ONR Supporting Shipbuilding "Speed at the Point of Need"

2023 NSRP All Panel Meeting

29 March 2023

Ms. Kelly Cooper
Program Officer, Sea Warfare and Weapons Dept.

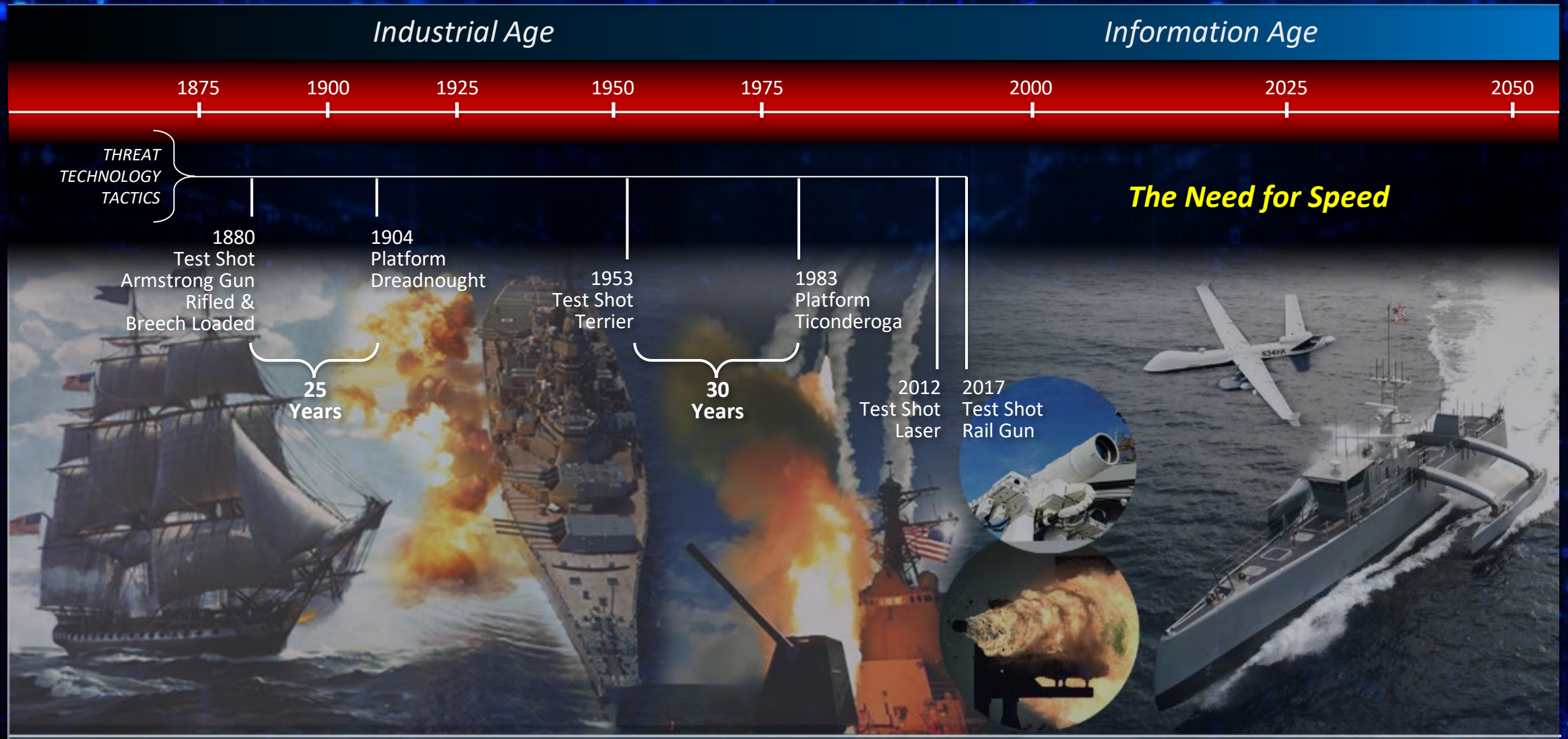
NATIONAL SHIPBUILDING RESEARCH PROGRAM™
Taking Shipbuilding and Repair to the Next Level

“What the future Navy will be like, we cannot say as yet.”

