Naval Engineering Workforce Development

ONR Code 33
Sea Warfare and Weapons Department

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*ACCELERATING TO THE NAVY & MARINE CORPS AFTER NEXT*

Issue

- Major shipbuilding programs are ramping up
- NAVSEA –Warfare Centers are all hiring to meet demand signal
- Employment of marine engineers and naval architects is projected to grow 12 percent from 2016 to 2026, faster than the average for all occupations (US Dept of Labor – Occupational Outlook)
- Additional skill sets are needed, and there is more competition for talent
- Lack of experienced ship design managers

National Naval Responsibility for Naval Engineering (NNRNE)

Objectives / Goals

- Investing and stabilizing sufficient resources (funding and staff) in the relevant programs;
- Maintaining seven key S&T areas in naval engineering;
- Sustaining, in conjunction with industry, an infrastructure for innovative shipbuilding concept;
- Issuing an annual Broad Agency Announcement (BAA) for graduate fellowships and post-doctorates; and
- Developing University/Industry/Laboratory Consortia that focus on naval engineering relevant S&T
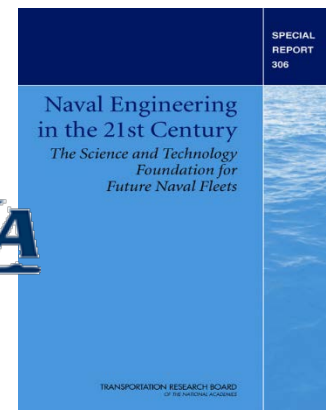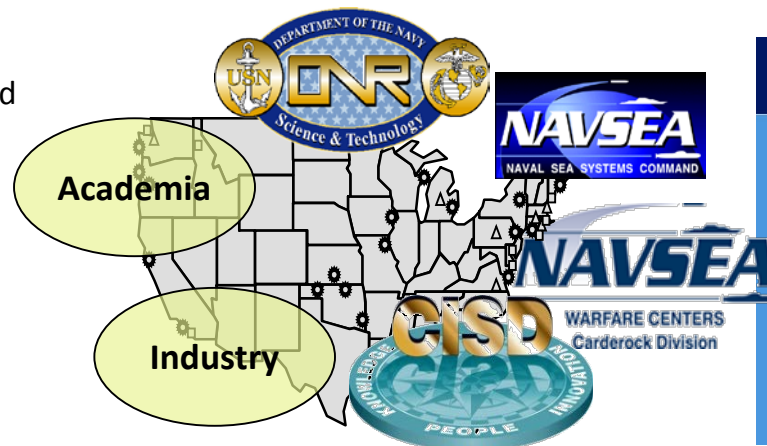
Technical Approach

- Formulate investments in seven key S&T areas in naval engineering.
  - *ship design tools* *ship structural materials*
  - *hydrodynamics* *advanced hull designs* *ship propulsion*
  - *ship automation* *systems integration*
- Focus on development of people, knowledge, and concepts to support the science of Naval Ship Design
- Establish Centers for Innovation in Naval Technologies (CINTS)
- Support research/ STEM partnerships

Naval Relevance / Impact

- Robust research expertise is sustained in the US working on long-term problems of importance to the DON
- Adequate pipeline of new researchers, engineers and faculty continues

Recent Accomplishments (FY17)

- 230+ graduate students supported
- 22 Postdocs supported
- 76 MS Graduated
- 32 PhD Graduated
- 107 Papers published
- 4 patents Awarded

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Education

Objective:

- Provide capable and knowledgeable future workforce in Naval Engineering.
- Maintain and enhance education infrastructure (programs, departments) to ensure education and research programs.

