H-60 Tip-To-Tail Performance Based Logistics Program Case Study

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Executive Summary

This case study examines the Tip-to-Tail program, explains how it works, why it has worked well, and what best practices it uses that could be of use for other Department of Defense product support programs.

The Tip-to-Tail is a performance-based logistics (PBL) program between the U.S. Navy and the Maritime Helicopter Support Company, a joint venture between Lockheed Martin and Sikorsky Aircraft. The Tip-to-Tail program, estimated to cost $1.4B between 2010 and 2015, supports and sustains about 1,200 helicopter parts used by the Navy's H-60 helicopter fleet. The central function of the T2T is fulfilling requisitions for covered parts. To do this, it manages sustainment information and the supply chain.

The T2T uses a fixed-price plus incentive fee contract. The fixed-price is per flight hour of the helicopters, not per part. The incentive fee is based on delivering requisitions on time. This fixed-price per flight hour structure creates the incentive for the support provider (for the T2T it is the Maritime Helicopter Support Company, or MHSCo) to lower its costs through improving the effectiveness of the support system, and lowering demand for parts.

The two key measures of PBL success are improved performance and lower ownership costs. The T2T succeeded on both measures. It lowered ownership costs and continuously achieved a superior supply response time compared to the Navy's pre-PBL operations.

Four lessons learned about the T2T are highlighted below and represent some, but not all, of the best practices in use by the T2T. These can serve as examples of 'what to do' for other PBL programs.

1) **PBLs work**. The T2T is a 'PBL' that actually *is* a PBL. PBL is a demonstrably superior product support strategy. If a PBL program is set up correctly--that is if it is set up to actually be a PBL--with all the requisite traits of a PBL, it tends to work. This has been proven through

many reviews and studies of PBL effectiveness. This point seems obvious, but it is important to emphasize because not all product support programs that were intended to be PBLs have all the characteristics of a PBL; and these partial PBL programs are not as successful. The T2T is evidence that a PBL, when designed properly, works as expected by improving performance and lowering cost.

2) **Communication is essential**. The T2T has many stakeholders who have a vote in how well or how poorly the program operates. The success of the T2T is due, in part, to the strong communications across the stakeholders. When communications were not working well, MHSCo creatively improved them; which is a lesson in creative problem solving.

3) **Partnership with the government is essential**. In a long-term contract, where neither party has a reasonable alternative, the outcomes of the contract for both parties depend more on their cooperation than on the underlying economics. Ensuring that both parties get a satisfactory outcome over the long term, even if this additional action has a cost in the short term, is the essence of cooperation. MHSCo has worked hard to establish and maintain a partnership with the government, and it has paid off; as demonstrated during its lengthy negotiation for the follow-on T2T contract.

4) Align incentives through the contract structure. The right program structure will align the incentives of the customer (the government) and the support provider; and can lead to a win-win scenario. Using fixed-price per flight hour, plus incentive fee on requisition responsiveness, is a contract structure that aligns the incentives of both the Navy and MHSCo. In the T2T, they both seek improved performance and lower cost.

I. Introduction

The Tip-to-Tail (T2T) is a performance-based logistics program between the U.S. Navy and the product support provider, Maritime Helicopter Support Company; a joint venture of Lockheed Martin and Sikorsky Aircraft. The Tip-to-Tail supports over 1,200 parts (aircraft and airframe) for Naval Air System Command's H-60 helicopters – the legacy SH-60B, SH-60F, HH-60H and the new MH-60R and MH-60S.[1]

This case study examines the T2T, operations and contractual structure, and shows that it has been a win-win for the Navy, as well as the support providers; and it suggests some of the best practices the T2T has used that could be of service in other PBL-type programs.

Figure 1: MH-60R on its maiden flight, July 19 2001 (Courtesy U.S. Navy)

The case study begins with an overview of the situation that gave rise to the T2T, and goes on to how PBL programs similar to the T2T sought to solve some seemingly

intractable problems through the use of new business strategies. It then provides a detailed description of the T2T; with an emphasis on how the contract is structured, and how it operates. This section provides a general description of a PBL and shows what it looks like in the practice of the T2T. The case study goes on to briefly discuss the results of the program to date. Results are discussed in terms of performance, cost, and secondary benefits such as improved accountability and supply chain management. The final part of the case study highlights some key issues and best practices of the program.

II. The Situation

In the late 1990s, the DoD found itself with a serious cost problem. Weapon system operating and support costs were rising, while readiness was declining. The aging Cold-War era weapons required increased maintenance, which drove up the support costs. The necessity of keeping the aging systems available led to shifts in the declining budgets, from modernization to support; and, as a result, modernization plans were frequently pushed to the right. Delaying modernization exacerbated the problem of aging systems, which continued to wear-down, and then required more and more maintenance. This positive-feedback loop, shown in Figure 2: DoD Death Spiral, was described as the "DoD Death Spiral" (Source: Dr. Jacques Gansler presentation).

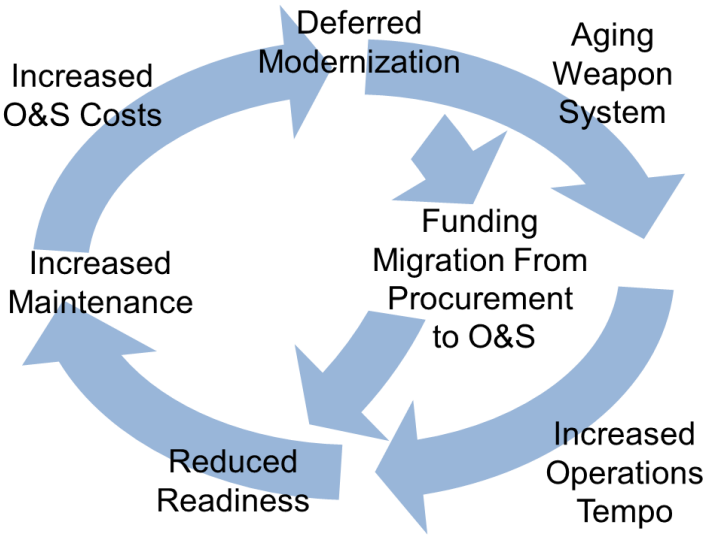

Figure 2: DoD Death Spiral

The H-60 Helicopter

The H-60 is the U.S. Navy's family of multipurpose twin-engine, medium-lift helicopters. The first Navy version, the Seahawk, entered service in 1983. Since then, the Navy has introduced two additional generations of the H-60 aircraft. The second

generation SH-60F and HH-60H were introduced in the late 1980's to specialize in antisubmarine warfare and combat search and rescue, respectively. The SH-60B Seahawk, and the second-generation SH-60F and HH-60H, have been the workhorse helicopters of the Navy for over 20 years.

The modernization plan for the fleet called for replacing all the legacy H-60 versions with the third generation MH-60R and MH-60S. These aircraft share upgraded mission systems, avionics and components, including a common cockpit that allows pilots to shift from one aircraft to another with minimal retraining. The MH-60R's primary mission is anti-submarine and surface warfare. The MH-60S is a multi-purpose aircraft with many missions – vertical replenishment, search and rescue, special operations support, and mine countermeasures. The Navy projected significant operational cost savings by switching to the MH-60R/S, based on the reduced support required for fewer types of helicopters that share many common parts.

The modernization plan however, was incremental. Formally introduced to the fleet in 2002, the first pure MH-60R squadron stood up in 2006, and the first aircraft carrier deployment was in 2009.[2] Until the legacy aircraft are replaced, SH-60B, HH-60H and SH-60F continue to fly, and continue to require support.

Support for the aging H-60 fleet was an exemplar of the 'death spiral' profile. Providing support for the H-60 was complicated by the number of versions that were in service, the length of their service, and the introduction of the two new models. The high ops-tempo of the aircraft, combined with the uniquely-challenging maintenance of rotary wing aircraft and the corrosive effects of maritime operations, meant these helicopters were particularly susceptible to increasing operating and support costs, and lower availability.[3] Obsolete parts, always an issue with military equipment and avionics, were an additional problem. Their support meant procuring and/or repairing small-batches of custom-made parts at high cost, or undertaking expensive engineering changes to replace the obsolete parts with a newer type. Furthermore, support systems were far from world-class, did not

use best practices, and, as a result, were inefficient. A GAO report from 1996 noted that one specific part "had a repair time of 232 hours, only 20 hours of which was spent actually repairing the item. The remaining 212 hours involved time to handle and move the part to different locations." [4] Business relationships with suppliers and support provider were not optimized for performance and cost. As a result, military logistic systems were substantially slower, and more expensive, than the private sector.

