MACK-BLACKWELL
Rural Transportation Center

National Transportation Security Center of Excellence

Annual Performance Report
Year Two
July 1, 2009 – June 30, 2010
Funding Opportunity DHS-08-ST-061-003
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NATIONAL TRANSPORTATION SECURITY CENTER OF EXCELLENCE
Homeland Security

Department of Homeland Security
Center of Excellence

UNIVERSITY OF ARKANSAS
COLLEGE OF ENGINEERING

University of Arkansas

Executive Director:	**Kevin D. Hall, Ph.D., P.E.**
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OVERVIEW

The Mack-Blackwell Rural Transportation Center (MBTC) has been a nationally recognized transportation research and education center since 1991, when it was authorized by the Intermodal Surface Transportation Efficiency Act. In August 2007, MBTC was designated as one of seven members of the U.S. Department of Homeland Security (DHS) National Transportation Security Center of Excellence (NTSCOE), in accordance with HR1, Implementing the Recommendations of the 9/11 Commission Act of 2007.

As a member of NTSCOE, our focus is the security of the multi-modal transportation systems of the United States at the local, state, regional, and national levels. Our vision is to be a nationally-recognized research and education center dedicated to solving pressing scientific and technological issues related to transportation security, and producing transportation professionals capable of leading public and private sector efforts aimed at providing U.S. citizens a safe and secure transportation system.

MBTC has identified four research areas which support the DHS strategic goals and our "system-of-systems" engineering approach to the resiliency and sustainability of transportation security systems. These capabilities include:

- Supply Chain Security
- Transportation Infrastructure Protection
- Transportation Emergency Preparedness
- Transportation Security Data Integration

This document is the Year Two Annual Report for MBTC, which covers the period July 1, 2009 to June 30, 2010. Work under Grant Award DHS-08-ST-061-003 began halfway through the Year One budget period, with the initial funding available in January 2009. Figure 1 shows a timeline that indicates project funding and the relationship between the budget periods and performance periods for Years One and Two, with award amounts of $494,000 for budget Year One (FY09) and $531,000 for budget Year Two (FY10).

In Year One, MBTC leadership, with assistance from DHS, selected the projects that best coupled current strengths with DHS strategic goals and budget constraints. Five projects were selected for initial funding in Year One. Two of these projects were two-year "base" projects (indicated in blue in Exhibit 1) that support the two core program areas of MBTC's Work Plan. The other three were one-year "exploratory" grants (indicated in pink in Figure 1) awarded to investigate areas that reach outside of the MBTC core program areas to make contributions elsewhere. Two of the exploratory projects (MBTC DHS 1102 and 1103) were completed on

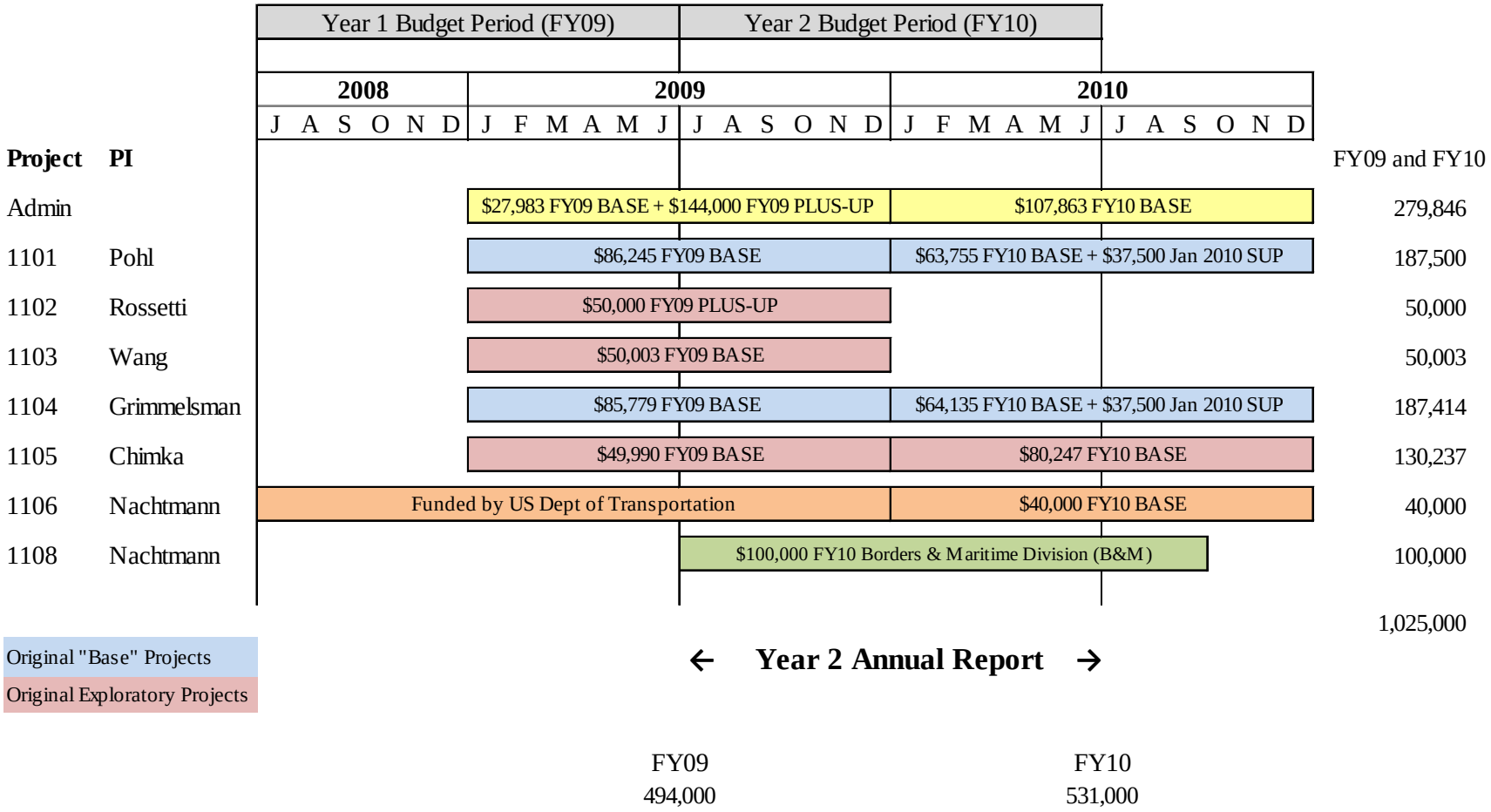

Figure 1. MBTC NTSCOE Project Funding

December 31, 2009. Their results are summarized in the next section and final project reports are available on the MBTC website. Based on recommendations by DHS, the third exploratory project (MBTC DHS 1105) was extended, with another year of funding and a revised scope of work.

During Year Two there were seven active projects, as indicated in Figure 1: the two base projects from Year One, two exploratory projects that ended in December 2009, one exploratory project extended from Year One, and two new projects of particular interest to DHS. Research accomplishments on all seven projects are summarized in the next section.

Performance of the MBTC NTSCOE program activities were measured through success factors in three key areas: research, education, and outreach, as shown in Figure 2. During Years One and Two, eleven faculty members participated in NTSCOE research. MBTC research projects relating to homeland security resulted in a number of journal articles, conference papers, technical reports, presentations, doctoral dissertations, and master's theses. Details on these research accomplishments and progress on each DHS-funded project are summarized in the following section.

MBTC is committed to educating our nation's future leaders and providing them with the expertise to excel in professional and research careers related to transportation security. During Years One and Two, NTSCOE projects have provided research opportunities for eighteen graduate students and seventeen undergraduate students. Additionally, eighteen NTSCOE-related courses were offered at the University of Arkansas, with a total enrollment of 194 graduate students and 214 undergraduate students. Our faculty members also developed one new transportation security related course, and modified two others to include security-related curriculum.

Throughout Years One and Two, our researchers have made efforts to identify how to better meet our nation's security needs by interacting with DHS personnel, federal, state, and local government agencies, and collaborating with researchers at other DHS Centers of Excellence and universities.

Research

- # of faculty involved in center activities 11
- # of faculty from underrepresented groups involved in center activities 1
- # of projects completed 2
- Follow-on funding from other sources 0
- Papers
  - # of journal articles 11
  - # of conference proceedings 5
  - # of doctoral dissertations 2
  - # of master's theses 2
  - # of technical reports 8
- Presentations
  - DHS sponsored 5
  - Non-DHS sponsored 18
- Software Products Developed 0
- Patents 0

Education

- # of students matriculated 35
- # of graduate students involved in center activities 18
- # of undergraduate students involved in center activities 17
- # of students from underrepresented groups involved in center activities 15

Outreach

- Requests for assistance or advice from DHS 3
- Requests for assistance or advice from Federal, State, Local Government 1
- Congressional Testimonies 0

Figure 2. MBTC Performance Measurements for Years One and Two

MBTC NTSCOE RESEARCH PROGRAM

Research Accomplishments

Faculty Involvement

During Years One and Two, eleven tenure-track faculty members in both the Civil and Industrial Engineering departments were engaged in NTSCOE research, as indicated in Table 1.

