



# EXCERPT FROM THE PROCEEDINGS

---

## OF THE TENTH ANNUAL ACQUISITION RESEARCH SYMPOSIUM LOGISTICS MANAGEMENT

### **Issues and Challenges in Self-Sustaining Response Supply Chains**

**Aruna Apte, John Khawam, Eva Regnier, Jay Simon, and Daniel Nussbaum  
Naval Postgraduate School**

Published April 1, 2013

Approved for public release; distribution is unlimited.  
Prepared for the Naval Postgraduate School, Monterey, CA 93943.

Disclaimer: The views represented in this report are those of the authors and do not reflect the official policy position of the Navy, the Department of Defense, or the federal government.



The research presented in this report was supported by the Acquisition Research Program of the Graduate School of Business & Public Policy at the Naval Postgraduate School.

To request defense acquisition research, to become a research sponsor, or to print additional copies of reports, please contact any of the staff listed on the Acquisition Research Program website ([www.acquisitionresearch.net](http://www.acquisitionresearch.net)).



ACQUISITION RESEARCH PROGRAM  
GRADUATE SCHOOL OF BUSINESS & PUBLIC POLICY  
NAVAL POSTGRADUATE SCHOOL

# Preface & Acknowledgements

---

Welcome to our Tenth Annual Acquisition Research Symposium! We regret that this year it will be a “paper only” event. The double whammy of sequestration and a continuing resolution, with the attendant restrictions on travel and conferences, created too much uncertainty to properly stage the event. We will miss the dialogue with our acquisition colleagues and the opportunity for all our researchers to present their work. However, we intend to simulate the symposium as best we can, and these *Proceedings* present an opportunity for the papers to be published just as if they had been delivered. In any case, we will have a rich store of papers to draw from for next year’s event scheduled for May 14–15, 2014!

Despite these temporary setbacks, our Acquisition Research Program (ARP) here at the Naval Postgraduate School (NPS) continues at a normal pace. Since the ARP’s founding in 2003, over 1,200 original research reports have been added to the acquisition body of knowledge. We continue to add to that library, located online at [www.acquisitionresearch.net](http://www.acquisitionresearch.net), at a rate of roughly 140 reports per year. This activity has engaged researchers at over 70 universities and other institutions, greatly enhancing the diversity of thought brought to bear on the business activities of the DoD.

We generate this level of activity in three ways. First, we solicit research topics from academia and other institutions through an annual Broad Agency Announcement, sponsored by the USD(AT&L). Second, we issue an annual internal call for proposals to seek NPS faculty research supporting the interests of our program sponsors. Finally, we serve as a “broker” to market specific research topics identified by our sponsors to NPS graduate students. This three-pronged approach provides for a rich and broad diversity of scholarly rigor mixed with a good blend of practitioner experience in the field of acquisition. We are grateful to those of you who have contributed to our research program in the past and encourage your future participation.

Unfortunately, what will be missing this year is the active participation and networking that has been the hallmark of previous symposia. By purposely limiting attendance to 350 people, we encourage just that. This forum remains unique in its effort to bring scholars and practitioners together around acquisition research that is both relevant in application and rigorous in method. It provides the opportunity to interact with many top DoD acquisition officials and acquisition researchers. We encourage dialogue both in the formal panel sessions and in the many opportunities we make available at meals, breaks, and the day-ending socials. Many of our researchers use these occasions to establish new teaming arrangements for future research work. Despite the fact that we will not be gathered together to reap the above-listed benefits, the ARP will endeavor to stimulate this dialogue through various means throughout the year as we interact with our researchers and DoD officials.

Affordability remains a major focus in the DoD acquisition world and will no doubt get even more attention as the sequestration outcomes unfold. It is a central tenet of the DoD’s Better Buying Power initiatives, which continue to evolve as the DoD finds which of them work and which do not. This suggests that research with a focus on affordability will be of great interest to the DoD leadership in the year to come. Whether you’re a practitioner or scholar, we invite you to participate in that research.

