TRB-CMTS Biennial Conference 2014

Transportation Research Board • U.S. Committee on the Marine Transportation System

PREPARE • RESIST • RECOVER • ADAPT

Innovative Technologies for a Resilient Marine Transportation System

Conference Summary and Call to Action

U.S. COMMITTEE ON THE MARINE TRANSPORTATION SYSTEM- TRANSPORTATION RESEARCH BOARD 2014 BIENNIAL CONFERENCE:

Innovative Technologies for a Resilient Marine Transportation System

A Conference Summary and Call to Action

Compiled and Written by Katherine Touzinsky, USACE
1/1/2015

This document is not a report of the Transportation Research Board or the National Research Council and has not been subjected to its review procedures

This conference was the result of the work of the Conference Planning Committee Members:

W. Jeff Lillycrop, U.S. Army Corps of Engineers (Chair)

Edward Anthes-Washburn, Port of New Bedford

Paul Bea, PHB Public Affairs

Helen Brohl, U.S. Committee on the Marine Transportation System

Scott Brotemarkle, Transportation Research Board

Blaine Collins, Det Norske Veritas (USA), Inc

Hota GangaRao, West Virginia University

Bill Hanson, Great Lakes Dredge and Dock Company

Rudy Peschel, Radio Technical Commission for Maritime Services

Joe Ryan, The Skip'r, LLC

Tom Wakeman, Stevens Institute of Technology

Jim Walker, American Association of Port Authorities

Jim Watson, American Bureau of Shipping

With special thanks to Scott Brotemarkle (TRB), Brittney Gick (TRB), Tom Wakeman (Stevens) and Sandra Knight (WaterWonks, LLC) for their hard work and guidance

This report is available at the following address:
Committee on the Marine Transportation System
1200 New Jersey Ave, Washington DC,
Phone: (202)366 3612 Web: www.cmts.gov

Table of Contents

Executive Summary

The 2014 biennial Marine Transportation System (MTS) research and development conference entitled Innovative Technologies for a Resilient Marine Transportation System was held on June 24-26th, 2014, at the National Academy of Sciences in Washington, D.C. The Conference was organized by the Transportation Research Board (TRB) and sponsored by the U.S. Committee on the Marine Transportation System (CMTS). The purpose of the conference was to work towards a more resilient Marine Transportation System (MTS) through the identification of current innovative technologies, the gaps in knowledge or future technology needs, determine current and future disturbances to the MTS, and uncover opportunities for collaboration. This report is a research and development call to action to help guide near-term MTS research by assimilating broad ideas that were presented during the conference keynote and plenary panels and introducing the innovative emerging technologies that are being developed by academia, the federal government, and private industry. The specific action items are found within the document, but the following bullet points outlines the findings for the four conference goals.

- **Identifying current innovative technologies:** Current technologies were identified during 49 technical presentations that are summarized within the "State of Technology in the MTS: Technical Breakout Sessions" section (pgs 8-11). The current technologies fell into nine themes: The Future of Navigation, System Performance, MTS Resilience, Engineering with Nature, Innovative Technology, Security, Environmental Stewardship, Data Management and Sharing, and Asset Maintenance Management.
- **Gaps in research and development:** The concepts of resilience within the MTS are understood but we do not possess the tailored quantitative tools to aid in resilient planning or decision making. The MTS must invest in up-front technical enterprise to measure and monitor resilience in order to set a baseline for resilience within the MTS. In order to facilitate broad involvement from a variety of sectors, MTS members must assess the potential barriers of data sharing and co-production, and provide guidance for Public-Private Partnerships. In addition, there are significant gaps in communication across the MTS and cyber security needs to be integrated into future developments.
- **Current and future primary disturbances for the MTS:** The disturbances that were identified allude to the need to view and operate the MTS as an interconnected system that will become more complex over time with the addition of issues from climate change, urbanization, the pace of technological advances, and environmental regulations.
- **Current and Future Opportunities to Co-produce:** In order to facilitate better collaboration there must be an assessment of administrative, legal, and regulatory hurdles and a wide survey of the appraisal value of the MTS should be conducted in order to make transparent and accurate decisions involving partnering. Once partnered it will be critical to understand interactions among stakeholders and to make consistent quality checks for data.

The call to action provides a list of the top R&D priorities for the MTS. It is not funded and requires the MTS community (government, industry, and academia) to team together and leverage funds together in order to produce solutions to many of these challenging needs.