Approach:

- Partner with professional societies to create venues for student interaction with Navy Labs, design Agents, and focus Universities
- Leverage existing K-12 technology education infrastructure.
- Include real world Navy challenges
- Leverage existing programs in outreach and education
- Expand existing local programs
- Insert outreach efforts into undergraduate level engineering courses.
- Focus ONR efforts on advanced degree capabilities.
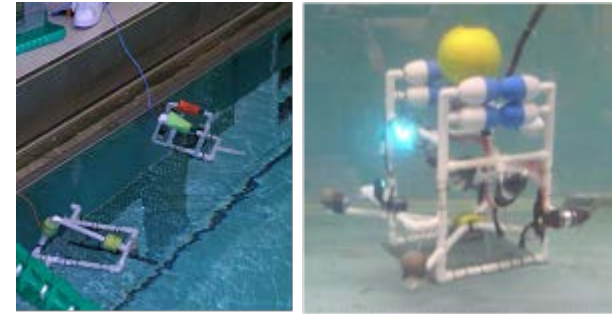
Navy Unique:

- Require US citizens to work in naval facilities.
- Engineering optimizations in platform design and build different then private sector.
- Undersea naval engineering opportunities very limited in private sector.
- Amphibious capabilities.

Payoff:

- Development of an Experimental Introduction to Marine Engineering
- Increase in student awareness of Naval Engineering course of study
- Expansion of Sea Perch Program using Society of Naval Architects and Marine Engineers
- Expansion of number of teams participating in AUV Competition
- Feedback from schools – enrollment in these programs is increasing, direct links to this effort

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Centers for Innovation in Naval Technology (CINTs)

Objectives

- **To sustain the capability i.e., people, tools, and knowledge, to develop future innovative naval technologies**
- **To maintain a pipeline of people capable of substantive research contributions to the naval research enterprise**
- **To reinvigorate interest in Navy unique research and technology development through topical, short term innovation cell activities**
  - Information Warfare: SPAWAR San Diego
  - Center for Innovation in Ship Design: NSWC Carderock
  - Littoral Warfare Innovation Center: NSWC Panama City
  - Center for Innovative Machinery Design and Integration: NSWC Philadelphia
  - Warfare Innovation Cell Knowledge for Educational Development: NSWC Dahlgren
- **Annually, each CINT selects topics from many sources; PEO Ships, OSD, NAVSEA, Warfare Centers.**
- **NREIP students, interns, summer faculty and new employees investigate, act, and report back.**

Digital ship design tools

CISD Carderock
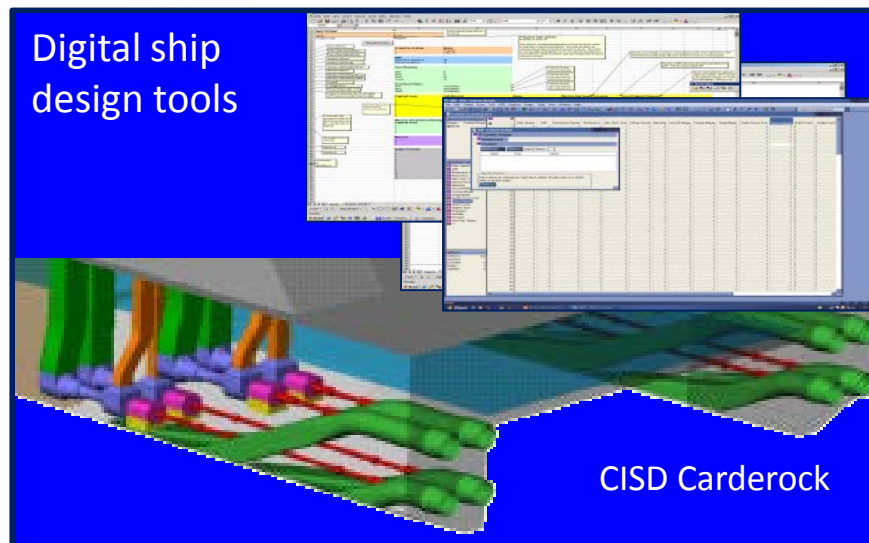
Recent Accomplishments

CINT	FY15-17	
	# of Students	# of hires
CIMDI	46	6
CISD	54	7
LWIC	24	1
WICKED	66	3
IW - SPAWAR	32	0
Totals	222	17