Figure 3: An SH-60 approaches the USS Shiloh (CG 67) in March 2011 (Courtesy U.S. Navy)

A June 26, 2004 NAVICP article sums up these problems with the H-60:

> "The SH-60F/B and HH-60H aircraft continue to experience increasing reliability issues, resulting in decreased readiness levels… The inability to address obsolescence issues has resulted in a steady decrease in readiness."[5]

These trends are illustrated in Figure 4: Pre-PBL Operating and Support Costs Rising**,** which shows how the per flight hour demand for the 40 most expensive Lockheed Martin

supplied parts trended upward. Meeting this growing demand meant purchasing expensive parts at an increasing rate, directly raising O&S costs.

In an effort to confront these problems, and as part of a DoD-wide push, the Navy sought a new product support strategy. The product support strategy is a decision about where, how, and by who support is provided. Fundamentally, the three key elements for this strategy are the following:

1) Who provides support – what is the optimum mix of public and private capabilities. Product support invariably includes some combination of government and private sector involvement. Some types of support, like budgeting, are 'inherently governmental' and therefore exclusively the domain of the government. Other types of support, like manufacture of major items (e.g., engines or tires) are exclusive to the private sector. In between, many types of support, like transportation, can be provided by either sector. The decision is about what particular combination of public and private support best meets the needs of a particular product.

2) How support is provided - the use of outcome-based or transactional support; or a mix of the two.

3) What is supported – the level to which the strategy will be applied. This can be system level, like the whole aircraft or engine; subsystem level, like the airframe; or component (part) level.

With the H-60 aircraft, the Navy chose to use a mix of public and private capabilities, at the subsystem level, using outcome-based product support through the use of performance based logistics (PBL) product support. H-60 support makes extensive use of both public and private capabilities, taking advantage of the capabilities of each and complying with regulations governing the role the public sector in product support; as will be discussed in detail below. The H-60 aircraft is supported by several outcome-

based PBLs that focus on different subsystems of the aircraft, rather than one all-inclusive PBL, covering the whole aircraft system.

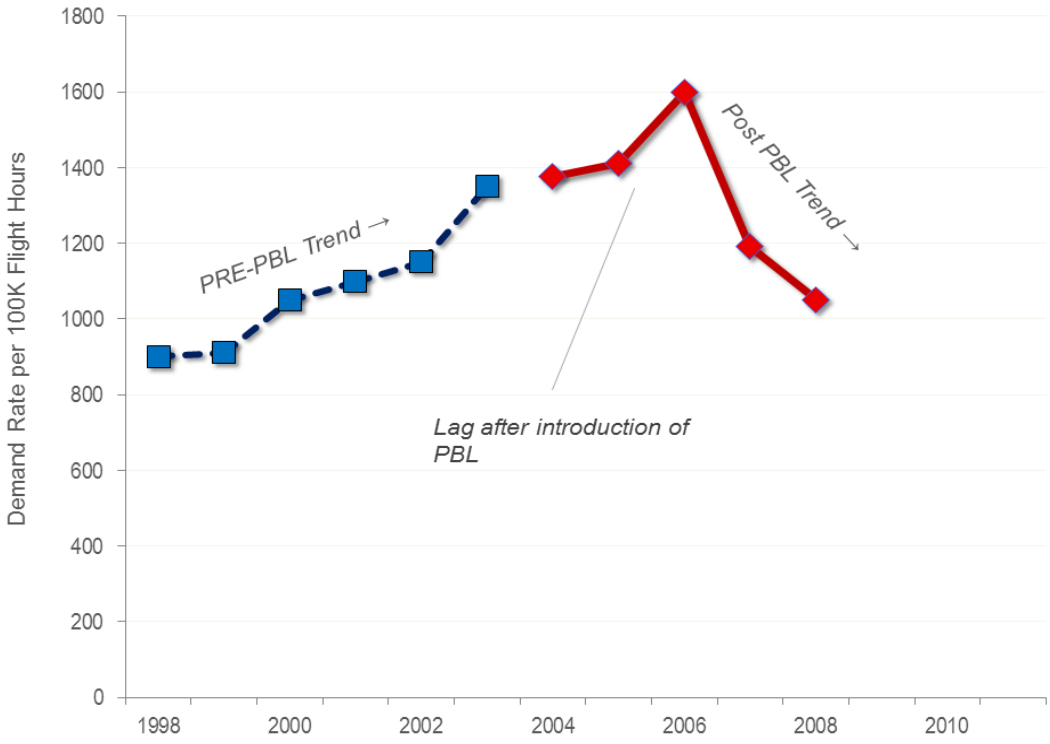

Figure 4: Pre-PBL Operating and Support Costs Rising (Source DAU Presentation by Jeff Heron, 2010)

III. Overview of Performance Based Logistics

Performance based logistics is an outcome-based product support strategy. With PBL, the relationship between the product support integrator[6] and the support providers is outcome-based. That is, support providers are contracted to deliver outcomes, or performance, not goods and services. In this way, PBL is different from the transactional sustainment model, where the parts are provided or repaired as needed. With PBL, the objectives of the support provider and warfighter are aligned, improved system availability and reduced costs.

The primary 'outcome' that PBL is concerned with is availability. Availability is what the warfighter cares about. It is a measure of whether a weapon system is ready for tasks and performing missions, based on material conditions. With PBL, the entire support team, including the product support providers (not just the military or program office) are focused on optimizing availability.

Key Traits of PBL

- Outcome-based product support strategy
- Contracting for *outcomes*, not goods and service
- Designed to optimize system availability
- Meets warfighter requirements in terms of outcomes
- Contract: Fixed Price + Incentive
- Aligns incentives
- Long-term with clear authority and responsibility

Most importantly, PBLs are warfighter-centric. PBL, as a support strategy, is designed to meet the warfighters requirements. Warfighters are the customers who use the product (the weapon system). Warfighters have specific quantitative requirements for the products they rely on. PBL focuses on clearly defining what these requirements are, how they are measured through performance metrics, and how they will be met by the product support providers.

The heart of PBLs is in the contract. In this case, the PBL contract is firm fixed-price per unit of 'outcome,' plus an incentive fee based upon the performance metrics. For aircraft engines, a common outcome unit is flight hours. This arrangement is often called "Power-by-the-Hour" and has been used by the private sector since the 1960's. Firm fixed-price per unit of outcome creates the incentive for the support provider to improve performance of those outcomes and to lower their costs through reliability and efficiency gains. The incentive fee creates a financial reward for support providers meeting and exceeding performance standards.

The power of PBL lies in the incentives created for the support providers. With a PBL, all support team members are incentivized to accomplish a common set of goals. This creates a more productive relationship between government and industry. With the proper incentives to improve performance and control costs, PBL can harness the best practices and innovation of the private sector.

PBLs are, or should be, long-term arrangements e.g. a five year contract with five one-year options. Long-term arrangements lower the significant transaction costs of starting-up a PBL (this cost includes establishing and building relationships), and allows sufficient time and funding stability to spur investments in reliability and efficiency improvements, so that the provider can recover the investment.

IV. Performance Based Logistics Implementation

Overview of the Tip-to-Tail PBL Program

The Navy's initial PBL pilot program supported the auxiliary power unit used on fixed-wing aircraft. This first PBL was very successful in improving readiness and controlling cost, validating the concept. It led the way for more PBL support within NAVAIR.[7] In 2002, PBLs were introduced into H-60 sustainment at the sub-system and component level; the Tip-to-Tail contract is the largest of these PBL contracts. It is a PBL contract between Naval Supply Systems Command, Weapon System Support (WSS) and the Maritime Helicopter Support Company (MHSCo).

The original T2T contract was awarded to MHSCo on 30 December 2003, and has been in operation ever since. See Figure 5: T2T Timeline for the main phases of the program over time. It was a five-year, firm fixed-price plus incentive contract, with an initial projected cost to the Navy of $417M ($83M/Year). At the time, it was the largest PBL awarded by Navy Inventory Control Point (NAVICP, renamed WSS in 2011).[8] The T2T grew over time through phases. At its inception, it was responsible for sustainment of 540 H-60 unique spares and repair parts, and has since grown to sustain 1,200 parts at a total estimated cost to the Navy of $900M in 2008. The T2T covers the following sustainment activities: requisition processing and satisfaction, requirements forecasting, inventory management, repair, overhaul, modification, packaging, handling, storage, transportation, configuration and obsolescence management, and reliability and technology improvement.