Table 1. Faculty Members Involved in NTSCOE Research, Years One and Two

	Name	Title	Department
1	Justin R. Chimka, Ph.D.	Associate Professor	Industrial Engineering
2	Brady R. Cox, Ph.D.	Assistant Professor	Civil Engineering
3	Kirk Grimmelsman, Ph.D.	Assistant Professor	Civil Engineering
4	Kevin D. Hall, Ph.D., P.E.	Professor	Civil Engineering
5	Ernie Heymsfield, Ph.D., P.E.	Associate Professor	Civil Engineering
6	Scott J. Mason, Ph.D.	Associate Professor	Industrial Engineering
7	Heather Nachtmann, Ph.D.	Associate Professor	Industrial Engineering
8	Edward A. Pohl, Ph.D.	Associate Professor	Industrial Engineering
9	Chase Rainwater, Ph.D.	Assistance Professor	Industrial Engineering
10	Manuel D. Rossetti, Ph.D., P.E.	Associate Professor	Industrial Engineering
11	Kelvin CP Wang, Ph.D., P.E.	Professor	Civil Engineering

Publications

The initial NTSCOE funding was received January 2009; therefore the NTSCOE research program has been active for eighteen months. However, MBTC researchers have been doing security-related research for a number of years. Through those efforts and the DHS-funded research during Years One and Two, MBTC researchers have produced eleven journal articles, five conference papers, two Ph.D. dissertations, two master's theses, eight technical reports, five DHS-sponsored presentations, and eighteen other presentations. The citations for this work are shown in Table 2. The presentations and publications that were submitted or accepted during Year Two are indicated in bold.

Table 2. Dissemination of Homeland Security Related Research

Journal Articles
1. Al-Otaibi, Mazen, Kurz, Mary E. and Mason, Scott J., "Analysis of a Tri-Criteria Disaster Relief Scheduling Problem with Precedence Constraints," submitted to *Computers & Industrial Engineering*.
2. Al-Otaibi, Mazen, Mason, Scott J. and Fowler, John W., "Scheduling Models and Heuristics for Disaster-Relief Operations," submitted to *Computers & Industrial Engineering*.

Journal Articles (cont.)
3. Chimka, Justin R., "Gamma Regressive Individuals Control Charts for Influenza Activity," *Quality Engineering*, Vol. 21, No. 2, 182-189, April 2009. 4. **Chimka, Justin R. and Walker, Lindsey., "Threshold Autoregressive Individuals Control Charts," *Economic Quality Control,* Vol. 24, No. 1, 55-73, 2009.** 5. **Gade, Dinakar and Pohl, Edward A., "Sample Average Approximation Applied to the Capacitated Facilities Location Problem with Unreliable Facilities," *Journal of Risk and Reliability,* Volume 223, No. 4, December 2009.** 6. Guzman, Mauricio and Pohl, Edward A., "Application of Reliability Methods to Social Networks," submitted to *Journal of Mathematical Sociology.* 7. Miman, Mehmet and Pohl, Edward A., "Modeling and Analysis of Risk and Reliability for Contingency Logistics Supply Chain," *Journal of Risk and Reliability*, Vol. 222, No. 4, 463-476, 2008. 8. Miman, Mehmet and Pohl, Edward A., "Multi-Objective Optimization of a Contingency Logistic Network through Physical Programming," submitted to *Computers & Industrial Engineering*. 9. **Nachtmann, Heather and Pohl, Edward A., "Transportation Readiness Assessment and Valuation for Emergency Logistics," to be submitted.** 10. **Townsley, Jared and Chimka, Justin R., "A Control Chart for Severityx to Detect Draught Compares Favorably to Logistic Regression," accepted by *Hydrology Research*.** 11. **Wang, Kelvin CP, Hou, Zhiqiong and Gong, Weiguo, "Automated Road Sign Inventory System Based on Stereo Vision and Tracking," accepted by *Computer-Aided Civil and Infrastructure Engineering.***
Conference Proceedings
1. **Balya, Rizki and Pohl, Edward A., "Resource Scheduling in a Project Management Setting Based on Schedule Reliability," *2009 American Society for Engineering Management National Conference Proceedings,* October 2009.** 2. **Grimmelsman, Kirk A., "Structural Health Monitoring and Structural Identification for Long Span Bridges," *12th International IEEE Conference on Intelligent Transportation Systems,* October 2009.** 3. **Malaviya, Ajay K., Rainwater, Chase and Sharkey, Thomas C., "Multi-Period Network Interdiction Models with Applications to City-Level Drug Enforcement," *Proceedings of the 2010 Industrial Engineering Research Conference,* Cancun, Mexico, June 2010.** 4. **Rossetti, Manuel D. and Ni, Quingbiao, "Simulating Large-Scale Evacuation Scenarios in Commercial Shopping Districts Methodologies and Case Study," accepted for publication in the *Proceedings of the 2010 Winter Simulation Conference*.** 5. **Salgado, Marcia F.P., Menezes, B.R. and Pohl, Edward A., "Developing Expert Opinion Based Models for Critical Infrastructure Risk Assessment and Vulnerability Analysis," *Proceedings of the 2010 Industrial Engineering Research Conference,* Cancun, Mexico, June 2010.**

Doctoral Dissertations
1. Al-Otaibi, Mazen, "Scheduling Disaster Relief Operations," Ph.D. Dissertation, University of Arkansas, December 2008. Directed by Scott J. Mason, Ph.D. 2. Miman, Mehmet, "Modeling and Analysis of the Reliability of Contingency Logistic Networks: A Multi-Dimensional Knapsack Approach," Ph.D. Dissertation, University of Arkansas, August 2008. Directed by Edward A. Pohl, Ph.D.
Master's Theses
1. Guzman, Mauricio, "A Probabilistic Programming Approach in the Analysis of Social Networks," M.S. Thesis, University of Arkansas, August 2008. Directed by Edward A. Pohl, Ph.D. 2. Keeley, Adam, "Emergency Medical Response via Inland Waterways" M.S. Thesis, University of Arkansas, May 2009. Directed by Heather Nachtmann, Ph.D.
Technical Reports (funded by DHS)
1. **Grimmelsman, Kirk A., Font, Alex, Herrman, Jason, and Rawn, Jeremy, "MBTC DHS 1104 – Structural Health Monitoring of Critical Intermodal Transportation Infrastructure Assets: Interim Report, June 2010.** 2. **Pohl, Edward A. and Mason, Scott J., "MBTC DHS 1101 – Designing Resilient and Sustainable Supply Chain Networks: Interim Report, June 2010.** 3. **Rossetti, Manuel D., "MBTC DHS 1102 – Simulating Large-Scale Evacuation Scenarios in Commercial Shopping Districts – Methodologies and Case Study," January 2010, available at http://www.mackblackwell.org.** 4. **Wang, Kelvin C.P., "MBTC DHS 1103 – Automated Real-Time Object Detection and Recognition on Transportation Facilities," February 2010, available at http://www.mackblackwell.org**.
Technical Reports (funded by U.S. Dept of Transportation)
1. Mason, Scott J., Meller, Russell D. and Pohl, Edward A., "MBTC 2086 – Routing Models for Rural Networks with Time-Varying Constraints," July 2008, available at http://www.mackblackwell.org. 2. **Nachtmann, Heather and Pohl, Edward A., "MBTC 2091 - Rural Transportation Emergency Preparedness Plans," July 2009, available at http://www.mackblackwell.org.** 3. **Nachtmann, Heather and Pohl, Edward A., "MBTC 3008 – Emergency Response via Inland Waterways," January 2010, available at http://www.mackblackwell.org.** 4. Rossetti, Manuel D. and Pohl, Edward A., "MBTC 2088 – Applications of GIS and Operations Research Logistics Planning Methods for Arkansas Rural Transportation Emergency Planning," July 2008, available at http://www.mackblackwell.org.
DHS-sponsored Presentations
1. Hall, Kevin, "Infrastructure of the Future: Structural Health Monitoring," U.S. Department of Homeland Security Third Annual University Network Summit, March 2009. 2. Nachtmann, Heather, "Mack Blackwell Rural Transportation Center – Research Overview," U.S. Department of Homeland Security NTSCOE Director's Meeting, Washington, D.C., May 2009.

DHS-sponsored Presentations (cont.)