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Center for Innovative Machinery Design & Integration NSWC Philadelphia
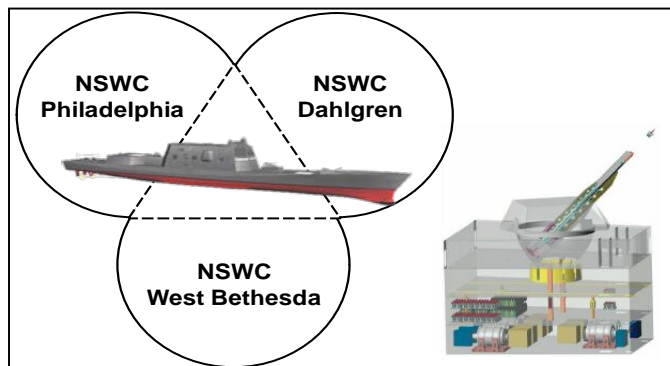
Objectives:

People
✓ Educate and develop the next generation of naval power engineers

Knowledge
✓ Advance the theory and practice of shipboard energy networks
✓ Explore new and innovative ways to develop naval shipboard electric power architectures

Innovation
✓ Provide an environment to develop and assess innovative ship technologies & concepts quickly


Examples of Research & work in 2016-2017

Year	Project Title	Associated Work
2017	UXV Launch & Recovery - Equipment Database & Concept Refinement (2016-2017)	* Launch & Recovery Database Development; * FDECO - Power and Data Transfer for Unmanned Vehicles
2017	Total Thermal Management System Modeling - DDG51 Chilled Water System (2016-2017)	* Smart Ship Systems (S3D) Tool Development, Electric Ship Research and Development Consortium; * SBIR Topic Title: Automated Method for Developing Concept Level Cooling Distribution Systems
2017	Integrated Electrical, Thermal, & Controls Assessment with Shared Energy Storage for Machinery Systems (2016-2017)	* PMS 320 Work on Energy Storage Modules: Zonal Distribution Systems, Shared vs Dedicated Energy Storage, Load Leveling, Rating/Cost/Size Impact; * Combat Power and Energy System Integrated Product Team (CPES OIPT)
2017	Sustained Power Loading for Integrated Combat Energy (SPLICE, 2015-2017)	* Collaboration with Dahlgren on SPLICE; * Ship Electric Power Status System (ShEPSS); Aegis Weapons System (AWS); * Energy Storage Unit (ESU) Modeling; Machinery Control System (MCS) Modeling
2016	Unmanned Vehicle Launch & Recovery - Benchmarking & Concept Exploration (2016-2017)	* Launch & Recovery Database Development; * FDECO - Power and Data Transfer for Unmanned Vehicles
2016	Thermal Management Systems Engineering - Tool Assessment (2016-2017)	* Smart Ship Systems (S3D) Tool Development, Electric Ship Research and Development Consortium; * SBIR Topic Title: Automated Method for Developing Concept Level Cooling Distribution Systems
2016	Shared Energy Storage - Benchmarking & Modeling (2016-2017)	* PMS 320 Work on Energy Storage Modules: Zonal Distribution Systems, Shared vs Dedicated Energy Storage, Load Leveling, Rating/Cost/Size Impact
2016	Integrated Risk Assessment - Calibrating Uncertainty	* PMS 320 Risk Database; * PMS 320 Naval Power Systems Technology Development Roadmap; * Combat Power and Energy System Integrated Product Team (CPES OIPT).

