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Are the Performance Based Logistics Prophets Using Science or Alchemy to Create Life-Cycle Affordability?

Using Theory to Predict the Efficacy of Performance Based Logistics

Wesley S. Randall

Numerous studies have provided evidence that performance based logistics (PBL) can control cost and improve performance. The success—and failure—of PBL strategies suggest the need to position the PBL research domain into a fabric of theory. Just as engineering theories predict the reliability of a new armored vehicle, economic and business theories provide a framework that explains the efficacy of PBL. This article describes the underlying theoretical fabric of PBL. Armed with a framework grounded in theory, senior leaders can make science-based decisions to explain, predict, refine, and advocate for affordability-enhancing, life-cycle governance structures by leveraging the critical success factors of PBL.

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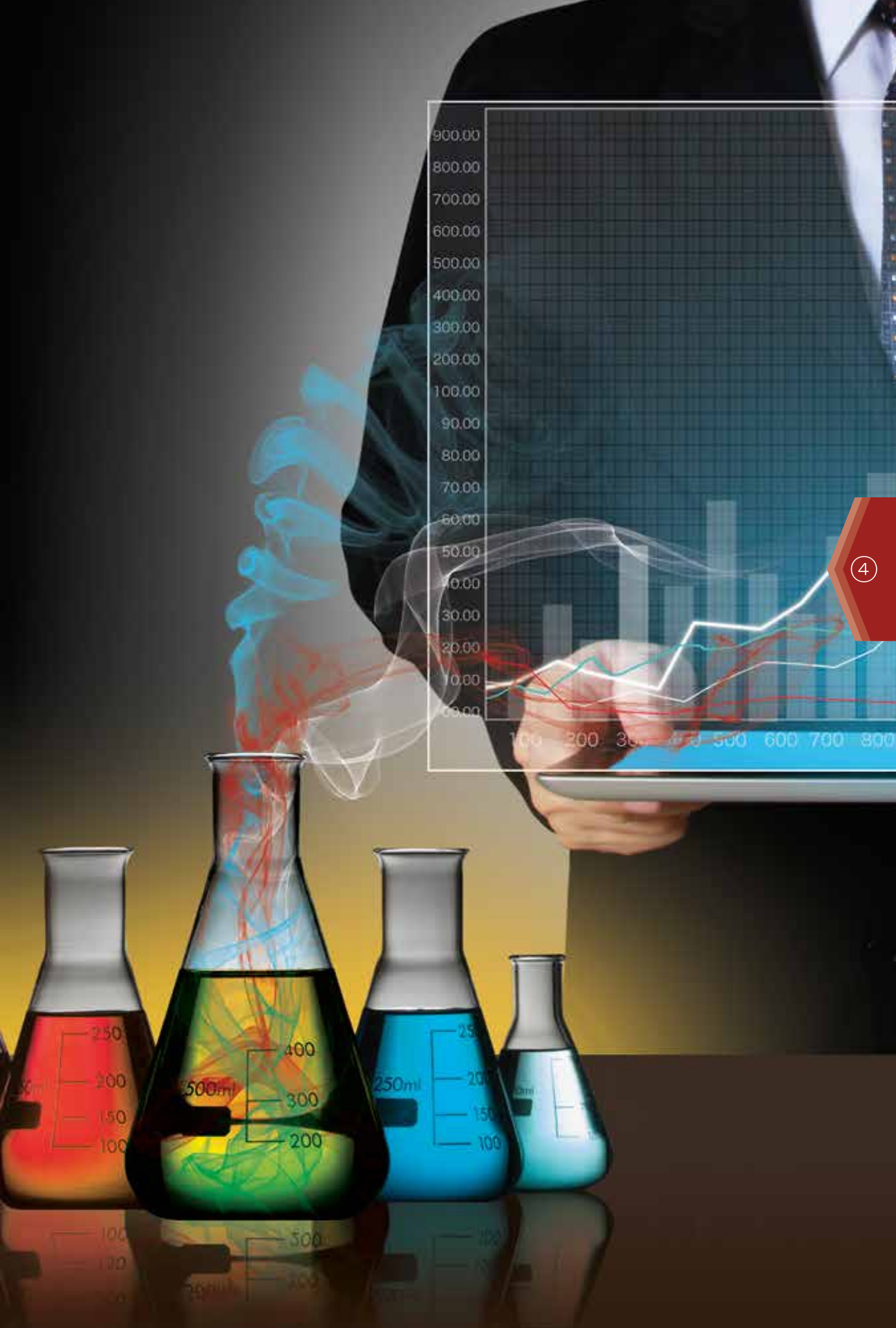
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In recent years, a great debate has surrounded the effectiveness of Performance Based Logistics (PBL). Articles have extolled the virtue and condemned the opportunism of PBL. In some quarters, consensus is growing that PBL works if you do it correctly (Boyce & Banghart, 2012). Initiatives like the DoD Weapon System Acquisition Reform Product Support Assessment (Department of Defense [DoD], 2009), Proof Point Project (DoD, 2011), and DoD guidance tell us the PBL debate is technically over. Yet, in other quarters there remains disagreement as to the efficacy of PBL.