3. **Medal, Hugh, "Designing Resilient Supply Chain Networks," U.S. Department of Homeland Security Fourth Annual University Network Summit – Student Poster, March 2010.**
4. **Pohl, Edward A., "Modeling Resilience of Transportation Systems," U.S. Department of Homeland Security Fourth Annual University Network Summit, March 2010.**
5. **Rossetti, Manuel D. and Ni, Quingbiao, "Simulating the Evacuation of Commercial Shopping Districts - A Case Study," National Evacuation Conference, New Orleans, LA, February 2010.**

Other Presentations (* denotes presenter)

1. **Black, Ryan, "Re-estimating and Remodeling General Aviation Operations," Institute of Industrial Engineers Region 5 Conference, San Antonio, TX, February 2010.**
2. **Black, Ryan* and Chimka, Justin R., "Information Enhancement Among Aviation Security Partners," MBTC Annual Advisory Board Meeting – Student Poster Session, October 2009.**
3. **Farrokhvar, Leily*, Nachtmann, Heather and Pohl, Edward A., "Emergency Response via Inland Waterways," MBTC Annual Advisory Board Meeting – Student Poster Session, October 2009.**
4. **Grimmelsman, Kirk A., "Dynamic Testing for Quantitative Condition Evaluation and Assessment of Structures," Structural Engineers Association of Arkansas, Annual Meeting, November 2009.**
5. **Guzman, Mauricio and Pohl, Edward A.*, "A Probabilistic Programming Approach in the Analysis of Social Networks," Institute for Operations Research and Management Science Annual Conference, October 2009.**
6. Medal, Hugh*, Mason, Scott J., Meller, Russell D. and Pohl, Edward A., "Routing Models for Rural Transportation Networks with Time-Varying Constraints," MBTC Annual Advisory Board Meeting – Student Poster Session, November 2008.
7. **Medal, Hugh*, Pohl, Edward A. and Mason, Scott J., "Designing Resilient and Sustainable Supply Chain Networks," MBTC Annual Advisory Board Meeting – Student Poster Session, October 2009.**
8. **Medal, Hugh*, "Routing and Resource Allocation for Disaster Relief," 2010 Health and Humanitarian Logistics Conference, Georgia Institute of Technology, Atlanta, GA. March 2010.**
9. **Medal, Hugh, "Protecting Networks Using Branch and Price with Stochastic Cuts," Industrial Engineering Research Conference – Ph.D. Colloquium, Cancun, Mexico, June 2010.**
10. **Medal, Hugh*, Rossetti, Manuel D., Pohl, Edward A., "Donations Management in the Humanitarian Supply Chain," Industrial Engineering Research Conference, Cancun, Mexico, June 2010.**
11. **Medal, Hugh*, Sharp, Stevenson, Nguyen, Huy-Nhiem, Pohl, Edward A. and Mason, Scott J., "Multi-Modal Supply Chain Network Analysis Under Disruption," Industrial Engineering Research Conference, Cancun, Mexico, June 2010.**

Other Presentations (cont., * denotes presenter)
12. Nachtmann, Heather, "Mack-Blackwell Rural Transportation Center," College of Engineering Dean's Advisory Council, Fayetteville, Arkansas, October 2008.
13. **Nachtmann, Heather, "Emergency Medical Response via Inland Waterways," Fayetteville Chamber of Commerce Transportation Committee, Fayetteville, Arkansas, October 2009.**
14. **Nguyen, Huy-Nhiem*, Salgado, M.F.P., Mason, Scott J., and Pohl, Edward A., "Risk and Vulnerability Analysis Techniques for Supply Chain Network Infrastructure," Industrial Engineering Research Conference, Cancun, Mexico, June 2010.**
15. **Ni, Qingbiao* and Rossetti, Manuel, "Simulating Transportation Modes in Large-Scale Evacuation Scenarios," MBTC Annual Advisory Board Meeting – Student Poster Session, October 2009.**
16. Pohl, Edward A.* and Nachtmann, Heather, "Vulnerability Assessment of Rural Transportation Networks," Industrial Engineering Research Conference, Miami, Florida, June 2009.
17. **Qiu, Minghua*, Font, Alex, Rawn, Jeremy, Moore, Haley, McQuire, Christian, Grimmelsman, Kirk, Cox, Brady R. and Heymsfield, Ernie, "Structural Health Monitoring and Assessment of Critical Intermodal Transportation Infrastructure Elements," MBTC Annual Advisory Board Meeting – Student Poster Session, October 2009.**
18. Sharp, J. Austin*, Nachtmann, Heather and Pohl, Edward A., "Emergency Response via Inland Waterways," MBTC Annual Advisory Board Meeting – Student Poster Session, November 2008.

Project Progress

Supply Chain Security

The objective of the Supply Chain Security core area is to develop models for resilient, reliable, and sustainable supply chain network design and vulnerability assessment using both reliability- and optimization-based tools and techniques. The concepts of reliability and resilience are relatively new in the supply chain literature. Resiliency is defined as the ability of a system or a set of inter-dependent systems to maintain appropriate performance levels in the face of unplanned events. Sustainability is defined as the ability to efficiently adapt a system or a set of inter-dependent systems to meet changes in performance demands over time in a cost-efficient manner.

Previous research in supply chain management has focused on dealing with demand uncertainties and building "lean" supply chains. While these issues are important, the issue of large scale disruptions affecting supply chains cannot be overlooked. Events this decade such as the 9/11 terrorist attacks, Hurricane Katrina, the 2002 West Coast port closure, and Operations Iraqi Freedom and Enduring Freedom have brought to light the vulnerabilities in current supply chains; in fact, they have motivated the need for new supply chain design tools, models, and techniques.

Supply Chain Security – MBTC DHS 1101

Designing Resilient and Sustainable Supply Chain Networks

Research Team

Name	Role	Department	DHS Funded
Edward A. Pohl, Ph.D.	PI	Industrial Engineering	√
Scott J. Mason, Ph.D.	PI	Industrial Engineering	√
Chase Rainwater, Ph.D.	PI	Industrial Engineering	√
Hugh Medal	Ph.D. Student	Industrial Engineering	√
Behrooz Kamali	Ph.D. Student	Industrial Engineering	√
Huy-Nhiem Nguyen	Ph.D. Student	Industrial Engineering	
Stevenson Sharp	Ph.D. Student	Industrial Engineering	
Willie Montgomery III	M.S. Student	Industrial Engineering	
Chen Wang	M.S Student	Industrial Engineering	
Marcia F.P. Salgado	Visiting Scholar, Brazil	Industrial Engineering	
Brittni King	Undergraduate Student	Industrial Engineering	√
Nick Martin	Undergraduate Student	Industrial Engineering	

Project Period: January 2009 – June 2011

Project Funding: $225,000
FY09: $86,245 BASE
FY10: $101,255 ($63,755 BASE and $37,500 January 2010 Supplement (SUP))
FY11: $37,500 BASE

Research Objectives

This research seeks to develop a fundamental understanding of the inter-dependence within and between critical supply chain infrastructure systems. The impact of this inter-dependence on both the resiliency and sustainability of supply chain systems is quantified, both individually and collectively. This research examines the trade-offs between resource allocation and the efficacy of various types of resources to mitigate supply chain vulnerability, and develops a theoretical foundation upon which analytical methods are constructed and utilized to effectively model, analyze, and improve the resiliency and sustainability of critical supply chain systems. These models would be useful both to emergency response teams and to military and civilian logistics planners during the planning and pre-planning phases of contingency assessment. The objective is to develop solution techniques that are suitable for implementation in decision support tools for contingency planning.

An expanded scope of work for this project was provided in the MBTC Four Year Work Plan, dated January 27, 2010, which was subsequently approved by DHS. The expanded project goals and tasks include:

- Develop an arc-based representation of the supply chain network, with special consideration given to the multiple states in which a particular arc may function in the presence of additional security resources,
- Explore techniques for solving large-scale time-expanded network fortification models,
- Work with DHS S&T and other DHS COE's to develop representative problem instances for a set of specific supply chain commodities, and
- Perform extensive computational testing of our approaches on representative real-life datasets.

Research Progress

During the first eighteen months of funded research (January 2009 to June 2010), progress was made in several areas. A thorough review of the existing literature on supply chain risk and vulnerability is available in the interim report completed in January 2010. This report is being utilized in a manuscript entitled "Analysis of Networks Subject to Disruptions: A Survey." This paper will soon be submitted to a special issue on "Risk Analysis of Critical Infrastructure" in the International Journal of Risk Assessment and Management. The Year 1 effort also focused on exploring multi-modal supply chain networks, resulting in the construction of hypothetical multi-modal models for the southeastern U.S. This effort has culminated in a working manuscript entitled "Fortification of Transportation Networks Subject to Disruptions," where methods to mitigate the risk of transportation networks subject to attack are presented. This research was presented at the 2010 DHS University Programs Summit and a presentation was given at the 2010 Industrial Engineering Research Conference, both by Ph.D. candidate Hugh Medal.

The problem instances have since been refined by focusing on a specific class of commodities in order to assess the impact that the models provide with regard to supply chain risk and resiliency. Leveraging our knowledge of the coal sector, along with the availability of open source GIS transportation data, a case study was developed that focused on the U.S. rail network, as it pertains to the sub-bituminous coal supply chain. This commodity is of interest because few shortage-planning strategies exist, despite the high demand for coal. To allow for a realistic risk analysis exercise, we include vulnerable infrastructure elements such as bridges and tunnels in our model. Currently we are applying our risk analysis and mitigation tools to this scenario.