# Center for Innovation in Ship Design (CISD)
NSWC Carderock

Objective / Goal

Through an integrated approach to People, Knowledge, and Innovation activities, the CISD will foster collaboration within the naval ship design community, and nurture interest and develop experience in the field of naval engineering
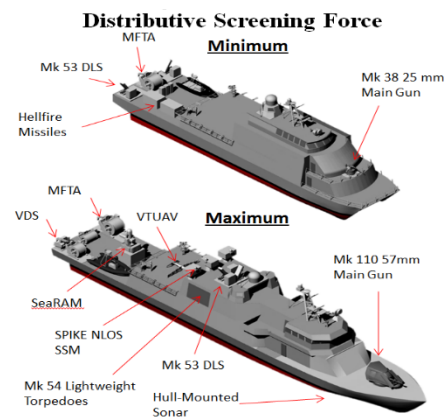

Desalination Renewable Alternative Green Ocean Network (DRAGON)
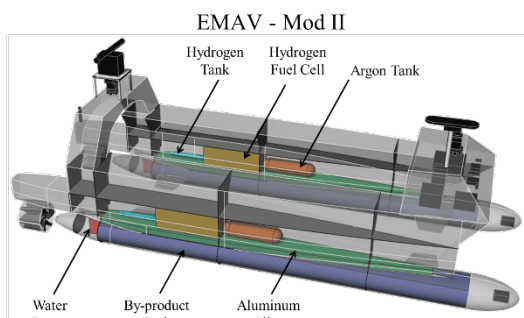
Electronic Module Autonomous Vehicle Mod II
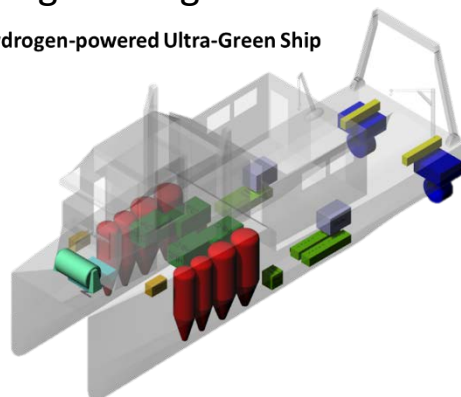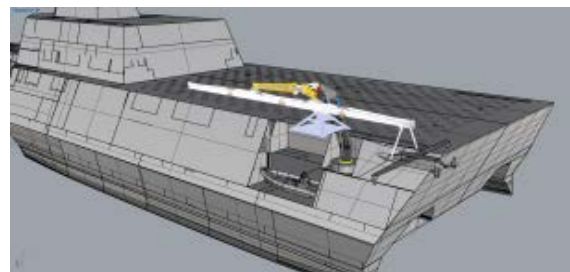

