

Power Systems Engineering

Maritime Education, Training, Research & Innovation Summit

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Future Changes in Marine Propulsion Systems – Historical Perspective

- 1800s –Steam ships develop
- 1830s – Screw propellers develop
- 1880s – Electric-powered boats develop
- 1892 – Rudolf Diesel invents the “diesel engine”
- 1894 – Steam turbine employed in a shipboard application
- 1940s – Steam power begins to be replaced by diesel power
- 1955 – First nuclear powered ship
- 1959 – LNG becomes a marine cargo
- 1970s – Energy crises
- 1980s – Climate change focus develops



Future Changes in Marine Propulsion Systems – System Perspective

- System of Systems
 - Geopolitical Framework
 - Economic System
 - Transportation System
 - Ship
 - Propulsion System
- System design drivers
 - Mission or need
 - Technology development
 - Constraints
 - Physics based
 - Economic based
 - Social/Political based



Future Changes in Marine Propulsion Systems - Pathways

- *Continuous improvement of existing technologies*
 - Electronically controlled diesel engines
 - Advanced heat recovery
 - Emission control/treatment systems
 - Hybrid systems
 - Electric systems and propulsion
- *Alternative and Augmenting Systems*
 - Sails
 - Solar
- *Alternative/Clean Fuels**
 - LNG
 - Biofuel
 - Hydrogen
 - Ammonia
 - Methanol
- *Development of new technologies*
 - Advanced batteries
 - Energy storage
 - Fuel cells
 - Modular reactors



Foundation Disciplines for the implementation of future propulsion systems

- Engineering and science fundamentals remain important
 - Basics of science and engineering science – empower understanding
 - Ability to learn and think – technology will change, constraints will change
- Design and systems thinking
 - Big picture vs. narrow focus
 - Challenges to implementing technological innovation
- Sustainability
 - “There’s no such thing as a free lunch”
- Data
 - Collection and analysis
 - Enabling better decision making
- Control and Automation
 - Autonomous systems are here now!
- Electric Power
 - Generation, storage, transmission, and utilization



Undergraduate Education of Marine Engineers

- Fundamentals are essential – science, engineering, technology, and design
 - Currency is critical
- Sustainability
 - Economic, Environmental, and Social
- Computer Programing
 - Data Analysis
 - Automation
- Optimization
 - Problems
 - Methods
- Electrical Engineering
 - Power
 - Control, Monitoring, and Automation
- Alternative Fuels



Workforce Development and Training Opportunities

- Maritime Training Schools and Union Schools
- State Maritime Schools – continuing education programs
- Graduate Programs – Marine Engineering
 - USMMA
 - U of M (NAME)
 - EU, Asia, Australia
- Graduate Programs - Other
 - Mechanical engineering
 - Aerospace engineering
 - Electrical engineering
 - Environmental engineering
- Professional Society - continuing education programs
- Classification Societies
- Equipment Manufacturers



Research Opportunities

- Data, Data, Data – collection from active ships and equipment manufacturers made available to researchers
- Robust modeling of ship and propulsion system
- Methodologies for sustainability-based analysis of propulsion system options
- Reliability and risk-based assessment approaches to inform the adoption of autonomous vessels and remotely supervised shipboard systems