We gratefully acknowledge the ongoing support and leadership of our sponsors, whose foresight and vision have assured the continuing success of the ARP:



- Office of the Under Secretary of Defense (Acquisition, Technology, & Logistics)
- Director, Acquisition Career Management, ASN (RD&A)
- Program Executive Officer, SHIPS
- Commander, Naval Sea Systems Command
- Program Executive Officer, Integrated Warfare Systems
- Army Contracting Command, U.S. Army Materiel Command
- Office of the Assistant Secretary of the Air Force (Acquisition)
- Office of the Assistant Secretary of the Army (Acquisition, Logistics, & Technology)
- Deputy Director, Acquisition Career Management, U.S. Army
- Office of Procurement and Assistance Management Headquarters, Department of Energy
- Director, Defense Security Cooperation Agency
- Deputy Assistant Secretary of the Navy, Research, Development, Test, & Evaluation
- Program Executive Officer, Tactical Aircraft
- Director, Office of Small Business Programs, Department of the Navy
- Director, Office of Acquisition Resources and Analysis (ARA)
- Deputy Assistant Secretary of the Navy, Acquisition & Procurement
- Director of Open Architecture, DASN (RDT&E)
- Program Executive Officer, Littoral Combat Ships

James B. Greene Jr.  
Rear Admiral, U.S. Navy (Ret.)

Keith F. Snider, PhD  
Associate Professor



# Logistics Management

---

## **Fully-Burdened Cost of Supply in Self-Sustaining Logistics Networks**

Eva Regnier, Jay Simon, Daniel Nussbaum, Aruna Apte, and John Khawam  
*Naval Postgraduate School*

## **Platform Design for Fleet-Level Efficiency: Application for Air Mobility Command (AMC)**

Jung Hoon Choi, Parithi Govindaraju, Navindran Davendralingam, and William A. Crossley  
*Purdue University*

## **Improving DoD Energy Efficiency: Combining MMOWGLI Social-Media Brainstorming With Lexical Link Analysis (LLA) to Strengthen the Defense Acquisition Process**

Ying Zhao, Don Brutzman, and Douglas J. MacKinnon  
*Naval Postgraduate School*

## **Addressing Counterfeit Parts in the DoD Supply Chain**

Jacques S. Gansler, William Lucyshyn, and John Rigilano  
*University of Maryland*

## **Wave Release Strategies to Improve Service in Order Fulfillment Systems**

Erdem Çeven and Kevin Gue  
*Auburn University*

## **Issues and Challenges in Self-Sustaining Response Supply Chains**

Aruna Apte, John Khawam, Eva Regnier, Jay Simon, and Daniel Nussbaum  
*Naval Postgraduate School*

## **Lead Time Demand Modeling in Continuous Review Supply Chain Models**

Barry R. Cobb, *Virginia Military Institute*  
Alan W. Johnson, *Air Force Institute of Technology*

## **Improving Multi-Component Maintenance Acquisition With a Greedy Heuristic Local Algorithm**

Sifat Kalam and Kash Barker, *University of Oklahoma*  
Jose Emmanuel Ramirez-Marquez, *Stevens Institute of Technology*

## **An Internal, Demand-Side Approach Toward Implementing Strategic Sourcing:**



**Political, Legal, and Economic Considerations**

John Fallon, *University of Maryland, University College*  
Timothy Reed, *Beyond Optimal Strategic Solutions*

**Optimizing Causes of Procurement Cost Through Strategic Sourcing: The Impact of Rate, Process, and Demand**

Timothy Reed, *Beyond Optimal Strategic Solutions*  
Michael E. Knipper, *United States Air Force*  
John Fallon, *University of Maryland, University College*



# Issues and Challenges in Self-Sustaining Response Supply Chains

**Aruna Apte**—Dr. Apte is an associate professor of operations and logistics management in the Graduate School of Business and Public Policy at NPS. She has over 20 years of experience teaching operations management, operations research, and mathematics courses at the undergraduate and graduate levels. Her research interests can be categorized in three broad areas in the field of operations and logistics management: humanitarian logistics, service operations, and military logistics. She has worked as a consultant at MCI. She has advised emergency planners in preparing for disaster response. She is the founding and current president for a new college (focus group) in Humanitarian Operations and Crisis Management under the flagship of Production and Operations Management Society. [auapte@nps.edu]

