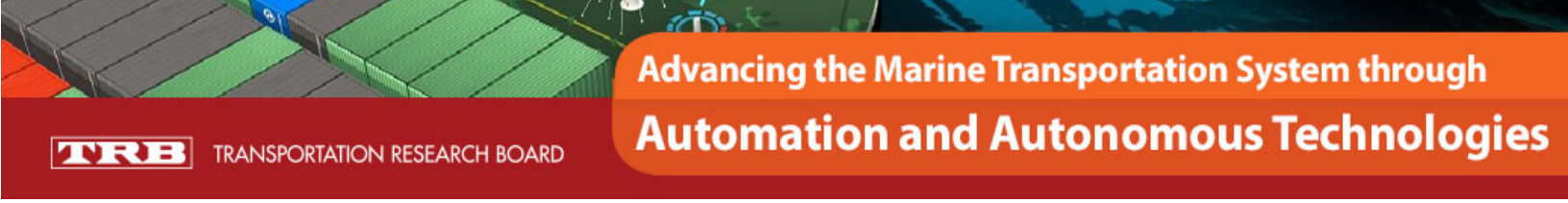


Printable Program

Sixth Biennial Marine Transportation System Innovative Science and Technology Conference:
Advancing the Marine Transportation System through Automation and Autonomous Technologies:
Trends, Applications and Challenges
March 15-17, 19, 2021

The virtual conference with its full interactive program is available to conference registrants online:
https://trb.secure-platform.com/a/page/marinetransport

This sixth biennial conference in partnership with the U.S. Committee on the Marine Transportation System (CMTS) will showcase current and emerging innovative science and technologies related to maritime transportation. Join your colleagues from government, industry, and academia to examine the rapidly evolving applications of autonomous and automated technologies. Through engaged discussion and debate with noted thought leaders, directed panelists, and leading scientists and engineers, we will explore the direction, technical challenges, enabling technologies, and potential hurdles to successfully navigate the future of the marine transportation system.

March 15, 2021

Opening Session

10:00-11:30 EST

This session will introduce the theme of the conference, provide the systemic context of the impact of automation and autonomous technologies in the Marine Transportation System (MTS), and put forward the key concepts to examine during the three day conference.

Jeff Lillycrop, Woolpert Strategic Consulting Group, Presiding Officer

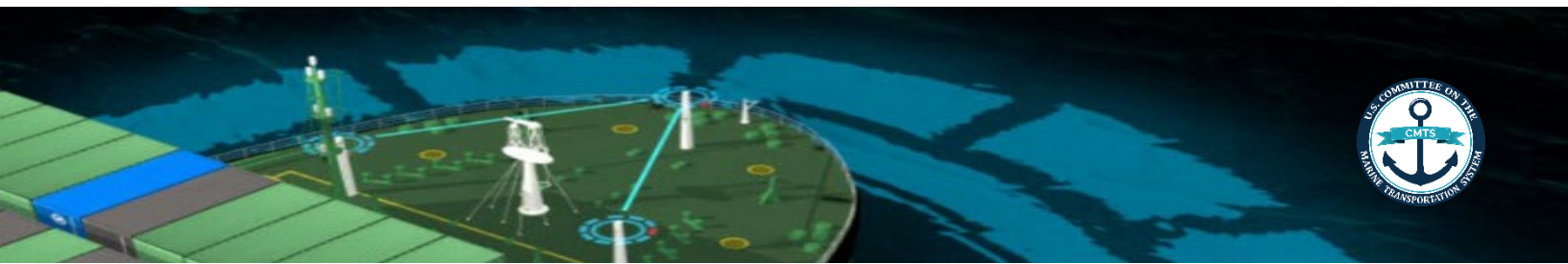
Opening Remarks

Helen Brohl, Executive Director, U.S. Committee on the Marine Transportation System
Rear Admiral Richard V. Timme, Assistant Commandant for Prevention Policy, U.S. Coast Guard – U.S. Committee on the Marine Transportation System (CMTS)

Opening Keynote Address

The Honorable Daniel B. Maffei, Commissioner, Federal Maritime Commission

Commissioner Daniel B. Maffei, of New York, was first nominated to serve on the Federal Maritime Commission (FMC) by President Barack Obama and confirmed by the United States



Senate on June 29, 2016. He was then nominated by President Donald Trump and confirmed by the United States Senate on January 2, 2019.

As a Commissioner, Mr. Maffei has shown a particular interest in addressing the vulnerability of the global transportation system to industry-wide financial and security risks. He has spoken at national and international conferences on the changing nature of the economics of international shipping due to technological advances and the pressures that newer and larger carriers have placed on U.S. transportation infrastructure.

A native of Syracuse, New York, Commissioner Maffei's career in government spans more than twenty years. He was elected to two terms in the United States House of Representatives from 2009 to 2011 and from 2013 to 2015. Immediately prior to his initial appointment to the FMC, Mr. Maffei was a Senior Advisor at the United States Department of Commerce.

Commissioner Maffei's time in Congress included service on the House Armed Services Committee, House Financial Services Committee, and House Judiciary Committee. He also served on the House Committee on Science and Technology and was Ranking Member of its Oversight Subcommittee.

Commissioner Maffei received his bachelor's degree in History and American Civilization from Brown University and holds master's degrees from the Columbia University's Graduate School of Journalism and Harvard University's John F. Kennedy School of Government.

Plenary One: Maritime Public Agency Stewardship Perspectives

12:00-13:45 EST

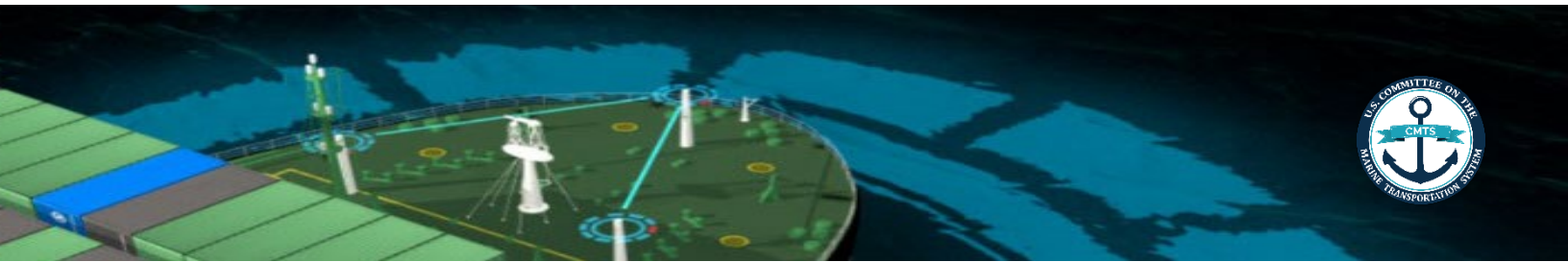
How will public agencies with stewardship over the marine transportation system facilitate innovation and create conditions for the safe and efficient integration of automation and autonomy? This "living-room style" session will bring forward the visions of agency leadership and discuss how they see their federal purviews and roles toward creating opportunities for automation and autonomy through policy and regulatory frameworks, data sharing platforms, and research initiatives.

Thomas Wakeman, Ph.D., Resilience Engineering Services (RES), Presiding Officer

Plenary One Panelists

Rear Admiral Richard V. Timme, Assistant Commandant for Prevention Policy, U.S. Coast Guard – U.S. Committee on the Marine Transportation System (CMTS)

Rear Admiral Shepard M. Smith, Director, Office of Coast Survey, National Oceanic and Atmospheric Administration



Thomas Smith, Chief, Operations and Regulatory, U.S. Army Corps of Engineers

Thomas C. Fu, Ph.D., Head (Acting), Mission Capable, Persistent and Survivable Naval Platforms Department, Office of Naval Research

Robert Heilman, Director, Highly Automated Systems Safety Center of Excellence (HASS COE), USDOT, Office of the Assistant Secretary for Research and Technology (OST-R)

Autonomous Ships and Technologies I

14:00-15:45 EST

This technical breakout session will showcase and discuss research related to the topic of Autonomous Ships and Technologies

Dr. Yan Jin, University of Southern California, Presiding Officer

Application of Artificial Intelligence in Maritime Automation

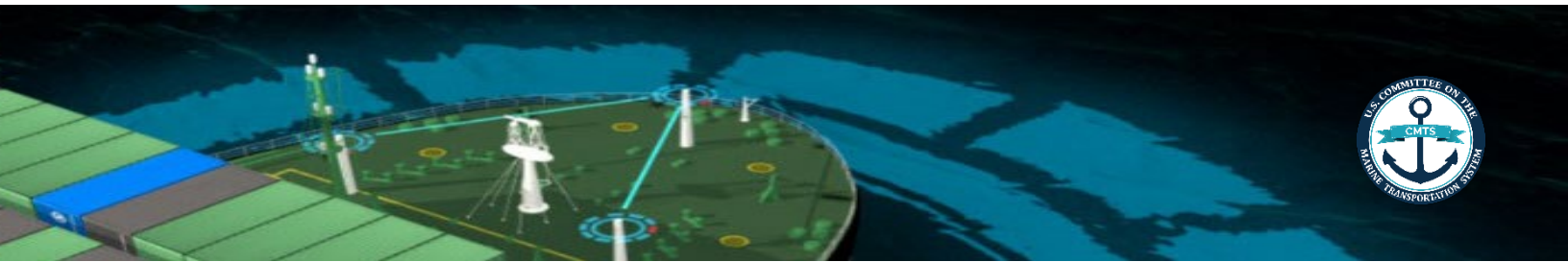
Mehdi Azimi, Assistant Professor, Texas Southern University

Co-authored by Enamul Karim Fayek. The current economics of maritime operations requires maritime domain to move towards major changes in the role of human operators. Technological advances do significantly contribute to maritime automation by removing operators from systems control and moving to minimal manning. Artificial Intelligence, one of the important technological advances, is an area of computer science that is concerned with building systems that demonstrate intelligent behavior. Machine learning (ML), a subset of AI, is the scientific study of algorithms and statistical models that computer systems use to effectively perform a specific task without using explicit instructions, relying on patterns and inference instead. Machine learning algorithms build a mathematical model based on sample data, known as “training data”, in order to make predictions or decisions without being explicitly programmed to perform the task. In this study, we will identify which aspects of Artificial Intelligence (AI) are most relevant to maritime domain and have potential to be applied in maritime automation.

NYK's Approach for Autonomous Ship - Building a Conceptual Framework for Open Collaboration

Hideyuki Ando, Senior General Manager, MTI

This paper shows a conceptual framework of APExS (Action Planning and Execution System), which NYK group considers as a core of autonomous navigation. APExS integrates several support functions with human-machine interface, targeting at to analyze surrounding situations and calculate optimized action plans. In addition, APS information is also shared with onshore operators, who provide additional information and advice to the crew. It is assumed that transmission information between ship and land, the transmission frequency, and remote

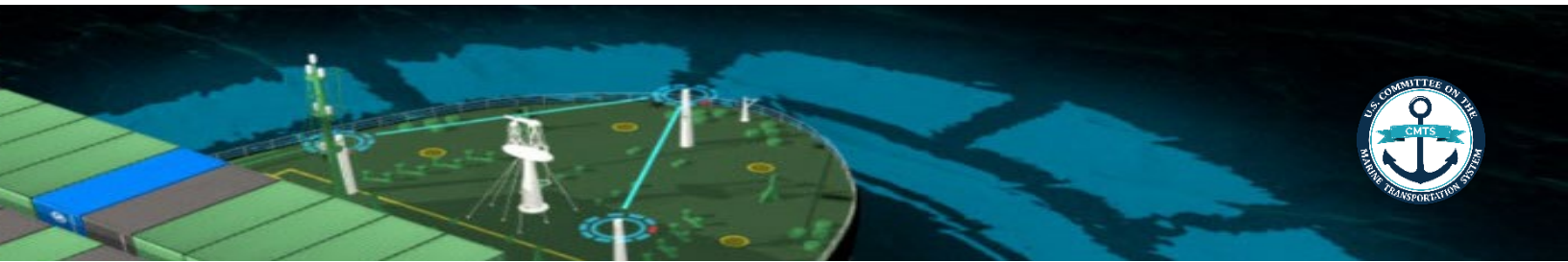


supporting menus (voyage planning based on the latest weather etc.) are to be changed depending on the available communication speed. APExS targets a system at making decisions necessary for the navigators to maneuver the vessel at the bridge, and specifically has the following three modes. 1. Anti-collision and anti-aground support: formulate and present an action plan to prevent collision and aground during voyage. The parameters for the analysis can be different depending on the area (ocean going, coastal area, congested area, or waterway). 2. Approach support: formulate and present an action plan for stopping and restarting the boat, e.g. anchoring, berthing and mooring. 3. Docking and undocking support: formulate and present action plan for docking/undocking including position adjustment, thruster and tag operation. This function is the same as the approach support mode for a ship with a docking and undocking capability by own. The Operational Design Domain (ODD) means a design area where the automated system functions properly. It can be composed by geographical restriction, weather conditions, availability of traffic system support, time zone (day and/or night), integral and reliabile information. We classified the status of implementing the "situation analysis" and "action planning" tasks of APExS into 4 categories. AP Normal 0-2 are in the ODD, and AP Failed is subject to “fallback”. Fallback means the alternative action to ensure a state that minimizes the risk (Minimum Risk Condition: MRC) when the automation system does not operate properly. Basically, MRC for APExS is guaranteed by the crews’ backup, therefore, it is necessary to have appropriate alert mechanism. In order to confirm whether fallback mechanisms are safe and reliable, we conduct fallback assessment, assuming external condition, internal condition and ODD. Time and distance allowance of the necessary action is assumed by each mechanism and Minimum risk condition is described. Based on these information, fallback mechanisms are to be judged. We have conducted iteration of risk assessment and planning countermeasures of APExS. Through the process, the importance of proper human-machine interface, appropriate measures to ensure cyber security and computer system reliability have been identified. Our consortium, consists of NYK Group and industry partners, has been selected by Japanese governmental agency MLIT to one of the groups who demonstrate autonomous and remote-control ships. For this demonstration, we aim to make use of APExS in an actual situation. The first demonstration of this test project was carried out on a tugboat in January 2020. A subset functions of APExS required for the demonstration was developed and worked properly.