Introduction

The 2014 biennial Marine Transportation System (MTS) research and development conference entitled Innovative Technologies for a Resilient Marine Transportation System was held on June 24-26th, 2014, at the National Academy of Sciences in Washington, D.C. The conference was sponsored by the U.S. Committee on the Marine Transportation System (CMTS), a federal coordinating body for the MTS, and organized by the Transportation Research Board (TRB) of the National Academies. The purpose of the conference as outlined by the conference planning committee was to identify current innovative technologies in development and in practice, determine gaps in knowledge and needs for future technologies, determine and understand the current and future disturbances to the MTS, and to uncover opportunities for collaboration. Additionally, the conference served as a platform for discussion about future research and development needs, opportunities, and dynamic partnerships.

For three days, over 110 registrants from academia, State, Federal, and international agencies attended 4 keynote discussions, 3 plenary sessions with 18 expert panelists, and selected from 12 technical breakout sessions that included 49 technical presentations. The conference planning committee modified and expanded the five priority areas of the 2008 *National Strategy for the Marine Transportation System: A Framework for Action* in order to select the following themes as breakout session topics and the backbone for the panel and keynote speaker selection:

- The Future of Navigation
- System Performance
- MTS Resilience
- Engineering with Nature
- Innovative Technology
- Security
- Environmental Stewardship
- Data Management and Sharing
- Asset and Maintenance Management

The purpose of this report is to formulate a research and development call to action to help guide near-term MTS research by assimilating the broad ideas that were presented in the conference keynote and plenary panels and introducing the innovative emerging technologies that are being developed by academia, the federal government, and private industry. The planning committee and authors analyzed the overlaps and gaps in technology, the current and future threats to the MTS, and opportunities for coordination in order to provide a strategic direction towards a resilient future MTS.

Changes in the MTS

In the two years since the last CMTS-TRB Conference, the operational environment of the MTS has changed. The 2014 conference attendees brought insights from recent experiences with a wide variety of current issues from technological innovations and e-Navigation, to new policies, new strategies in a post-Panamax system, new information on climate change and natural disasters, and new research efforts on the topic of resilience.

One major new technology that has been in development is e-Navigation—the ability to maintain maximum situational awareness through the harmonized collection, integration, exchange, presentation, and analysis of maritime information and ashore by electronic means[1]. Within the MTS, the spread of e-Navigation has resulted in large federal efforts to ensure that safety and security are woven into the fabric of innovation. These efforts have been lead by USACE, NOAA, USCG, and the CMTS and involve many partner organizations. Each project is unique in its approach to e-Navigation: formulating advances in e-MSI (Marine Safety Information), optimization of the balance between electronic and physical aids to navigation (ATON), development of smartphone technologies to put information directly into the hands of diverse users, and cyber protection of the shipping system despite increased electronic data output[2]. In addition to e-Navigation, the increases in electronic navigation have led MTS research and development towards performance measures and the use of big data in order to streamline the intermodal shipping network. Creating performance measures and utilizing big data allows the MTS to be viewed in the context of the overall national supply chain; providing even more efficiency, security, and understanding of the very dynamic intermodal network.

Along with new research in technologies, new policies have focused on rebuilding America's water resources infrastructure and the interactions of man-made infrastructure and the environment. In July 2014, the President's Build America Investment Initiative was stood up as a government-wide initiative to increase infrastructure investment and economic growth, and the Build America Transportation Investment Center was created and housed at the DOT to provide a one-stop shop for cities and states seeking to use innovative financing and partnerships with the private sector[3]. In addition to the Center, the Water Resources Reform and Development Act (WRRDA) 2014 bill laid a large amount of responsibility on the US Army Corps of Engineers (USACE) to streamline environmental reviews, maximize the contributions of non-federal interests to moving projects forward, encourage resilient construction techniques

[1] *e-Navigation Strategic Action Plan*, February 2014, by the Committee on the Marine Transportation System

[2] http://www.cmts.gov/Activities/ActionTeams.aspx

[3] *Actions and Accomplishments of the CMTS, July 1, 2013- June 30, 2014*. The Committee on the Marine Transportation System.

and the use of innovative materials on water resources infrastructure, and conduct resilience studies on America's coasts.