A preliminary manuscript titled "Analyzing the Tradeoff Between Risk Reduction and Assessment" explores the value of information with regard to risk. Extending existing research, this work assumes imperfect information and allows the decision maker to improve the accuracy

of the information by investing more risk assessment resources. Thus, the decision maker must allocate one pool of resources between risk assessment and risk mitigation in the supply chain.

Changes from the initially approved project: The project scope has been expanded, as noted above.

Budget changes: The budget amount for Year Two increased by $37,500 to allow for the additional scope of work.

Unanticipated problems: none

Supply Chain Security – MBTC DHS 1108

Sustaining Resilient Inland Waterways via Renewable Energy

Research Team

Name	*Role*	*Department*	*DHS Funded*
Heather Nachtmann, Ph.D.	PI	Industrial Engineering	√
Letitia M. Pohl, Ph.D.	PI	Industrial Engineering	√
Priya Aitharaju	M.S. Student	Industrial Engineering	√
Coby Durham	Undergraduate Student	Industrial Engineering	√

Project Period: July 2009 – June 2011

Project Funding: $200,000
FY10: $100,000 Borders & Maritime Security Division (B&M)
FY11: $100,000 B&M (Tentative)

Research Objectives

Inland waterways can play an important role in the Nation's sustainability effort. Water transportation has environmental and economic benefits, existing capacity, and low energy consumption. The broad scope of the project will encompass the twelve thousand miles of commercially-relevant inland waterways that are under the control of the U.S. Army Corps of Engineers (USACE), and more specifically, the over ten thousand miles of inland waterways within the Eighth U.S. Coast Guard (USCG) District.

We will explore how renewable energy sources can be utilized to support inland waterway security and operations. These capabilities could support port security and monitoring in both inland and maritime environments by providing back-up support during unplanned power outages. MBTC is partnering with the National Renewable Energy Laboratory (NREL) to explore the feasibility of renewable energy usage and generation within the Nation's inland waterway system. The following joint research questions will be addressed:

- What are the most critical components with potential renewable energy applications within the Nation's inland waterway system?
- What are the areas for immediate, quick-win application of renewable energy within the identified critical components of the system?
- What is the long-term strategic way forward in implementing renewable energy in the inland waterways?

Research Progress

Through a number of telephone conferences, MBTC, NREL and DHS personnel refined the research goals and partnership responsibilities for this project. This effort resulted in a revised scope of work that is outlined in the MBTC Four Year Work Plan, dated January 27, 2010, and has been approved by DHS.

MBTC has begun the system identification task, which includes (1) identifying critical inland waterway system components, (2) providing an assessment and description of critical components of the inland waterway system as related to maritime security, and (3) identifying appropriate contacts for data collection on these components. Progress to-date includes:

- In the process of developing a system description of the inland waterway system within the Eighth District, including the rivers, states, major inland ports, major bridges, dams and locks and critical infrastructure on the rivers.
- In the process of developing an understanding of the maritime security program currently in-place for inland waterways. Progress has been made by reviewing key government documents that indicate potential threats, national priorities and goals, responsible agencies and maritime security initiatives, and by interfacing with regional inland waterways stakeholders, including USCG and USACE.
- MBTC researchers met with USCG personnel from the Lower Mississippi Sector, Memphis, TN, during the Arkansas Area Maritime Security (AMS) Committee meetings in January and April 2010, and participated in a tabletop security incident exercise. Information-gathering has also taken place during site visits to public and private ports on the Arkansas River, to the Trimble Lock and Dam on the Arkansas River, and to the Bonneville Lock and Dam on the Columbia River.
- In the process of identifying key Points of Contact within the USCG and USACE on the national level, through our regional contacts.

Changes from the initially approved project: The scope of work for this project was revised in January 2010, as indicated above.

Budget changes: The anticipated expenditures for FY10 were not required because there were no Graduate Assistants available to work on this project in the Spring and Summer of 2010. We are making progress with the PIs.

Unanticipated problems: none

Transportation Infrastructure Protection

The objectives of the Transportation Infrastructure Projection core area are to develop monitoring systems and advanced materials to enhance the protection and resilience of transportation infrastructure elements. It is important to note that transportation infrastructure elements represent "constructed systems" – therefore, the characterization and assessment of these systems under normal operating conditions is subject to significant uncertainty. This uncertainty associated with constructed systems is distinct from their "manufactured systems" counterparts which arises from the fabricated/constructed nature of these systems (i.e. variability in welded and bolted connections, composite construction, etc.), the use of different materials and variability in material properties (i.e. steel, ready-mixed concrete, etc.), the typically large physical scale of these systems, local variations in the site conditions and subsurface characteristics of sites, exposure to uncertain or unknown operating conditions (i.e. service loads and their history), environmental conditions, and demands for extremely long service lives. The behavior and performance of any constructed system is ultimately influenced in large part by these factors.

Transportation Infrastructure Protection – MBTC DHS 1104

Structural Health Monitoring and Assessment of Critical Intermodal Transportation Infrastructure Elements

Research Team

Name	Role	Department	DHS Funded
Kirk Grimmelsman, Ph.D.	PI	Civil Engineering	√
Brady R. Cox, Ph.D.	PI	Civil Engineering	√
Ernie Heymsfield, Ph.D., P.E.	PI	Civil Engineering	√
Alex Font	M.S. Student	Civil Engineering	√
Jason Herrman	M.S. Student	Civil Engineering	√
Minghua Qiu	M.S. Student	Civil Engineering	√
Jeremy Rawn	M.S. Student	Civil Engineering	
Christian McGuire	Undergraduate Student	Civil Engineering	
Haley Moore	Undergraduate Student	Civil Engineering	
Javier Torres Goitia	Undergraduate Student	Civil Engineering	

Project Period: January 2009 – June 2011

Project Funding: $224,914
FY09: $85,779 BASE
FY10: $101,635 ($64,135 BASE and $37,500 SUP)
FY11: $37,500 BASE

Research Objectives

Presently, the safety and serviceability of bridge structures are assessed and evaluated using time consuming and cumbersome visual inspection methods that require an engineer to be physically present at the structure. Remote structural health monitoring could provide rapid condition evaluations of these structures, which would be particularly critical following hazard events, and thereby enable more rapid and reliable emergency response and recovery operations.

The main objective of this research is to devise and evaluate an optimal method for rapidly and quantitatively characterizing the safety and serviceability of in-service bridges. The focus of the research is on using dynamic testing methods for obtaining a global level characterization of a structure at any instant during its lifecycle as this approach appears to be most feasible and efficient. A related objective of the project is to develop and utilize laboratory models as demonstration platforms for educating and training transportation professionals and managers in the effective use and analysis of the enabling experimental, analytical and information technologies necessary to quantitatively characterize in-service bridges.

The research will provide DHS with practical experimental methods and procedures that can be implemented for improving the resiliency of transportation infrastructure systems. The research outcomes will be particularly helpful for end users such as FEMA, state highway transportation agencies, and other agencies that coordinate and plan emergency response and recovery operations which rely on transportation infrastructure systems.

An expanded scope of work for this project was provided in the MBTC Four Year Work Plan, dated January 27, 2010, which was subsequently approved by DHS. The expanded project scope includes extending the results obtained from the laboratory studies to field trials with in-service bridges. Specifically, the research team will instrument and test at least two in-service highway bridges to evaluate the feasibility of structural health monitoring using dynamic characterization and evaluation methods developed with the laboratory model. The field testing program will focus on identifying the minimum requirements for developing a baseline characterization of a bridge's structural safety and devising the optimal strategies and methods for using the baseline characterization for follow-up assessments, especially after hazard events.

Research Progress

During the first eighteen months of funded research (January 2009 – June 2010), several small-scale physical models incorporating increasing degrees of structural complexity and uncertainty have been constructed in the laboratory. These physical models have been instrumented using an array of off-the-shelf sensors including strain gages, accelerometers, and linear displacement sensors. The structures have been characterized for an initially undamaged condition using both analytical and experimental methods. The analytical characterizations provide a baseline for evaluating and corroborating the experimental characterization results and are obtained from numerical and finite element models of the structures. The analytical characterizations are not subject to the same uncertainty that is present from experimental characterizations.

The models have been experimentally characterized at the global level using static and dynamic testing methods. For the static testing, known loads were placed on the models in various configurations and the corresponding displacements and strains at key locations were measured. A static flexibility matrix was computed for the structures from the measured displacements. The static test measurements provide one means for linking the analytical characterizations to the actual structure. It should be noted that a global characterization by static testing is less practical for applications to in-service bridge structures.