PBL is part of a family of strategies, such as performance based contracting and pay for performance, whose essence is a shift from purchasing discrete products and services to the purchase of performance (Kim, Cohen, & Netessine, 2007; Randall, Nowicki, & Hawkins, 2011). PBL success depends on interactions among numerous variables. For instance, short-term contracts generate quick wins in classic logistics (warehousing, transportation, and inventory), medium-length contracts improve purchasing and item management, but real reliability-driven affordability requires a longer term contract (Hypko, Tilebein, & Gleich, 2010; Randall, Pohlen, & Hanna, 2010). As is true of any science, PBL research has been a journey of discovery. Predicting PBL success can be summed up in words frequently echoed throughout the halls of the

Defense Acquisition University: "*It depends* . . . ." The logical next step in PBL, and the goal of this article, is to provide the business and economic science behind PBL success.

The most profound contribution of academic research is theory. Theory provides the power to explain, predict, and improve the future.

What is Science, Where Do We Use It?

The most profound contribution of academic research is theory. Theory provides the power to explain, predict, and improve the future. Imagine an engineer tasked to build a light armored vehicle capable of 10,000 miles without major overhaul. Without theory as a guide, how does that engineer complete the task? The engineer will likely look to what seemed to work in the past and often overbuild the vehicle. The engineer will range-test the vehicle, rework the design of what breaks, and keep going until the goal is met. Armed with engineering theory, our intrepid engineer is focused and efficient. Theory informs computer simulation, tests, refinement, production, and employment of a vehicle that works as predicted. To a degree, PBL today is that engineer relying on experience without theory. We have identified where PBL has worked—and hasn't worked—no small task. Now is the time to define a theory-based framework that guides PBL implementation and execution.

One of the first classes in a business PhD involves a philosophy of science. The goal of this seminar is to provide the aspiring academic a foundation to accept the idea of business theory. Typically, the class starts with theory from the hard sciences such as engineering and physics simply to lay out the idea of theory. The hard sciences are used because students generally have find it easier to accept the predictive validity of natural laws like gravity. There is little resistance to the idea that engineering theories will explain how a new material will impact system performance (e.g., reliability, maintainability, and supportability). In the hard sciences, the idea of innovation improving performance and reducing costs, even for fielded systems, is relatively concrete.

In the soft sciences, such as business and economics, the explanatory ability of theory is not so intuitively grasped. This is because business and economic theories are less precise in making point predictions, but fairly precise in making statistical predictions. While business theory will struggle to explain the success or failure of a particular firm, business theory is effective in making statistical projections about groups of firms. So it is not unreasonable for business theory to suggest that on average firms that increase their inventory turn rates will outperform those who do not (Arnold, 2002). The need to explain and predict general success in the marketplace and overall health of a national economy make business theory critical. Likewise, the hard science business theory takes some of the alchemy out of strategy. Without sound business theory, leaders may find themselves moving from one "fad strategy" to the next, not understanding why things work in one context and not the next.

What Does This Mean for PBL?

The DoD budget realities highlight the need for strong, theoretically based, business acumen in weapon system sustainment. Such theory acumen is critical to the fiduciary responsibility of leaders charged with stewardship of defense budgets, warfighter effectiveness, and the success of the defense industrial base. The goal of this article is to lay a foundation for that acumen. Just as engineering theories explain the reliability of the new light armored vehicle, economic and business theories can be used to explain the efficacy of PBL and other postproduction support strategies.