Autonomous Ship Situational Awareness through Extraordinary Sensory Cognition

R Glenn Wright, President, GMATEK Inc.

Maritime autonomous surface ship (MASS) technology is concerned primarily with automating the reasoning processes used by seafarers in the fusion and analysis of data and information provided by various onboard sensors and display equipment. Parallel ongoing research efforts are concerned with COLREGs compliance on the part of MASS operating in close proximity with other vessels. Similar efforts are being undertaken for hazard to navigation detection and avoidance and for threat assessment. The scope of sensors being considered follows an evolutionary path encompassing needs identified under national and International Maritime Organization (IMO) mandatory carriage requirements (e.g., GNSS, ECDIS, echosounder, radar,



etc.) with visual imaging (e.g., daylight and infrared) sensors to fill the role of seafarer eyes. Such approaches using the most advanced machine learning and artificial intelligence techniques make methods to appraise situational awareness more efficient, yet fail to compensate for or correct many flaws that permeate these methods within the existing regulatory environment. The IMO Regulatory Scoping Exercise on MASS being completed in May 2020 is a good start towards addressing salient issues, but succeeded in merely identifying what existing regulations may or may not apply to MASS without providing any guidance as to how technological innovations may enhance situational awareness and ultimately improve safety of navigation. Such findings can lead to the ultimate demonstration of whether MASS can operate safely in full autonomous mode without human supervision, yet are still years in the future. This presentation describes a disruptive approach to vastly expand awareness and knowledge of current and pending events associated with natural and manmade objects and processes existing within the environment, and the potential consequences of decision making that may result. Integral to this approach are new sensor technologies, reasoning methods and communications capabilities that provide unprecedented insight to the environment above, at and below the waterline.

Enabling Autonomous Operations on Inland Waterways I

14:00-15:45 EST

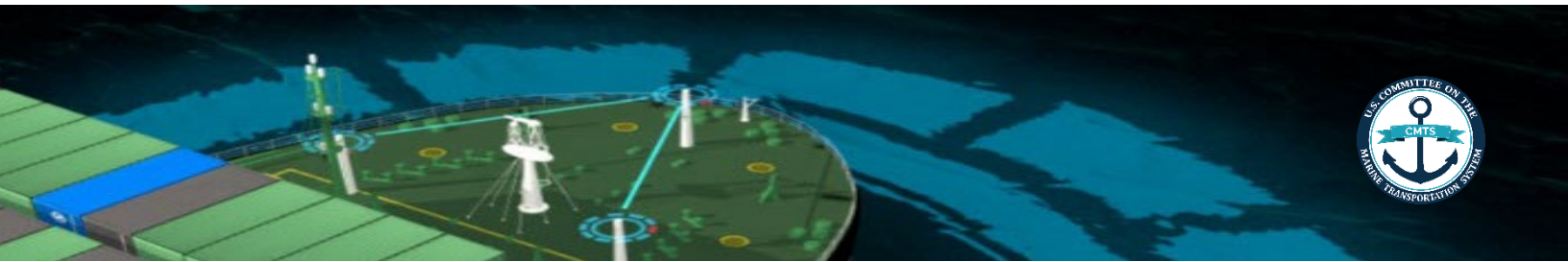
This technical breakout session will showcase and discuss research related to the topic of Enabling Autonomous Operations on Inland Waterways

Marin Kress, U.S. Army Corps of Engineers, Presiding Officer

River Information Services: Integrating Data for Corps Navigation

Timothy Fudge, Chief of Operations, US Army Corps of Engineers

River Information Services (RIS) makes navigation data more accessible and usable in support of USACE navigation operations and maintenance (O&M). Data is ubiquitous across the public and private navigation stakeholders. Most stakeholders, public and private, are data produces and data consumers. Sharing data improves daily operations as well as long term planning, with many uses between these time-scales. The USACE navigation mission is to provide safe, reliable, efficient, effective and environmentally sustainable waterborne transportation systems for movement of commerce, national security needs, and recreation, where each of these may be improved with RIS. RIS uses several enabling technologies, such as USACE inland electronic navigational charts, USCG National Automatic Identification System (NAIS), USACE CorpsNet, and the Navigation Data Integration Framework (NDIF). Linking to specific authoritative data provided by the USACE and others enables creation of the information services and is facilitated through the NDIF that helps users discover authoritative navigation data across public and private stakeholders. Through LOMA, the information services may be transmitted at an



enterprise scale, as in the case of weather information for every USACE navigation project, or at a project scale, as has been the case of a safe fairway through the active construction zones. Services may also be created and made available through other digital means, such as an Internet site. Mariners are not the only beneficiaries of accurate, timely information from RIS. Because an enabling RIS technology is NAIS Lock Operators can see tows approaching project and better manage the flow of vessels. It also helps the lockmaster schedule maintenance activities when there is time between lockages. What was once a blind process handled over VHF radio calls is now a visual and much more accurate process because of the real-time locations provided through NAIS. For the USACE, RIS delivers the capability to help provide safe, reliable, efficient, effective and environmentally sustainable navigation to waterway users. Based on needs, we can create information services that meet national, regional or project needs that communicate directly with mariner to help them move safely and efficiently along the inland rivers and shallow water coastal locks. RIS also helps improve reliability and sustainability for the USACE through significantly improved situational awareness of tows on the waterways and automatic collection of related data. Future RIS services are limited only by user needs and imagination.

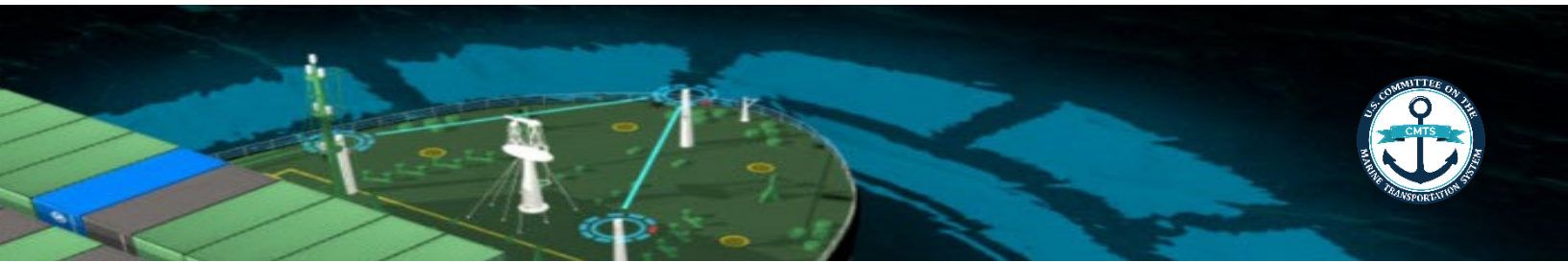
Automated Collection of Weather Observations via Shipboard Automatic Identification System (AIS)

Brian Tetreault, Navigation Systems Specialist, U.S. Army Corps of Engineers

In the aftermath of the sinking of the US-flagged container ship EL FARO in October 2015, one of the recommendations of the U.S. National Transportation Safety Board (NTSB) was to explore increasing the collection of weather data from ships in order to improve weather forecast products. Currently the National Weather Service runs the Voluntary Observing Ship (VOS) program, where ships voluntarily submit weather observations to NOAA. However, only a small fraction of the thousands of vessels sailing worldwide participate in this program, and VOS weather observations are submitted infrequently via a mainly manual process. The US Army Corps of Engineers and the Maritime Administration, in cooperation with NOAA have started a project to investigate the feasibility of automating and increasing the frequency of collection of observations by using existing Automatic Identification System (AIS) equipment installed aboard commercial vessels. A processor aboard a vessel will connect to existing or specially installed weather sensors, process the observations and create an AIS message that can be presented to the ship's AIS transceiver. The transceiver will transmit it (without affecting the normal operation of the AIS) and the transmitted message may be received by other vessels, shore AIS stations, or AIS receivers aboard low earth orbit satellites. Once received, the messages will be parsed, placed in a database, and provided to forecasters or others who find the data valuable. This capability has the potential to augment VOS and increase the number of observations collected, fill in gaps in areas where observations are scarce, and improve ocean weather forecasts.

River Information Services: International Developments and US Implementation

Joe Celano, Director of Operations and Business Development, Trabus Technologies



River Information Services (RIS) is "the concept for information services in inland navigation to support traffic and transport management in inland navigation, including interfaces to other transport modes." RIS has existed as a concept and in operation for over two decades, with most implementation being in the European Union. PIANC has published RIS Guidelines since 2002; these Guidelines have been updated three times, most recently in 2019, to accommodate refinements of the RIS concept, lessons learned in RIS implementation, technological developments, and developments of information services supporting other transport modes such as Intelligent Transportation Systems (ITS) and e-Navigation. The US, while keeping pace in development and implementation of navigation technologies, has lagged behind Europe in RIS implementation. In recent years, the US has stepped up efforts to close this gap, including robust participation in the updates to the PIANC RIS Guidelines, and establishment of a framework for the formal establishment of RIS in the US. This presentation will cover the basics of the RIS concept, international developments including European RIS implementation and the PIANC RIS Guidelines, and the status and plans for US RIS implementation.

Automation of Travel Time Statistics for Improved IMTS Efficiencies

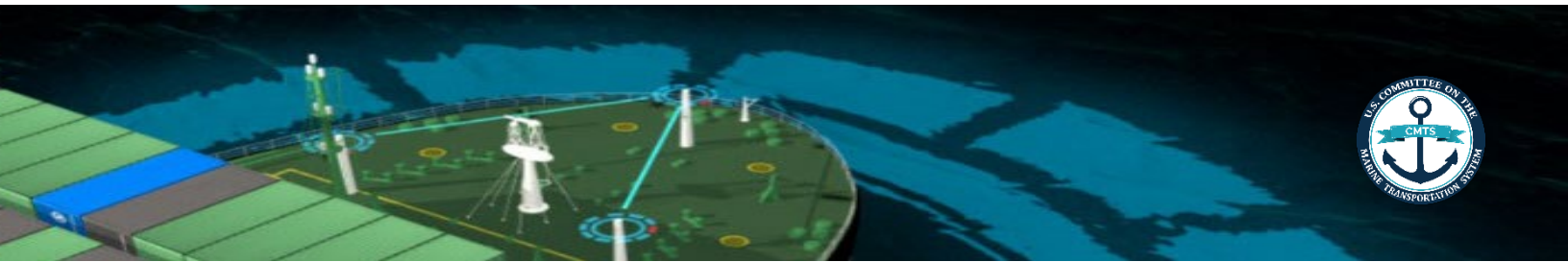
Patricia DiJoseph, Transportation Systems Researcher, U.S. Army Corps of Engineers

The advent of readily available Automatic Identification System (AIS) data, both as an archival record of marine vessel traffic as well as real-time informational feeds, has enabled the U.S. Army Corps of Engineers (USACE) to compile a Travel Time Atlas for the Inland Marine Transportation System (IMTS). This compendium of segment-level statistical summaries provides baseline measures against which future IMTS conditions may be compared, allowing for determination of performance trends through time and system-scale level of service assessments. When combined with River Information Services (RIS) and requisite back-end automation of transit time calculations, the Travel Time Atlas approach transforms into a real-time traffic monitoring capability for the IMTS. Marine operators, voyage planners, and government and industry decision makers will all benefit from a live view of IMTS traffic conditions, and future work will focus on extending these towards near-term projections of waterway traffic congestion.