In December 2010, after two bridge contracts (2009, 2010) and a challenging renegotiation, the T2T was renewed for four years at an estimated five-year projected cost of $1.4B ($350M/Year).[9] The significantly greater cost per year is due to the follow-on contract expanding to cover the MH-60R/S models as well as the legacy models. These new helicopters have shorter maintenance intervals and higher maintenance costs that increase their operating and support costs and, therefore, the costs of providing T2T support.[10]

The Tip-To-Tail PBL Program

- Maritime Helicopter Support Company (MHSCo), a LM/SAC joint venture
- Sustains 1,200+ helicopter parts
- Firm Fixed Price + Incentive
- $1.4B estimated cost to Navy over five years
- Periods of Performance:

  2004 – 2008 (Initial)
  2009 (Bridge)
  2010 (Bridge)

Maritime Helicopter Support Company

The T2T prime contractor, MHSCo, is a 50/50 joint venture between Lockheed Martin Systems Integration (LMSI) and Sikorsky Aircraft Company (SAC). The Navy awarded MHSCo the T2T as a sole-source, since they determined that no other organization was qualified for the T2T because of the technical data and intellectual property required to execute the program. LMSI is the original SH-60B integrator and an original equipment manufacturer (OEM) for the MH-60R/S avionics. Sikorsky is the OEM of SH-60F and HH-60H avionics and the H-60 airframe. As the prime integrator and OEM on H-60s, LMSI and Sikorsky own the technical data required for the T2T program. Configuration engineering and obsolescence management, for example, require detailed technical data; which, in this case, it is only available to the manufacturer or system integrator. If the Main Module Gearbox were to become obsolete, only LMSI and Sikorsky have the engineering data, process sheets, tolerances, and dimensions to qualify new suppliers.[11]

With the H-60, the sub-systems and components are integrated, so if either company had the T2T independently, it would, by necessity, have had to collaborate with the other company. This factor led the two companies to formalize this partnership, and establish MHSCo as the sole source capable of executing the T2T.

The success of the T2T has paid off for LMSI and Sikorsky, but this joint venture is not without issues. Their partnership adds a layer of administrative complexity as major decisions must be approved by both companies. The original business case analysis (BCA) took over 100 iterations, during which MHSCo had to negotiate with the Navy and with both parent companies; a four-way rather than two-way negotiation. It was a time-consuming process.[12] Once formed, MHSCo had to choose how to organize itself and which business practices to take from LMSI and which from Sikorsky. Like most joint ventures, the legal and cultural issues were particularly complex to work out at the beginning.[13]

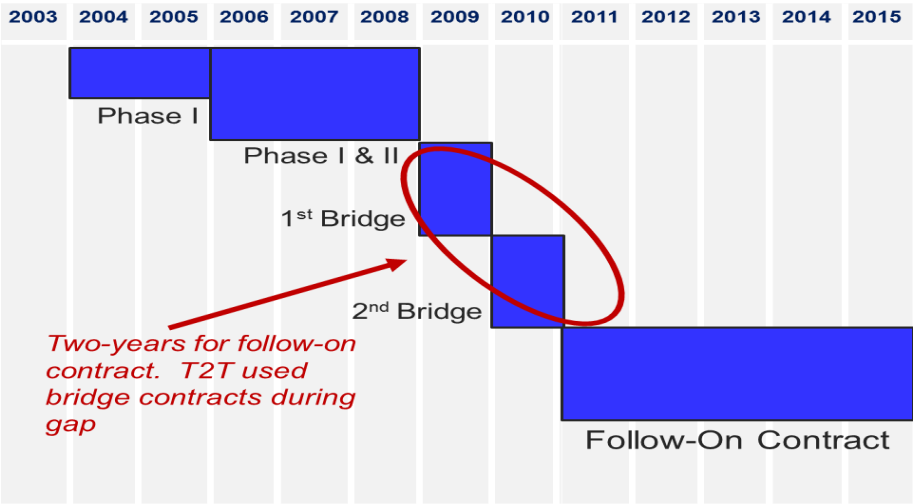

Figure 5: T2T Timeline

The U.S. Navy

U.S. Navy has three major players involved in this aircraft sustainment PBL– the helicopter squadrons that operate the aircraft, contract management team H-60 IWST,

and Naval Air Systems Command, which sustains the aircraft and runs the H-60 program office PMA-299.

The end users of the helicopter are the helicopter squadrons. They are the operational units that fly the helicopters, execute missions and tasks, and perform the day-to-day organizational maintenance on the helicopters. The Navy's helicopter squadrons typically consist of 10 - 30 of a single type of helicopter with a common mission and equipment set, and are typically attached to a larger operational unit, like a Carrier Air Wing. Ultimately, the PBL supports these squadrons carrying out their missions, by improving the availability of their aircraft.

All naval aircraft, including the H-60, receive full life-cycle support from Naval Air Systems Command (NAVAIR). This Vice Admiral-led command provides sustainment, research and design, development, acquisition, testing and evaluation, training, modification, repair, engineering and logistical support to all naval aviation aircraft and weapon systems. NAVAIR is the 'customer' for aircraft sustainment PBLs.

Within NAVAIR, the H-60 fleet is managed by the program office, PMA-299, which is responsible for the cost, schedule and performance of H-60 sustainment. PMA-299 has a Performance Based Agreement (PBA) with NAVAIR that formally documents the required support to be provided to the customer (NAVAIR) by the program office. The required support, documented by the PBA, is used as the basis for its PBL programs.

A separate Navy organization, NAVSUP WSS holds component PBL contracts and is the contract manager on behalf of PMA-299 and NAVAIR. The H-60 Integrated Weapon Support Team (H-60 IWST) is the specific team within NAVSUP WSS that manages these contracts on a daily basis. The two offices, PMA-299 and H-60 IWST, work in close coordination. PMA-299 provides oversight and technical, engineering and logistical support to H-60 IWST, while H-60 IWST provides contract management expertise.

T2T Operations

The T2T program sustains the 1,200 H-60 naval helicopter parts and components covered in the PBL contract. It provides "repair, overhaul, modification, procurement of attrited material, packaging, handling, storage outbound transportation, configuration management, obsolescence and reliability management."[14]

At its core, these activities carried out by the T2T contractor support the key operation of delivering requisitions to the Navy on time. As an indicator of how important this operation is, the T2T's performance metrics only measure this supply response time (described in detail below). At a basic level, the success or failure of the T2T depends on whether it is delivering requisitions on time. In order to ensure that the parts covered by the T2T are available when requisitioned, the T2T manages a complex supply chain that supplies those parts.

When the Navy personnel need a part, usually for maintenance purposes (e.g., the part is at the end of its service life and needs to be replaced), they submit a requisition to the Navy's supply system. If the part is covered by the T2T, MHSCo supplies the part.

In its simplest form, this supply of parts has two sources –new parts and repaired parts. MHSCo itself does not manufacture any new or repaired parts. A supply chain of public and private enterprises do the manufacture and repair. New parts are supplied primarily by OEMs, but can also be supplied by other non-OEM firms or by government enterprises like depots. Repaired parts are supplied by the Navy's maintenance system where these failed parts are repaired and returned to service.[15] Note that private sector firms are also integrated throughout the Navy maintenance system.