The structures are also being experimentally characterized in a global sense using several different dynamic testing methods. The structures have been tested using classical modal testing in which controlled dynamic excitation is applied to the structure using instrumented impact hammers (impulsive excitation) or linear mass shakers (harmonic excitation). These methods applied using single-input multiple-output (SIMO) and multiple-input, multiple output (MIMO)

testing configurations. The dynamic properties of the structure (natural frequencies, modal vectors, damping ratios, and modal scaling) were extracted from the measurements and provide a quantitative link to the analytical characterization results. Modal flexibility was also extracted from the vibration measurements to provide an additional means for comparing the analytical and experimental characterization. Ambient vibration testing has also been conducted for the models. In this method, the normal operational and environmental loads provide unmeasured and uncontrolled dynamic excitation to the structure. Output-only methods are used with these measurements to extract the dynamic properties of the structure. The global characterizations of the structures obtained from these different dynamic testing approaches are being evaluated to devise an optimal strategy (test design, implementation, and analysis) for using dynamic testing methods to rapidly evaluate the safety and serviceability of in-service bridge structure.

One of the physical models will be subject to a series of controlled damage scenarios, and the effectiveness and utility of the dynamic characterization strategies will be evaluated for each scenario. This work is currently in-progress. In the final stage of the project, the optimized dynamic characterization strategies will be tested and evaluated in the field with an in-service bridge structure.

Changes from the initially approved project: The project scope has been expanded, as noted above.

Budget changes: The budget amount for Year Two increased by $37,500 to allow for the additional scope of work.

Unanticipated problems: none

Transportation Emergency Preparedness

The objective of this emerging area is to increase the nation's ability to prepare and respond to emergency situations when responders and citizens are dependent upon transportation. Sound and robust emergency preparedness plans and general emergency education will reduce the vulnerability of transportation systems to terrorist attacks as well as more common crises and assist in the efficiency of a response. Knowledge about and guidance for developing transportation emergency preparedness plans are needed. This emerging program area seeks to improve emergency response operations and planning dependent on transportation as well as provide relevant education products for increasing public awareness and improving communication during and after an event.

Simulating Transportation Modes in Large-Scale Evacuation Scenarios

Research Team

Name	Role	Department	DHS Funded
Manuel D. Rossetti, Ph.D., P.E.	PI	Industrial Engineering	√
Qingbiao Ni	M.S. Student	Industrial Engineering	√
Tanvir Sattar	Undergraduate Student	Industrial Engineering	√
Huan Guo	Undergraduate Student	Industrial Engineering	√
Coby Durham	Undergraduate Student	Industrial Engineering	√

Project Period: January 2009 – December 2009

Project Funding: $50,000
FY09: $50,000 PLUS-UP (100% of tasks completed on 12/31/09)

Research Objectives

The planning of large-scale evacuation has become an important area of emphasis for emergency planners. Large-scale evacuation involves the movement of people and resources both to escape the disaster and to respond to the disaster. Such disasters include natural and man-made events (e.g. earthquakes, tsunami, wildfire, radioactive release, and terrorist attacks). In areas prone to emergency events, such as wildfire interfaces, canyon communities, large shopping malls or islands offshore, the preplanning for evacuation is necessary and crucial. For instance, more than twenty people were killed in the Oakland Hill wildfire in 1991, where most of them lost their lives within half an hour after the fire.

The modeling of mid to large range evacuations (e.g. neighborhoods, parking areas, large building structures, commercial districts, etc.) remains an open area of research due to the fact that more detail as to the vehicle and pedestrian movement is required. Previous evacuation modeling assumes that all the vehicles or pedestrians will be released directly into the traffic flows, without considering the detailed movements within parking structures (e.g. vehicles backing out of parking spots or driveways, and the interaction with pedestrians). These assumptions are made because of the computational burden of this analysis and because adequate modeling of these processes has not yet occurred. It should be clear that the detailed modeling of how the vehicles get into the road network is necessary because of the potential effects that this time can have on emergency plans.

The overall goal of this exploratory study is to investigate methods for simulating large-scale evacuation scenarios caused by emergency events such as terrorist attacks and disasters that threaten the safety of the public. The objectives include:

1. Understand the state of the art for modeling large scale evacuations, especially via simulation, and
2. Develop, apply, test, and validate the effectiveness of simulation models on realistic evacuation scenarios, with special emphasis on multiple movement modes (e.g., pedestrians and vehicles).

The purpose of the evacuation scenario is two-fold. First, the evacuation scenario provides a concrete example of the modeling and use of the software. Secondly, the scenario provides a context for experimenting with different evacuation strategies involving multiple modes of transport. For simulating evacuations, the main questions being asked of the simulation model are: "Can the area be evacuated within a prescribed time? Where do the hold-ups in the flow of people occur? And where are the likely areas for a crowd surge to produce unacceptable or dangerous bottlenecks?" The main challenges in simulating crowds and traffic during an evacuation include providing a realistic method of collision avoidance, a strong connection with the environment, and an ability to properly collect numerical and statistical results.

Research Progress

One year of funded research (January 2009 – December 2009) resulted in the following completed tasks:

- A state of the art review of commercial and government sponsored micro-simulation tools for evacuation modeling was completed and summarized in report form. The strengths and weaknesses of the current software models were described. Areas for improvement to enhance evacuation modeling were identified.
- A literature review of previous and current evacuation models and methodologies was completed and summarized in report form. The literature review identifies the research areas that need attention.
- A comprehensive methodology for performing an evacuation simulation study was constructed, described, and tested. The methodology can be used by other researchers and governmental bodies to improve the likelihood of success of evacuation studies.
- A detailed Paramics simulation model of the evacuation of a commercial shopping district was constructed, verified, validated, and utilized to make detailed recommendations for improving the evacuation of the area under study. This model is available for future use and analysis. The methods used to model the area were documented so that other agencies can more readily perform similar studies.
- Eight different evacuation scenarios were constructed and analyzed in terms of the risk and cost trade-offs for the effected population. An optimization evacuation assignment

model was created and cost models for the scenarios developed. A specific scenario involving the optimized evacuation assignments and emergency responder traffic interdiction was recommended.

- Established contact with City of Fayetteville staff concerning traffic volume and road characteristic data, and collaborated with the Center for Advanced Spatial Technologies, University of Arkansas, who provided data related to the geographic area within the case study.
- Documented study results in a final project report, dated January 2010.

Changes from the initially approved project: none

Budget changes: none

Unanticipated problems: none

Transportation Emergency Preparedness – MBTC DHS 1106 (MBTC DOT 3008)

Emergency Response via Inland Waterways

Research Team

Name	Role	Department	DHS Funded
Heather Nachtmann, Ph.D.	PI	Industrial Engineering	√
Edward A. Pohl, Ph.D.	PI	Industrial Engineering	√
Leily Farrokhvar	Ph.D. Student	Industrial Engineering	√
Adam Keeley	M.S. Student	Industrial Engineering	
John Austin Sharp	Undergraduate Student	Industrial Engineering	
Mark Kilgore	Undergraduate Student	Industrial Engineering	

Project Period: July 2008 – December 2010

Project Funding: $100,568
FY09: $60,568, funded by U.S. Department of Transportation
FY10: $40,000 BASE

Research Objectives

Each catastrophic disaster has its own damage characteristics and emergency response requirements. Emergency planning involving transportation resources requires thorough contingency planning in case of route destruction or excessive equipment demand. Incorporating multiple transportation modes into emergency operations plans is an obvious contingency action. Inland waterway transportation has the potential to provide emergency response services to a large geographic area of the United States. Our research goal is to quantify the potential of communities to benefit from inland waterway emergency response through the development of a Waterway Emergency Services index and to provide decision support to help emergency planners design an inland waterway-based emergency response system that will enhance the effectiveness of their emergency operations plans.

Our previous research (during FY09) investigated the feasibility of using inland waterway transportation to provide emergency medical response to the state of Arkansas following catastrophic events. A Waterway Emergency Medical Service (WEMS) index was developed to assist emergency planners in evaluating the potential of incorporating emergency medical response via inland waterways into their emergency operations planning.

In response to DHS interest in this topic, the project has been extended and will be funded with Year 2 BASE funding. An expanded scope of work for this project was provided in the MBTC Four Year Work Plan, dated January 27, 2010, which was subsequently approved by DHS. We seek to expand from strictly medical emergency support to general emergency support by

developing a methodology to determine how many barges are required to provide a desired level of emergency response and where the barges should be initiated to provide maximum emergency response coverage and to expand our case study region. The primary research objectives are to:

- Develop a waterway emergency service index to measure the potential of communities to benefit from general inland waterway emergency response,
- Provide decision support to emergency planners by developing a methodology to determine how many barges are required to provide a desired level of emergency response,
- Provide emergency planning decision support by developing a methodology to best locate available barges to provide maximum waterway-based emergency response coverage for communities with the potential to benefit from inland waterway emergency support, and
- Expand our case study region to cover the lower Mississippi region.

This project is intended to support FEMA's All-Hazard approach to emergency operations planning by providing decision support for state and county emergency planners. The project outcomes will enable emergency planners to evaluate the feasibility of using the inland waterways as a contingency mode of transportation in their emergency response operations.