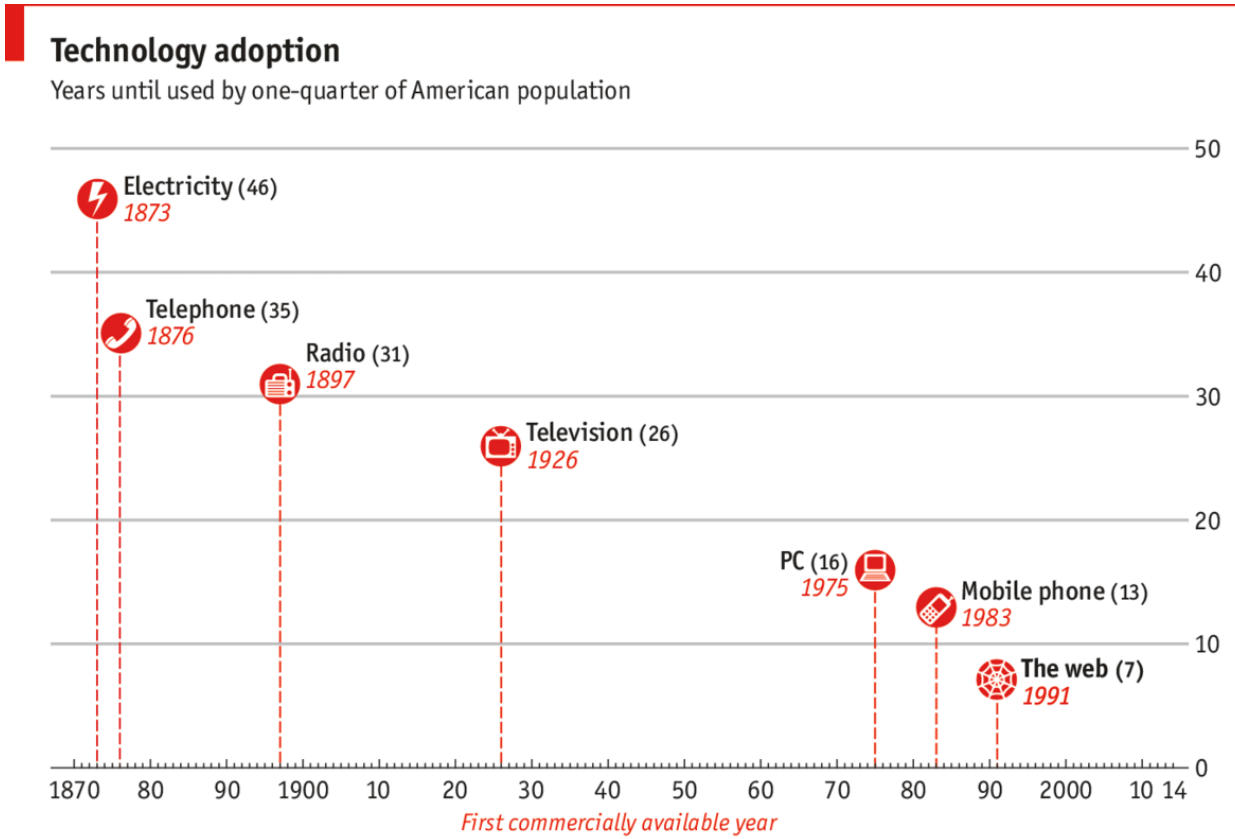
Chief of Naval Operations Fleet Admiral Chester Nimitz