**John Khawam**—Dr. Khawam is an assistant professor at the Naval Postgraduate School GSBPP and received his PhD from the Department of Management Science & Engineering at Stanford University in 2009. His thesis focuses on warranty inventory management in the presence of a reverse supply chain. He spent 2009–2010 as a postdoc at WHU, Otto Beisheim School of Management. He received his master's degree (2001) and BS (2000) from Cornell University's OR&IE Department. He worked at Lord & Taylor as an internal consultant, where he received Six Sigma training. He has also worked at Gap Inc., Eaton Corp., Allied Signal, and End-2-End Analytics. [jkhawam@nps.edu]

**Eva Regnier**—Dr. Regnier is an associate professor of decision science at the Defense Resources Management Institute (DRMI) at NPS. Dr. Regnier teaches decision analysis and management of defense resources. Her research is in decisions under uncertainty, including both optimization and characterizing uncertainty for decision-makers, with a focus on applications with sources of uncertainty in the natural environment. [eregnier@nps.edu]

**Jay Simon**—Dr. Simon is an assistant professor of decision science at the Defense Resources Management Institute (DRMI) at NPS. His research is in decision analysis. His main research focus is multi-attribute preference modeling, particularly involving outcomes which occur over time, space, or groups of people. His current and recent work includes a prostate cancer decision model, preference models for health decisions, preferences over geographical data, altruistic utility modeling, and multi-attribute procurement. He is an associate editor of the journal *Decision Analysis*. Dr. Simon joined the DRMI faculty in August 2009. [jrsimon@nps.edu]

**Daniel Nussbaum**—Dr. Nussbaum is a professor of operations research at the Naval Postgraduate School. His expertise is in cost/benefit analyses, life cycle cost estimating and modeling, budget preparation and justification, performance measurement and earned value management (EVM), activity-based costing (ABC) and total cost of ownership (TCO) analyses. From December 1999 through June 2004, he was a principal with Booz Allen Hamilton, providing estimating and analysis services to senior levels of the U.S. federal government. He has been the chief advisor to the Secretary of Navy on all aspects of cost estimating and analysis throughout the Navy and has held other management and analysis positions with the U.S. Army and Navy, in this country and in Europe. In a prior life, he was a tenured university faculty member. [danussba@nps.edu]

## Abstract

The most basic representation of a supply chain has three elements: supply, demand, and the flow between the two. A humanitarian response supply chain (RSC) has to a large extent unknown demand and at best uncertain supply demand with disruptive flow. A self-sustaining supply chain (SSSC) requires that the supply chain itself provide all resources consumed while transporting supplies, thus complicating the operations with numerous challenges and unfamiliar issues. If an RSC is self-sustaining, it will reduce some of the uncertainties in supply. However, self-sustaining response supply chains (SSRSC) generate significant



additional cost for being extreme supply chains. To understand the costs associated with SSRSC observed in special operations and humanitarian assistance and disaster relief (HADR), they must be compared and contrasted against the known characteristics of traditional supply chains. This work explores the issues and challenges of SSRSC that arise in logistics networks.

## Summary

We can partition supply chains into three broad categories in terms of how the supply chain manages material—traditional, sustainable, and self-sustainable. Traditional supply chains that function in traditional logistics networks have been well studied in operations management. Sustainable supply chains (SSC) have received considerable attention in this age of green consciousness and fiscal austerity, and they can be measured by looking at their agility, adaptability, and alignment (Lee, 2004). SSC often achieve these through “The Three R’s”: reduction, reuse, and recycling—the latter two “R’s” are often performed outside of the traditional supply chain. Self-sustaining supply chains (SSSCs) extend themselves beyond the reuse and recycling. They require that all resources consumed while transporting supplies to their destinations be provided via the network itself. This makes SSSCs even more complex—they essentially become supply chain islands, where the network must be

- nimble enough to transport, create, conserve, and consume supply;
- flexible enough to repair and reuse the waste that it produces; and
- rigid enough to fulfill the ultimate demand of the supply chain while simultaneously fulfilling its own needs during the process of delivering the good or service it promises.