MHSCo has over 30 private sector suppliers. MHSCo's joint venture parent firms are the two primary suppliers. LMSI and SAC, through their own network of sub-contractors, supply most parts; however, MHSCo has separate relationships with upstream suppliers

and OEMs. Many have PBL-like contracts with MHSCo, while smaller suppliers have traditional transactional relationship with MHSCo.[16]

The network of suppliers includes the government depots that specialize in the repair and maintenance of H-60 aircraft. MHSCo has public-private partnerships (PPPs), in the form of commercial service agreements, with five depots. These PPPs are designed to comply with the Title 10 50/50 rule requirements (i.e. not more than 50 percent of the funds made available in a fiscal year to a military department or a Defense Agency for depot-level maintenance and repair workload may be used to contract for the performance by non-Federal Government personnel on such workload); however, there is a decision to be made about the extent to which any private firm running a PBL should interact with depots beyond 50/50 Rule compliance. MHSCo has chosen to embrace the

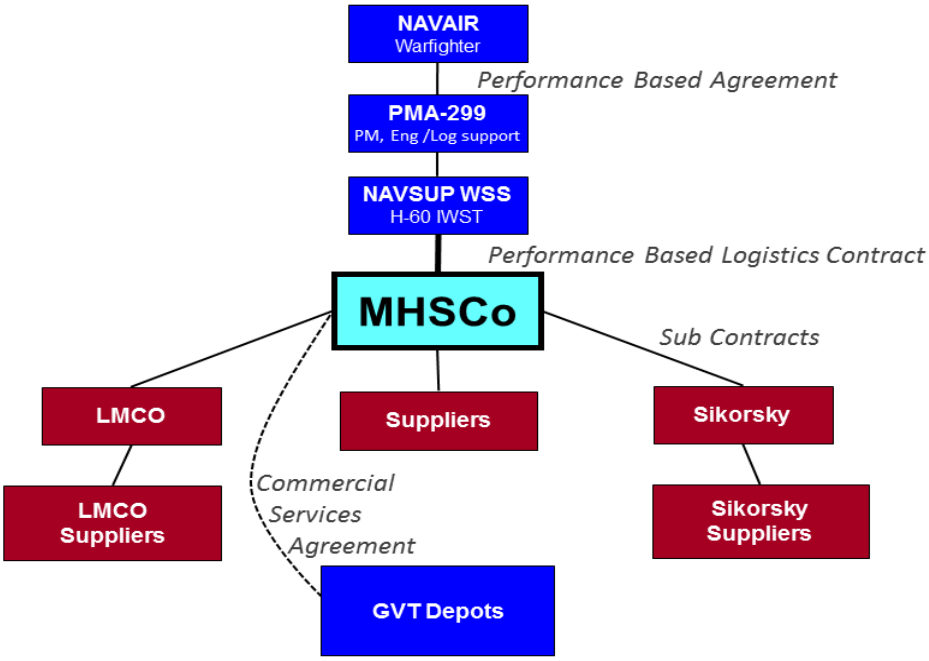

Figure 6: The T2T Network

depots and maximize their PPPs for competitive reasons. For the T2T program, depots provide key advantages; these include expert artisans, specialized tools and equipment,

and other logistical advantages (naval depots are often co-located with operational units, simplifying transportation and communication). The depots can provide competitive pressure on OEMs, by expanding the industrial base supporting a component. The PPPs leverage these capabilities.

Managing information through the effective use of Management Information Systems (MIS) is essential to the T2T. MHSCo's President, Rod Skotty, in a 2012 presentation, lists information management as one of four core functions of MHSCo.[17] Their coordination of the supply chain function is made possible by the extensive use of management information systems, to interface with Navy logistics systems and helps inform both internal and external decision-making. The MIS automates and monitors requisition processes, thereby increasing control and lowering costs.

Information analysis allows both MHSCo and the Navy to improve efficiency through data-based analysis. For example, MHSCo analysis indicated that about ten 'chronically ill' parts, like the gearbox, are crucial, continually back-ordered, and make up 40% of the cost of the contract.[18] They needed special attention. These parts now have separate tracking in the new contract. The web portal provides tracking and overall visibility to the customer.

From the perspective of MHSCo, the primary cost driver of the T2T is procurement of parts from the supply chain (which it then delivers to the Navy), so MHSCo has a strong incentive to lower these costs through lowering demand for parts. Lower demand means fewer requisitions that the T2T must fill; directly lowering its costs. Demand for parts can be lowered by making parts more reliable, and making processes more efficient (through, for example, system engineering, using Lean/Six Sigma practices, etc.). A more reliable part with a higher mean-time-between-failure (MTBF) requires fewer repairs, and will be requisitioned less often, allowing the T2T to procure and/or repair fewer of those parts. A more efficient sustainment process, like transportation, allows the T2T to deliver parts more quickly, and reduces the time in transit.

Rotary blades provide an example of what demand reduction and process change looks like. Blades left on the ground were being unintentionally stepped on, which damaged their honeycombed interior and rendered them inoperable. MHSCo mitigated this problem by the simple addition of "DO NOT STEP" decals to the blade. A more elaborate process improvement occurred in changing the way blades are repaired. The U.S. Army, which has extensive experience with the H-60 helicopter, had a blade rebuild process superior to that of the Navy. Sikorsky, as the blade manufacturer, saw and compared the two rebuild processes, determining the Army's method was superior, and introduced it to the Navy. Finally, a special nut used to attached the rotor blades to the rotor head was being stripped during routine maintenance; driving up demand for replacement nuts. MHSCo developed a special-purpose wrench, eliminating the stripping problem, and thus reduced the demand for frequent nut replacements.

Figure 7: Sailor performing maintenance on MH-60R
(Courtesy U.S. Navy)

MHSCo analyzes where and how to invest in better processes that lead to improved efficiency, and lower demand. When analysis indicates that an upfront investment will save money over time, there is sufficient return on investment (ROI) for that investment. The longer the term of the contract, the more time that investment has to pay off (the

greater the ROI for a given investment). These investments can be substantial. As of 2011, WSS reported that industry partners had invested $150M in process improvements.

The T2T program executes its operations behind the scenes, out of sight of the fleet. That is, the end-users at the squadron level see no difference between T2T sustained parts and non-T2T sustained parts. End-users requisition and receive T2T managed parts using the same IT systems as any other part. This is a deliberate feature of the program, designed to minimize the administrative burden of military logisticians.

T2T Fee Structure & Incentives

The T2T program uses a firm fixed-price per flight hour, plus an incentive-fee contract. MHSCo's base-fee is a fixed dollar amount per flight hour, multiplied by the combined total number of flight hours flown by all H-60 aircraft during a given time period. Firm fixed-price means the Navy pays a fixed amount per flight hour to the MHSCo. The costs the support provider incurs, complying with the contract, are not considered; so they absorb all risk and responsibility for cost and resulting profit or loss. The 'plus incentive' is a fee in addition to the fixed-price that is earned by the support provider when they meet certain performance metrics. The incentive criteria for the T2T in the original contract was based upon meeting and exceeding the baseline metric—Fill-Rate. In the follow-on contract, fill-rate was replaced with a new metric, Supply Response Time (SRT). Both are variations of logistical response time, a standard PBL metric of supply performance. The incentive fee of the T2T is a percentage of the base fee.

Using firm fixed-price offers three advantages to the Navy. First, a fixed-price prevents increases in per flight hour costs from being absorbed by the Navy. With a firm fixed-price contract, the Navy has transferred the task of cost-control, and the risk of rising costs, to the support provider. Second, flight hours are the single largest factor driving demand for components provided by the T2T. Meeting this demand is the major cost for the T2T. Linking increases in demand for T2T support to increased revenue for the T2T

program balances financial risk between the Navy and the support provider. Third, fixed-price makes the cost of sustainment explicit, which allows more informed budgeting and planning decisions. With the T2T, the Navy knows exactly how much it must pay per flight hour, and it can use that information when planning operations and making budgets.

The major risk for the Navy, with this type of fixed-price contract, is that it does not have visibility into MHSCo's costs; this makes it more difficult to ensure they are paying a fair and reasonable price and that the government is getting the best value. The longer the term of the fixed-price contract the greater this potential risk that cost-data, both pre-PBL and from similar programs, becomes less useful as a basis for extrapolating what the program should cost. After five years of operation under the T2T program, the Navy could not find acceptable cost-data to use for comparison during the re-negotiation with MHSCo. In an effort to ease this concern, MHSCo agreed to share its cost-data, and used that for cost analysis during the re-negotiation.

For the support provider, the fixed-price is a strong financial incentive to lower the cost of providing support (while maintaining performance standards), and to lower demand through improving part reliability, and improving the effectiveness of the sustainment system. This is the alignment of incentives that makes PBLs effective – the Navy and the support provider have the same incentive to control costs, improve maintenance and supply chain processes and lower demand. These incentives work best with long-term PBL contracts, where the support provider has the insurance that upfront investments can be recouped within the term of the contract.

Since there is some risk, in this fixed-price contract, of fluctuations in flight hours; so the original contract included a risk-mitigating "equitable adjustment clause" at +/-15% of the Navy flight hour forecast.[19] During the renewal negotiation, MHSCo gave up the equitable adjustment clause as a concession.[20] By then, MHSCo had developed the

capability to rapidly respond to fluctuations in demand, and fluctuations in revenue were not expected to be a major issue going forward.