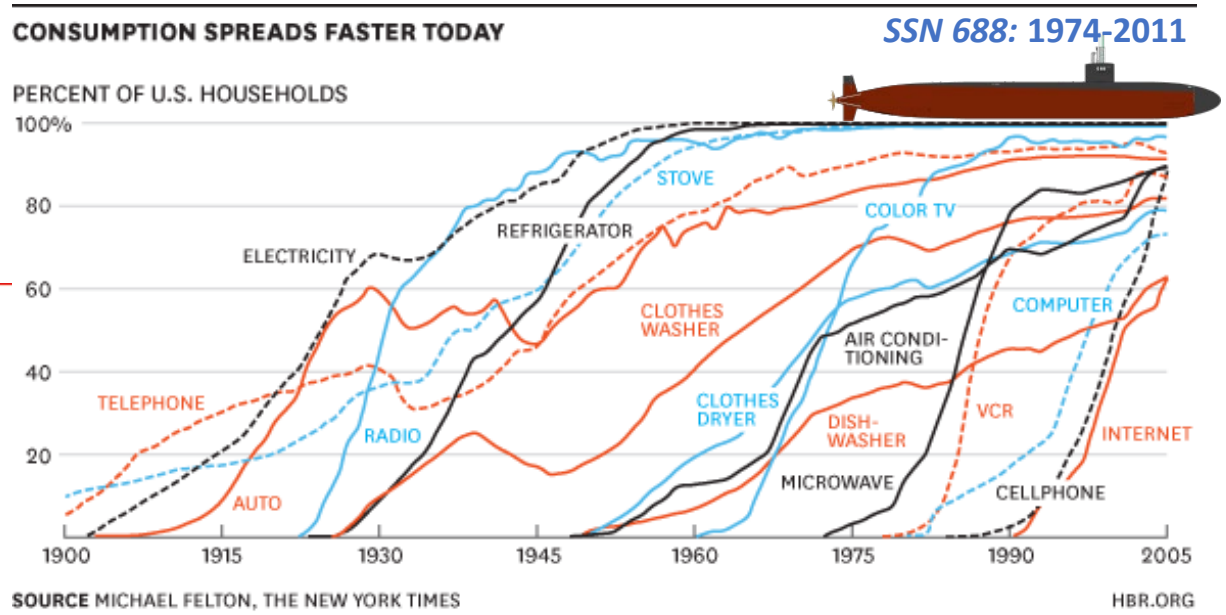
Approved, DCN# 43-8385-21

Evolution of Naval Warfare



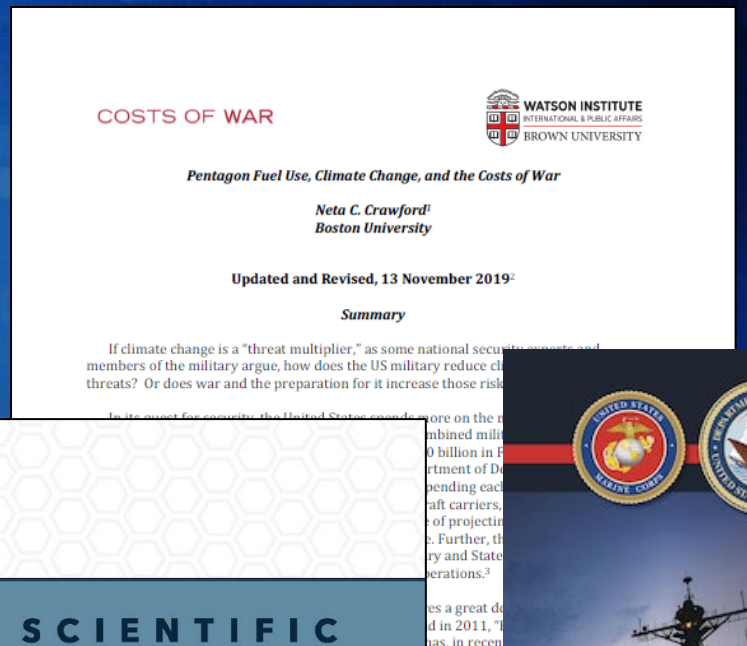
Pace of Change

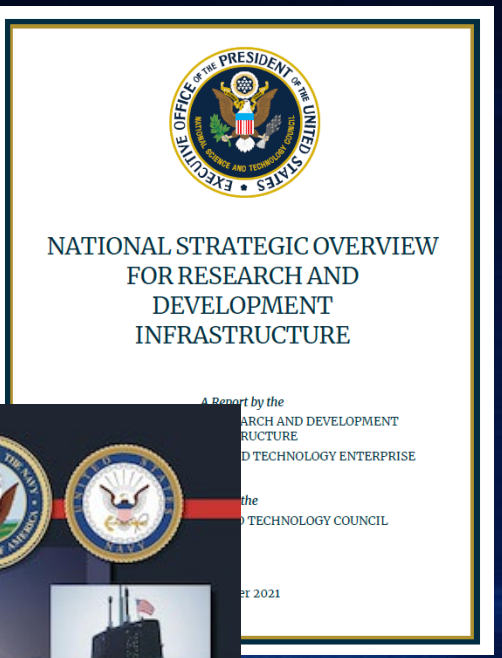


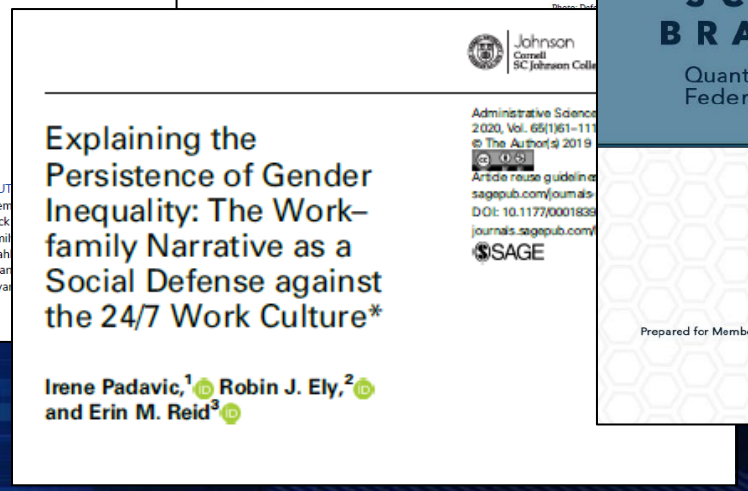


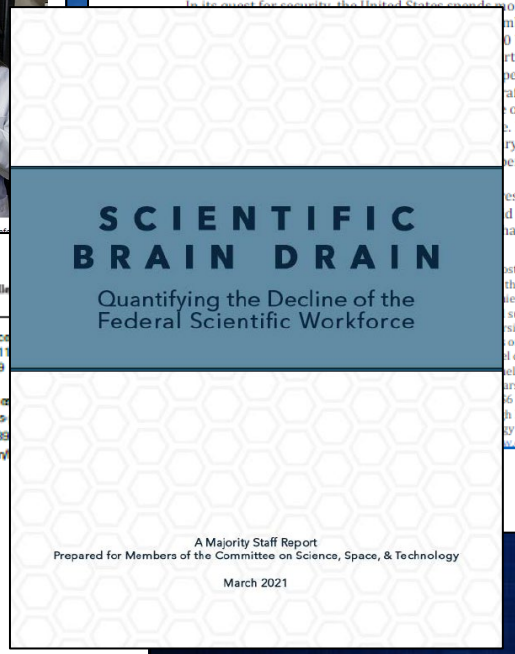
- The ***speed of innovation*** and ***adoption*** continues to ***increase***.
- To maintain competitive advantage, we ***need to move faster*** to capture those opportunities
- Knowing our major platforms have ***30 - 40 year service*** lives