Theory Foundation for Performance Based Logistics

In recent years, practical and academic PBL research in defense and beyond has experienced a veritable explosion (Boyce & Banghart, 2012; Guajardo, Cohen, Kim, & Netessine, 2012; Kim, Cohen, Netessine, & Veeraraghavan, 2010); Kratz & Diaz, 2012; Mirzahosseinian & Piplani, 2011; Randall, Pohlen, & Hanna, 2010; Sols, Nowicki, & Verma, 2007). Organizations looking to the World Bank for financial support to provide healthcare are expected to use a performance based toolkit (The World Bank, 2008). Siemens (2011) has an integrated performance based strategy for rail services. More than 35 countries are using performance based approaches for roads and highways (Transportation Research Board, 2009). The State of Illinois has been recognized for its performance based approach to child welfare services (Administration for Children &

Families, 2011). Nearly 70 percent of commercial maintenance, repair, and overhaul functions employ performance based strategies (Flint, 2007). Poignantly, our colleagues in the former Soviet Union provide concise insight into the essence of a performance based strategy (Organisation for Economic Co-Operation and Development, 2011):

> Ultimately, performance based contracts, if developed properly, can help to lay the basis for the long-term sustainability of water utilities, increasing their efficiency and creating conditions where investment capital can be attracted. (p. 3)

What does research say?

- PBL manufactures internal competition, eliminates waste, and improves quality (Boyce & Banghart, 2012).
- PBL aligns incentives to avoid suboptimization (Randall et al., 2010).
- PBL leverages long-term contracts to spur investment (Sols, Nowicki, & Verma, 2007).
- PBL optimizes management of assets that are difficult to predict statistically (Kim et al., 2010).
- PBL shifts from a return on sales to return on investment business model (Randall et al., 2011).
- PBL creates optimal outcomes while dealing with uncertainty and differing constraints (Kim et al., 2007).
- PBL creates a governance structure based upon long-term relationships, stable cash flow, clear scope, and intelligent metrics (Kratz & Diaz, 2012).

The net-net of this research activity is performance based strategies work.

Governance: So That's What PBL is Really All About

Research funded by the Naval Postgraduate School Acquisition Research Program and conducted by the University of North Texas Complex Logistics Systems Cluster (Randall et al., 2011) found:

> PBL establishes a metric-based governance structure where suppliers make more profit when they invest in logistics process improvements, or system redesign that reduces total cost of ownership. (p. 324)

Governance is critical to business and economic theory. Oliver E. Williamson won a Nobel Prize describing firm governance. For Williamson and his colleague, William G. Ouchi (1981), governance is a way of organizing transactions. Governance is more than a contract; it is "a much broader concept than control. Essentially, governance includes elements of establishing and structuring exchange relationships as well as aspects of monitoring and enforcement" (Heide, 1994, p. 72). The essence of PBL is a governance mechanism that efficiently organizes complex supply chain transactions. Just as the efficiency of transaction "bundling" predicts the success of the firm (Coase, 1937), PBL provides a "consistent sustainment governance process institutionalizing a life-cycle perspective on affordable and effective product support from acquisition through operations and support" (Kratz & Diaz, 2012, p. 40).

Coase's Theory of the Firm: Rationale for a Product Support Integrator (PSI)

Ronald Coase, Williamson's mentor, won a Nobel Prize (The Ronald Coase Institute, n.d.), by asking a very elemental question: Why do firms exist? Using precise and brilliantly simple terms, Coase (1937) explained that firms provide a governance structure that, for some transactions, is more efficient than market transactions. The firm does this by avoiding the market costs associated with knowing true price, searching for products and information, and enforcing contracts. Value is created when, "within a firm, . . . market transactions are eliminated, and in place of the complicated market structure with exchange transactions is substituted the entrepreneur-coordinator, who directs production" (Coase, 1937, p. 388). For Coase, the firm is an entrepreneur efficiently bundling and integrating market transactions.

The ideas embedded in the Theory of the Firm provide a foundation to explore the contention that multiyear PBL contracts are monopolies. Long-term firm existence demonstrates that nonpure competition governance structures can provide value superior to frequent market competition. More specifically, competitive position is then based upon the firm's ability to integrate complex transactions more efficiently than what a customer could achieve in the market alone. The firm governance is a form of "internal competition," which uses profit as a source of learning (Hunt, 2000). When the PBL governance results in portions of profit being reinvested into innovation that drives future profit, the multiyear PBL creates internal competition where profit leads to learning that increases affordability (Randall et al., 2010; Randall et al., 2011).

The critical nuance that is often misunderstood by competition advocates is that profit, not competition, provides the signal that allows firms to learn.

The critical nuance that is often misunderstood by competition advocates is that profit, not competition, provides the signal that allows firms to learn. Integrating complex transactions then is the key to the efficacy of the PLB strategy profit—learning cycle. Randall and his colleagues (2010) found:

> [that the] integrator acts as the network entrepreneur, bundling knowledge and capital resources to achieve the end user's requirements . . . integration links achievement of an outcome with network members' actions. (p. 43)

Effective PBL strategies demonstrate that monopoly is not synonymous with opportunism. Good PBL governance structure can mitigate potential opportunism by aligning profit-based incentives (Guajardo et al., 2012).