Performance Metrics

The T2T uses a single performance metric, which is unusual for PBLs. The Air Force's C-17 PBL program, which began at about the same time (2004), had six metrics. The MHSCo CEO, Mr. Skotty, cites the single metric as an important reason for the program's success – all parties have clearly identified what is important. Furthermore, simplicity and clarity are particularly important when explaining the program to senior Navy officials, who do not necessarily have a background in PBL or helicopter support.[21]

The original contract used the performance metric Fill Rate, which measured the percentage of requisitions fulfilled on-time by the T2T. In the renewed contract, the performance metric is Supply Response Time (SRT). SRT, like Fill Rate, is a measure of on-time requisitions. The process begins when Navy logistics personnel enter a requisition request for a component into their logistics ordering system. If the part is covered by the T2T, the requisition is received by MHSCo and the "SRT" clock starts. Requisitions for high priority items (classified as Issue Priority Group 1) are required to be delivered to the requestor unit within five business days. Lower priority parts must be delivered within fourteen business days. SRT, expressed as a percentage, is calculated by dividing the number of requisition requests met within the required time criteria by the total number of requisitions. For requisitions that missed the required fulfillment schedule on the 'first pass', the requisition gets a 'second pass.' On the second pass, the clock starts over. To get the full incentive, the second pass must fill 100% on time. The renewed contract also separately measures the SRT for a handful of 'chronically ill' special management items, whose expense and low performance warrant special attention.

The T2T's performance on SRT determines MHSCo's incentive fee. This is how the performance metric creates a financial incentive to improve performance. Prior to the introduction of the T2T, the Navy's own performance on Fill Rate was an average of 69%. With the T2T, the Navy established that an 80% SRT would earn 100% of the incentive fee (a percentage of that period's total revenue). Since the contract began, MHSCo has surpassed the 80% metric and received 100% incentive at each incentive period. The closest T2T came to falling below the 80% threshold happened in 2006 during a Sikorsky labor dispute.

V. Performance of PBL

Improved Performance

The T2T PBL contract performance is summarized in Figure 8**: T2T Performance**. It shows the Fill Rate/SRT continuously exceeding 80% in each period over the life of the program. It averages 88% overall; an improvement of 19% over the pre-PBL rate of 69%. This metric is the key performance indicator of this PBL. It has exceeded the 80% required for a 100% incentive fee continuously since its inception. This is the best evidence that the T2T program has succeeded by the performance standards of the Navy.

In addition, the fill rate for "special management items," the separate sub-metric in the 2010 contract, has increased from 80% to 99%.[22]

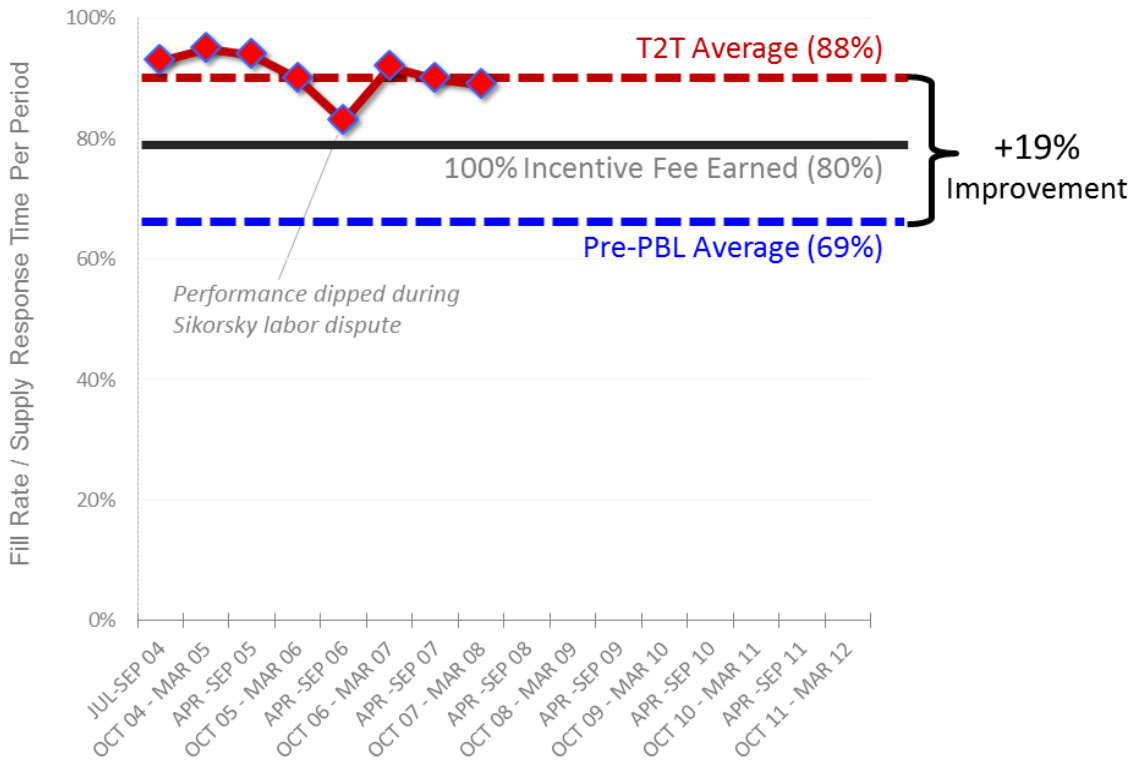

Figure 8. T2T Performance

Cost Reduction to Customer

These performance improvements did not come at an increased cost. Quite the opposite, in the follow-on contract for T2T support of legacy helicopters, the fixed-price per flight hour was reduced by $310, or 17% - a major reduction in costs to the Navy. This reduction is an example of what should happen in a well-structured PBL, i.e. a PBL with the appropriate incentive structure. Over the course of the contract, the support provider improves performance, while reducing costs. In the follow-on contract, the customer is able to capture some of those lower costs through a price reduction.

For the original contract, NAVSUP estimated in 2008 that the T2T had saved the Navy $41M over five years.[23] That is a savings of approximately 4.5% using the $900M total five-year program cost estimate. The Navy's business case analysis of the follow-on 2010 contract projected savings to the Navy of $46M over the five years of that contract. These represent significant savings.

Secondary Indicators of Performance

The primary benefits of PBLs are absolute performance improvement and reduced costs compared to the alternative product support strategies; however, these are not the only benefits. The T2T has demonstrated benefits as seen in reduced backorders, controlled growth in demand, and development of measures of system performance.

Backorders, a measure of parts ordered but not received on time, has declined by over 90% during the follow-on contract. In the two years of the bridge contracts (2008, 2009) backorders averaged 361 per month and did not exhibit any clear downward trend. In the follow-on contract back-orders trended steeply downward, declining to a low of 24 in April 2012; Figure 9: Backorders shows this decline. This change in trend suggests the importance of long-term contracts to support programs.