Remote Lock Operation: Benefits of Automation

Eddie Wiggins, U.S. Army Corps of Engineers

While numerous inland waterways across Europe already use automation for remote operation of locks and bridges, daily operation of U.S. Army Corps of Engineers (Corps) locks is constrained by the technologies that were available at the time the Locks were designed – usually between 50 and 100 years ago. The concept of remote operation of various lock features is well established within the Corps. It is believed that all of the tasks and actions necessary to lock a vessel and tow through an Inland Marine Transportation System (IMTS) lock can be performed remotely. Automating and remotely operating Corps locks will allow one set of operators in a central location to operate multiple facilities, Remote operation of multiple facilities can reduce operation costs and allow more funding flexibility for capital reinvestment and maintenance.



Consolidated staffing would also allow for extended operating hours at facilities that are currently closed during times of low demand, a positive net benefit for industry and recreation users. This economy of scale continues to become more important as operations costs increase and river traffic changes. Several Corps Districts, to include Pittsburgh and Vicksburg, are postured to implement projects that can demonstrate the viability of remote lock operations on a large scaled commercial waterway within the navigation system. Pittsburgh District has a shovel ready project at Grays Landing lock located at river mile 84 of the Monongahela River in Greensboro, PA. The proposed remote operation and control of the lock will be accomplished in two sequential phases. Phase I will consist of remotely controlling the lock from a location onsite that is out of view from the lock. Phase 2 will consist of remotely controlling lock from an offsite location. If implemented across all Ohio River locks, cursory analysis indicates the potential for over $13M in annual savings.

Maritime Data Access

14:00 -15:45 EST

This technical breakout session will showcase and discuss research related to the topic of Maritime Data Access

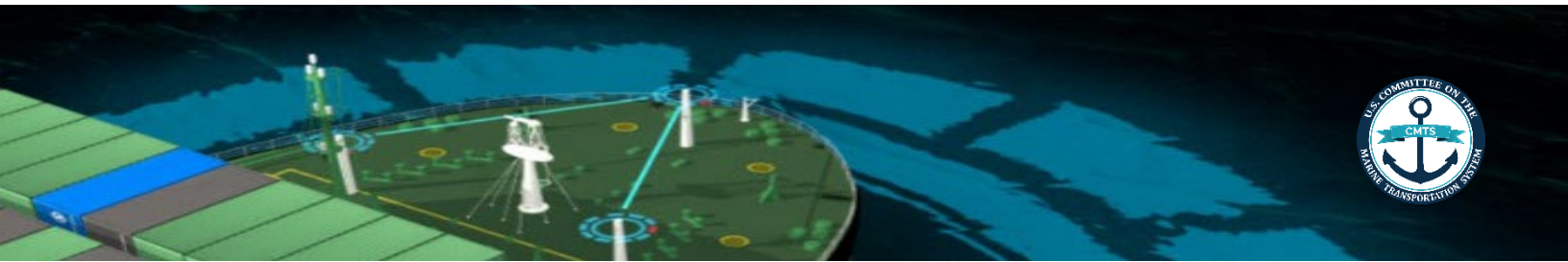
RADM Samuel P. DeBow, NOAA (Ret), Presiding Officer

Transportation and Maritime Analytics Partnerships Hub

Heather Nachtmann, Professor, University of Arkansas

Conducted through the Maritime Transportation Research and Education Center (MarTREC), the Transportation and Maritime Analytics Partnerships Hub (TransMAP) project is led by the University of Arkansas in partnership with the Texas A&M Transportation Institute. This presentation will share ongoing research working to make available large-scale data and visualization tools related to maritime freight transportation on infrastructure, systems, and networks accessible to humans and machines through the Internet of things, in order to enable improved resilience, planning, investment and operational decisions. TransMAP's goal is to develop a 'visual decision space' for effective planning, management, and advancement of efficient, resilient, and sustainable multimodal transportation systems including highway, rail, maritime, and pipeline. Efficient, resilient, and sustainable multimodal transportation is a national priority. To meet the challenging environment of the Nation's complex and ever-changing transportation system, large-scale data sets need to be captured and analyzed to support research and planning, and made available for real-time access for use by government agencies, industry and citizens. Intelligently using big data is critical to manage, improve, maintain, design and build our transportation infrastructure. The research objectives of the TransMAP Hub are to:

• Curate, archive, and disseminate transactional and dynamic data across multiple software



platforms to make a variety of transportation data sets accessible on a real-time basis to government agencies, industry and citizens

• Improve visualization of physical and socioeconomic data related to multimodal transportation in three-dimensional space and over time

• Develop interactive map animations so researchers, citizens, and current and future industries can access data-rich maps to make informed decisions for effective planning, management, and advancement of efficient, resilient, and sustainable multimodal transportation systems including highway, rail, maritime, and pipeline. This presentation will share the goals of the project, discuss ongoing progress, and invite stakeholder input from the audience.

Precision Navigation and the Future of Data Dissemination

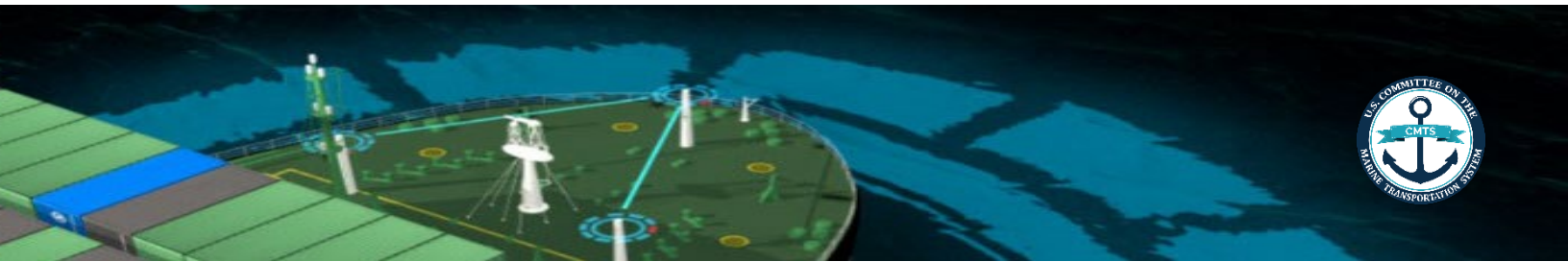
Julia Powell, Chief, Navigation Surveys Division, Office of Coast Survey, NOAA

As ships are increasing in size, mariners are navigating with smaller margins of error, and the tools and data available to support them must adapt to meet these needs. NOAA's Precision Navigation program will provide the mariner with data to make the best decisions from the sea buoy to the berth by creating a dissemination infrastructure for machine to machine distribution of different types of data for navigation. NOAA is the authoritative source for nautical charts, water levels and current measurements, as well as weather forecasts, and other critical real time data within U.S. ports. In order to meet the more precise data needs of mariners NOAA is working to produce a series of different types of datasets such as high resolution bathymetry, surface currents, water levels and forecasts of winds, waves, water levels, and currents for use by electronic navigation systems and under-keel clearance software. This new dissemination site will provide the backbone of Precision Navigation by allowing mariners to access all of NOAA's marine navigation data in a single location. Additionally, NOAA will format these data to meet current and future International Hydrographic Organization (IHO) S-100 suite of standards and provide data discoverability in machine to machine inter-operable formats. NOAA is starting to implement port-specific Precision Navigation projects designed to address the stakeholder defined needs of individual ports. The needs of each port are unique and will require different solutions accordingly. Through Precision Navigation, NOAA will provide high resolution, integrated data for the safe and efficient movement of commerce throughout our nation's maritime transportation system.

A Bibliometric Analysis of Research on Maritime Traffic Data from the Automatic Identification System

Steven Meyers, Chief Scientist, University of South Florida St. Petersburg

Steven D. Meyers1*, Laura C.B.C. Azevedo1, and Mark E. Luther1 1Center for Maritime and Port Studies, College of Marine Science, University of South Florida, St. Petersburg, FL *corresponding presenter, smeyers@mail.usf.edu co-author contact info: laurac8@mail.usf.edu , mluther@usf.edu Submitted to: Enabling Innovative Science and Technology Vessel traffic records from the Automatic Identification System (AIS) are a useful source of training data for maritime-related artificial intelligence (AI) systems, including large autonomous vessels. Basic research in this field provides the foundation for development of

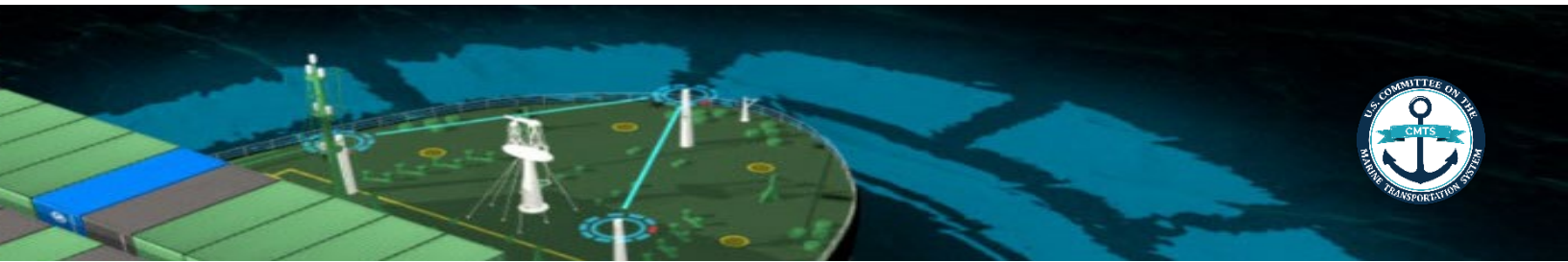


maritime tools that will impact economic growth and security. The distribution of this effort over time and across the globe is examined through a bibliometric study of publications involving AIS data from 1997-2019. The number of publications, authors, and national affiliations of the authors were found. The annual number of publications have increased from about 5 publications per year before 2003, and then roughly doubling roughly every 5 years after that. Overall, authors affiliated with China contributed to 20% of all publications, followed by the US (9%) and Italy (8%). No other single national affiliation represented more than 6% of publications. Publications with at least one member from any EU country were most common, nominally being 40%±10% of total publications. In 2017 publications with at least one China-affiliated author matched this relative level of output, having risen from about 20% in 2007. From 2017-2019 both EU- and China-affiliated authors were listed on about 3 times the number of articles as US-based authors. There has been little international collaboration in this field, with 82% of all publications written by authors based in a single country. US- and UK-based authors were most likely to have collaborative publications with authors based elsewhere. re.

Towards Multimodal Freight Network Modeling: Geospatial Map-Matching of AIS data and Integration with Truck Movements [Student Honor Award]

Magdalena Asborno, Graduate Research Assistant, University of Arkansas

Automatic Identification System (AIS) consists of vessel's traffic data, collected for navigational safety purposes (e.g., collision avoidance). The AIS data is continuous and ubiquitous over time and space, capturing timestamped locations of vessels. Historic AIS data can be leveraged for long-range freight planning purposes, project prioritization, etc. While previous studies successfully reconstructed vessel trajectories from AIS data, they were unable to assign reconstructed trip chains to a representative inland waterway network. The ability to map vessel trips to a waterway network, and for that network to connect to truck and rail networks, is critical for developing true multimodal freight Travel Demand Models (TDMs). This work improves upon existing methods to analyze trajectories from AIS data by developing and applying a geospatial map-matching algorithm to identify vessel trips, assign those trips to a representative inland waterway network, and generate multimodal freight flows integrating water and land side movements. To integrate waterway flows with land side movements, vessel trips identified by the algorithm are fused with truck trips (observed from GPS data) to and from freight port facilities, generating freight port "catchment areas" for project evaluation and prioritization. The methodology is applied to AIS data on the Arkansas River to calibrate and validate algorithm parameters. Multimodal integration results show that each port's catchment area varies significantly, indicating that adopting an arbitrary radial impact area for different ports would lead to inaccurate project benefit estimates. Through the approaches introduced in this work, we highlight the value of AIS data for long-range freight planning and recommend future data elements to be included in AIS datasets. As we experience the rapid evolution of autonomous and automated technologies, we anticipate significant increases in the volume and veracity of vehicle and vessel movement data, giving our approach for trip identification and multimodal catchment area definition continued support.