WRRDA 2014 was not the first document to highlight the need for resilience. A large number of national studies have been published with an even larger number of Federal sponsors (refer to Appendix A for a list of highlighted studies). The spike in the discussion of resilience is considered a direct result of the devastation of 2011, where over 820 natural disasters caused a total of 27,000 deaths $380 billion in economic losses worldwide[4]. The disasters of 2011 were outstanding and prompted the Federal Agencies of the MTS to think about planning in the face of a diverse number of future threats. These threats include the effects of climate change through sea level rise and increasing storm frequency, aging infrastructure, and growing coastal populations. These new ideas about future threats and uncertainties point to the need to plan U.S. coastal infrastructure to accommodate an uncertain future through resilient practices.

Resilience for the MTS

Resilience originated from the Latin word resilīre meaning to spring back or rebound[5]. For many years, resilience has been used as a term to describe ecological systems[6] and psychology studies[7]. Recently there has been a shift among many government and academic institutions to use resilience as a broad term to describe how systems such as communities can demonstrate increased capacity to adapt to natural disasters and change. Between 2012 and 2014 three major studies were released to aid in the MTS evaluation of resilience: the National Academy of Sciences report entitled *Disaster Resilience: A National Imperative*, *The President's Climate Action Plan*, and the *North Atlantic Coast Comprehensive Study: Resilient Adaptation to Increasing Risk*. It is widely agreed that the definition of resilience depends on its intention of use and the system of study. However, in

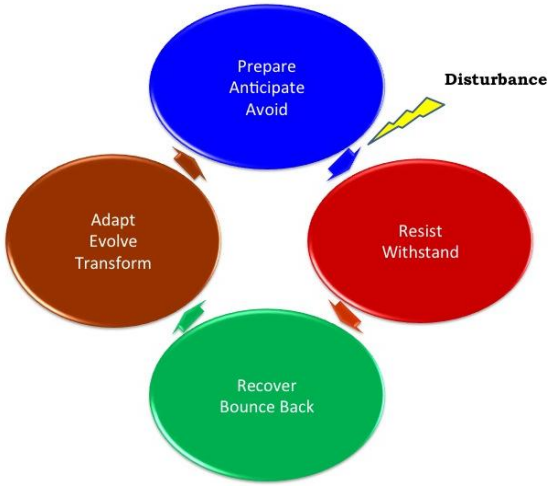

Figure 1: The Resilience Cycle

[4] Schiermeier, Quirin. "Two-Thirds of Natural Disaster Costs in 2011 Were Unrelated to Climate and Weather." *Nature 481* 12 Jan. 2012: 124-25. *Scientific American Global RSS*.
[5] http://dictionary.reference.com/browse/resilience
[6] Holling, C.S. 1973. Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics*. 4:1-23.
[7] Werner, E.E. 1971. The children of Kauai: a longitudinal study from the prenatal period to age ten. Honolulu: University of Hawaii Press, ISBN 0870228609

each case, four key concepts are consistently represented: Prepare, Resist, Recover, and Adapt (Figure 1). These concepts work together to ensure that a system can maintain or quickly recover its function following a disturbance. For the Marine Transportation System, we define resilience as follows:

Resilience: the ability of a system to be prepared, resist, recover, and adapt to disturbances in order to achieve successful functioning

A system of interest can span from a specific set of infrastructure projects such as a river segment with ports, locks, and channels to an entire coastal watershed with deep and shallow draft ports, channels and harbors. Successful functioning requires that the system is designed and operated to achieve a specific functionality that must be maintained or restored soon after a disturbance. If the function is not maintained then recovery must be rapid. When evaluating resilience within a system is it important to include Ecosystem (i.e. barrier islands, forested lands, wetlands), Community (i.e. emergency preparedness, sewage and water systems, transportation and evacuation routes), and Engineering elements (i.e. sea walls, ports and channels, dams, levees). Each of the three elements depends upon each other's specific functions to resist, adapt and recover. Moving forward, the MTS must strive towards understanding what resilience means for the entire system and the role that new technology will play in creating a resilient MTS.