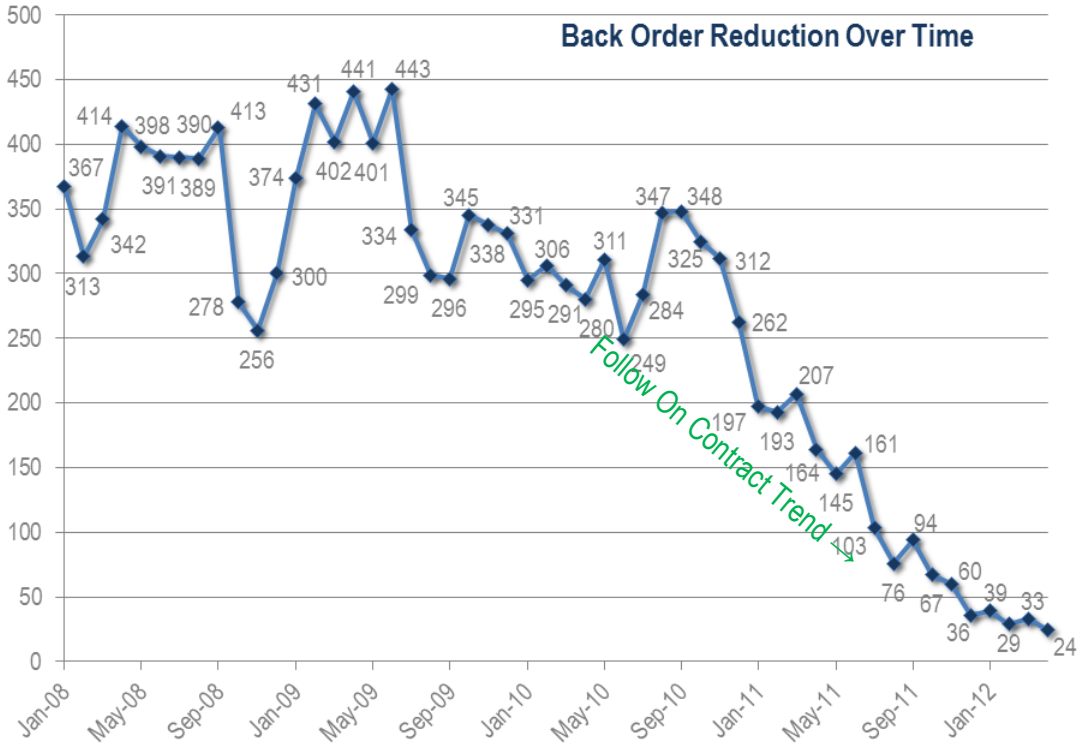

Figure 9: Backorders

Lowering demand is an essential aspect of PBLs, and a key measurement of program performance. Lower demand means lower costs to the support provider and greater reliability for the customer. Figure 10: Demand Curves shows that the rate of increase of demand for parts has declined since the introduction of the T2T. Note that the demand for parts has not decreased in absolute terms, but that the rate of increase is decreasing. This is known as 'bending the cost curve' and represents real improvements in performance, particularly when considering that this demand comes from the legacy helicopters that continue to age, and covers a period of war when ops-tempo throughout the services dramatically increased with correspondingly dramatic increase in operating and maintenance costs.[24]

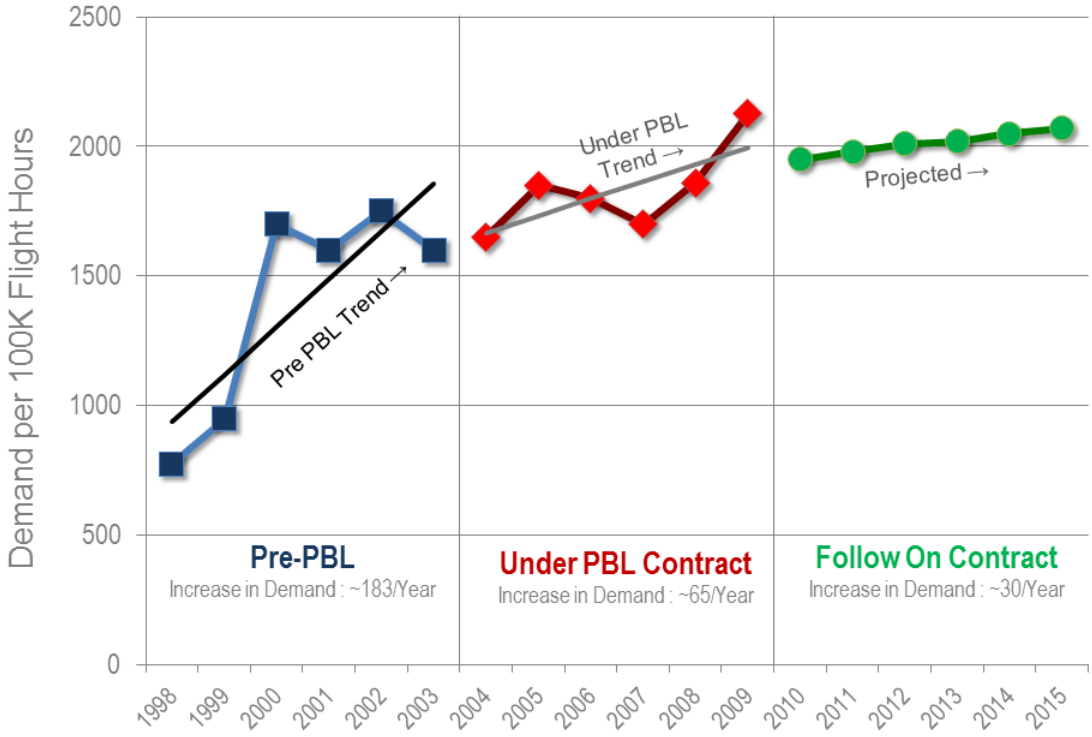

Figure 10: Demand Curves

Moreover, the maintenance process is far more efficient. As of 2011, 91 depot-level repairs are now done at the intermediate-level, lowering cost $1.5M. The number of items requiring above I-level maintenance is down by 80%.[25] Each repair that no longer needs to done at the D-level, lowers cost and reduces turn-around-time; since D-level activities are the most expensive, and moving components to and from D-level takes additional time.

Improved Management Information System (MIS)

The T2T has also improved information flow, through use of MIS, which provides supply chain transparency, enabling more informed decision-making. The T2T provides web-based, real-time status on requisitions. As of 2011, Navy personnel have placed 336,000

inquiries through the portal. Previously, inquiries were conducted through a time-consuming, ad-hoc mix of email and phone calls.[26] The same MIS system gives the Navy visibility on the $350 million government-owned, but T2T managed, inventory. MHSCo reports that since the T2T began, they have never lost any inventory, something the Navy could not claim, as the Navy did not have full visibility into its inventory pre-T2T.[27]

MHSCo has set up a structure that has improved the flow of information within the Navy, by acting as an intermediary between Navy offices. Early in the program's life, MHSCo discovered a problem with internal Navy communication. Offices at different echelons were not communicating with each other; leading to inconsistent guidance and executive decisions not being carried out by lower level units that were not informed of those decisions. MHSCo ultimately helped to solve this problem, by taking it upon themselves to facilitate communicate between Navy offices. They do this through scheduled meetings with different levels of Navy offices. They meet at the General Officer (Admiral) level monthly, and meet frequently at lower levels. The purpose of these meetings is to exchange information about the T2T, and to ensure that the Navy offices all have the same information. [28]

The T2T has also improved the situation of sustaining obsolete components. Procuring and repairing obsolete parts is expensive, time-consuming, and resource intensive as these parts are procured in small, on-demand batches. The material and technical capabilities necessary to work on these parts are expensive. There are few machine shops or artisans who can, for example, repair the old technology of the ARQ-44 Data Link; manufactured in the early 1990's and made obsolete in 2005.[29] The T2T has used the standard practices of obsolescence management to control cost. It has opened new after-market sources of supply, including using a Fleet Readiness Center as a manufacturer that can compete with the OEM. It has used engineering and design changes to replace some particularly costly obsolete parts with newer, more reliable parts, like with the ARQ-44. It improved the salvaging of some components (taking a part that was once scrapped

when it failed and, instead, repairing it and returning it to use). Finally, it has done some lifetime buys, which is purchasing sufficient parts to meet projected future demand (e.g., athletes that favor a specific shoe about to end its production run will purchase, say, 10 pairs of that shoe, to ensure they have it for the foreseeable future).

What the Government Officials Say

Navy and OSD executives agree that the T2T program is a successful PBL. NAVSUP has nominated the T2T for the Secretary of Defense Performance-Based Logistics Award four times (2006, 2008, 2011 and 2012). RADM Raymond Berube, former commander of NAVSUP WSS said in 2010, "this program [T2T] is one of the Navy's most successful PBLs to date. The H-60 PBL contract is a superb example of improving fleet support at a reduced cost."[30] Commenting on the T2T shortly after its renewal in 2010, Shay Assad, former Director of Defense Procurement Acquisition Policy, Office of the Secretary of Defense[31] noted: "The H-60 Tip-to-Tail Performance Based Logistics program is a shining example of Dr. Ashton Carter's efficiency initiatives in action."

VI. A Challenging Negotiation for Follow On Contract

Negotiation Brought New Policies and Priorities

An extended negotiation was a major issue for the T2T and MHSCo. The first contract between MHSCo and the Navy expired at the end of 2008. On 31 Dec 2010, the follow-on contract was signed. Negotiation unexpectedly extended for two years because the contract expiration coincided with the arrival of a new administration that brought in new leadership, with new priorities, to key acquisition positions in the Office of the Secretary of Defense (OSD) and Assistant Secretary of the Navy (ASN). They properly placed a priority on the government receiving better value for the taxpayer and warfighter;[32] but the new administration was less receptive and knowledgeable about PBLs – and it took a more restrictive view of the proper role of the private sector, and the role of the profit motive, in weapon system sustainment. These new priorities and policies translated into a lengthy review of the contract, the Navy pushing to get best value for its money, more oversight into costs and profits as means of controlling 'excess' profit, and an effort to insert competition into a sole-source program.