Port & Harbor Automation

14:00 -15:45 EST

This technical breakout session will showcase and discuss research related to the topic of Port & Harbor Automation

Daniel Hackett, Hackett Associates, LLC, Presiding Officer

Negotiating Tradeoffs in Marine Terminal Automation

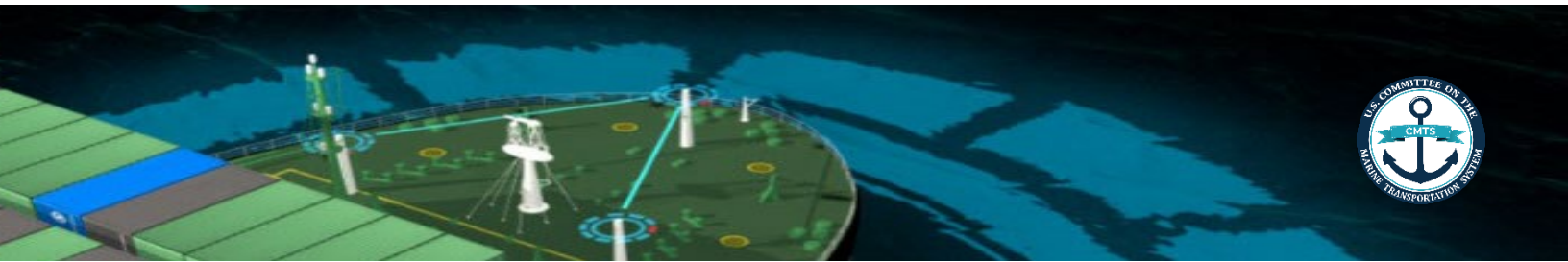
Daniel Smith, Principal, The Tioga Group

This presentation will address the divergence of marine container terminal automation paths between high and low capital approaches, greenfield and brownfield sites, and semi-automated and fully automated approaches. Drawing on examples from North America, Europe, Asia, and Australia, the presentation will address and pros and cons of RMG/AGV systems versus RMG/Auto-strad, RMG/manual strad, and complete auto-strad systems. The presentation will further distinguish between greenfield opportunities and the challenge posed by transitioning existing terminals.

Simulation and Emulation Applications in Planning and Designing Automated Container Terminals

Yu (Alan) Zhang, Sr. Port and Transportation Engineer, Moffatt & Nichol

Developing an automated terminal poses a greater financial risk than developing a conventional manned terminal due to the high initial investment and fixed nature of the infrastructure. Nonetheless, automated terminals have become popular in recent years because, over the long term, automation answers the demand for lower operational costs, cleaner equipment, and more reliable service. Therefore, finding tools that lower the level of risk to implement an automated terminal provides immense value for all concerned stakeholders. Unlike the conventional bottom-up approach that begins with infrastructure design, Moffatt & Nichol promotes a top-down development approach for automated terminals that begins with a clear definition of the project business case, which ultimately defines the required infrastructure. Simulation and emulation play essential roles in this top-down approach by demonstrating and validating the performance of the integrated proposed solution, including infrastructure and equipment, thus lowering development risks. At an early planning stage, discrete event simulation is used to analyze critical terminal areas to evaluate performance capabilities and limitations. Later, a full-terminal simulation is used to investigate the complex dynamics and interactions as in a holistic way for a proof-of-concept, providing decision makers a higher level of confidence in the development. Simulation is especially useful for comparing and optimizing alternatives by experimenting with various factors and strategies. In later stages of terminal development, emulation may be used to link the simulated virtual world to control systems used in real-world operations, such as the Terminal Operating System (TOS) or Equipment Control



System (ECS). Emulation is an excellent tool for assisting in development of control systems, training terminal operators, and optimizing the system performance in a virtual environment. In this presentation, we will discuss the process and include a few our recent project examples that used simulation and/or emulation in automated terminal development.

Utilizing Emerging Technology in Maritime Piloting

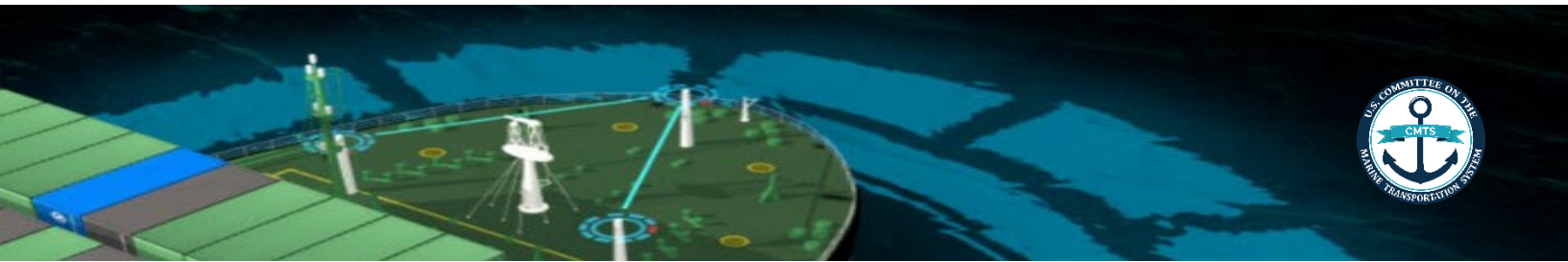
John Betz, Port Pilot, Port of Los Angeles

Call Topic Area: Vessels Technology to assist in situational awareness and decision making Presenter Captain John Betz JD MS MNI Port Pilot, Los Angeles Pilot Service Vice-Chair, Los Angeles / Long Beach Harbor Safety Committee President California Maritime Academy Alumni Association Abstract Utilizing emerging technology in maritime piloting Technology is being incorporated into all phases of maritime port and ship operations and management. Maritime piloting, the business of navigating ships safely within port confines, is an area where opportunity remains to better utilize technology to develop more robust navigation safety systems. Some maritime pilots currently utilize Portable Pilot Units (PPU's) to assist with routine navigation of vessels within port confines and to enable non-routine navigation of vessels such as conducting vessel movements in confined waterways during restricted visibility. One often-discussed advancement is the potential to use technology to enable shore-based pilots to provide navigation assistance to vessels, particularly when pilot boarding cannot be safely undertaken. This presentation reviews the current state of emerging technology as it relates to piloting vessels and explores ways that emerging navigation and communication technologies might be applied to the business of piloting ships with a goal of increasing marine safety and efficiency. The objective is to spark discussion aimed at moving this issue forward by asking: "What might be possible?"

Trends in Container Terminal Infrastructure and Technology

Omar Jaradat, Technical Director, Moffatt & Nichol

There is a growing gap between infrastructure development and technology. Over the past 20 years, increasing container ship size has been a key market driver. Port planners, engineers, and scientist need to prepare for increase automation, upper limits for future ship size, and port infrastructure. This presentation provides insight into future infrastructure development and technology needs based on these factors and suggests steps to maintain resilient port systems. Ongoing growth in ship size requires an integrated approach to infrastructure development and technology to ensure technology advancement, infrastructure resiliency, terminal operations, and sustainability at future container terminals. The continued growth in the use of containerized cargo, ever-increasing ship size, and need to modernize container terminals at US ports require a review of the evolution of container terminals, current and future trends, and needed investments. Research, investment, and information sharing are needed to ensure critical upgrades in US container terminal capacity and infrastructure due to autonomous ships, increased vessel size, and needed upgraded port infrastructure. Container ports are the center of the cargo distribution transportation hub and the most significant contributor to the US

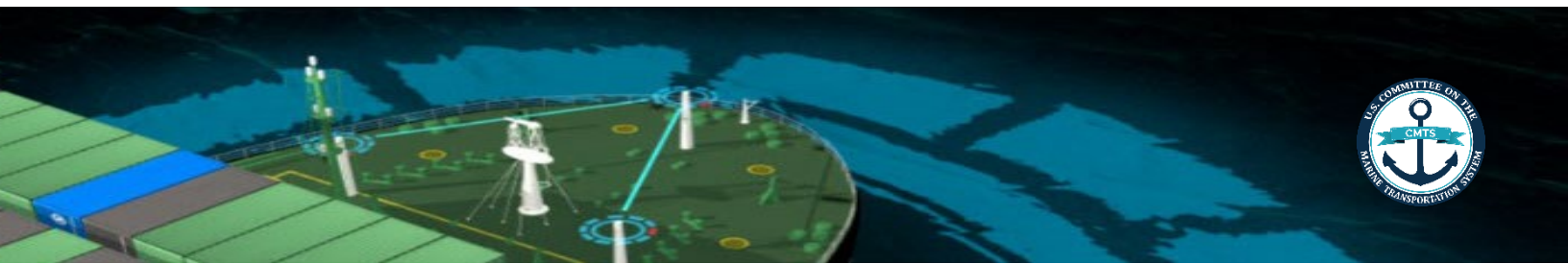


economy. Port cargo activity contributes roughly $4.8 trillion to the economy yearly, over 23 million jobs, and over $320 billion annually in federal, state, and local tax revenues (AAPA 2017). Since an ocean carrier's greatest asset is its ship and a port owner's greatest asset is its infrastructure and these assets can be optimized enhance productivity, data analysis, and integration. Active management and interaction are crucial to provide seamless movement of cargo through the supply chain to consumers. The ability to understand and forecast these changes helps stabilize and reduce risk in the process. This presentation depicts trends and changes in one part of the chain have a cascading effect on the rest of the chain.

A Concept of the Next Generation Container Terminal in South Korea

Sanghei Choi, Deputy President, Korea Maritime Institute

Due to stiff competition between container terminals, port authorities and terminal operators have been trying to improve the productivity of container handling. Since the 1990s, several types of automated container handling systems have been adopted to international terminals. Especially, automated yard cranes are utilized in many terminals and yard trucks are replaced with automated guided vehicles and automated straddle carriers. The Government of South Korea and many stakeholders have also been trying to advance their terminals. The government ordered a project that develops a new concept and equipment of container handling while focusing on high throughput. Korea Maritime Institute performed the project from 2014 to 2018 with Busan National University and many companies for required structures, hardware and software. The core concept of the next-generation container terminal includes such ports that are able to provide high throughput over 350 moves per hour while adopting container handling automation with overhead bridge cranes between aprons to the yard. Therefore, the system has been named overhead shuttle system (OSS). The OSS mainly consists of overhead shuttles and flatcars: Flatcars operate like typical yard trucks but move on rails. Therefore, they are able to move fast while maintaining their planned paths. Overhead shuttles travel along overhead linear lanes to stack and discharge containers, not changing their lanes, and therefore no collision occurs. The prototype of the system was constructed at the end of the project, and a series of experimental tests showed that the system is potentially available in such terminals that require safe, efficient terminal operations.



March 16, 2021

Plenary Two: Automation and Autonomy: Northern European Perspectives and Lessons Learned

10:00-11:45 EST

The international transportation sector is experiencing a modern evolution towards greater demands for cleaner and more efficient logistics solutions that may require dramatic changes to industry practice. Such solutions involve modernization through advanced automation, which purport to increase safety, lower costs, and increase efficiency. Northern European countries are proving to be early adopters and innovators in this space. Panelists will discuss the market conditions, governance, policies, economics, and cultural enablers that have given rise to Northern European early adoption of automation and autonomous technologies. Discussions will include unique partnerships, research collaboration, testbed activity, best practices, and case study examples that have propelled innovations in all areas of marine and freight transportation.