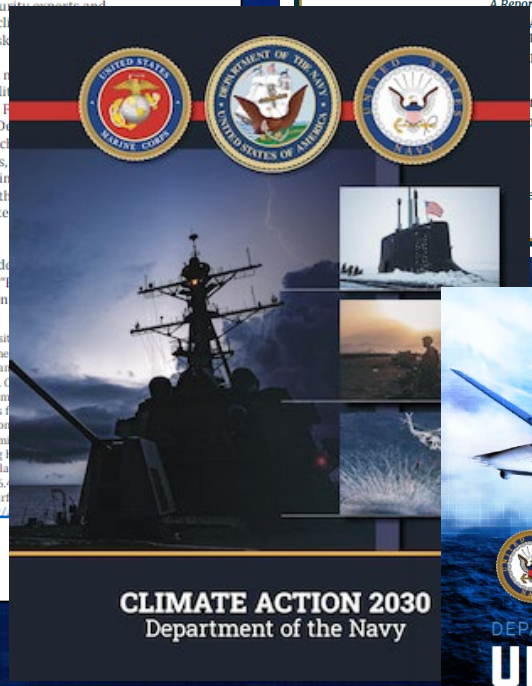
S&T Issues/Concerns





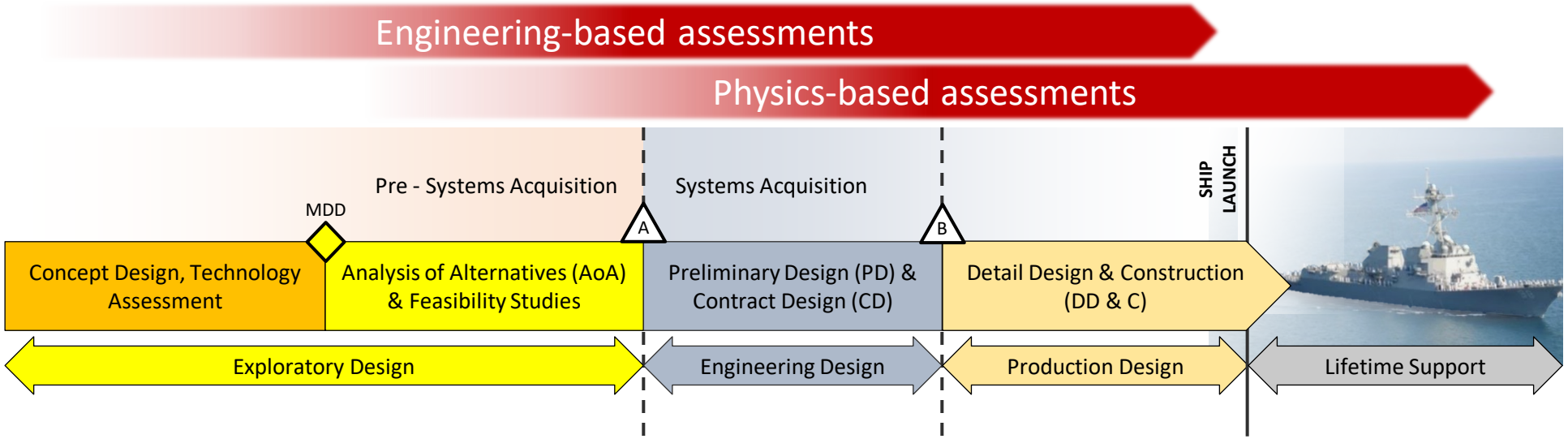






Speed at the Point of Need

ONR's support to the National Shipbuilding Research Program and *Speed at the Point of Need* is part of ONR National Naval Responsibility for Naval Engineering



