MARITIME EDUCATION, TRAINING, RESEARCH & INNOVATION (METRI) VIRTUAL SUMMIT: *IMPLICATIONS FOR EDUCATION, WORKFORCE DEVELOPMENT AND TRAINING*

SESSION 2 REPORT OUT

SESSION 2: ENERGY, PROPULSION & CONTROL SYSTEMS

MODERATOR: EDWARD N. COMSTOCK, MARINE BOARD CHAIR, INDEPENDENT NAVAL ARCHITECT

- **JING SUN, PROFESSOR AND CHAIR, UNIVERSITY OF MICHIGAN**
- **MATTHEW WERNER, DEAN, WEBB INSTITUTE**
- **CAPTAIN MICHAEL R. BURNS JR, DIRECTOR, CENTER FOR MARITIME AND PROFESSIONAL TRAINING, MASSACHUSETTS MARITIME ACADEMY**
- **CHRISTOPHER J. WIERNICKI, CHAIRMAN, PRESIDENT AND CEO, ABS**

MARITIME EDUCATION, TRAINING, RESEARCH & INNOVATION (METRI) VIRTUAL SUMMIT: *IMPLICATIONS FOR EDUCATION, WORKFORCE DEVELOPMENT AND TRAINING*

AUTOMATION AND CONTROL SYSTEMS - JING SUN

1. Transformation in NAME fields
   Was: Ship centric
   Is: Multi platform - ships, offshore platforms, wind turbines, AUVs
   Will be: Marine space oriented - condition monitoring, digital twin
2. Shifting paradigms in marine world associated with autonomy, sensing, electrification, real-time decision support, & active control
3. Marine systems are becoming more "control-intensive"
   a. Control as the "integrator!"

MARITIME EDUCATION, TRAINING, RESEARCH & INNOVATION (METRI) VIRTUAL SUMMIT: *IMPLICATIONS FOR EDUCATION, WORKFORCE DEVELOPMENT AND TRAINING*

4. Control Engineering
   a. Math, signals and systems, estimation and optimization
   b. Domain knowledge in multiple disciplines
5. Feedback & dynamics foundational subjects, as essential as math
6. Control and other "soft-engineering" skills becoming essential to succeed in digitalized, electrified, & automated marine world
7. Multi-disciplinary nature requires leveraging resources across disciplines, institutions, societies in education & workforce training

MARITIME EDUCATION, TRAINING, RESEARCH & INNOVATION (METRI) VIRTUAL SUMMIT: *IMPLICATIONS FOR EDUCATION, WORKFORCE DEVELOPMENT AND TRAINING*

8. Control Engineering curriculum at Univ of Michigan
   a. Generic courses: 2 undergrad, 7 graduate
   b. Domain specific courses: 6 undergrad, 9 graduate
   c. 4 of these courses within NAME
9. Other training and development opportunities
   a. Transportation system industries e.g., auto, aero
   b. Professional Societies, e.g., IEEE, ASME

MARITIME EDUCATION, TRAINING, RESEARCH & INNOVATION (METRI) VIRTUAL SUMMIT: *IMPLICATIONS FOR EDUCATION, WORKFORCE DEVELOPMENT AND TRAINING*

POWER SYSTEMS ENGINEERING - MATTHEW WERNER

1. Pathways to future changes in marine propulsion systems
   a. Continuous improvement of existing technologies e.g., hybrid
   b. Alternative and augmenting systems e.g., sail
   c. Alternative/clean fuels e.g., hydrogen
   d. Development of new technologies e.g., advanced batteries
2. Foundation disciplines for future propulsion systems
   a. Engineering and science fundamentals remain important
   b. Design and systems thinking
   c. Sustainability, data, control and automation, electric power

MARITIME EDUCATION, TRAINING, RESEARCH & INNOVATION (METRI) VIRTUAL SUMMIT: *IMPLICATIONS FOR EDUCATION, WORKFORCE DEVELOPMENT AND TRAINING*

3. Foundation disciplines for future propulsion systems
   a. Essential fundamentals - science, engineering, technology, & design
   b. Sustainability, Economic, Environmental, and Social
   c. Computer Programing, Optimization
   d. Electrical Engineering
   e. Alternative Fuels
4. Workforce development and training opportunities provided by:
   a. Maritime, State, and Union Schools – continuing edu programs
   b. Graduate programs in marine engineering and other disciplines
   c. Professional and class societies, equipment manufacturers

MARITIME EDUCATION, TRAINING, RESEARCH & INNOVATION (METRI) VIRTUAL SUMMIT: *IMPLICATIONS FOR EDUCATION, WORKFORCE DEVELOPMENT AND TRAINING*

5. Research opportunities
   a. Data, Data, Data – collection from active ships & equipment manufacturers made available to researchers
   b. Robust modeling of ship and propulsion system
   c. Methodologies for sustainability-based analysis of propulsion system options
   d. Reliability and risk-based assessment approaches to inform adoption of autonomous vessels and remotely supervised shipboard systems

MARITIME EDUCATION, TRAINING, RESEARCH & INNOVATION (METRI) VIRTUAL SUMMIT: *IMPLICATIONS FOR EDUCATION, WORKFORCE DEVELOPMENT AND TRAINING*

OFFSHORE WIND - CAPTAIN MICHAEL R. BURNS, JR.