In addition to the management of material, one important aspect of supply chains is the environment in which they operate. At one end of the spectrum are traditional supply chains with less variable fluctuations in demand; on the other end are “response” supply chains in which supply, demand, customers, and network configurations continuously change due to unpredictability. A supply chain in its most basic form encompasses three elements: supply, demand, and flow—flow being the intermediary between the other two components. Typically, a traditional supply chain supplies a pre-established, standardized product to customers to meet a relatively constant and forecasted demand through structured resources and continuous flow. In contrast, at any given time, a humanitarian response supply chain supplies a wide range of products and services fulfilling spurts of demand while sharing the flow and capacity with other relief items (Apte, 2009). Traditional supply chain models may fail when they are stressed due to unknowns and uncertainties. Supply chains stressed in this way—extreme supply chains—need special attention from the researchers.

Sustainable, self-sustainable, and response supply chains are becoming more relevant to the Department of Defense (DoD) as we proceed through the 21st century. A major reason for this is the era of fiscal austerity that we have entered after the 2008 financial crisis. The U.S. DoD budget is tighter, so it must be able to maintain the same capabilities as in the past while using fewer resources. Thus, sustainability and self-sustainability become key strategic initiatives for the DoD. Strategy also comes into play when developing response supply chains—as people move to more disaster-prone areas of the world, the U.S. military will continue to play a major role in being the first responders in humanitarian assistance and disaster relief (HADR). Also, the face of conflict has tacked





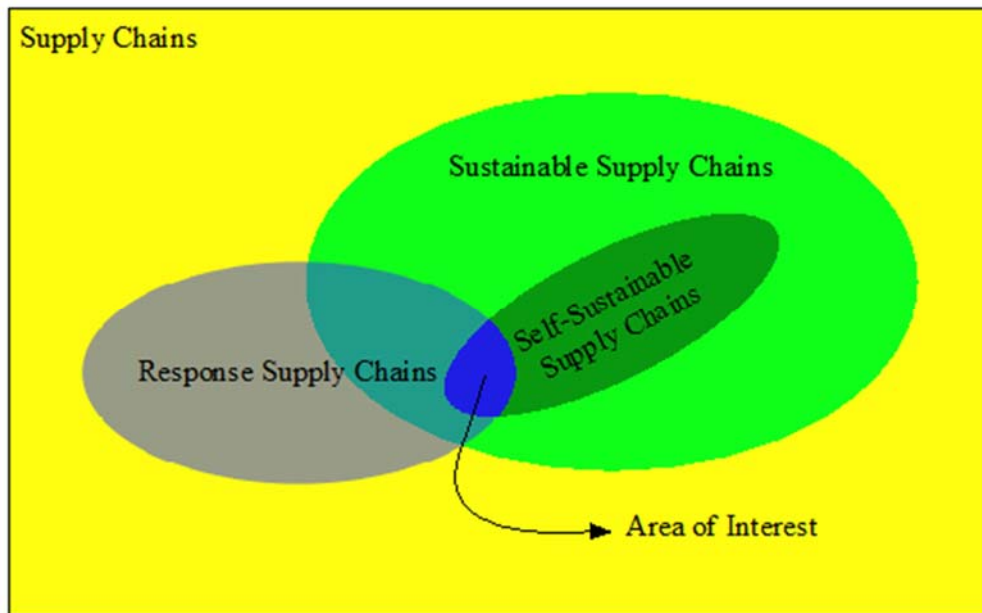
towards more irregular enemies vice large armed forces, thus requiring smaller, independent teams that coexist with each other over long periods of time.

Virtually every supply chain, regardless of whether it is self-sustaining or not, shares common characteristics such as supply, inventory, distribution networks, flows, lead times, information systems, customers, demands, and key performance indicators. In this research we study the similarities and differences of SSRSC with SSSC to expose the challenges in SSRSC in terms of operations. We believe studying operations is the first step to understanding the burden of cost in such supply chains (Regnier & Nussbaum 2011a, 2011b).