Transaction Cost Economics: Explaining Integrated Supply Chain Management and Long-Term Contracts

Coase's student, Oliver Williamson, was also a Nobel Laureate. Williamson (1971, 1975) wondered why megafirms did not vertically integrate complete markets. In his research, Williamson identified behavioral dimensions, which he labeled as bounded rationality, that limit the quantity of transactions a firm could effectively bundle. At a certain point, the coordination of transactions inside the firm becomes so complex, decision-maker capacity is limited by bounded rationality, and additional transactions result in disproportionate cost (Rindfleisch & Heide, 1997; Williamson, 1975). Further, this bounded rationality was proportional to the uncertainties and complexity associated with transactions (Rindfleisch & Heide, 1997).

Bounded rationality explains the success of an integrated supply chain network when the transactions are complex. Weapon systems sustainment strategies are tremendously complex. Transaction Cost Economics (TCE) suggests that complicated tasks require an expert integrator and a diverse network of supply chain partners who have the decision-making capacity to avoid bounded rationality for their subsystem (Kim et al., 2010; Randall et al., 2011; Williamson, 2008). At the same time, bounded rationality explains how some more easily bundled transaction sets, such as an organic depot returning a part to specification, can be more cost-effective.

A second element of TCE relevant to PBL is opportunism. Williamson (1985, p. 47) defined opportunism as "self-interest seeking with guile." Transactional relationships have little safeguard against opportunistic behavior. The governance structure of the firm avoids opportunism associated with internal transactions by creating convergent goals, controlling activities, and rewarding success (Rindfleisch & Heide, 1997). If the PBL strategy is considered a "firm-like unit" for the purpose of governance, then TCE can be used to explain how metrics and long-term contracts create convergent goals, control activities, and reward goal achievement through profit. For complex transactions, the PBL supplier network, working under sound governance, aligns metrics and profit to provide a learning process superior to frequent competition and minimizes the effects of bounded rationality.

In transactional sustainment, little incentive exists, and even less capital is available, to make life-cycle affordability investments. PBL reverses that trend by treating repair and redesign similar to make or buy.

Make or Buy Decisions: Know When to Hold 'em (Repair) and Know When to Fold 'em (Redesign)

A defining element of a complex system is one where the postproduction spend significantly exceeds the production spend. Unfortunately, that postproduction spending at best simply maintains the status quo. In transactional sustainment, little incentive exists, and even less capital is available, to make life-cycle affordability investments. PBL reverses that trend by treating repair and redesign similar to make or buy.

Simply put, make or buy predicts, when all transactions costs are considered, if firms should make or buy an item (Coase, 1937; Walker & Weber, 1984; Williamson, 1985, 2008). The make-or-buy decision seeks "the most efficient mode of governing the transaction" (Walker & Weber, 1984, p. 373). The idea underlying the choice of make or buy is similar to the spare-or-repair decisions predicted by the PBL governance structure. The goal in make (repair) or buy (redesign) is to seek the most cost-efficient approach to satisfy demand for some item.

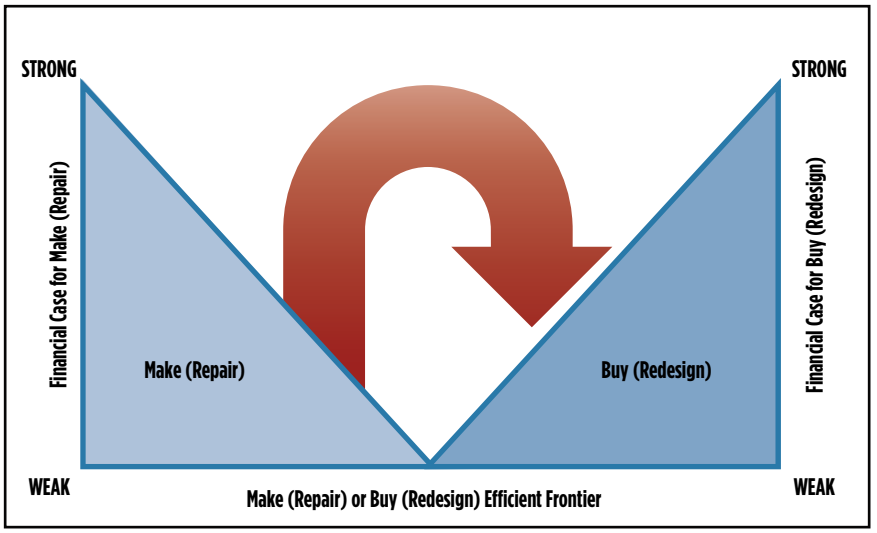
PBL and non-PBL managers focus on gaining efficiency and effectiveness regarding inventory management, repair, and overhaul. Yet, for the PBL manager the money spent purchasing spares, repairs, and overhaul is continuously calculated against an investment in new materials, processes, and technologies that will improve reliability and correspondingly drive out demand for that particular spare part (and its warehouse, inventory, and transportation cost), along with repair or overhaul tasks (Randall et al., 2011).