Sea Warfare & Weapons

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

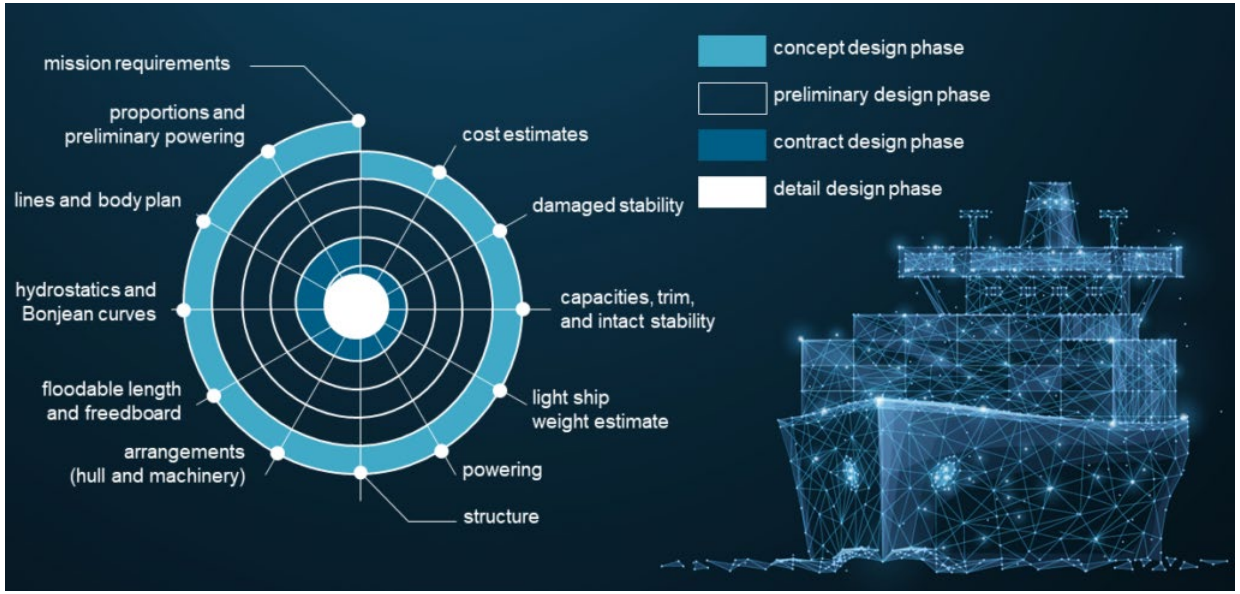
Technical Approach

- Formulate investments in key S&T areas in naval engineering.
- 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
- Support the entire Naval Engineering Enterprise

Naval Relevance / Impact

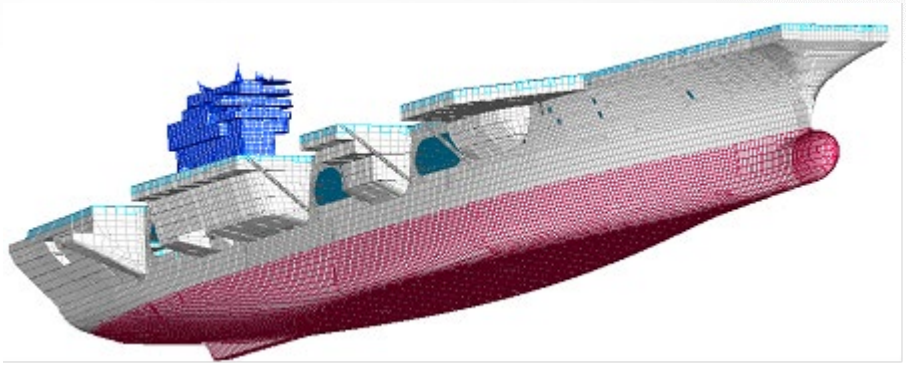
- Robust research expertise is sustained in the US working on long-term problems of importance to the DON
- Adequate pipeline of new researchers, engineers and faculty continues

SHIP DESIGN


mission requirements
proportions and preliminary powering
lines and body plan
hydrostatics and Bonjean curves
floodable length and freedboard
arrangements (hull and machinery)
structure
powering
light ship weight estimate
capacities, trim, and intact stability
damaged stability
cost estimates
concept design phase
preliminary design phase
contract design phase
detail design phase

Sea Warfare & Weapons

Ship Design Tools



Objective:

- Reduce platform design cycle time.
- Reduce acquisition cost through integrated design and software tools.
- Extend design options as long as possible.