When a self-sustaining supply chain is initiated, it is endowed with a certain set of goods. These goods are used to sustain the SSSC itself during the transport, and these may also be the same types of items that it is attempting to deliver to its customers. When a self-sustaining supply chain begins, it has a limited amount of space to carry all of the goods being delivered and consumed during the delivery. Therefore, the choice of goods to carry is critical in that the SSSC cannot restock during the delivery process. The carriers must be efficient, innovative, and sustainable in their use of goods—they must have the tools to not only reach their destination, but also to have the provisions that the customer desires. If the supply chain runs out of goods, not only does the customer not receive goods, but also the supply chain itself could perish, resulting in, at best, unfulfilled demand—at worst, loss of life. Thus, efficient reuse is critical, as space is at a premium. Furthermore, the logistics network in an SSSC could be unstable and variable over time. These SSSCs, especially within the context of HADR and DoD special operations, provide for a unique research opportunity that has not been thoroughly studied (see Figure 1).

For example, consider the supply chain of providing fuel. Transportation of this single commodity requires fuel to be consumed by vehicles that transport it. There exist numerous challenges in this network if it is to be self-sustaining. It has also been researched and proved that such SSSCs can incur significantly higher costs than traditional networks (Regnier, Simon, & Nussbaum, 2012). We in this project will study such challenges in response supply chains, where multiple goods are conveyed and consumed through the same network—a network that is rife with uncertainty.





**Figure 1. Positioning Self-Sustaining Response Supply Chains**

Uncertainty in response supply chains is typified by “unknown unknowns,” to quote Donald Rumsfeld. When disaster strikes, authorities do not know who is hurt, what the severity of the damage is, what portions of the network remain or are degraded, how the supply chain will develop in the future, where demand will materialize, where supply will materialize—to name a few unknowns. The only knowns are the goals to save lives and to reduce suffering. Saving lives involves delivering the goods that are needed to sustain life—the same goods, such as water, fuel, medical supplies, equipment, and information, that SSSCs use and deliver during their life cycles. In such instances, the transportation capabilities needed to deliver goods, save lives, and reduce suffering have to be reliable. The uncertainties are brought on due to the process of providing relief that in turn makes SSRSC more complex. We plan to explore these complexities in SSRSC, thus allowing the DoD to identify the burden of cost.

### References

- Apte, A. (2009). Humanitarian logistics: A new field of research and action. *Foundations and Trends® in Technology, Information and OM*, 3(1), 1–100.
- Lee, H. (2004). The triple-A supply chain. *Harvard Business Review*, 82(10), 102–113.
- Regnier, E. D., Simon, J. R., & Nussbaum, D. A. (2012). *Estimating logistics burdens in support of acquisition decisions* (NPS Technical Report NPS-AM-12-C9P24R01-091). Retrieved from <http://www.acquisitionresearch.net/files/FY2012/NPS-AM-12-C9P24R01-091.pdf>
- Regnier, E. D., & Nussbaum, D. A. (2011a). Theory and feasibility of implementing economic input/output analysis of Department of Defense to support acquisition decision analysis and cost estimation. In *Proceedings of the Eighth Annual Acquisition Research Symposium* (Vol. 2). Retrieved from [http://www.acquisitionresearch.net/\\_beta/files/FY2011/NPS-AM-11-C8P15R03-057.pdf](http://www.acquisitionresearch.net/_beta/files/FY2011/NPS-AM-11-C8P15R03-057.pdf)
- Regnier, E. D., & Nussbaum, D. A. (2011b). *Theory and feasibility of implementing economic input/output analysis of Department of Defense to support acquisition decision analysis and cost estimation* (NPS Technical Report NPS-CE-11-204). Retrieved from <http://www.acquisitionresearch.net/files/FY2011/NPS-CE-11-204.pdf>





ACQUISITION RESEARCH PROGRAM  
GRADUATE SCHOOL OF BUSINESS & PUBLIC POLICY  
NAVAL POSTGRADUATE SCHOOL  
555 DYER ROAD, INGERSOLL HALL  
MONTEREY, CA 93943

[www.acquisitionresearch.net](http://www.acquisitionresearch.net)