The Future of the MTS: Panel and Keynote Discussions

The Marine Transportation System is one of the Nation's most valuable economic assets, and the future of the MTS depends on the ability to create opportunities for collaboration, innovate and share new technology, adapt and plan for climate change, and work with the environment. MG John Peabody of the US Army Corps of Engineers (USACE) was the first to bring forward the definition of resilience and how the four concepts of "prepare", "resist," "recover," and "adapt" relate to the MTS. The definition, concepts, and application to the MTS were as a result of almost two years of work from the USACE Coastal Engineering Research Board, led by MG Peabody. In addition to new responsibilities for resilient design and operations, there are increased financial constrictions of Federal funds for the MTS. A solution for continued works despite Federal financial pressure was suggested by the Keynote speaker Admiral (RET) Thad Allen. He suggested the term *co-production*, or the ability of the public sector and citizens to share resources and assets to achieve better outcomes and improved

efficiency. The idea of creating partnerships was carried throughout the conference and identifying opportunities for co-production became a main goal. Other keynote speakers highlighted the need to keep up with technology and the "internet of things" through changes in security, policy, and socialized technology; taking note that the financial and automotive sector has made great strides in this arena, and could be used as a model for future development in the MTS.

The "Innovative Technology for a Resilient Marine Transportation System" panelists were a variety of professionals in the Federal government (NOAA, USACE), private industry (Great Lakes Dock and Dredge), and academia (Virginia Tech, National Cooperative Freight Research Program). The panel identified the six biggest risks and challenges that will require resilience as the following: the nation's aging infrastructure, the need to sell public works as a success instead of complaining about failures, the lack of public understanding of the MTS, the slow nature of climate change impeding the ability to make big policy changes, the private sector view of business continuity, and the need to identify alternate solutions before a crisis, not after. To overcome these challenges, the panel suggested partnering with private industry to engage in R&D for crisis management and making sure that R&D projects are carried to in-the-field implementation, using the USACE Institute for Water Resources as a think tank for alternative financing, and using new technology to manage surge, identify choke points, and increase system capacity. Resilience within the MTS is an issue that spans nationwide, and the community resilience aspects were brought forward in a discussion on how to bridge socio-economic boundaries. Panelists suggested that future R&D on Natural and Nature Based Features (NNBF) should be a top priority. NNBF are natural and engineered features that are used to produce engineering functions in combination of ecosystem services and social benefits. With dwindling budgets and increasing socio-economic disparities, NNBF applications may be one of the keys to coastal storm protection moving forward. The issue is, as one panelist pointed out, "We cannot let our R&D knife get dull." Research and development should assume a lead in investigating and validating resilient practices for the future.

"We cannot let our R&D knife get dull"

The second panel, "The Future of Navigation: Impacts of e-Navigation on the MTS" assembled panelists from the U.S. Coast Guard, NOAA, Port of Pittsburgh Commission, General Electric, and MarineNet LLC. The panelists were asked to share their thoughts on how to manage moving forward with maritime information management. The process of e-Navigation technologies in the U.S. was discussed as "evolutionary, not revolutionary." Instead of a massive overhaul of the information sharing system, there is benefit to proceeding with caution and insuring that the system is tailored to specific waterways' needs. The future of e-

Navigation should aim to become goal-operational and move to ensure that current fragmented development in technologies become unified in order to improve the bottom line. The top R&D need identified by panel members was an investigation in how to remove barriers to public-private partnerships in order to facilitate better co-production. The main question answered by the final panel, "Optimizing Freight Transportation System Performance" was to describe what resilience within the MTS means to professionals in the system performance field. The panelists highlighted options, flexibility, optimization, and maintaining the capability to function during disturbances as the key factors to resilience.

State of Technology in the MTS: Technical Breakout Sessions

Throughout the conference, 49 technical presentations were given during 12 breakout sessions. Each session was moderated by a topic expert who worked with the presenters and attendees to create a series of take-away points that were discussed during a closing workshop session. The following sections are summaries of the presentation topics and take-away points for each of the nine themes.

1. Future of Navigation: The Future of Navigation panelists presented on the benefits of enlisting NGOs and commercial entities as providers of the eLoran system for satellite navigation, the role of the Radio Technical Commission for Maritime Services in the integration of navigation and communications functions for e-Navigation, and future of digital nautical charting.

The Future of Navigation panel was focused on the current technologies in maritime data dissemination and brought forward two major ideas in ensuring success in implementing future e-Navigation innovations. First, standards for navigation technology are vital to ensuring the safety of the MTS, and those standards must be consistently updated to keep pace with technological evolution or advancement. Second, multiple delivery methods are necessary to limit or reduce vulnerabilities; meet diverse user needs to receive navigation services or portfolio data, and comply with geographic restrictions on communication methods. In addition for these needs, a resilient MTS needs more R&D on the next generation of Alternate Positioning, Navigation, and Timing (PNT) to ensure safe and diverse methods of operation in advance of a disturbance or interference with the system.