Research Progress

- Expanding the Scope to General Emergency Services
    - We are revising the factors that form the WEMS Index to evaluate the potential of counties in the United States to benefit from general inland waterways emergency support. This is being done through the conduct of literature review and review of emergency operations plans.
- Designing the Optimal Inland Waterway Emergency Response System
    - We have formulated two optimization models. The first model maximizes emergency response coverage of counties that have potential to benefit from waterway-based emergency response as measured by our developed index. The second model minimizes the number of barges required to provide a desired level of coverage. Initial testing of these models on our case study data has been conducted.
- Expanding the Case Study beyond the State of Arkansas
    - We have identified a set of counties along the lower Mississippi River region to include the states of Arkansas, Tennessee, Mississippi, and Louisiana in our expanded case study. Data for the original WEMS index factors have been collected for these four states.

Changes from the initially approved project: The scope of work for the second phase of the project was approved by DHS, as noted above.

Budget changes: Funding for the extension to the project will come from the Year 2 BASE funding.

Unanticipated problems: none

Transportation Security Data Integration

The objective of the emerging MBTC Transportation Security Data Integration area is to increase the efficiency and effectiveness of the transportation security data supply chain in order to advance threat and risk mitigation.

Transportation Security Data Integration – MBTC DHS 1105

Information Enhancement among Aviation Security Partners

Research Team

Name	Role	Department	DHS Funded
Justin R. Chimka, Ph.D.	PI	Industrial Engineering	√
Qin Hong	Ph.D. Student	Industrial Engineering	√
Jing Wu	Ph.D. Student	Industrial Engineering	√
Ryan Black	Undergraduate Student	Industrial Engineering	√
Maci Dickson	Undergraduate Student	Industrial Engineering	√
Jaclyn Gilmore	Undergraduate Student	Industrial Engineering	√
Morgan Ulesich	Undergraduate Student	Industrial Engineering	

Project Period: January 2009 – December 2010

Project Funding: $130,237
FY09: $49,990 BASE
FY10: $80,247 BASE

Research Objectives

The "Top Ten Challenges Facing the Next Secretary of Homeland Security" include the following: Continue to improve intelligence and information sharing (Homeland Security Advisory Council, September 11, 2008). The objective of this project is to adopt and/or develop tools to derive knowledge specific of potential terrorist attacks against general aviation (GA) by integrating a variety of data formats, and transforming raw data into useful and understandable information that enables productive and efficient analysis. The following exploratory activities were accomplished during the first year of the project:

1. Consider what is relevant about commercial examples to GA, and make recommendations for improved intelligence and information sharing which originates at GA landing facilities.
2. Reference the Airport Characteristics Measurement Tool (TSA Security Guidelines for GA Airports, Information Publication A-001, May 2004) to develop reporting standards, and analyze information that would come from reports.
3. Estimate and/or identify models of usual GA activity that could be used to detect potential attacks.

This exploratory project was selected by DHS to receive further funding. An expanded scope of work was provided in the MBTC Four Year Work Plan, dated January 27, 2010, which was

subsequently approved by DHS. Additional activities would extend model-based control of GA to the most appropriate of other contexts chosen among highway, maritime transportation systems, mass transit, pipeline systems, and rail. The expanded project goals and tasks include:

1. Extend the philosophy that if we can estimate good models of usual activity associated with transportation, then we can effectively monitor operations, and detect unusual activity that may indicate a security threat.
2. Identify the other (in addition to GA) contexts that make the most sense physically for extension of lessons learned from GA. These would seem to be the ones to be most likely affected by unscheduled activity.
3. Explore the concept of a simultaneous, multi-context monitor that would integrate not only information from disparate sources within mode, but also information across modes to enhance transportation security.

While the University Affiliate Centers to the Institute for Discrete Sciences (IDS) were established by DHS for advanced methods research in information analysis, IDS activities focus on common author identification, influenza surveillance and text analysis.

In the GA domain TSA and the Aircraft Owners and Pilots Association have implemented an Airport Watch Program using pilots for reporting suspicious activity. Also TSA and the National Response Center (U.S. Coast Guard) have implemented the GA Hotline for airport operators, technicians and pilots to report suspicious activity. However there are not more formal information reporting and sharing systems available to GA. In order to design such effective systems, and make GA a more equal partner in homeland security, the following would seem to be important exploratory activities.

Research Progress

During the first eighteen months of funded research (January 2009 – July 2010), the following progress was made:

- Collected useful data relevant to GA security
- Estimated useful models that will facilitate recommendations and methods for Homeland Security
- Researched statistical model based control of GA operations, and practical recommendations for monitoring and detection of unusual activity
- Identified other contexts for extension and data collected for analysis and further proof of concept.

The new data we have chosen to analyze are U.S. Border Crossings reported by the Bureau of Transportation Statistics. We have begun to estimate statistical models of crossings as functions

of available predictors including state, port, mode (e.g., truck, train, bus personal vehicles, pedestrians), year and month. We expect to communicate our methods and results about US Border Crossings in much the way we are drafting a manuscript about the GA operations analysis.

We have begun discussion about proposed methods to integrate transportation modes associated with US Border Crossings (and perhaps GA operations) with multivariate monitoring and detection methods. Among them are some regression based in order to integrate the statistical modeling and lessons learned from the project thus far.

Changes from the initially approved project: The project scope has been expanded, as noted above.

Budget changes: Funding for the extension to the project will come from the Year 2 BASE funding.

Unanticipated problems: none

Transportation Security Data Integration – MBTC DHS 1103

Automated Real-Time Object Detection and Recognition on Transportation Facilities

Research Team

Name	Role	Department	DHS Funded
Kelvin CP Wang, Ph.D., P.E.	PI	Civil Engineering	√
Zhiqiong Hong	Ph.D. Student	Civil Engineering	
Emerson John	M.S. Student	Civil Engineering	√
Ryan Reynolds	Undergraduate Student	Civil Engineering	√
Mark Upchurch	Undergraduate Student	Civil Engineering	√

Project Period: January 2009 – December 2009

Project Funding: $50,003
FY09: $50,003 BASE (100% of tasks completed on 12/31/09)

Research Objectives

Rapid inspection of critical transportation infrastructure elements is essential to the efficient operation of the nation's transportation systems. This is particularly crucial in the period immediately following a catastrophic event, i.e. earthquake, terrorist attack, etc. Rapid response and inspection of transportation infrastructure elements is vital to ensure routes into and out of affected areas are safe for emergency traffic and/or evacuation of persons outside danger zones. The primary objective of this research is to develop a fully automated, real-time, high definition digital video inspection system suitable for implementation on a vehicle-based platform operating at near-highway speeds. Such a system would allow security personnel to rapidly inspect and assess critical infrastructure elements such as bridges, tunnels, rail, and highway surfaces with respect to safety and suitability for use after a catastrophic event.

Research Progress

One year of funded research (January 2009 – December 2009) resulted in the following completed tasks:

- Conducted a comprehensive literature review of available technologies related to data collection and visualization of infrastructure imagery in high-definition video sequences.
- Purchased equipment and built a high-definition visualization laboratory facility to serve as the primary platform to support subsequent efforts related to inspection/recognition and assessment algorithms for infrastructure elements.

- A working level hardware system housed in the Digital Highway Data Vehicle (DHDV) has been developed and initial versions of calibration and processing software have been tested.
- The accuracy of the developed stereo vision system was evaluated via a case study by comparing them to locations measured by a handheld precision GPS receiver. This study concludes that the proposed stereo vision based automated road sign inventory system has achieved acceptable accuracy.
- The results are documented in a final project report, dated February 2010.

Changes from the initially approved project: none

Budget changes: Funds originally budgeted for student tuition were reallocated to equipment purchase. This change was approved by DHS in September 2009. Total budget amount was unchanged.

Unanticipated problems: none

EDUCATION

University-based research programs, by necessity, must have strong educational underpinning for long-term success. Faculty and staff researchers rely heavily on undergraduate and graduate students to fully achieve the goals of a research program. These students, in turn, must be provided the solid educational experience necessary to become significant contributors to the research effort. It is vital that the institution have in place, or be committed to develop, those courses which will serve the program. In addition to the research program, MBTC is committed to workforce development. MBTC's vision includes *"…producing transportation security professionals capable of leading public and private sector efforts…"* which necessitates a strong cross- and multi-disciplinary educational program.

Research Assistants

During Years One and Two, there were eighteen graduate students and seventeen undergraduate students engaged in homeland security related research within MBTC (see Table 3). Of these 35 students, eleven are women, two are African American and one is Hispanic. As indicated, some of these students were funded by NTSCOE, and some were funded from other sources. The students who were actively engaged in NTSCOE research during Year Two are indicated in bold in Table 3.

NTSCOE-Related Courses

The primary providers of the MBTC educational activities include the Department of Civil Engineering and the Department of Industrial Engineering. The coursework from these two departments, along with others, support two of the College of Engineering key programmatic activities (Transportation, Logistics and Infrastructure; and Homeland Security) to offer students both technical and domain training in transportation security.

The Four Year Work Plan, dated January 27, 2010, identifies 26 NTSCOE-related courses provided at the University of Arkansas. During Years One and Two, 18 of these 26 courses were offered, with a total enrollment of 194 graduate students and 214 undergraduate students, as shown in Table 4.