When a supplier has a new process that reduces the cost to redesign (buy) a part, then the PBL strategy dictates a shift from repair to redesign. Figure 1 graphically depicts using the idea of make or buy for repair

or redesign. The vertical axis denotes the financial case for repair or redesign. The horizontal axis represents different parts. The parts that appear on the left and right side have a clear financial case. The ability of the PBL governance to use innovation and investment to move the parts near the middle from repair to redesign is the essence of life-cycle affordability. In transactional postproduction support, there is no governance mechanism to shift the repair-redesign frontier.

The long-term contracts create pools of monetized cost avoidance that represent potential profit when the repair-redesign frontier is moved to the right. The profit pools provide the suppliers an incentive to invest in new material, process, and capabilities that will push items across the repair-redesign efficient frontier. Thus the learning—investment—profit cycle of PBL overcomes the potential opportunism of limited external competition.

FIGURE. GRAPHIC DEPICTION OF THE IDEA OF MAKE OR BUY FOR REPAIR OR REDESIGN



The idea that new materials, processes, and technologies will move parts across the redesign frontier is fairly intuitive. The economic case for shifting from repair to redesign is less intuitive. The costs associated with redesign can be daunting; they include the engineering hours of the design itself, production of parts, changes to the configuration baseline and technical orders, new test equipment, and new spares. However, the cost associated with continuous repair is very real. Ultimately, life-cycle

cost reduction requires managers to recognize a compelling case for the recovery of nonrecurring costs linked to redesign. The math associated with redesign is fairly surprising.

Table 1 provides a redesign economic model. This example illuminates the impact that contract length has on the repair-redesign decision. Targeting demand reduction on a few key parts can have significant impact on affordability. This example assumes constant year dollars, and no weighted average cost of capital discount. Given that a $7 million component redesign doubles the mean time between failure, and that doubling reduces demand for that component by 50 percent (200 to 100 demands per year), a rational actor, given a 3-year contract, will not invest the $7 million in nonrecurring redesign costs. However, extending the contract by 1 year, we find that a rational actor will make the redesign investment. Universally, when a component switches from repair to redesign, both the near-term (on-equipment maintenance) costs and long-term (total life-cycle) costs go down for the customer. Once the nonrecurring costs are recouped, the cost avoidance piles up for the remaining life of the system—increasing affordability.

TABLE 1. IMPLICATION OF CONTRACT LENGTH ON REPAIR VERSUS REDESIGN EFFICIENT FRONTIER

	Repair	Redesign
Demand	200	100
Cost per repair	$20,000	$20,000
Nonrecurring	$0	$7,000,000
Total cost year 1	$4,000,000	$2,000,000
Cumulative cost	$4,000,000	$9,000,000
Total cost year 2	$4,000,000	$2,000,000
Cumulative cost	$8,000,000	$11,000,000
Total cost year 3	$4,000,000	$2,000,000
Cumulative cost	$12,000,000	$13,000,000
Total cost year 4	$4,000,000	$2,000,000
Cumulative cost	$16,000,000	$15,000,000
Total cost year 5	$4,000,000	$2,000,000
Cumulative cost	$20,000,000	$17,000,000
Cost Savings Redesign		$3,000,000

Note. For simplicity, analysis does not consider discounted net present value.

In PBL, contract length directly impacts the repair-redesign efficient frontier and has tremendous implications for life-cycle affordability.