Concessions on Sharing Cost Data

During the negotiation, MHSCo had to make a challenging decision about providing the Navy greater visibility of its costs. Even though this initiative was structured as a fixed-price contract, the Navy insisted on requiring MHSCo to provide its cost data before the sole-source Justification and Approval would be signed.[33] In effect, this meant the contract would not be renewed without MHSCo's agreeing to share this sensitive proprietary data. The Navy was concerned that since there were no competitors, they needed this data to evaluate the proposed rates. Allowing the government to see cost data in a PBL was viewed as a major risk and required a strategic decision by MHSCo. The downside risk is that the government, a monopsony buyer, could use this data to set profit

levels or otherwise use the data in ways that would harm the interests of MHSCo or its parent companies.

To assuage the concern about lack of competition, the two parties agreed to use MHSCo's own prior performance as a baseline for competition. The Navy used MHSCo's cost data during negotiation for pricing analysis. This was a form of self-competition that CEO Rod Skotty compared to a long-distance runner competing against his own time, rather than against other runners.[34]

To assuage the concern about windfall profit, MHSCo ultimately conceded to the Navy's demand and agreed to report cost data every six months. In interviews, officials noted that other contractors facing similar demands had let the contract expire rather than share the cost data. MHSCo ultimately decided to share their data with the government, rather than let the successful program expire; as long as the Navy agreed not to use it for profit claw-backs. To date, the concerns about use of the cost data by the government have not been realized; MHSCo noted that although they are providing the data, they have not received any feedback; so they are not sure if the Navy is using the data in any way—or if they are satisfied with what they found.

Concessions on Contract Term & Competition

The second major challenge was about the length of the follow-on contract. The Navy was pushing for a shorter-term contract. Its rationale was that a shorter-term contract would promote more competition through more frequent bidding, giving more favorable terms to the government. Their concern was that longer-term contracts could 'lock-in' the incumbent and limit government flexibility. Initially, there was preliminary discussion of possibly extending out the follow-on contract beyond five years through the use of one-year options, which would have made the T2T an unusually long-term PBL. A recent "Project Proof Point" study of PBL effectiveness examined 21 PBLs, of which none had a term longer than 6 years.[35]

The two parties compromised with a 5-year follow-on contract with no options. The Navy wanted short term, MHSCo longer. MHSCo was able to persuade the Navy that five years was a reasonable term. MHSCo successfully argued that the customer benefited from continuity; that it required a long-term contract to recoup investments; and that the competition concerns of the government could be assuaged through other means. The continuity argument detailed the significant start-up costs to both parties during a new business relationship; as the support provider, PSI, PSM and customer must all climb up the learning curve together. These costs are significant enough to discount some of the perceived benefits of competing frequently, using shorter-term contracts. The investments made by MHSCo and its suppliers required at least a five-year contract in order to reach an acceptable return-on-investment (ROI).

VII. Best Practices

A 'PBL,' that actually is a PBL, works.

The T2T is a textbook PBL program. When a program is properly structured as a PBL, it will work, as is the case of the T2T.

The T2T operates under a fixed-price plus incentive fee contract. It is designed to optimize availability and uses performance metrics. It has one support provider who manages the program on behalf of the government. It aligns incentives, particularly through the demand reduction. It operates under a five-year contract, which is relatively long-term for federal contracts.

PBLs are definitively a superior support strategy. There is abundant evidence of the effectiveness of PBL. Two recent articles are particularly helpful in summarizing the evidence. The first article, the OSD sponsored *Project Proof Point,* is the most current study of PBL and decisively concludes that PBL works. The second article, *Explaining the Effectiveness of Performance-Based Logistics: A Quantitative Examination* by

Randall et al., has an extensive discussion of previous studies that demonstrated PBL effectiveness and concludes that PBL is "a win-win strategy."[36] Critically, both articles (and numerous others) emphasize that low performance PBLs tend to have *some* of the characteristics of PBL, but not *all* the necessary characteristics to be a PBL. The T2T has all the characteristics of a PBL, and so it works.

Good Communications

Having effective communication throughout the program is essential for high performance. When the T2T program experienced a communication issue early on, it found a creative and effective solution.

Early on, MHSCo noted that there was an issue with the Navy's internal communication. Different offices at different echelons were not communicating and consequently the Navy was not speaking to its partner MHSCo with a unified voice. In particular, executive decisions were not being executed further down the chain of command because those decisions were not being communicated. MSHCo officials noted that the contract officer (who is the only person warranted to enter into, change or terminate contracts) was understandably reluctant to carry out changes to the contract without clear and unified guidance throughout the chain of command.[37]

MHSCo decided that the communications disconnect needed correction, and they came up with an elegant solution. MHSCo established a communication system where MHSCo officials met with their Navy counterparts separately at different levels and offices, and used those meetings to communicate information not only between MHSCo and the Navy, but also to facilitate communication among the Navy offices. For example, once a decision is made during an executive meeting at the Admiral level, MHSCo will reiterate that decision at each meeting it has with lower echelons. This system ensures all Navy offices know about the decision. MHSCo regards this communication solution to be one of the key "lessons learned" from the program.

The Importance of Partnerships between Government and Industry

The relationship between government and industry drives the performance of the PBL program for *both* parties. Achieving and maintaining good relations is the single most important factor for program success.

The literature of PBL strongly indicates that good relationships between parties involved in the program are essential to a well-run and successful PBL. MHSCo officials repeatedly emphasized the importance of their partnership with government to the success of the program. There is a rich academic literature on the importance of relations between the two parties when they are committed to a long-term contract. A recent journal article on the subject sums up the issue as this:

> "Lock-in problems transform a contract from a market exchange to a political relationship whose outcomes are determined less by market forces and more by the strategic relationship between the buyer and seller"[38]

The first pay-off of a good partnership is cooperation. If the buyer (Navy) and seller (MHSCo) cooperate, they can both win; but if they do not cooperate, they can both loose. Cooperation is going beyond the bare requirements of the contract to ensure that both parties get a satisfactory outcome over the long term, even if this additional action has a cost in the short term. In a long-term contract, cooperative actions become particularly important because of the ability to respond through 'tit-for-tat' retaliation over time, that can otherwise turn the buyer and seller into adversaries.

The second payoff is trust. A successful PBL requires that government take a 'hands-off' approach to the support provider's operations. The support provider needs freedom of maneuver in its internal practices, so it can modify and adjust those practices to optimize its performance. This requires trust. The government must trust that the support provider will deliver, without knowing exactly how it will deliver. The support provider must

trust that the government will allow it to operate freely; and that, for example, cost-savings won't be penalized through claw-backs.

The third pay-off is political backing. PBLs, and military acquisition more generally, exist within a political environment. PBL support providers require political backing when the program, or the company, gets caught up in political situations. For example, large contracts like the T2T require Congressional notification and Congress can essentially veto the contract. Support providers that have good relations with their government partners can depend on those partners to give them valuable political support.

The T2T program has successfully established and maintained good relations with its government partners. The best evidence is that during the renegotiation process the Navy and depot personnel supported the T2T program and lobbied on its behalf. A major concern about PBLs is that they degrade the capabilities of the government's organic workforce, by 'outsourcing' work from government facilities to private-sector firms. The depots lobbying on behalf of a PBL was an effective means of countering the concern about outsourcing. Indirect evidence is that WSS nominated the T2T PBL for multiple awards (The 2010 Annual Stan Arthur Logistics Team of the Year Award, the 2012 Secretary of the Navy's PBL Award…and the DoD Program Excellence Award, among others).

Performance Incentives

Incentives are powerful, and careful contract design aligns incentives to make a win-win scenario.

The combination of fixed-price per flight hour and the SRT-based incentive fee create the right incentives for the T2T program. Fixed-price per flight hour creates the incentive to control costs and lower demand, while striking the right balance of financial risk between the Navy and MHSCo. The power of the PBL lies in its ability to harness the innovation

of the private sector, but that innovation only occurs with the right incentives. A fixed price is the right incentive, as it spurs the support provider to innovate ways to lower cost and lower demand – both desirable outcomes for the customer and the provider. The SRT-based incentive fee gives MHSCo the incentive to reach and maintain a high standard of performance, rather than to simply meet the minimum performance required by the contract.

The T2T has earned 100% incentive for each performance period since the contract began, and has routinely exceeded the 80% SRT by over ten points. The case could be made that evidence indicates the performance incentives are too low, or the cost of the program is too high. However, there are two simple reasons that the criticism does not apply to the T2T. First, the Navy renewed the T2T after an extensive renegotiation during which MHSCo made significant concessions. The renewed contract modified the performance metrics and incentive fees; though the 80% SRT metric remained in place. This strongly argues that the Navy could have modified the metric, but chose not to because it was satisfied with the incentive fee as it was. Second, NAVSUP has nominated the T2T for PBL awards and the former commander of NAVSUP spoke very favorably of the T2T following contract renewal; which argues that the Navy continues to be very satisfied with the T2T, even with its current incentive structure.