Curriculum Development

During Year One, one new security-related course was developed: INEG 4383/ 5383 Risk Analysis in Transportation and Logistics. The course development was provided by Dr. Edward Pohl, and funded by MBTC under project MBTC DOT 2061. The new course, offered in the Spring 2009 semester, presents engineering students with the fundamentals of modeling risk, analyzing risk, and managing risk in a variety of industrial and government decision making settings, with a focus on the transportation and logistics problem domain.

Table 3. Students Involved in NTSCOE Research, Years One and Two

	Name	Position	Department	DHS Funded
Graduate Students				
1	**Priya Aitharaju**	**M.S. Student**	**Industrial Engineering**	√
2	**Leily Farrokhvar**	**Ph.D. Student**	**Industrial Engineering**	√
3	**Marcia F.P. Salgado**	**Ph.D. Student, Brazil**	**Industrial Engineering**	
4	**Alex Font**	**M.S. Student**	**Civil Engineering**	√
5	**Jason Herrman**	**M.S. Student**	**Civil Engineering**	√
6	**Qin Hong**	**Ph.D. Student**	**Industrial Engineering**	√
7	**Zhiqiong Hou**	**Ph.D. Student**	**Civil Engineering**	
8	Emerson John	M.S. Student	Civil Engineering	√
9	Behrooz Kamali	Ph.D. Student	Industrial Engineering	√
10	Adam Keeley	M.S. Student	Industrial Engineering	
11	**Hugh Medal**	**Ph.D. Student**	**Industrial Engineering**	√
12	Willie Montgomery III	M.S. Student	Industrial Engineering	
13	**Huy-Nhiem Nguyen**	**Ph.D. Student**	**Industrial Engineering**	
14	**Qingbiao Ni**	**M.S. Student**	**Industrial Engineering**	√
15	**Minghua Qiu**	**M.S. Student**	**Civil Engineering**	√
16	Jeremy Rawn	M.S. Student	Civil Engineering	
17	**Stevenson Sharp**	**Ph.D. Student**	**Industrial Engineering**	
18	**Jing Wu**	**Ph.D. Student**	**Industrial Engineering**	√
Undergraduate Students				
1	**Ryan Black**	**Undergraduate Student**	**Industrial Engineering**	√
2	**Maci Dickson**	**Undergraduate Student**	**Industrial Engineering**	√
3	**Coby Durham**	**Undergraduate Student**	**Industrial Engineering**	√
4	**Jaclyn Gilmore**	**Undergraduate Student**	**Industrial Engineering**	√
5	**Javier Torres Goitia**	**Undergraduate Student**	**Civil Engineering**	
6	Huan Guo	Undergraduate Student	Industrial Engineering	√
7	Mark Kilgore	Undergraduate Student	Industrial Engineering	
8	**Brittni King**	**Undergraduate Student**	**Industrial Engineering**	√
9	**Christian McGuire**	**Undergraduate Student**	**Civil Engineering**	
10	**Haley Moore**	**Undergraduate Student**	**Civil Engineering**	
11	**Ryan Reynolds**	**Undergraduate Student**	**Civil Engineering**	√
12	Javier Torres-Goitia	Undergraduate Student	Civil Engineering	
13	**Tanvir Sattar**	**Undergraduate Student**	**Industrial Engineering**	√
14	John Austin Sharp	Undergraduate Student	Industrial Engineering	
15	**Kendall Tran**	**Undergraduate Student**	**Industrial Engineering**	√
16	Morgan Ulesich	Undergraduate Student	Industrial Engineering	
17	Mark Upchurch	Undergraduate Student	Civil Engineering	√

Table 4. NTSCOE-Related Courses Taught During Years One and Two At the University of Arkansas

Course Number	Course Title	Undergraduate Students	Graduate Students
Technical			
CVEG 5463	Transportation Modeling		7
INEG 4383/ 5383	Risk Analysis in Transportation and Logistics	4	19
ELEG 5653	Artificial Neural Networks		16
INEG 4623	Introduction to Simulation	41	
INEG 5313	Applied Probability/Stochastic Processes		16
INEG 5333	Design of Industrial Experiments		8
INEG 5613	Optimization Theory I		31
INEG 5643	Optimization Theory II		16
INEG 5823	Systems Simulation I		6
INEG 6823	Systems Simulation II		5
Domain			
CVEG 4433	Transportation Pavements and Materials	100	3
CVEG 5413	Transportation and Land Development		5
CVEG 5473	Transportation System Characteristics		6
CVEG 5483	Transportation Management Systems		4
TLOG 5653	Global Logistics Strategy		31
TLOG 5673	Transportation and Logistics Modeling		26
INEG 4433	Systems Engineering & Management	49	2
MEEG 5263	Introduction to Micro Electro Mechanical Systems		13
Totals		**194**	**214**

During Year Two, two courses were modified to include security-related curriculum: INEG 5393, Applied Regression Analysis for Engineers, and INEG 3333, Industrial Statistics. In both cases, the goals of and techniques used in MBTC DHS 1105 were discussed and a homeland security related paper was studied.

OUTREACH

MBTC's outreach program involves sharing our research results through conference and seminar presentations; collaborating with other universities and DHS Centers of Excellence on joint research and research proposals; interfacing with industry and with local, state and federal government agencies to ensure the applicability of our research to the nation's transportation needs; and interacting with the community through K-12 programs that introduce children to careers in transportation. These outreach efforts have been successful in the past because MBTC leadership and faculty researchers are actively involved in academic and professional associations, and through previous projects have formed partnerships with transportation industry and government leaders.

Throughout Years One and Two, MBTC researchers have made efforts to identify how to better meet our nation's security needs by interacting with DHS personnel, federal, state and local government agencies, and collaborating with researchers at other universities and DHS Centers of Excellence. These collaborative activities are summarized in Table 5.

During Years One and Two, MBTC researchers have made a concerted effort to collaborate with universities within the NTSCOE and with other DHS COEs. In response to the NTSCOE Competitive FOAs, MBTC has participated in a number of collaborative proposals with other NTSCOE institutions:

- Year 1
    - *Rural Infrastructure Protection and Risk Assessment Plan (RIPRAP),* with Tougaloo College
    - *Development of an Interactive Petrochemical Incident Location System (PILS),* with Texas Southern University (lead) **(funded)**
- Year 2
    - *Supporting Secure and Resilient Inland Waterways*, with Rutgers University
    - *Southern Regional Surface Transportation Security Education and Training Center*, with Tougaloo College (lead), Texas Southern University and Long Island University
    - *A Modeling and Analysis Framework for Threat, Vulnerability, and Consequence Assessment of Surface Transportation Systems*, with University of Connecticut and Mineta Transportation Institute
    - *Hybrid Analysis Framework with Integrated Sensing and Control: Towards Resilient and Sustainable Bridge Structures under All-hazards*, with University of Connecticut (lead)

Table 5. External Collaboration and Interaction with Government Agencies

Name	Title	Organization
Jeanne Lin	Deputy Director, Science & Technology Directorate	Department of Homeland Security
K.C. Crowley	Protective Security Advisor	Department of Homeland Security, Little Rock, AR
Jerry Henderson Kevin Styron	Federal Security Director Customer Service Manager	Transportation Security Administration (TSA), Little Rock, AR
Mike Gardiner Philip Boruszewski	Captain of the Port Contingency Operations Policy and Planning	U.S. Coast Guard, Lower Mississippi District, Memphis, TN
Gary Henderson	Maritime Security Specialist	U.S. Coast Guard, Eighth District, New Orleans, LA
Randy Hathaway, Ph.D., P.E. Glenn Proffitt Brad Shoemaker Conrad Miller	Deputy District Engineer Chief of Navigation Navigation Hydropower	U.S. Army Corps of Engineers, Little Rock District
Keith Garrison	Executive Director	Arkansas Waterways Commission
David Bertelin	Law Enforcement Coordinator	Arkansas Department of Emergency Management
Kay Chisholm	Managing Editor, *International Journal of Applied Aviation Studies*.	Federal Aviation Administration
Jeff Coles	Transportation Division	City of Fayetteville, AR
Christina Scarlat	Research Assistant	Center for Advanced Spatial Technologies, University of Arkansas
Dr. Pat Driscoll	Professor of Systems Engineering	United States Military Academy
Andrea Watson Alicen Kandt	Project Leader Senior Mechanical Engineer	National Renewable Energy Laboratory
Dr. Chip White Dr. Alan Erera	Professor of Industrial and Systems Engineering, NCFPD System Strategies Theme Leader Associate Professor of Industrial and Systems Engineering	Georgia Institute of Technology, partner in National Center for Food Protection and Defense (NCFPD)
Dr. Jose′ Ramirez-Marquez	Associate Professor	Stevens Institute of Technology, National Center for Secure & Resilient Maritime Commerce

- Year 3
    - *Supporting Secure and Resilient Inland Waterways*, with Rutgers University **(funded)**
    - *Mitigating Dynamic Risk in Multi-Modal Perishable Commodity Supply Chain*, with the National Center for Food Protection and Defense (Georgia Tech) **(funded)**

Requests for Assistance from DHS

1. Dr. Heather Nachtmann was contacted by Ms. Jeanne Lin at DHS S&T to develop a proposal for renewable energy in inland waterways, which was subsequently funded in July 2009 by the Borders and Maritime Security Division.
2. MBTC responded to a request by DHS for the NTSCOE to be a Transportation Security resource for the 2009 FIRST LEGO® League Challenge. The theme of the challenge was "Smart Move – Transforming Transportation." MBTC developed a kid-friendly website designed to educate young people on transportation security and its importance. The link to the new website was advertised on the FIRST LEGO® League website (starting September 2009) as a resource for the over 100,000 international participants, and can be found at http://fll.mackblackwell.org/Transportation_Security_Home.html.
3. MBTC was invited by the U.S. Coast Guard, Lower Mississippi Sector, to provide a representative to the Arkansas Area Maritime Security (AMS) Committee. The establishment of AMS Committees is mandated by the Maritime Transportation Security Act of 2002. The AMS Committees are formed and directed by the Coast Guard Captain of the Port for each zone, and are tasked with identifying critical port infrastructure and operations, identifying risks, and determining mitigation strategies and implementation methods.