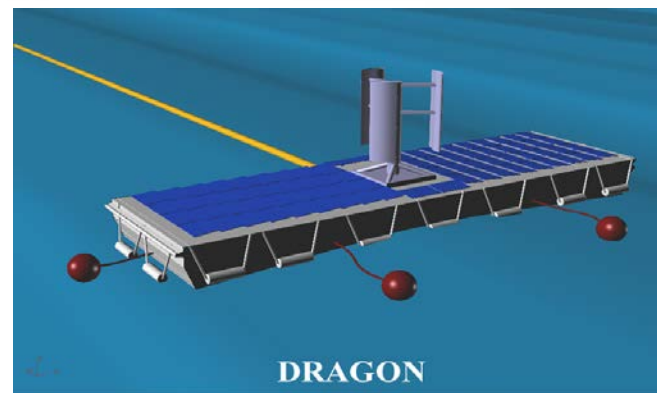**Ultra-Green NOAA Fisheries Vessel**

Distributed Screening Force

SideARM Unmanned Air Vehicle Ship Integration
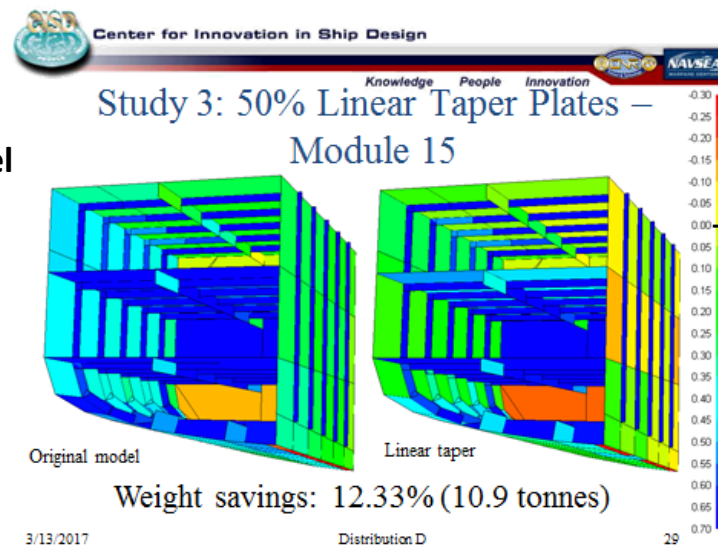
Structural Optimization for a 3D printed Ship

Science, Technology, Engineering & Math
SeaPerch, RoboBoat, RobotX

Objective / Goal
- SeaPerch creates awareness of, develops interest in, and encourages pursuit of degrees and career fields in STEM through hands-on experiential learning activities.
- RoboBoat competition is to enhance the community of innovators capable of substantive contributions to the domain of autonomous unmanned surface vessels (USVs).
- RobotX expands RoboBoat and RoboSub to multiple vehicles performing cooperatively in all domains.

Technical Summary of Research
- SeaPerch K-12 Basic introduction to Remotely Operated Vehicles (ROVs)
- RoboBoat – combines systems engineering thinking through sensor/platform integration
- Increasing focus on Autonomy

Major Participants
- AUVSI Foundation
- NSWC, NUWC

Funding
Funded through NNRNE

Participants in RoboBoat and RobotX are self funded

Recent Accomplishments
- 10th RoboBoat June 2017 Daytona Beach, FL will include Unmanned Aerial Vehicles
- Annual SeaPerch Challenge May 19-20 at Georgia Tech
- RobotX 2016 – Keeho Lagoon, Sand Island, Oahu, December (held biennieally)

Key Milestones / Projected Transition
- SeaPerch becoming a self-sustaining program
- SeaSense adds data collection to SeaPerch
- RobotX 2017 – Sydney Australia will include virtual simulation environment for testing algorithms and provide a venue for publication of research utilizing the WAM-V

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Objective / Goal

- RobotX competition enhances the community of innovators capable of substantive contributions to the domain of autonomous unmanned surface vessels (USVs) cooperating with unmanned aerial vehicles (UAVs) and autonomous underwater vehicles (AUVs).
- RobotX provides a venue and mechanism whereby the practitioners of the autonomous USV community form new connections and collaborations, increase their proficiency and inventiveness, and foster their passion for robotics and all domains.

Technical Summary of Research

- Multi-domain cooperative behavior required
- Increasing focus on autonomy
- Perception, decision making, and actuation