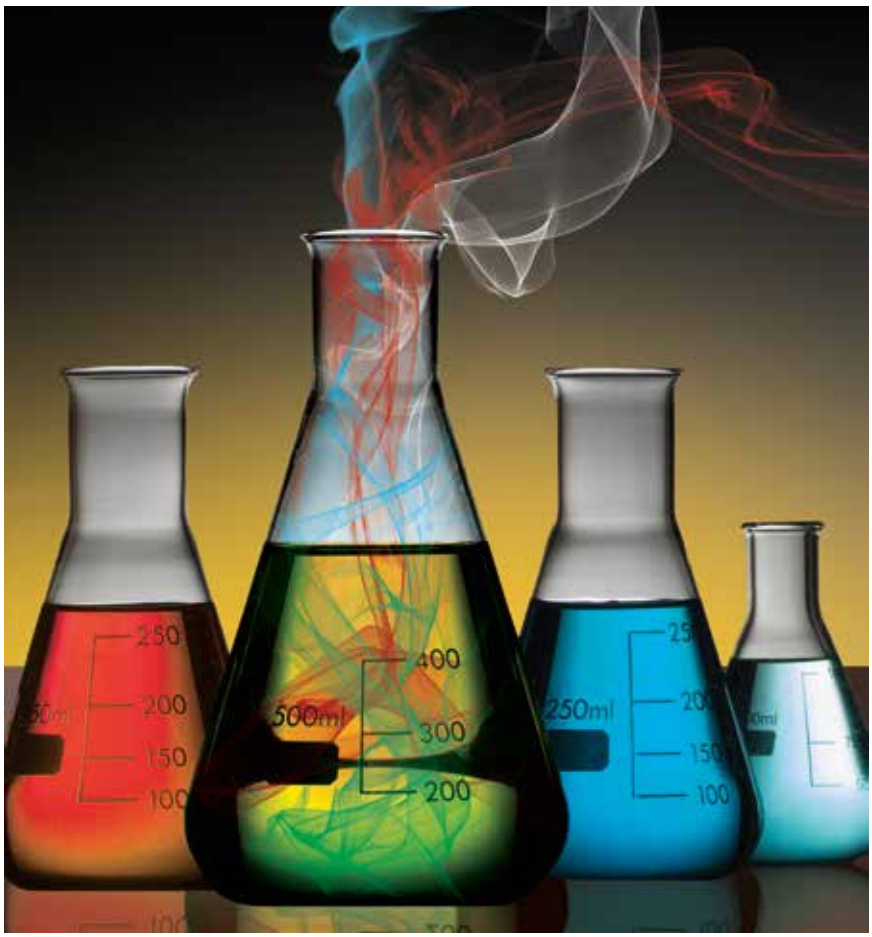
In PBL, contract length directly impacts the repair-redesign efficient frontier and has tremendous implications for life-cycle affordability. The length of a specific PBL contract depends on the potential to drive out cost by redesign, recovering nonrecurring costs, and the costs associated with repair. This raises the question, is there an end point where no more cost can be avoided? In theory, yes; in practice, no. The key determinants for success will be the availability of new processes, materials, and technologies, and the ability to monetize out-year spending. As long as innovation and supply chain collaboration results in a shift from repair to redesign, and as long as defense postproduction spending accounts for billions of dollars, PBL-type strategies will continue to produce efficiency and effectiveness improvements.

Core Competency: Exactly Who Should Do What and Why?

Significant PBL discussion is still ongoing about who should do what and why. A 1990 *Harvard Business Review* article by Prahalad and Hamel (1990) provides a theory-based way to answer that question. They discuss the idea of core competency as a framework to integrate organizations that have the complementary "core competencies" needed to achieve success. Core competencies are "the most powerful way to prevail in global competition" (Prahalad & Hamel, p. 79). Core competencies are central to business success. By definition, the core competencies of a firm are difficult to imitate, versatile in the marketplace(s), and protect against commoditization by being recognizable as significant value to the end customer (Prahalad & Hamel, 1990). Recognizing what core competencies are and are not allows business strategists to figure out when to partner, and who should do what.

The idea of core competency should drive the teaming strategy of the PBL governance structure. For example, generally, the entity that designed and produced the part will have the highest redesign core competency. When a third party offers a lower cost solution, this is likely to

be the result of some externality (e.g., the third party wanting into the market, the third party developing some type of Schumpeterian innovation, the original equipment manufacturer [OEM] losing competency, or an inefficient OEM cost structure). The competency logic also applies to purchasing, inventory management, warehousing, and transportation. Core competency explains why highly successful third-party logistics providers, like Menlo Logistics, are valued DoD partners. When it comes to repair and overhaul, the DoD depots have established core competencies that often make them the smart partner of choice. Few would argue the ability of Tinker and Jacksonville to overhaul engines, or Ogden to rebuild landing gear. Core competency provides a theory-based framework for decision makers to predict who should be doing what and why.



It makes sense that suppliers would bear the risk for performing typical logistics functions, while also making the repair-redesign decision. Yet, risk management is about balancing risk and reward.