Approach:

- Set based approaches.
- Integrate emerging research results into physics-based, technology performance evaluation tools.
- Complement concept development activity with analytical tool development and model testing.
- Investigate translation of higher order physics based models to quicker running surrogate models appropriate to order of design fidelity.
- Determine methodologies to treat all aspects of the design as a variable.
- Investigate alternative geometric design representations for alternative analytical techniques.

Navy Unique:

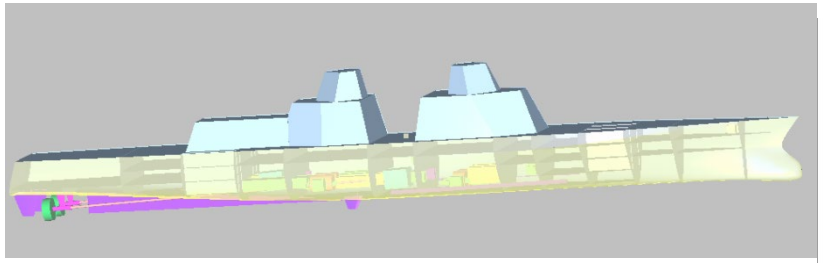
- Integration of complex war-fighting systems.
- Survivability features for wartime environment.
- Large variability in operational profile.
- Interfaces with proprietary design software.

Payoff:

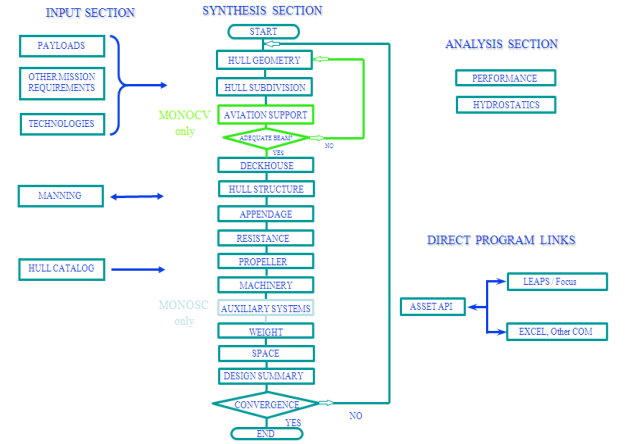
- Support innovative design concepts.
- Provide traceability in design process applications.
- Intelligent search of design space.
- Provide methodology to deal with uncertainty and variability of inputs and designs.
- Systems optimization.