1. Future growth opportunities for USCG credentialed mariners
   a. Operate construction/transport vessel, supply/support craft
2. Require traditional USCG licensing & STCW, nav/safety training
3. Require specialized skills: propulsion systems, dynamic positioning, crew transfer, power plant/aux/steering/hab/internal power ops
4. Foundational disciplines for energy sys design, ops, maintenance
   a. EE, mech, civil, marine, environmental, quality, health/safety

MARITIME EDUCATION, TRAINING, RESEARCH & INNOVATION (METRI) VIRTUAL SUMMIT: *IMPLICATIONS FOR EDUCATION, WORKFORCE DEVELOPMENT AND TRAINING*

5. Multiple schools now offering undergrad/grad programs, courses, degrees, with synergies in Offshore Wind (OW) Energy, and incorporating Global Wind Organization (GWO) training
   a. MASS Maritime: Engr/Mgmt 7 BS deg/3 MS deg/GWO training
   b. UMASS-Amhurst: Wind Energy Center 1 MS Mech deg/1 grad Cert
   c. UMASS-Lowell: Center for Wind Energy, Research and Education
   d. Tufts Univ: OW Energy Engr PB courses/1 MS deg/1 PhD deg
   e. Bristol CC: OW Power 2 Technician Cert/1 AS deg/GWO courses
   f. Univ of Delaware: OW Skills Academy (not for vessel operators)

MARITIME EDUCATION, TRAINING, RESEARCH & INNOVATION (METRI) VIRTUAL SUMMIT: *IMPLICATIONS FOR EDUCATION, WORKFORCE DEVELOPMENT AND TRAINING*

6. Research opportunities are emerging e.g., explore requirements and demand for CTV operators, expanding GWO suite, helicopter hoisting, industry safety practices
7. Massachusetts investing in OW workforce development
8. Institutions developing pathways to enter OW industry at many levels
9. Working with OW industry to meet workforce needs

MARITIME EDUCATION, TRAINING, RESEARCH & INNOVATION (METRI) VIRTUAL SUMMIT: *IMPLICATIONS FOR EDUCATION, WORKFORCE DEVELOPMENT AND TRAINING*

ALTERNATIVE FUELS - CHRISTOPHER J. WIERNICKI

1. Pathway to 2050 net zero carbon emissions will be a combination of alternative fuels and energy sources, technology improvements, and operational efficiency
2. Fuel pathways:
   a. Short-term Carbon Reduction: HFO/bio diesel, LNG, alcohol
   b. Mid-term Carbon Neutral: gas to liquid fuels, bio or electro-methane/methanol
   c. Long-term Zero Carbon: bio & electro fuels, hydrogen, ammonia

MARITIME EDUCATION, TRAINING, RESEARCH & INNOVATION (METRI) VIRTUAL SUMMIT: *IMPLICATIONS FOR EDUCATION, WORKFORCE DEVELOPMENT AND TRAINING*

3. Fuel type maturity and transition driven by number of factors:
   a. Infrastructure – existing or adaptable bunkering infrastructure or facilities e.g., import/export terminals
   b. Security of supply - sufficient global production to meet demand
   c. Energy density - volumetric energy content, on-board storage req'ts
   d. CO_2 and SO_X - impact on emissions
   e. Safety - handling, storage, and consumption risks
4. Technology readiness level and savings ranges are quite variable
   a. Savings: 20% LNG, 75% bio-ammonia/methanol, 8%-95% electric
   b. TRL: 9 LNG, 6-9 for bio-ammonia/methanol, 7 electric

MARITIME EDUCATION, TRAINING, RESEARCH & INNOVATION (METRI) VIRTUAL SUMMIT: *IMPLICATIONS FOR EDUCATION, WORKFORCE DEVELOPMENT AND TRAINING*

5. Fuel consumption forecast to 2050
   a. Oil based fuel steady decline to ~40% as alternatives emerge
   b. LNG as transitional fuel grows and holds steady at ~10%
   c. Ammonia/hydrogen increase to ~35%, methanol/biofuels ~15%

6. Talent equation transformation
   Was: Age + Experience + Skills + Training = Talent
   Is: ((New Tech + Rate of Change) + People) + Learning = Talent

CONTINUOUS LEARNING IS ESSENTIAL