Requests for Assistance from Federal, State and Local Government

Keith Garrison, Executive Director of the Arkansas Waterways Commission requested that MBTC consider doing an economic impact study on the Arkansas Waterways. A similar study was done by MBTC researchers in 2002, but is now outdated. In response, a research proposal on the economics of Arkansas waterways and the impact of potential disruptions has been developed.

Interaction with the Community

MBTC was a sponsor of the Arkansas regional tournament for the 2009 FIRST LEGO® League Challenge, which was held in Mountain Home, AR, on December 12, 2009. The theme of the challenge was "Smart Move – Transforming Transportation," and was open to 9-14 year olds. Drs. Tish Pohl and Chase Rainwater represented MBTC as tournament judges. The Arkansas tournament organization honored MBTC's sponsorship by creating an MBTC Special

Recognition Award to be presented to the team whose research best represented the center's mission. The winning team, "High Flyers," was from Batesville, AR. Their research project focused on the security of the bridge that spans the White River and connects Batesville and Southside. The team was concerned that in the event of a natural disaster or terrorist event, the loss of the bridge would create a dangerous situation for the community by impeding emergency evacuation and movement of emergency personnel between the two communities. They investigated several alternative solutions and proposed the purchase of a pontoon bridge to be used during emergency situations.

ORGANIZATION, MANAGEMENT and PARTNERS

MBTC has been a nationally recognized transportation research and education center since 1991 when it was authorized by the Intermodal Surface Transportation Efficiency Act. The center is one of seven charter members of the DHS NTSCOE. Its fundamental assets include established procedures for research solicitation, evaluation and dissemination, strong educational program development and state of the art professional training programs through our *Center for Training Transportation Professionals* (CTTP). MBTC has established relationships with all critical transportation security stakeholders including federal, state and local government agencies, universities and colleges, minority-serving institutions, industry partners, and professional associations.

The administrative team of MBTC spearheads the effort to plan, establish, and execute the transportation security mission of the center. Figure 3 shows key MBTC administrative personnel. Dr. Kevin D. Hall, Principal Investigator and Executive Director, oversees the effort. Dr. Heather Nachtmann, MBTC Director, leads all planning processes and provides the bulk of the day-to-day administration of the program. Dr. Letitia Pohl, Assistant Director of MBTC, provides managerial support. Dr. Stacy Williams is the director of CTTP. Administrative and financial planning support is provided by MBTC staff.

In addition to the MBTC staff, the Center also benefits from oversight and input from its Executive Committee (Department Heads of Civil Engineering and Industrial Engineering, Chaired Professor in Transportation Marketing and Logistics, Vice-Chancellor for Research/Dean of the Graduate School), Professional Advisory Board and Academic Advisory Board. The 15-member Professional Advisory Board meets annually to receive updates on Center activities and provide strategic direction for Center programs. All education and training efforts sponsored by the Center are reviewed and guided by the five-member Academic Advisory Board.

MBTC also enjoys strong relationships with other research centers located at the University of Arkansas. To date, MBTC has collaborated with on-campus centers which include the Center for Innovation in Healthcare Logistics (CIHL), the Center for Advanced Spatial Technology (CAST), the Center for Engineering Distribution and Logistics (CELDi), and the Radio Frequency Identification (RFID) Center.

MBTC emphasizes collaboration with minority-serving institutions, building on a successful research partnership with the University of Arkansas at Pine Bluff (a historically black university). The NTSCOE offers prime opportunities for collaboration with member institutions including Tougaloo College and Texas Southern University.

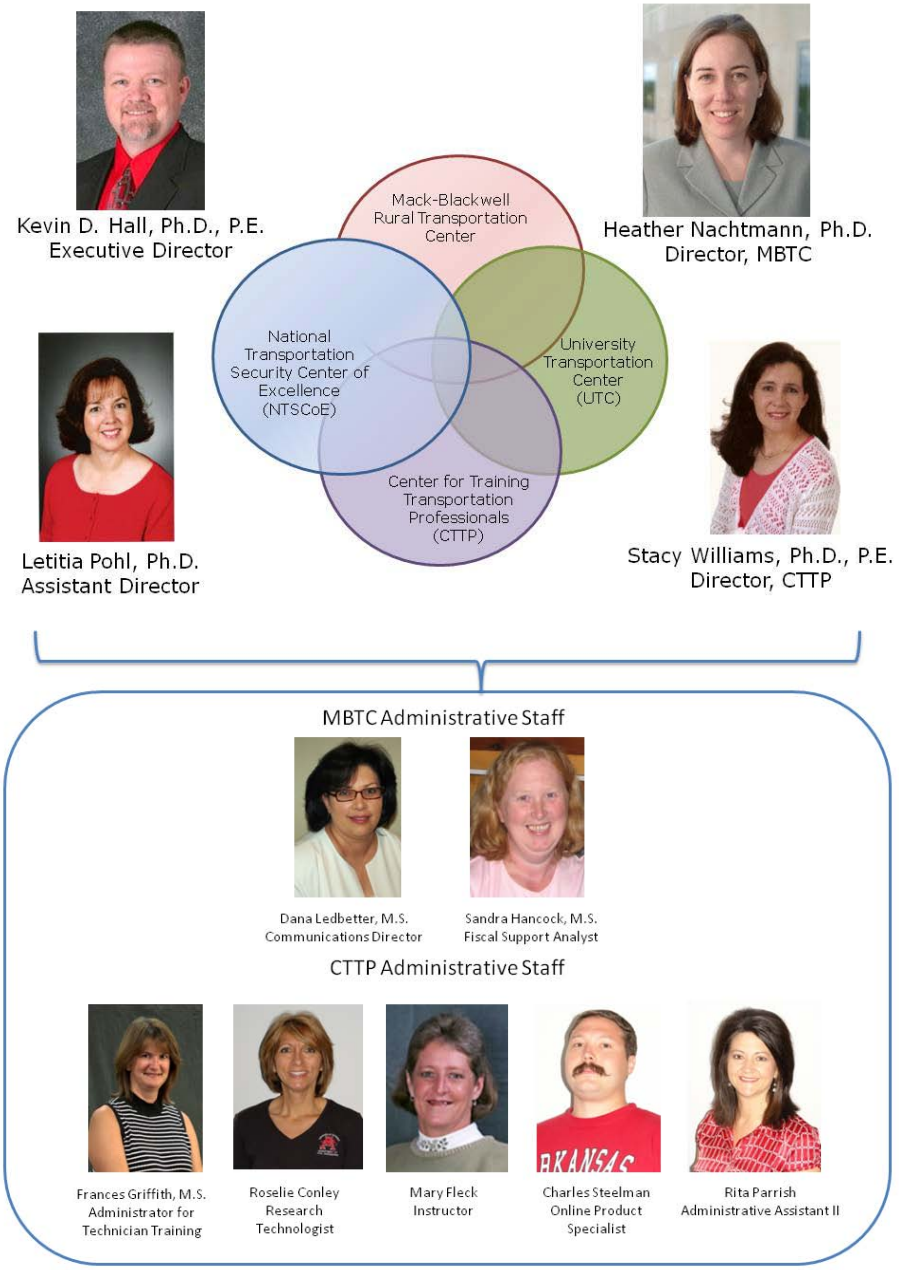

Figure 3. MBTC Administrative Personnel

PATENTS

To the best of my knowledge, I, Heather Nachtmann, MBTC Director, certify that no patentable inventions were created during Years One and Two.

FINANCIAL REPORT

The expenditures from July 1, 2008 through June 30, 2010 are included in Table 6. Initial funds were available in January 2009, rather than the award date of July 1, 2008, therefore the Year 2 activities from the initial projects will be complete December 31, 2010, rather than June 30, 2010.

Table 6. MBTC NTSCOE Expenditures for the period July 1, 2008 through June 30, 2010

Available upon request.