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

Plenary Two Panelists

Sean T. Pribyl, Esq., Senior Counsel, Holland & Knight LLP

Päivi Haikkola, Ecosystem Lead, One Sea Ecosystem

Tom Eystø, Managing Director, Massterly AS

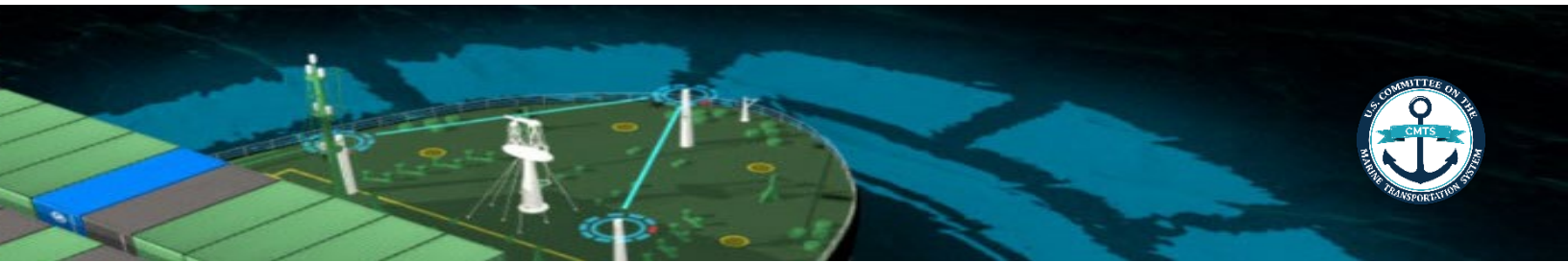
Are Jørgensen, Senior Principal Engineer, DNV GL – Maritime

Martin Aamodt Stensland, Counselor for Trade and Industrial Affairs, Royal Norwegian Embassy

Keynote: Focus on Automation and Autonomy in Marine Transportation

12:00-12:45 EST

This keynote presentation is on the topic "Focus on Automation and Autonomy in Marine Transportation," presented by RADM James A. Watson (USCG-Ret) who is currently the Senior Vice President at the American Bureau of Shipping Global Government Services.



Jeff Lillycrop, Woolpert Strategic Consulting Group, Presiding Officer

Focus on Automation and Autonomy in Marine Transportation

RADM James A. Watson (USCG-Ret), Senior Vice President, Global Government, American Bureau of Shipping

James Watson is currently serving as President and COO for the Americas Division of ABS. He is responsible for all operations of the American Bureau of Shipping in the Western Hemisphere. Prior to joining ABS, Watson served as Director of the Bureau of Safety and Environmental Enforcement at the US Department of Interior. In this role he provided regulatory oversight for energy exploration and production on the US Outer Continental Shelf. Before becoming BSEE Director, Watson served as the US Coast Guard's Director of Prevention Policy for Marine Safety, Security and Stewardship, where his responsibilities included commercial vessel safety and security, ports and cargo safety and security and maritime investigations. He was also designated as the Federal On-Scene Coordinator for the government-wide response to the Macondo incident in the Gulf of Mexico.

Watson earned a Bachelor's of Science in Marine Engineering from USCGA in 1978. He received his Master of Science in Naval Architecture and his Master of Science in Mechanical Engineering from the University of Michigan in 1985. Watson earned an additional Master of Science in Strategic Studies at the National Defense University in 2001.

Use of Point Data to Understand MTS Operations

13:30-15:00 EST

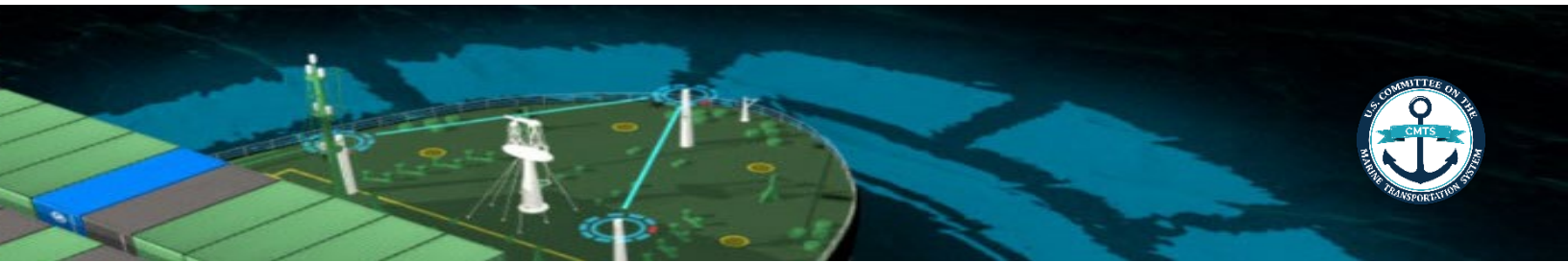
This technical breakout session will showcase and discuss research related to the topic of Use of Point Data to Understand MTS Operations

Heather Gilbert, NOAA, Presiding Officer

A Collaborative Approach for Developing a Port Infrastructure Resilience Guide

Katherine Chambers, Research Scientist, USACE Engineer Research and Development Center

The Cybersecurity and Infrastructure Security Agency (CISA) and the US Army Corps of Engineers Research and Development Center (ERDC) are collaborating on an effort to develop a Port Resilience Assessment and Decision Guide that can be used by multiple federal agencies and decision makers. The Guide aims to provide a holistic understanding of port operations, the infrastructure systems that serve these operations, and analysis methods that can be utilized to understand functional resilience and support investment and other decisions. Resilient ports are able to adapt to disruptions and rapidly restore these transportation functions after disruptions. In order to provide the best possible direction for Guide users, the project team has integrated existing studies, methods and data from CISA and the USACE, as well as additional



resources from US Committee on the Marine Transportation System agencies and partners in order to understand the operational and jurisdictional components of port operations. For the purpose of this research, ports are defined as part of the critical transportation infrastructure that moves goods and people to support national and local health and economic systems and the resilience of communities around them. Therefore, ports are defined to include inland waterway as well as coastal systems of transport operations and functions that require access to land transportation, communications and other systems, systems that may operate among multiple ports.

Assessment and Measurement of Port Disruptions

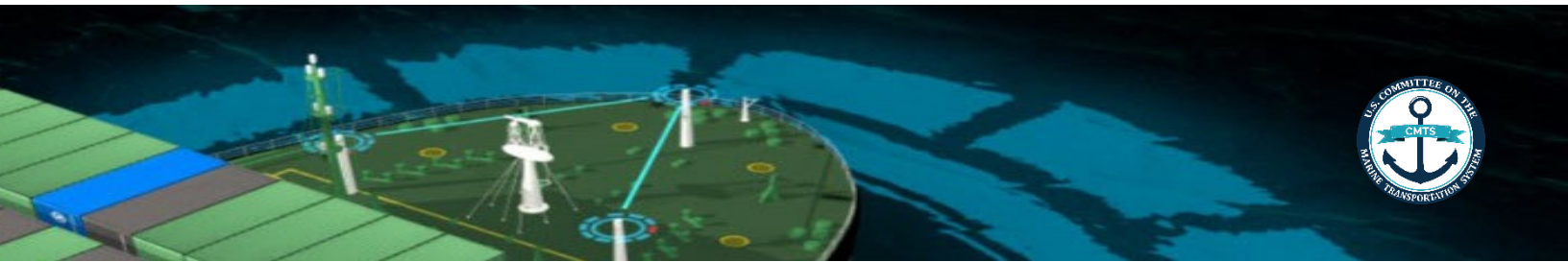
Gabriel Weaver, Research Scientist, University of Illinois at Urbana-Champaign

The Maritime Transportation System (MTS) is critical to global commerce. In 2017, more than 80% of global merchandise trade relied upon the MTS and in 2018, the MTS accounted for more than a quarter of US GDP. Port stakeholders must accommodate larger vessel sizes and coordinate the movement of larger trade volumes to support a global, just-in-time supply chain. As a result, operators increasingly rely upon communications and IT networks to support critical functions that include water and land-side container movements, surveillance for physical security, and port-wide situational awareness. The efficiencies introduced by such systems, however, may increase the ability for an adversary to disrupt commerce by denying resource availability (NotPetya/Ryuk ransomware attacks), compromising data integrity (Port of Antwerp hack), or breaching confidentiality (DC surveillance camera intrusion). Stakeholders need a holistic, system-of-systems approach to risk assessment. In order to address this gap, our research has developed tools to support data-driven risk assessments. Using our Port Disruptions Tool (PDT) stakeholders can simulate cascading disruptions across multiple critical-infrastructures and organizations. Given seasonal commodity flows and an evolving natural and adversarial environment, stakeholders need tools for continual risk assessment. For example, the impact of a ransomware attack may vary depending upon its timing and the location of affected stakeholders. Our approach simulates information and commodity flows through a mulitilayered network of cyber and transportation assets within a shipping port. This approach allows us translate real-world cross-infrastructure, inter-organizational disruptions into general patterns that can then be applied to the context of a specific shipping port. For example, we have analyzed the potential impact of targeted denial of service attacks on the flow of commodities through Port Everglades, FL. Additional collaborators that have informed our research include USTRANSCOM, the Army Cyber Institute, and Ports of Auckland, NZ.

Multi-Modal Marine Applications of Vehicle- and Vessel-Based GPS Position Data at the Bureau of Transportation Statistics

Kyle Titlow, ORISE Spatial Analyst Fellow, Bureau of Transportation Statistics

The Bureau of Transportation Statistics (BTS) is working on several projects that use vehicle probe GPS position data to spatio-temporally analyze passenger and freight transport in the United States. The three primary GPS data sources are (1) automatic identification system ship



locations from the United States Coast Guard and Army Corps of Engineers, (2) aircraft positions from the Federal Aviation Administration's System Wide Information Management platform, and (3) aggregated, anonymized, non-customer-specific truck movements from the American Transportation Research Institute (ATRI). For each, individual vehicle trajectories are represented as a series of continuous points, or "pings", representing respective movements through the national transportation system. The unprecedented nature of this project comes from fusing the location information inherent to each ping (latitude, longitude, date-time, and speed) with any vehicle unique-identifiers (ship and aircraft names and operators are readily available while ATRI trucks are essentially anonymous) and/or by inspecting pings vis-à-vis geographic units (e.g., administrative areas, terminals, networks, etc.). This talk will discuss two of these projects. The first uses ATRI truck data to estimate average truck turn times at seven major U.S. container ports. It hinges on a massive spatial database of pings, collectively representing the movements of approximately one million commercial trucks in the United States between October 2018 and the present. The second is an exploration of potential applications of ship AIS data towards a reinitiated passenger cruise statistics program. Preliminary work has focused on reconstructing and visualizing routes, estimating in-port dwell times, and interrogating the growth of cruises along interior rivers and the Great Lakes. The talk will emphasize statistical and geospatial methodologies (e.g., wrangling "big" GPS data, converting pings to trips, geofencing port terminals, and estimating terminal dwell times) while concurrently highlighting how each helps BTS achieve its mandates. Audience feedback on methods and initial findings is requested.

Autonomous Ships and Technologies II

13:30-15:00 EST

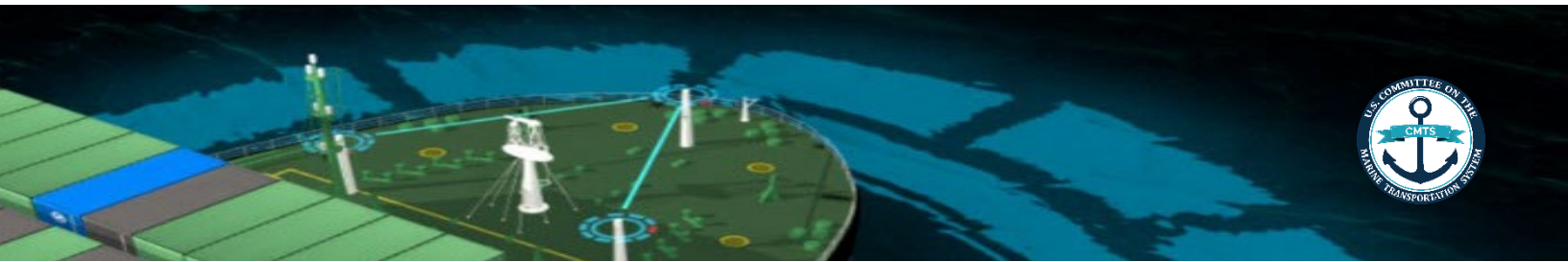
This technical breakout session will showcase and discuss research related to the topic of Autonomous Ships and Technologies

Todd Ripley, Maritime Administration, Presiding Officer

Autonomous Vessel Cybersecurity: Securing the Underlying Foundation

Dean Shoultz, CTO, MarineCFO

As the technologies that empower autonomous vessels mature and grow, so too do the vulnerabilities associated with their use. Improper design planning, as well as continual cyber hygiene and scrutiny, could have disastrous implications. There are numerous technologies, platforms, devices, software applications, firmware versions, data flows, and human processes involved in a single autonomous vessel solution, and the skillsets and disciplines required to properly secure each vary dramatically. It is often beyond the skillsets of a single person to properly assess and secure the compete environment. To properly secure the complete



lifecycle, a top-down, wholistic approach is required. This session will start with an illustration of the technologies involved, including:

• An organizations internal network

• The public cloud

• Private clouds

• A variety of vessel connectivity solutions

• Third-party actors

• Onboard devices and equipment

• Data in motion and at rest

• Sensor and device firmware

• IoT Software and communication protocols

• Identification of passwords, connection strings, and keys

• Network and encryption protocols

It will then condense all these areas into a complete and detailed Attack Surface Map. For each element on the Attack Surface Map, a comprehensive approach to securing that element will be presented, including the various techniques, pit falls, and approaches to doing so. Along the way, the presentation will provide valuable insight and guidance into:

• Vetting the cybersecurity hygiene of vendors and subcontractors

• Mapping the elements of the Attack Surface Map to specific regulatory cyber frameworks items (i.e. ID-AM-1, ID-AM-2, etc.), including NIST 800-153. NIST CSF, SOC and others

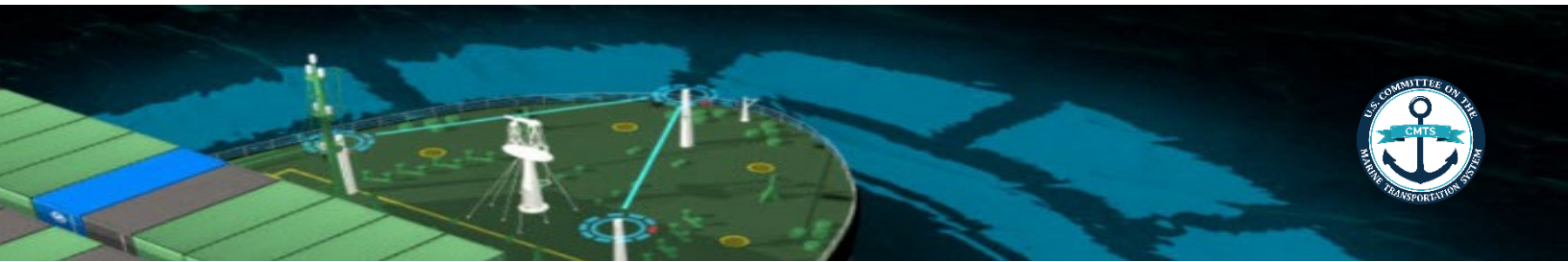
• Creating a continual cyber hygiene and maintenance process to maintain the autonomous vessel after go-live

• Proper reporting to stakeholders and regulatory authorities as to the cyber state of the solution on an ongoing basis The presentation will be explained in simple terms and not assume the audience has steep technical or cybersecurity expertise.

Lessons Learned from Making 10 Vessels Autonomous over 10 Years

Mohamed Saad Ibn Seddik, CEO, blkSAIL

This talk is all the lessons learned from putting autonomy on-board marine vessels ranging more 1 meter long to a 50 meter long ferry with the most advanced system. First, we will explore some of the technical and regulatory limitations of deploying autonomous ships today. We will then focus on the challenges that were faced while deploying the world first autonomous ferry



with COLREGS. And finally, we will challenge the economics of deploying autonomous vessels today.

3D Interactive, Immersive Environments for Reconfigurable Control Centers

Kevin Heffner, Senior Researcher, Pegasus Research and Technologies

The 21st century has been marked by the advent of autonomous vehicles. In recent years, the IMO MASS scoping activity is identifying needed changes to existing regulation while IALA has been developing a set of technical products and specifications that can contribute to the safe introduction of MASS operations for the maritime transport industries. E-Navigation is defined as the harmonized collection, integration, exchange, presentation and analysis of marine information on board and ashore by electronic means to enhance berth-to-berth navigation and related services for safety and security at sea and protection of the marine environment. E-Navigation specifies the need for presentation and analysis of information and calls for employing human-centered design approaches to ensure high usability with the goal of achieving and maintaining shared situational awareness to inform critical decision-making for both conventional ships and MASS operations. MASS operations will require shore control centres (SCC) where crew will remotely monitor and operate vessels. One challenge faced by SCC designers is that of providing shared situational awareness to the remote vessel crew while avoiding information overload. The advent of virtual reality, augmented reality and mixed reality technologies has created new opportunities for interactive, immersion that is required for performing critical tasks. This presentation considers the human as the decision-maker during MASS operations but allows for varying levels of human supervisory control, made possible using automation and considers the use of digital twins and 3D interactive, immersive virtual environments as a key technology for creating reconfigurable SCC is presented.

Autonomous Vessels in National Waterways

Mike Emerson, Director, Marine Transportation Systems, U.S. Coast Guard

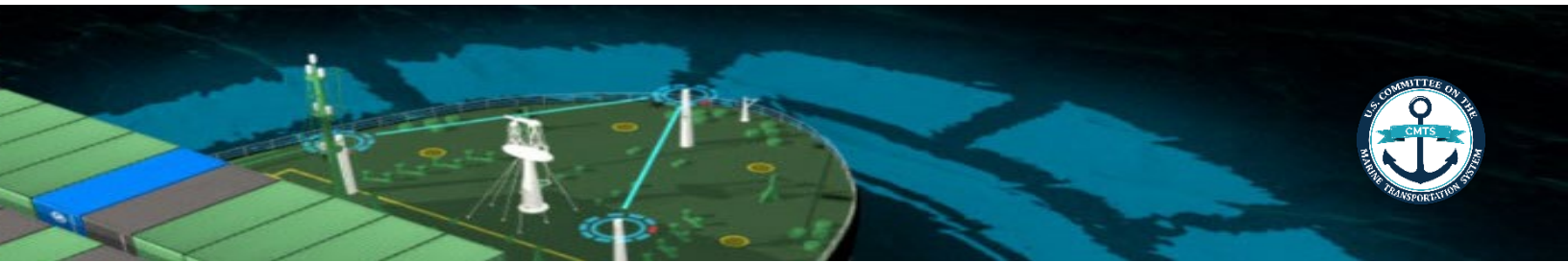
Examination of Captain of the Port authorities and responsibilities that will be factored into marine safety and waterway policies with the admission of automation and autonomous vessels. Navigation safety risk assessments will lead early conversations for thoughtfully integrating these vessels with maritime commerce operators, and other waterway users.

Automation Drivers & Challenges

13:30-15:00 EST

This technical breakout session will showcase and discuss research related to the topic of Automation Drivers & Challenges

Shannon McLeod, WSP USA, Presiding Officer



State and Local Impacts of Automated Freight Transportation Systems

Jolene Hayes, Senior Associate, Fehr & Peers

Project NCHRP 20-102(22) - "State and Local Impacts of Automated Freight Transportation Systems" - is developing insights into the implications of freight industry automation for state and local governments and planners. Within the marine sphere, the study is addressing public sector concerns with marine terminal automation, the possibilities of autonomous vessels, and the critical nexus between marine and landside transportation. The presentation will highlight the types and applications of automation in the marine sector, and the ways in which they will interact. Specific topics will include the state of the art and state of the practice in terminal automation, new-build versus retrofitted automation, and private sector development directions.

Economic Impact Study of Digitization and Automation of Marine Port Terminals in British Columbia

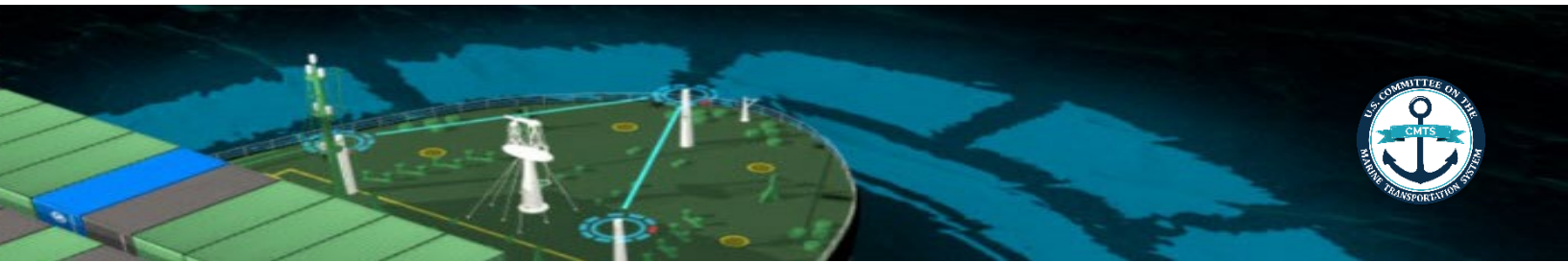
Bob Dhaliwal, Treasurer, ILWU Canada

The impact analysis shows that port automation and digitization would have a substantial effect on local economies. In terms of jobs, the large impact of reduced employment is off-set in a very limited way by increased indirect employment. Greenfield Scenario Fully automated ports , it is estimated that there will be 8,747 fewer jobs across the census sub-districts, with highest loss evident in the district of Delta. The estimated job loss across the sub-districts of Delta, Vancouver and Prince Rupert account for 2% of the total labour force of 431,975. Further, core job loss in Delta, Vancouver and Prince Rupert account for 4% of total jobs paying above $70,000 per year. In Prince Rupert the results are particularly felt as the district would have a larger proportional impact relative to the overall population. Losses in employment income would negatively impact both individuals and the local economy. Not only would there be a significant decline in wages and salaries for core and supporting jobs, but decrease in consumer spending would negatively impact local economies. The termination of employer contributions to employees' pension and benefit plans would also impact them materially. In the most severe case of automation, employment income would decline by a net value of $628M provincially and $577M across census sub-districts, when accounting for the loss in both wages and salaries and loss of employer contribution to pension and benefit plans. In the Greenfield Scenario, the provincial impact of revenues is expected to result in a net reduction of $66.6M in federal tax revenue, $28.9M in revenue for the British Columbia government, and $8.3M for municipalities in British Columbia. It is clear that loss of jobs stemming from automation will have a significant impact on lost wages for individual workers, but also the communities in which they live.

Maritime Clusters: Trends and Challenges in the U.S. Context

Cassia Galvao, Faculty Member, Texas A&M University

Clusters are generally defined as a concentration of industry members in a certain geographic area. These organizations usually agglomerate due to various types of linkages and or competitive advantages present in that region. The maritime sector could be considered as

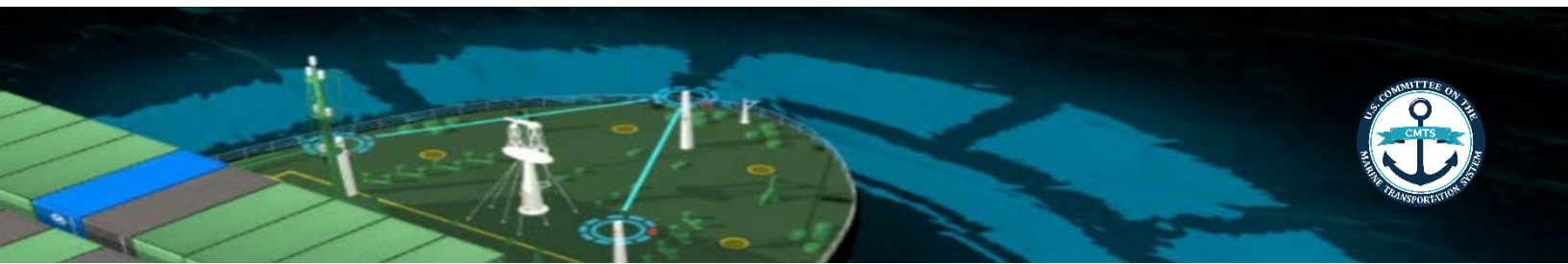


natural cluster formation due to its typical characteristics alongside coastal cities and proximity to markets. In the case of the U.S., we found a dearth in the literature about maritime clusters, despite an abundance of economic impact studies about ports. As such, it is clear the need of investigation beyond the economic significance of maritime clusters. This study builds on the body of knowledge of strategic competitiveness of maritime clusters and aims to investigate the key driving forces and the development stage of maritime clusters in the context of U.S. Giving the country dimensions and diversity of maritime activities, the geographical area selected focused on the seven locations where a Maritime Academy is present, given the strategic importance of the academies supported by Federal Government. We employ a multi-method methodology composed of SWOT analysis; content analysis and case studies techniques to conduct the analysis. Preliminary results indicate two main trends: first, cluster members do not share the same level of information, which impacts knowledge transfer and the benefits associated with that; and second, the need for further innovation applied to the maritime industry, in particular considering the impact of automation and digitalization in the sector. Additional research is being carried out to further investigate the implications for business leaders and policymakers of the intentional development of maritime clusters.