2. System Performance: Panelists outlined future uses for AIS tracking systems, efforts in creating aggregated data, MTS performance measures and assessment, multi-state marine freight development efforts, and ShipMoves as a new synthesized and coherent information sharing system for vessel, facility, and transit data.

All panelist members from the System Performance breakout sessions agreed that data sets to analyze or improve system performance must have common descriptors for MTS elements, improved fidelity, account for physical characteristics of waterways, and be aggregated or disaggregated to properly reflect varying time-scale and geographic-scale data. Several new innovative techniques were presented that will aid in administrative and operationalized efficiencies through security (Shipmoves.org), communication and improvement of data (Federal and Industry Logistics effort), crowdsourcing (real-time water level data), AIS based predictions of arrival times, and automatic retrieval of data. Additionally, seaport data was discussed as useful in assessing resilience of ports following disturbances.

3. MTS Resilience: Panelists presentations centered on the resilience of ports: developing guidelines for storm resilience, Department of Homeland Security port resilience policy and implementation strategy, climate change adaptation leadership, and port and supply chain resilience following hurricanes. Two pilot studies on resilience were presented in Mobile, Alabama, and Providence, Rhode Island.

The best management strategies for a resilient MTS involve trust, shared culture, and co-production among stakeholders. These alliances accelerate decision making regardless of available technologies, infrastructure, or the political agenda in a region. Resilience should be shared through BMPs and translated into action. To accomplish this, economic aspects (i.e. profit, business continuity) must be recognized as the functional objective of the private sector. Additionally, resiliency must include human factors, like the readiness of the labor force.

4. Engineering with Nature: Panelists presented on dredged material placement practices for creating river habitat and thin layer in-bay placement, a program entitled Systems Approach for Geomorphic Engineering (SAGE), and current green infrastructure alternatives.

Across the U.S., innovative waterways management through dredging practices are being implemented but communication of these successes must be increased. It is also important to develop robust partnerships and increase communication between public and private partners to share the best techniques/practices and lessons learned. It has been shown that nature-based elements can be incorporated into grey infrastructure in order to increase ecological habitat but metrics must be developed to access their success.

5. Security: Presentations included strategies for implementing security methods: the need for microgrids in power facilities to increase efficiency and power output, aggregation of data from GPS and eLoran as a safe backup for PNT at sea, applying a Dynamic Risk Management Model (DRMM) to ensure resilient networks and alleviate security risks within U.S. ports and waterways, and exploring alternatives for navigation given GPS denial scenarios.

There is a paradox in MTS security: reliance on automated and connecting information, data, and services is increasing but none of it is secure without effort. The MTS needs threat intelligence, systematic risk assessment, coordinated application of standards, and system monitoring augmented by public-private and private-private information sharing. Solutions for security start with proactive, unified effort of mission/business line owners, IT and security managers, manufacturers/developers, and end users.

6. Environmental Stewardship: The environmental stewardship panel covered emission control areas and fuel regulations, sustainability of intermodal integration, the spread of invasive species, and compliance with new EPA lubricant regulations.

The panel aggregated accomplishments based upon participants presentations: negative environmental impacts of maritime traffic regulations can be minimized through researching best management practices on how to respond and implement regulations, by working closely with vessel owners, captain, and crews, and by using National Automatic Identification System data. An increase in modal share of freight by the MTS will result in a reduction in freight-related CO_2 emissions. This fact is demonstrated through analysis of available multi-modal data. Finally, readily biodegradable products used as lubricants for ship maintenance perform as good or better than traditional lubricants and their lower costs can be computed using life cycle costs.

7. Innovative Technologies: The presented technologies included new composite materials for fixing damaged or damage-prone infrastructure, developments in real-time data for navigation.

Fiber reinforced polymer composites have recently been tested and proven for a wide variety of applications including strengthening wraps for corroding steel, allusion bumpers for bridge pilings, to pipe fillings and life gate rollers. In addition to new infrastructure composites, data communication and decision tools are evolving: NOAA's Center for Operational Oceanographic Products and Services (CO-OPS) is maintaining and growing the National Water Level Observation Network (NWLON) and Physical Oceanographic Real-Time Systems (PORTS), and MONALISA and MONALISA Ice (MICE) tools are closing the gap of tracking vessels and having real-time situational awareness.