It's About Risk

Risk allocation and, more specifically, placing risk where it is handled most cost-effectively is elemental to PBL (Randall et al., 2011):

PBL represents a governance structure that drives responsibility for supply chain transactions to those entities most capable of completing those transactions at the least cost and lowest risk. (p. 343)

It makes sense that suppliers would bear the risk for performing typical logistics functions, while also making the repair-redesign decision. Yet, risk management is about balancing risk and reward. Not uncommonly, PBL contracts may specify some type of gain sharing when profits exceed a certain level, subject to investments having been recovered. At the same time, it may be appropriate that customers share in costs associated with unforeseeable circumstances. Both ends of the risk-reward spectrum can be addressed by the governance structure.

Supply Chain Management: On the Rise

In a landmark 2001 *Supply Chain Management Review* article, Rice and Hoppe (2001) argued that competition is no longer firm against firm, but supply chain versus supply chain. Improved connectivity, increased efficiency, higher quality, and standardized processes have reduced supply chain transaction costs (Kaipia, 2009). Supply chain management efficiently brings together firms with complementary core competencies.

How significant is the rise in supply chain management? Manufacturers spend 40 to 70 percent of the cost of goods on purchased goods and services (Trent, 2007). The efficiency of supply chain governance structures and the ability to integrate complementary core

competency have resulted in transactions moving from the firm to the supply chain. Even Walmart goes to the supply chain for logistics support—Exel Logistics manages Walmart's Canadian logistics operations. Bose has heavily integrated suppliers into its research, design, and manufacturing.

Effective supply chain management can deliver products and services that create customer value at the least total cost. Supply chain management *value* (outcome divided by cost) is based upon the ability of the integrated supply chain to exceed the value of internally managed transactions (Lambert & Garcia-Dastugue, 2006; Walker & Weber, 1984, 1987). The rise of efficient supply chain governance structures is not coincidental to the rise of PBL success.

Providing value is inherently a return on investment strategy and requires a long-term relationship between customers and suppliers.

Service-Dominant Logic: A New Exchange Framework—And It Looks a Lot Like PBL

Scholars Stephen Vargo and Bob Lusch (2004) recently developed a new framework for market exchange called Service-Dominant Logic (SDL). SDL suggests that economic expansion and competitive position can be predicted based upon the supplier networks' ability to leverage knowledge to create evolving customer value. Similar to PBL, SDL creates value not by delivering products, but by using knowledge to create performance.

In SDL, the product is not in and of itself valuable—the product is a distribution mechanism for value (Lusch, 2011). This value focus is similar to PBL. In PBL, the metric provides a value-based feedback mechanism. Specifying delivery of performance, not products, leaves the suppliers free to invest in innovation, create cost avoidance, and harvest profits. This dynamic creates learning, rewards investment, and spurs new investment. Similarly, in SDL the primary flow is knowledge, and integration is the highest core competency.

The idea of PBL as an application of SDL has received considerable attention in academic circles. A 2011 PBL-focused article in the *International Journal of Logistics Management* won the emerald literati commendable paper award (Randall et al., 2011). That article states that SDL:

> . . . provides an effective mechanism to show how certain PBL ecosystems, their suppliers, customers, and integrator, can efficiently adapt to environmental changes, and thus predict competitive advantage of that network. The key to that competitive advantage is the flow of knowledge-based resources between the supplier network partners as focused on satisfying a customer service requirement. (p. 332)

Providing value is inherently a return on investment strategy and requires a long-term relationship between customers and suppliers. The knowledge orientation of SDL and its focus on creation of value, not simply supplying product, provides an economic foundation to predict the success of a PBL governance structure that aligns metrics, incentive, knowledge management, integration, capital, supply chain relationships, and learning to create affordability.

Research should seek to develop design solutions, coupled with efficacious PBL governance structure, thereby enabling cost-effective innovation across a program's life.

A Framework for PBL Governance Decisions

PBL rests on a fabric of sound business and economic theory. PBL governance structures minimize the costs associated with filling demand for parts, while continuously reevaluating how new material, processes, and technologies can improve reliability and repair efficiency, reduce demand for parts, and decrease life-cycle cost.

This implies a powerful, yet fairly simple PBL-based Life Cycle Affordability framework (Table 2). Given a proper PBL governance structure, affordability can be achieved by reducing the supply chain cost associated with meeting demand for parts (X-axis) or reducing the demand for parts and cost of repair (Y-axis). Program characteristics (e.g., parts demand) can be used to determine differing potential, contract structure, and partnerships—governance.