Digitalization and Automation of Ports and Terminals: Policy and Regulation Perspectives

EunSu Lee, Associate Professor, New Jersey City University

Port automation has been discussed and advanced to improve efficiency and mitigate the environmental impact of port activities and infrastructure on society and the environment. This presentation examines the challenges and trends of digitalization and port automation from the perspective of policies and regulations. Policies and regulations should be investigated at various city, state, federal and international levels because of the various ownership and roles of ports and terminals. The analysis is based on a triple-bottom line approach, including social, environmental and economic impacts. The study focuses on U.S. container terminals.



March 17, 2021

Keynote: Focus on European Inland Waterways

10:00-10:45 EST

This keynote presentation will be presented by Dr. Edwin Verberght on the topic of "Focus on European Inland Waterways"

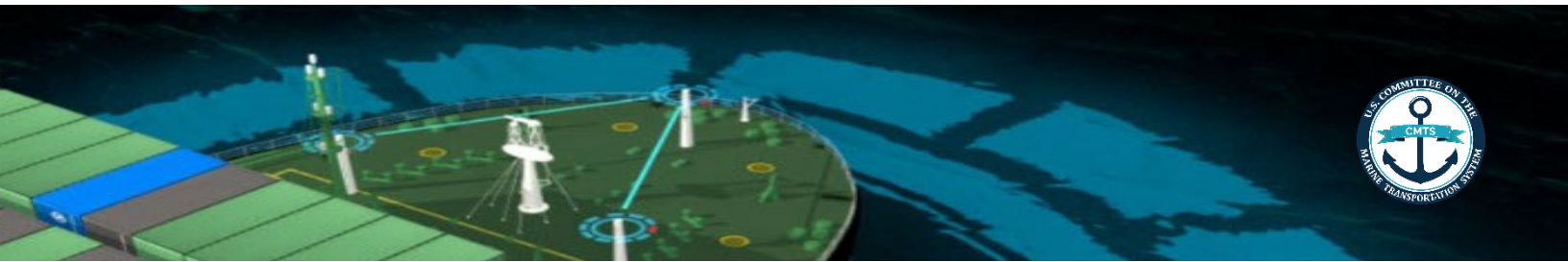
Jeff Lillycrop, Woolpert Strategic Consulting Group, Presiding Officer

Innovation on the European Inland Waterways

Edwin Verberght, PhD, Research Professor, Department of Transport and Regional Economics, University of Antwerp

Dr. Verberght has a PhD in Applied Economics and is a Maritime, Political & Social scientist, has worked as policy officer, a port business analyst and is specialized in Inland Navigation innovation, policy and data analyses. He has a strong focus upon role of (European) policy next to welfare economic analyses. He is the main author of indicator books in freight transport in Flanders and publications concerning innovation in inland navigation such as alternative fuels, automation, RIS, digital applications and small waterways reactivation. He is a former European IWT expert for the Belgian delegation for CCNR, CESNI QP standards and the EU directive concerning crew requirements and was vice-president of the regional examination commission for IWT crews. He is passionate about transport, innovation and especially waterways. Nowadays, he works as a policy officer at the Corporation Inland Tanker Barge Owners with a focus on policy concerning crew, tech, innovation and dangerous goods.

A number of exciting things have been going on in Europe for the past few years. During his research, Dr. Verberght has identified more then 30 IWT innovations and zoomed in on river information services, automated vessel and mooring, alternative fuels (f.ex. LNG, Electricity), small waterway reactivation (pallet shuttle barge, watertruck+) and electronic barge chartering. First part of the presentation will explain innovation and how one can perceive it. This part gives the audience a schematic, a framework and an idea how innovation can evolve. This part is based on the System innovation approach (SIA) and goes back to Schumpeter. A second part is how society benefits of these innovations and how investors look at this. The discrepancy between those views motivated the need for support measures or even penalties. A final part explains the importance of public actors and the role of regulation. This presentation can be of interest for investors, policymakers, financial institutions and of course people in the IWT sector, but it can also be appealing for other transport experts and scholars while the IWT is still a field where a lot of research can be done.



Plenary Three: Multimodal Sector Technology Perspectives

11:00-12:30 EST

This panel will address automation and autonomy innovation from the perspective of multimodal transportation and infrastructure operators. Panelists will highlight the state of play, opportunities and potential barriers to introducing and advancing automation and autonomy in marine transportation, and share their visions for collaboration among federal agency partners, multimodal stakeholders, and the research community.

Craig Philip, Ph.D., Vanderbilt University, Presiding Officer

Plenary Three Panelists

Olivier Cadet, President, Kongsberg Maritime Inc.

Mark Higgins, Director, Motor Carrier Experience, Virginia Internation Terminals, LLC

Jason Merrick, Professor, Virginia Commonwealth University

Albert Barnes, Senior Electrical Engineer, Tetra Tech

Innovations in Data Driven Automation

13:00-14:30 EST

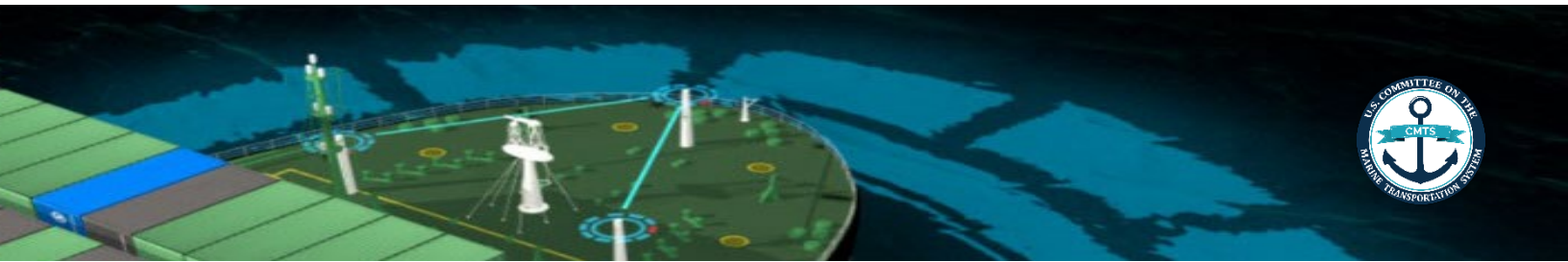
This technical breakout session will showcase and discuss research related to the topic of Innovations in Data Driven Automation

Juan Carlos Villa, Texas A&M University System, Presiding Officer

Blockchain-Based Port Community System Proof of Concept at the Port of Veracruz, Mexico

Juan Carlos Villa, Research Scientist, Program Manager, Texas A&M Transportation Institute

Port Community System (PCS) is a neutral and open electronic platform enabling intelligent and secure exchange of information between public and private stakeholders in order to improve the competitive position of maritime ports communities. Innovative digital technologies, specifically Blockchain, have emerged as potential drivers to improve port operations. Blockchain allows creating a neutral and non-hierarchical PCS through auditability and traceability of transactions by individual stakeholders. Blockchain technology provides a decentralized trust layer where all stakeholders are equal contributors to the PCS. The objective of this project was to demonstrate to the stakeholders, benefits and challenges of automating container export process workflow with a blockchain-based system at the Port of Veracruz, Mexico. The project included identifying port community business problems and needs; define blind spots and role of blockchain in a specific workflow; design and propose various proof of concept blockchain designs; and develop and deploy proof of concept for the container export



process. A web-based application was developed and is being released to stakeholders for use and gather performance measures and identify the benefits of the blockchain-based solution. Implementation challenges and recommendations for future deployment are presented.

The Importance of Adapting Record Keeping Methods for Advancing Human Assisted Automation in Technologically Supported Vessel Operations for Analysis, Safety, and Maintenance

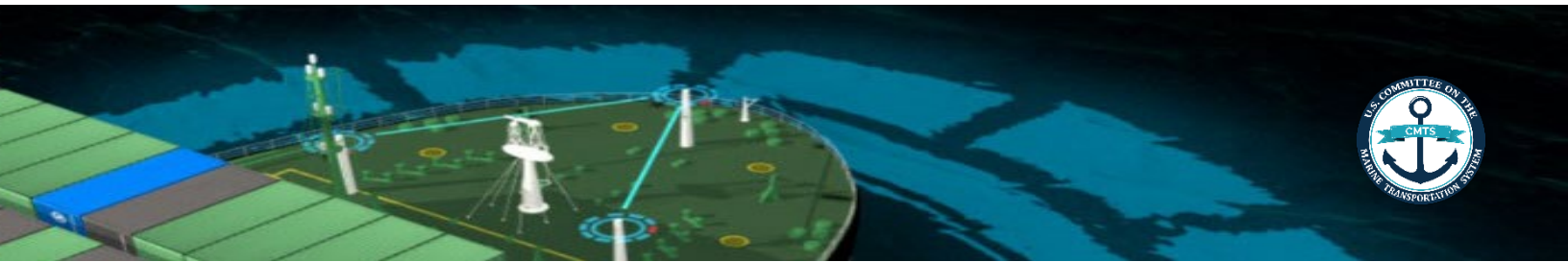
Jaquelyn E. Burton, Technical Manager - Bridge and Automation Product Harmonization, Kongsberg Maritime

Increasing implementation of integrated and automated navigation systems onboard vessels and potentially reduced crew or crewless operations highlights the need for continuous record-keeping via digital logbook systems. Traditionally, logs and record books are maintained by the vessel's officers continuously, with some flag states still requiring them to be kept in a paper format (hardcopy), written by hand, and signed in ink for all entries. This method works in a traditional vessel context, but to support future shipping operations where autonomous or automated systems are creating events that are traditionally logged, more advanced, tamper-resistant, and transparent digital record-keeping methods are needed. Notably, in new cases of operations that have limited or no crew onboard during a voyage to create the records - will still require those records and documents to be maintained demonstrating proper maintenance, operations, and record-keeping for auditors, flag states, and officials for inspection. Currently, we supply an electronic record book (ERB) as an application within our K-Fleet software suite called K-Fleet Logbook. It enables easy access through one single point of entry to multiple logbooks. Supporting increasingly automated systems by connecting various automation and navigation systems, automatic sensor data, and, for crewed vessels, manually inserted events related to operations, maintenance, and inspections. With all data stored securely in a tamper-proof database onboard. Crewed vessels or shore controlled crewless vessels can also utilize automatic triggers or reminders, to ensure that no tasks pass undocumented, or that required entries are left incomplete. At the present time, the U.S. is not accepting the use of ERB's. However, many flag states do approve and authorize ERB's currently as a full replacement of hard copy logbooks. This regulatory challenge will need to be addressed before the commercial introduction of autonomous vessel operations in the United States, whether those vessels are crewed or crewless.

Trade-Off Analytics for Port In-Water Structures

Steve Famularo, Vice President – Marine, McLaren Engineering Group

MARAD's Office of Ports and Waterways is developing an asset management tool for domestic port planning. The pilot program targets in-water structures as critical infrastructure vulnerable to unmanaged risks. The purpose of this application is to provide ports and private terminals with tools to establish risk-based management plans to defend and prioritize funding for capital-intensive assets. The growing need to defend an investment portfolio requires a tool that will appropriately balance risk and revenue growth. While some US ports have developed custom asset registries, these tools do not include the risk-based, multi-objective decision-making that is



the core of effective asset management. This presentation will introduce the trade-off analytics of the Phase 1 tool. Capital projects are scored on their potential to grow revenue, maintain transportation infrastructure in a state of good repair, and mitigate risk. Failure to budget via a robust decision-making process ensures unsatisfactory outcomes in one or more of these areas, along with the often unmanageable complexities that arise from being caught unawares. These categories of capital project value are sufficient to outfit ports amid the increasing intensity and frequency of disruptive natural events and a fiercely competitive global marketplace.

