The Design of Responsive Sea-Based Logistics Delivery Systems

Abstract: The United States Navy uses sea-based logistics to provide the operational and tactical sustainment of forces operating on and from the sea. Sea-based logistics will transform a set of vessels into floating distribution centers that are responsible for fulfilling supply orders from troops on shore. Vital components of sea-based logistics include selective offloading capabilities in high-space-utilization environments, delivery of emergent requests for tailored resupply packages, ship-to-objective logistics via aerial delivery, and cargo transfer at sea. In addition, sea-based logistics operate in a challenging and uncertain environment. Thus, our research is interested in developing models to quantify and evaluate sea-based logistics system design in the face of imperfect visibility. We focus on two important sea-based logistics decisions: selective offloading in dense storage environments and cargo transfer decision making with imperfect location visibility.

Dense storage systems provide high-space utilization; however, because not all items are immediately accessible, retrieval operations often require shifting of other stored items in order to access the desired item. When not properly tracked, this shifting creates the propagation of uncertainty in item locations over time. As a result of location uncertainty, before an item can be retrieved, the item needs to be identified, which requires searching. We develop models that describe the propagation of uncertainty over time, as well as search plan optimization and expected search time models.

Underway Replenishment is a method for transferring cargo from one ship to another while the two ships are moving at sea. To reduce the amount of idle time and to improve the utilization of the cargo transfer process, the concept of pre-staging cargo on the flight deck is used. Pre-staging involves retrieving and storing cargo on the flight deck of the supply ship in anticipation of requested demand. Given imperfect information about the location of assets, we are interested in determining which items, and in what quantity, to pre-stage that balances the costs with the rewards of pre-staging. We prove structural results about the property of optimal pre-staging policies and find that due to the presence of imperfect location visibility, the recommended pre-staging policy is different than the one that is recommended with perfect visibility.

Speaker Bio: Jennifer Pazour, Ph.D. is an assistant professor of Industrial Engineering and Management Systems at the University of Central Florida. Jen holds three degrees in Industrial Engineering (a B.S. from South Dakota School of Mines and Technology, as well as a M.S. and Ph.D. from the University of Arkansas). Her research interests involve developing and using mathematical models to guide decision making in service industries. Her research has primarily focused on analytical modeling of logistic challenges and application areas include distribution center design, material handling systems, health care, military, and transportation. She teaches courses in operations research, supply chain management, and industrial engineering applications in the service sector. Her research has been published in a number of peer-reviewed journals and has been funded via federal and industry sponsors. She is a recipient of the Young Investigator Program from the Office of Naval Research (2013), a Research Start Up grant from the Material Handling Institute (2013), a Doctoral Dissertation Enhancement Project from the National Science Foundation (2010), and national fellowships from Tau Beta Pi (2006), the Institute of Industrial Engineers (2005, 2007, 2009), and the Material Handling Education Foundation (2007 – 2010). She blogs about her research and teaching at https://jenpazour.wordpress.com/