8. Data Management and Sharing: Panelists discussed e-Navigation innovations including AIS, web services, VHF Data Exchange System (VDES), wide area broadband, and NOAA's nowCOAST (a GIS-based web-mapping portal), and the application for these technologies following disasters. Another panelist discussed the Coastal Data Information Program (CDIP) in Scripps Institution of Oceanography and their partner program, the Integrated Ocean Observing System (IOOS).

Implementation of e-Navigation will require development of interoperable communications technologies and data collectors and information providers are shifting from delivering products through single purpose portals to providing web and map services that can be used on many applications. Disasters provide a particular challenge because data management planning must occur beforehand in order to be effective and baseline data collection must be structured.

9. Asset and Maintenance Management: Panelists explored options for optimal dredging practices: navigation projects that take into account budget, shoaling, deep and shallow-draft use, options for confined dredging disposal, and the economic risk of U.S. Army Corps maintenance of navigation assets. Additionally, a presentation was given on the National Ocean Service predictions for extreme water levels.

Enterprise development and integration of data systems, or improved data sharing is a major challenge for the MTS. Lots of data and many models exist for various part of the overall Life Cycle Assessment approach. What is needed is a comprehensive integration that leverages the entire process, and improved methods of gathering quality data or improving existing data. A means of relating the value of investment choices between different infrastructure or parts of a system would enable prioritization and lead to greater resilience through optimal risk reduction.

Call to Action

The final day of the conference convened all participants, speakers, and technical presenters in order to facilitate discussion and conclusions from the proceedings of the conference. Moderators from each of the technical sessions provided the group main take-away points on surfacing technologies, gaps in technology, and opportunities for R&D in the future, as summarized in the section above. In addition to those take-away points, conference organizers prompted three questions for open discussion in order to formulate the final summary for the state of R&D within the MTS and a call to action for future work:

- What gaps were identified in research and development?
- What are the current and future primary disturbances to the MTS?
- What are the opportunities now and in the future to “co-produce”?

Gaps in R&D

In general, we understand the concepts of resilience but within the MTS, we do not possess the tailored quantitative data or tools to aid in resilient planning or decision-making. Because of the wide number of potential users—from the Federal government to private institutions—the concept of resilience and their quantifications need to broaden and include engineered

infrastructure and both community and environmental factors. In order for this to be accomplished, we need to understand the potential barriers of data sharing and co-producing between these MTS users and research more heavily the advantages and limitations of natural and nature-based features in port communities. In addition to resilience quantification needs, there are significant gaps in communication across the MTS: a lack of public understanding, communication and awareness of current sustainable practices (i.e. dredging practices, alternative fuels), and the need to sell public works as a success and a worthwhile investment for private partners. Currently, no guidance exists for Public-Private Partnerships and would be an excellent way to bolster that process. Finally, with the exponential increases in technology, there must be an effort to ensure that cyber security is fully integrated into future developments.

R&D Needs:

- Quantify resilience performance for components of the MTS: test and validate multiple tiers of methods for a wide variety of users to quantify resilience that integrates Engineering, Environmental, and Community aspects
- Develop guidance for choosing applicable tools and technologies to assess port and community resilience
- Invest and develop communication sciences to facilitate public awareness and understanding of resilience and to help bring new technologies into practice
- Develop solutions to increase cyber security by borrowing lessons from the financial and automotive industry
- Create guidance for forming public-private partnerships and explore creative solutions to financing

Current and Future Primary Disturbances to the MTS

The current and future primary disturbances that were identified during the conference allude to the need to view the MTS as an interconnected and intermodal system that will only become more complex over time. The functional environment of the MTS is changing through competition, reductions in workforce, urbanization, technological advances, and climate change. The waterways have multiple users with competing demands that influence capacity by creating bottlenecks and chokepoints in transport. Increasing coastal population densities will mean different considerations for port development and a rise in congestion issues. In general, there is a limited understanding of the negative effects of navigation projects, and the shipping industry in general. Additionally, the MTS must ensure that standards for navigation technology keep pace with the speed of technological innovation and advancement in order to maintain cyber security. Along with the changing functional environment, natural influences, legislative restrictions on partnerships and action, and uncertainty have become major threats.

The MTS must operate despite a carbon emissions constrained environment, inefficient organization of environmental regulations, and increasing concerns about climate change and the balance of commerce with fragile coastal ecosystems.