VIII. Observations and Conclusion

PBL remains as relevant today as it did in the late 1990's when the DoD and Congress were searching for creative ways to break out of the 'death spiral.' As of late 2012, it is highly likely that defense budgets will be cut, or at the least remain flat for the foreseeable future. Program managers will increasingly be faced with the dilemma of how to maintain, let alone improve, performance with declining budgets. The private sector will be faced with the dilemma of how to operate a viable business supporting the DoD while facing downward pressure on their revenue. In short, it looks like there is potential for a scenario remarkably similar to the 1990's death spirals. In this event, PBL will likely become increasingly relevant as a way of squeezing more performance out of DoD dollars.

Program managers and private sector firms will be looking for examples of product support strategies, like PBLs, that they can use as models; and they will be well advised to look at the T2T program. It serves as an example of what a PBL program looks like when done properly.

From its inception, the T2T has delivered the outcomes that ultimately determine success or failure of a support program. It has lowered costs and improved performance. Beyond that, it has improved the functioning of the H-60 support processes.

The lessons the T2T has to offer other PBL programs are that the contract structure and metrics, which drive incentives, are essential to get right; that communications throughout the program must be kept open; and that, most importantly, the relationship with the government customer will ultimately determine whether the program works or not.

IX. Acronyms

ASN: Assistant Secretary of the Navy

AT&L: Acquisition, Technology and Logistics

BCA: Business Case Analysis

C-17: A military transport aircraft

CH-46D: "Sea Knight," medium-lift tandem rotor military helicopter

Derco: A Sikorsky Aerospace Services Company

D-Level: Depot level maintenance.

DoD; Department of Defense

EDI: Electronic data interface

ERP: Enterprise Resource Planning software

FRC: Fleet Readiness Center

H-60 IWST: H-60 Integrated Weapon Support Team

H-60: "Seahawk," family of medium-lift military helicopters

HH-1N: "Iroquis," medium-lift military helicopter

HH-60H: "Seahawk," search and rescue version of the H-60

HSI: Helicopter Services Incorporated

I-Level: Intermediate Level Maintenance

IT: Information Technology

LMCO: Lockheed Martin

LMSI: Lockheed Martin Systems Integration

MH-60R: "Seahawk," anti-surface and anti-submarine warfare helicopter, latest version of H-60

MH-60S: "Seahawk," multi-purpose helicopter, latest version of H-60

MHSCo: Maritime Helicopter Support Company

MIS: Management information system

MTBF: Mean time between failures

NAVAIR: Naval Air Systems Command

NAVICP; Naval Inventory Control Point, renamed WSS in 2011

NAVSUP: Naval Supply Systems Command

NWCF: Navy Working Capital Fund

OEM: Original equipment manufacturer

O-Level: Organizational level maintenance

OSD: Office of the Secretary of Defense

PBA: Performance Based Agreement

PBL: Performance Based Logistics

PMA-299: H-60 Program Office

PPP: Public Private Partnership

PSI: Product Support Integrator

PSM: Product Support Manager

RADM: Read Admiral, a naval senior commander

ROI: Return on investment

SAC: Sikorsky Aircraft Company

SAP: a leading enterprise resource application software company

SH-60B: "Seahawk," original Navy version of H-60

SH-60F: "Oceanhawk," antisubmarine warfare version of H-60

SRT: Supply Response Time

T2T: Tip-to-Tail

UH-3H: "Sea King," anti-submarine warfare military helicopter

WSS: Weapon System Support, formerly NAVICP

X. Footnotes

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[1] The T2T also support USGS and foreign H-60s; however, these aircraft will not be discussed in this report.

[2]These data come from multiple sources. See the following two links:
http://www.utc.com/News/Sikorsky+helicopters+make+naval+history,
http://www.history.navy.mil/nan/backissues/2000s/2002/mj02/mj02.htm

[3] Jeff Heron. PowerPoint presentation at DAU. 18 NOV 2010.

[4] GAO/NSAID-96-156. *Inventory Management. Adopting Best Practices Could Enhance Navy Efforts to Achieve Efficiencies and Savings.*

[5] Margaret Kenyon-Ely. "*BRTs aggressively attack barriers to cost-wise readiness*." NAVAIR News. Jul 26, 2004.

[6] The Product Support Integrator (PSI) is an entity (i.e., individual, organization - public or private sector) charged with integrating all public and private support sources, defined within the scope of PBL agreements, to achieve the documented performance outcomes. The PM, while remaining accountable for system performance, effectively delegates authority for delivering warfighter outcomes to the PSI. In this relationship, and consistent with 'buying performance,' the PSI has considerable flexibility and latitude in how the necessary support is provided, so long as the outcomes are accomplished.

[7] Jeff Heron. PowerPoint presentation at DAU. 18 NOV 2010.

[8] "*Lockheed Martin, Sikorsky Venture Wins $417 Million Contract*." Lockheed Martin Press Release. January 08, 2004.

[9] http://www.defense.gov/contracts/contract.aspx?contractid=4435

[10] Interview with MHSCo officials. June 05, 2012.

[11] "*Justification for other than full and open competition, J&A# 13822*" NAVICP. June 01, 2009.

[12] Interview with MHSCo officials. June 05, 2012.

[13] Ibid.

[14] "*Nomination For The 2011 Secretary Of Defense Performance Based Logistics Award Program*." NAVICP Memo. 1 June 2011.

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[15] The Navy uses a three-level concept of maintenance - Organizational, Intermediate and Depot. Frequent tasks that require fewer facilities and skills are done the organizational-level (O-level). Preflight checks and fueling are common O-level activities. I-level maintenance provides the next level up of support. I-level maintenance covers multiple operational units within a geographic region, based at a particular station or aboard ship. D-level maintenance, the most expensive and complex type of maintenance, is done at depots with industrial facilities by expert artisans. Fuselage rebuilds and rewiring are examples of D-level activities.

[16] Interview, MHSCo and Presentation, Skotty, 2012.

[17] Rod Skotty. Untitled PowerPoint presentation. 2012

[18] Interview with MHSCo officials. June 05, 2012.

[19] A contract clause providing the contractor the right to adjust terms, particularly price. This is often an increase in price in response to the government modifying requirements that increase costs to the contractor.

[20] Interview with MHSCo officials. June 05, 2012.

[21] Ibid.

[22] Ibid.

[23] "*Nomination For The 2008 Secretary Of Defense Performance Based Logistics Award Program*." NAVICP Memo. 1 June 2008.

[24] See CRS's "The Cost of Iraq, Afghanistan and Other Global War on Terror Operations Since 9/11" published March 29, 2011 for a brief overview of how operating and maintenance costs increased between 2001 and 2011.

[25] "*Nomination For The 2011 Secretary Of Defense Performance Based Logistics Award Program*." NAVICP Memo. 1 June 2011.

[26] Interview with MHSCo officials. June 05, 2012.

[27] Ibid.

[28] Ibid.

[29] http://www.dtic.mil/dtic/tr/fulltext/u2/a263124.pdf. This is a technical paper discussing the 'new AN/ARQ-44" dating from 1993.

[30] NAVSUP Monthly Update. January 2011.

[31] http://utc.com/StaticFiles/UTC/StaticFiles/2012-03-15_sikorsky.pdf

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[32] For summary of current administration acquisition priorities and policies see "*Better Buying Power: Guidance for Obtaining Greater Efficiency and Productivity in Defense Spending*." Office of the Secretary of Defense Acquisition, Technology and Logistics. September 14, 2010.

[33] Interview with MHSCo officials. June 05, 2012.

[34] Rod Skotty. Untitled PowerPoint presentation. 2012

[35] Boyce, John & Banghart, Allan. "*Performance Based Logistics and Project Proof Point*." Defense AT&L: Product Support Issue. March-April 2012.

[36] Wesley S. Randall, David R. Nowicki, Timothy G. Hawkins, (2011) "Explaining the effectiveness of performance-based logistics: a quantitative examination", International Journal of Logistics Management, The, Vol. 22 Iss: 3, pp.324 - 348

[37] Interview with MHSCo officials. June 05, 2012.

[38] Brown, Potoski and Van Slyke. *Contracting for Complex Products.* Journal of Public Administration Research and Theory. Volume 20, pages i41-i58.

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