TABLE 2. LIFE-CYCLE AFFORDABILITY FRAMEWORK

Reliability and repair potential	Supply chain integration potential: LOW	Supply chain integration potential: HIGH
HIGH	**Cost avoidance potential — Medium** • Demand for parts is low • Demand for repairs is low • Redesign potential is high **Potential opportunities:** • Reliability, repair, and diagnostic	**Cost avoidance potential — High** • Demand for parts is high • Demand for repairs is high • Redesign potential is high **Potential opportunities:** • Supply Chain, reliability, repair, and diagnostic
LOW	**Cost avoidance potential — Low** • Demand for parts is low • Demand for repairs is low • Low, or risky redesign potential **Potential opportunities:** • Limited	**Cost avoidance potential — Medium** • Demand for parts is high • Demand for repairs is high • Low, or risky redesign potential **Potential opportunities:** • Supply chain

Quite simply, how quickly and cost-effectively new materials, processes, and technologies are infused into a PBL program is the essence of affordability. Research should seek to develop design solutions, coupled with efficacious PBL governance structure, thereby enabling cost-effective innovation across a program's life.

Summary

This article uses business and economic theory to weave a theoretical framework that gives leaders the ability to explain, predict, refine, and advocate for effective PBL strategy. The theory of the firm provides a mechanism to the role of an integrator to act as the network entrepreneur who reduces transaction cost and efficiently links actions with outcomes. TCE affirms the role of integration, while describing in theoretical terms how PBL governance addresses bounded rationality and opportunism. Bounded rationality and the idea of core competency explain why PBL strategies benefit from the network of firms collaborating to increase affordability. Understanding opportunism gives insight into how monetizing cost avoidance ameliorates the negative aspects of a monopoly partnership. Ultimately, profit leads to learning, and learning leads to smart investment—thus profit, learning, and investment cannot be. DoD can continue to spend on spares, repairs, and overhaul, or it can create partnerships that leverage new materials, processes, and technologies and *supplier* investment to improve affordability. TCE shows how the PBL governance structure manufactures internal competition that is more efficient than frequent market competition for complex transactions. Make or buy explains how shifting from repair to redesign is the essence of affordability, and the role of contract length in that decision process.

Supply chain management is shown to provide the complementary core competencies needed to create affordable complex systems. PBL also uses the idea of competency to drive risk to the point where it is managed most cost-effectively. PBL is shown to be a practical implementation of the SDL exchange paradigm. This means the massive expansion of high-quality, peer-reviewed research into SDL research provides a readymade foundation to further the efficacy of PBL. In PBL and SDL, what matters most to customers is performance (service), not parts (products).

Conclusions

The Proof Point Project (Boyce & Banghart, 2012) provided empirical evidence of PBL success. This article augments that effort by providing the business and economic theory at the core of that success. The criticality of reducing a weapon system's life cycle demands that senior leaders

inculcate into the acquisition corps a respect for business theory—similar to the strong respect that the corps has for engineering theory. It is critical that decision makers continue the intellectual engagement aimed at understanding the theoretical and practical foundation for successful PBL governance structures.

Can we do better? Certainly. But let's not forget what we have done. DoD has provided the most capable and reliable warfighting systems ever known. I have personal experience with a number of these systems, and I am awestruck by their capabilities and the competencies of the men and women who created them. At the essence of PBL, we encounter familiar concepts. We know how to team. We know how to invest. We know how to blend core competencies—sea, land, air, and space. We know how to innovate. PBL simply provides a rational governance structure that blends new ideas with old ideas to create more affordable systems. The Life Cycle Affordability Framework for PBL is encapsulated in Table 2. What is left is a few guiding thoughts on how managers might implement these insights via the framework. Table 2 provides those thoughts.

In capitalism, the metric for success is *profit = revenue – expense*. In DoD, the metric for success will be quantified as capability (*assets x readiness*) where *capability = budget – cost*. An effective entrepreneurial program leader will increase capability (i.e., lethality, maintainability, and/or reliability) by leveraging innovation and governance to lower cost. To that end, grooming leaders and program integrators who function as business-savvy entrepreneurs is essential to the success of the nation's warfighters.

Business theory allows one last prediction. Leaders have a choice. Those leaders who choose not to develop a theoretical understanding of life-cycle affordability may unwittingly begin to resemble mercurial alchemists, with a frustratingly inconsistent ability to reduce weapon system life-cycle cost or explain the efficacy of affordability-oriented strategies like PBL. Leaders who do not understand theory will be forced to watch as their peers explain, predict, refine, and advocate for PBL success after success. Leaders armed with theory will understand how to employ PBL strategy to build collaborative supply chain governance structures that increase the affordability of national security.

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