R&D Needs:

- Maximize efficiency and situational awareness through e-Navigation and ensure that standards for navigation technology keep pace with the speed of technological innovation
- Develop interoperable communication technologies for e-Navigation
- Analyze or evaluate system performance and optimization with data sets that have common descriptors, improved fidelity, and can be open for crowdsourcing and open retrieval
- Streamline O&M of our critical MTS structures and conduct research to identify the interdependencies and interactions between aging flood and storm protection infrastructure and climate change
- Enterprise measuring and monitoring of the MTS to increase reliability and resilience by supporting daily operations, informing asset management, maintenance management, and alternative maintenance investigations, and providing emergency response situational awareness
- Communicate knowledge about resilience through best practices, lesson learned, and quantification to better assess the success of resilient projects and scope future projects.
- Investigate the benefits and feasibility of incorporating beneficial use or natural and nature-based features into planning and design of MTS projects

Current and Future Opportunities to Co-produce

Finding current and future opportunities to co-produce includes a re-examination of many of the tenants by which the MTS operates. In order to facilitate better collaboration there must first be an assessment of administrative, legal, and regulatory hurdles. In addition to assessing hurdles, a wide survey of the appraisal value of the MTS should be conducted in order to make transparent and accurate financial decisions about partnering. Once partnered, it will be critical to understand common threats, objectives, and interdependencies among stakeholders and to make quality checks for outside and/or crowd-sourced data before incorporation into R&D. Finally, create a framework for resilient technology within infrastructure design and planning.

R&D Needs

- Bring cutting-edge entrepreneurs and young academics to the table to share work and ideas

- Communicate federal research needs to academia
- Outreach to programs that provide academic fellows and interns to the MTS
- Assessment of regulatory barriers to co-producing and to identify “wicked problems” of co-production in order to get to solutions
- Find a “project” that can be co-produced between private industry, academia, and multi-agencies that could contribute to the needs outlined in the conference (e-Navigation, Resilience, Safety & Security, etc)
- Partner and communicate with private industry to share new technologies, lessons learned

Appendix

Appendix A: Organizations involved with the CMTS Research and Development Integrated Action Team and the Conference Planning Committee

A) American Bureau of Shipping
B) American Association of Port Authorities
C) U.S. Committee on the Marine Transportation System Executive Secretariat
D) Det Norske Veritas (USA), Inc
E) Great Lakes Dredge and Dock Company
F) National Transportation Safety Board
G) PHB Public Affairs
H) Port of New Bedford
I) Port of Pittsburgh Commission
J) Radio Technical Commission for Maritime Services
K) The Skip'r LLC
L) Stevens Institute of Technology
M) U.S. Department of Commerce
    a. National Oceanic and Atmospheric Administration
N) U.S. Department of Defense
    a. U.S. Army Corps of Engineers
    b. Office of the Oceanographer of the Navy
O) U.S. Department of Energy
    a. Oak Ridge National Laboratory
    b. Sandia Laboratory
P) U.S. Department of Homeland Security
    a. U.S. Coast Guard
Q) U.S. Department of Transportation
    a. Maritime Administration
        i. U.S. Merchant Marine Academy
    b. Research and Innovative Technology Administration
        i. Volpe Center
    c. Saint Lawrence Seaway Development Corporation
R) U.S. Environmental Protection Agency
S) West Virginia University

TRB-CMTS

Biennial Conference 2014

Transportation Research Board • U.S. Committee on the Marine Transportation System

Innovative Technologies for a Resilient Marine Transportation System

Organized by the U.S. Committee on the Marine Transportation System Research and Development Integrated Action Team Members and the Conference Planning Committee:

American Association of Port Authorities
American Bureau of Shipping
U.S. Army Corps of Engineers
Bureau of Transportation Statistics
U.S. Coast Guard
U.S. Department of Transportation
Det Norske Veritas (USA), Inc
Federal Highway Administration
Federal Maritime Commission
Great Lakes Dock and Dredge Company
Maritime Administration
National Oceanic and Atmospheric Administration
Oak Ridge National Laboratory
PHB Public Affirs
Port of New Bedford
Port of Pittsburgh Commission
Radio Technical Commission for Maritime Services
The Skip'r, LLC
Stevens Institute of Technology

PREPARE • RESIST • RECOVER • ADAPT

TRB
TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

CMTS
U.S. Committee on the Marine Transportation System