Major Participants

- AUVSI Foundation
- Singapore MinDef
- Australia DTSG
- Navatek

Funding

Event funded through NNRNE, Singapore MinDef, Navatek

Each participating team self funded

Recent Accomplishments

Competition conducted in Kehee Lagoon

- 13 University teams from US, Australia, Singapore, South Korea, and Japan
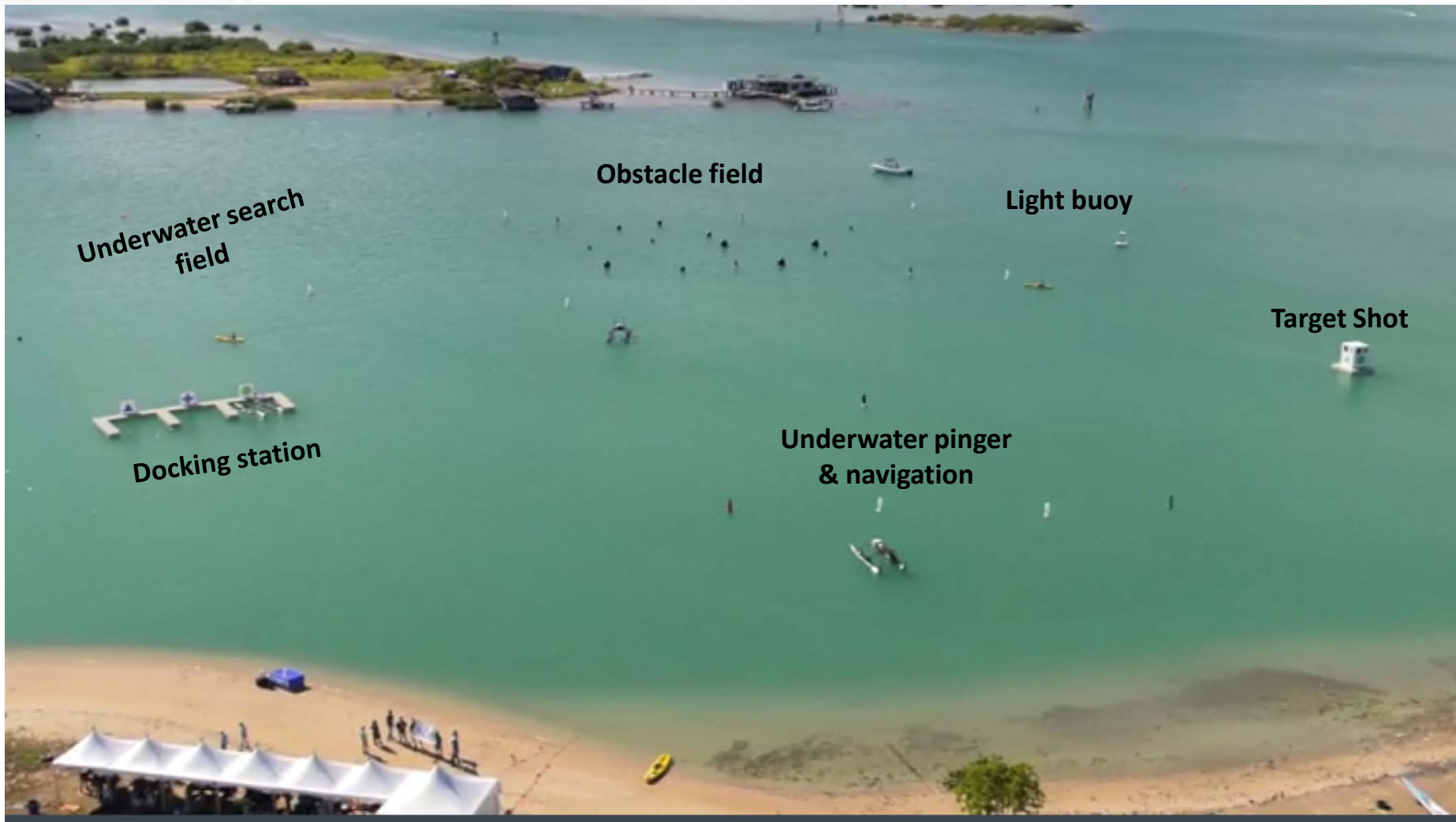
Research being conducted at multiple universities utilizing the WAM-V

- FAU, ERAU, MIT, Newcastle, Flinders, QUT, NUS, Harbin

Future Schedule:

- RobotX 2017: Sydney Australia
  - Virtual simulation environment for testing algorithms
- RobotX 2018 – Hawaii
- RobotX 2019 – TBD
- RobotX 2020 – Singapore

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International Maritime RobotX Challenge

Aerial view of one RobotX Course – Keehi Lagoon, December 2016