and Carson, may have used turn-ins to stretch budgets.

The Analysis Found No Statistically Significant Age-Cost Relationship

Our analyses of the available data found no statistical evidence of an age effect on M1 spare part costs, for either M1A1s or M1A2s, whether examining actual expenditures or exchange price estimates. Thus, by themselves, turn-in practices are not sufficient to obscure an age-cost relationship. Figure S.2 shows the relationship between spare part costs per kilometer and average age of M1A1s for units at six locations. Each point in the graph represents the average age of M1A1 tanks in a brigade and the exchange price estimate of spare part costs adjusted for total usage for the brigade over one fiscal year between 1999 and

Figure S.2
Average Age Does Not Positively Affect M1A1 Exchange Price Estimate When Adjusted for Total Usage



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2002. There is no upward trend in the figure, visually confirming that units with older tanks do not necessarily have higher spare part costs (based upon exchange prices), even when adjusted for total usage. We found similar results for M1A2s, and for actual expenditures of spare part costs.

However, because of the mitigating factors discussed above, these results should not be interpreted to mean that equipment age has no effect on maintenance costs. This study should only be taken as an indication that if there is a relationship between tank age and spare part costs, it is suppressed by other factors or a lack of individual tank-level data on maintenance costs.

More Refined Data May Permit Improved OMA OPTEMPO Budget Process

More refined data are needed to conduct a conclusive study on the effects of equipment age on maintenance costs. Labor costs are not fully tracked, and some transactions, such as local purchases and workarounds, are missing from databases. Increased visibility of missing transactions and the ability to link part orders and labor costs to individual end items would allow the application of economic useful life models to better estimate future maintenance costs. Without quantitative results linking age to costs, budget increases will remain difficult to justify.

A full accounting of maintenance costs may also permit an improved OPTEMPO budgeting process. Currently, the OPTEMPO budget process assumes that a unit's requisition history accurately reflects its spare part needs. More refined data would allow the OPTEMPO budget process to take into account costs that may otherwise remain hidden. Other potential improvements to the budget process would be to include a trend component and to reduce the lag time between the calculation of the cost estimates and the final budget proposal.