Navigation Safety

13:00-14:30 EST

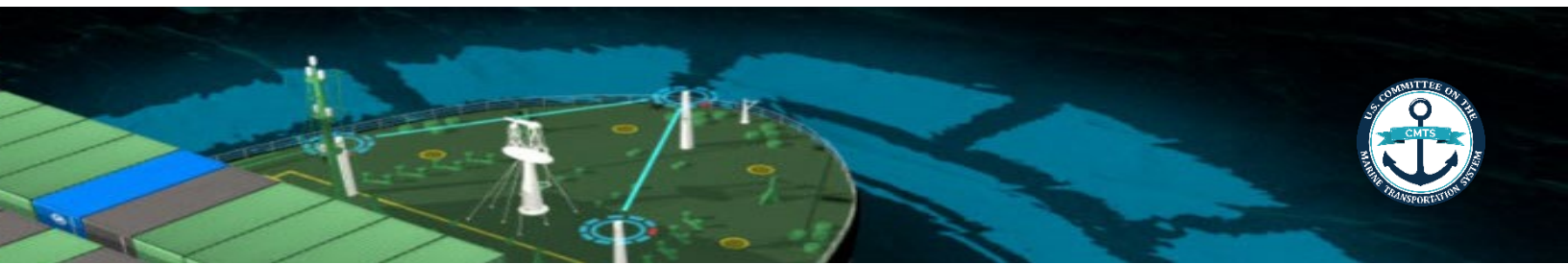
This technical breakout session will showcase and discuss research related to the topic of Navigation Safety

Tracey Mayhew, Paul Hall Center for Maritime Training & Education, Presiding Officer

NOAA Office of Coast Survey Operationalization of Unmanned Vessels for Hydrographic Survey

Damian Manda, Chief, NOAA OCS Hydrographic Systems and Technologies Branch, NOAA Office of Coast Survey

NOAA's Office of Coast Survey (OCS) has been investigating the use of unmanned vessels for hydrographic mapping applications since 2004. These unmanned vessels include: Autonomous Underwater Vehicles (AUVs), Unmanned Surface Vessels (USVs), and Unmanned Aerial Vessels (UAVs). OCS' Coast Survey Development Laboratory (CSDL) has directly conducted, managed, and advised deployments of a wide range of vessels in different use cases in the intervening years. Initially, operations were focused on the use of AUVs for nearshore and rapid response applications. Later, operations were expanded to bathymetric data collection with larger AUV platforms. After the experience CSDL gained from the operation of AUV and the lessons learned about their management and applicability for hydrography, focus shifted to surface vessels. In 2015, CSDL purchased small, human-portable systems and also tested larger USVs, including deployment from a NOAA ship the following year. Through partnerships with academic institutions and other NOAA offices, recent operations have included multiple models of diesel-powered USVs, long-duration Saildrone missions, and conversion of existing hydrographic launches to support optionally unmanned usage. This presentation describes CSDL's testing and use of unmanned systems to facilitate their integration into routine operations. In addition, to advance programmatic readiness, CSDL maintains efforts to improve data processing and train personnel for next-generation methods. Next steps in CSDL research of unmanned systems include: assessment of unmanned launch conversions, dedicated ship-supported unmanned systems, and independent platforms. CSDL is also working on building capacity through training and more personnel experience with unmanned systems.



Safety Elements for Automated/Autonomous Operation on Ships

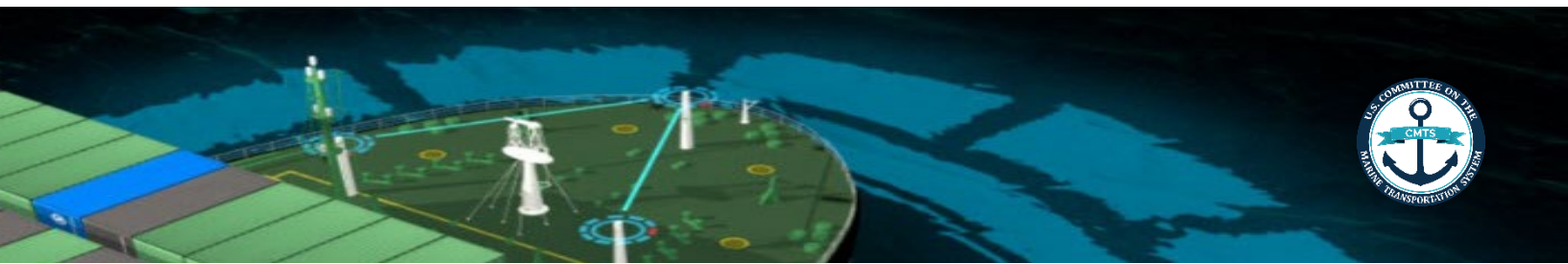
Tomoaki Yamada, ClassNK

Autonomous driving technology has been advanced in automobiles, but the target can be limited to driving. On the other hand, a ship can be considered to be one plant system, and onboard operations can be classified into various functions such as navigation, propulsion, power management, cargo management and so on. These functions can also be subdivided into several operations. Given these circumstances, it is expected that autonomous shipping technology will be designed based on various concepts. It can be said that the direction of the developments can be roughly divided into the following two ways. One is design and development aiming to save the number of crews onboard or unmanned ships for comparatively small ships on with limited short navigation routes, and the other is design and development for partial automation of onboard tasks or remote support, mainly with the purpose of supporting the onboard operation of crews onboard. Although there may be some exceptions, the development of autonomous shipping technology related along the former direction for coastal vessels and the latter for general merchant vessels is expected to progress gradually. Considering the above situation, ClassNK has newly published “Guidelines for Automated/Autonomous Operation on ships ~Design development, Installation and Operation of Automated Operation Systems/Remote Operation Systems~”. The presentation explains the detail of these Guidelines including the requirements in each stage of design and development, installation, and maintenance management during operation of autonomous shipping technology.

The Use of GIS in Automated Navigation Product Support

Guy Noll, Maritime Consultant, Esri

Traditional navigation services by NOAA and USACE have focused on printed publications, recently migrating to be sourced directly from the International Hydrographic Organization S-57 data format. This will eventually be replaced by products and services that are created from data that meet IHO S-100 specifications. Esri supports compilation of these products and services provided from the source data, and will support future product specifications. There are also a newly-emerging class of fit-for-purpose navigation products that can be automated from authoritative databases, and this is part of the transition from traditional raster/paper compilation towards a new mode of navigation with autonomous shipping. Having more than 'robotic sailors', we will need a combination of machine-readable and human-consumable information products that are aligned with expectations of safe and secure transits. NOAA's recently announced "Raster Sunset" leverages the work of Esri in development of Custom Charting that creates opportunities for additional GIS content compiled automatically with traditional navigation products. A proposed best practice in leveraging a combination of authoritative and locally-available and/or crowd-sourced content will be discussed and demonstrated.



Digital Twins

13:00-14:30 EST

This technical breakout session will showcase and discuss research related to the topic of Digital Twins

Matthew D. Smith, U.S. Army Corps of Engineers, Presiding Officer

Non-Contact, Vision-Based Sensing for Health Monitoring of Inland Navigation Infrastructure.

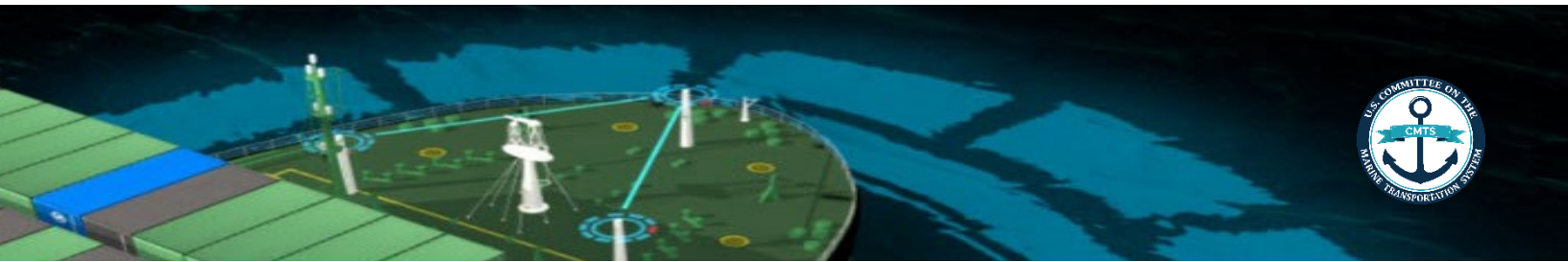
Brian Eick, Research Civil Engineer, US Army Corps of Engineers

Inland navigation infrastructure such as locks and dams are critical to the U.S. economy as is facilitates the transportation of hundreds of billions of dollars in goods annually. Unplanned closure of a lock and dam site for emergency repairs to structural components can have significant economic impacts due to stalled traffic on a river and goods not getting to market. Obtaining information on the condition of inland navigation infrastructure to address small issues before they become major problems is difficult and expensive. To address the difficulty in obtaining information, the US Army Corps of Engineers has recently begun to develop structural health monitoring (SHM) tools to continuously provide inland navigation asset managers the necessary, actionable information they require to allocate maintenance resources to ensure continued operability of their assets. Traditionally, SHM tools rely on a network of sensors installed directly onto a structure to collect the data necessary to assess the condition of the structure. An issue with SHM is that the sensors, cabling, and data acquisition equipment necessary to implement an SHM system can be prohibitively expensive. Recent advances in video technology and video processing techniques are such that videos can now be used to obtain much of the information on the behavior of a structure that would be of interest to an engineer for structural assessment without the need for direct contact to the structure. Accordingly, this discussion focuses on the use of video combined with computer vision techniques to supplement the need for contact sensors. Several examples of vision-based monitoring implemented by the USACE are highlighted, such as measurement of pre-tension in structural components and dense strain measurement. The challenges of video based monitoring are discussed, and the potential for expanded use of computer vision for the implementation of SHM and digital twins is highlighted.

Towards Large-Scale Digital Twins of Maritime Heritage Structures

Falko Kuester, Professor, University of California San Diego

The reefs surrounding Bermuda are home to a broad range of shipwrecks that have become naturalized components of the benthic ecology. Their stories tell of human ambition and courage, as well as adventures, misadventure and tragedy, resulting from failures in marine transportation. Knowing the location and integrity of these shipwrecks in combination with each site's morphology is essential to reconstructing the natural and cultural processes as well as timelines that resulted in the formation of the wreck sites. Faced with the perils of time as well as extreme events, the creation of a comprehensive digital twin is a critical steppingstone

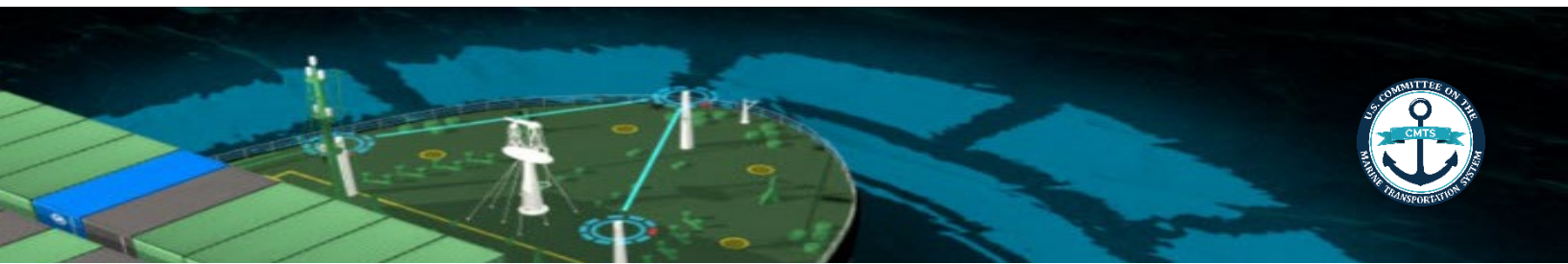


towards structural health and risk assessment, risk mitigation and long-term stewardship. The data acquisition, synthesis and visual analytics workflow required for the creation and exploration of an island-scale digital twin, will be presented and the translational impact on documenting large-scale national infrastructure systems, discussed.

Towards a Digital Twin for Life Cycle Asset Management: Example of Lock Gates

Michael Todd, Professor of Structural Engineering, University of California San Diego

The concept of a digital twin is primarily defined by its use. Digital representations or manifestations of some structural asset may be used for a number of activities including (but not limited to) visualization/curation, state awareness quantification, assessing as-built geometry or other properties, optimization of in-situ monitoring systems, or prediction of performance (e.g., when critical limit states or even failure are expected to occur). Consequently, digital twins take a variety of forms ranging from point clouds to machine learners to physics-based simulators (such as finite element models). This presentation creates a digital twin representation of a deteriorating miter gate system for the purpose of optimizing life cycle costs; such as model may be used to initiate effective risk-informed budget plans for maintenance and repair. In this example, since the physical degradation process related to the quoin block bearing gap evolution in the miter gate is not well-known, a finite element model, trained on the Greenup lock system, is combined with a Markov transition model, and cost models are integrated with probabilistic Markov predictions of damage evolution to yield optimal time-to-maintenance. Comparisons are drawn between optimal solutions employing an autonomous structural health monitoring system (such as SmartGate) versus the solution presented by the current USACE inspection protocols.



March 19, 2021

Closing Session

10:00-12:00 EST

This open forum interactive session will bring forward the key maritime innovative science and technology concepts, research needs, and lessons learned identified during the conference for future consideration and R&D activity

Jeff Lillycrop, Woolpert Strategic Consulting Group, Presiding Officer