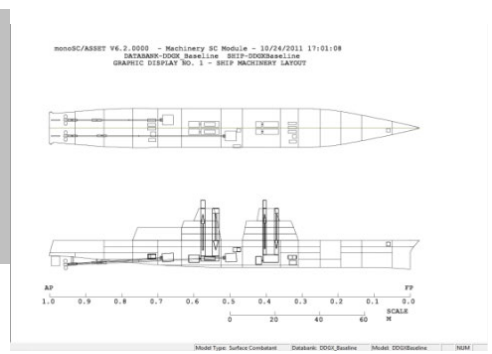
Sea Warfare & Weapons

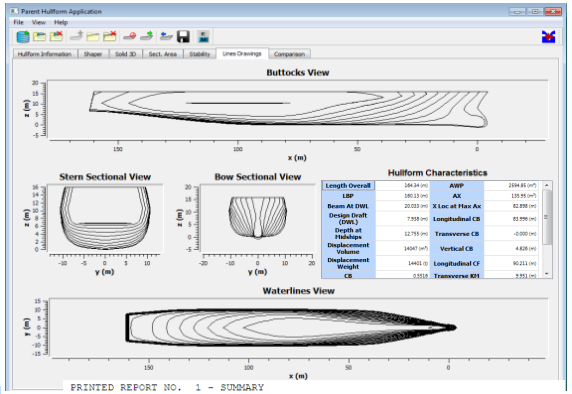
Early-Stage Ship Design Tools

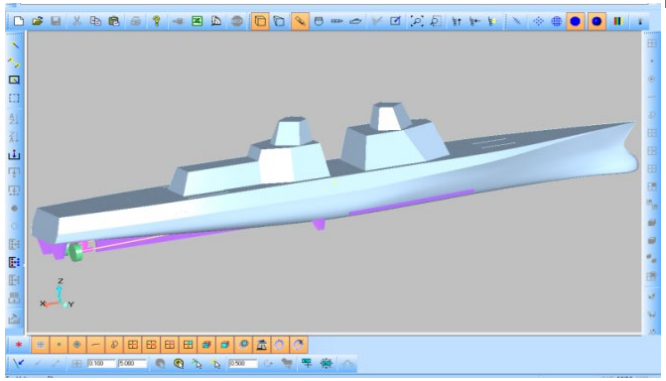


ASSET Version 6 - Module Structure



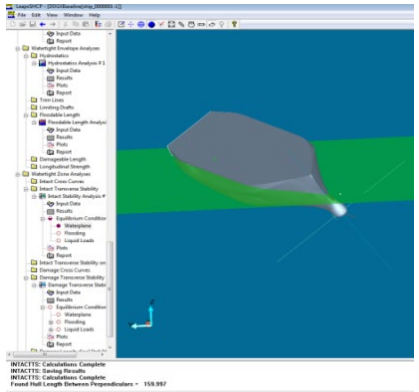


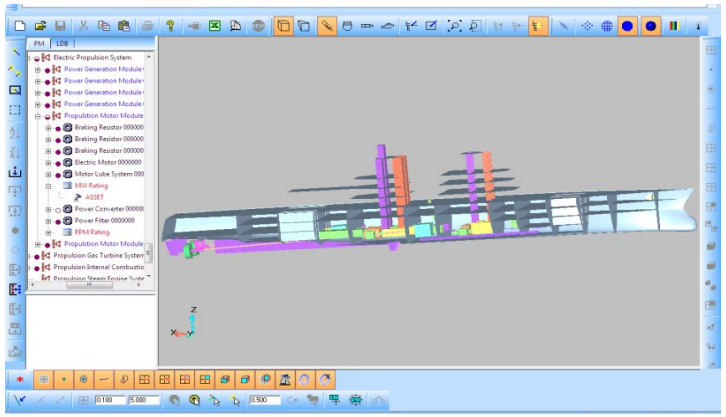


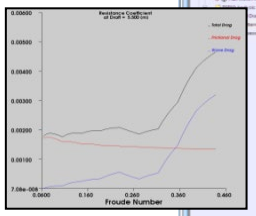


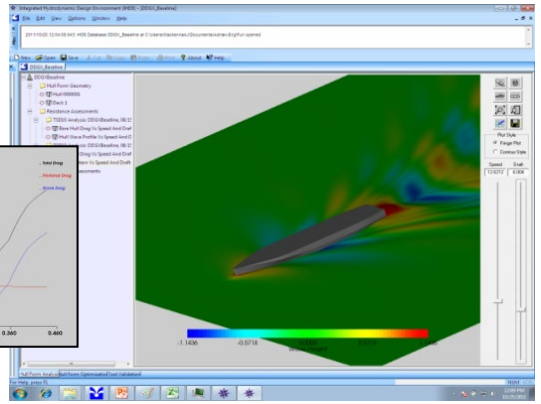
PRINTED REPORT NO. 1 - SUMMARY

SWBS	G R O U P	W E I G H T MTON	PER CENT	LCG M	VCG M
100	HULL STRUCTURE	3075.3	29.8	83.71	7.55
200	PROPULSION PLANT	1341.1	13.0	92.58	5.25
300	ELECTRIC PLANT	459.2	4.5	81.14	5.96
400	COMMAND + SURVEILLANCE	486.7	4.7	65.99	13.99
500	AUXILIARY SYSTEMS	1010.1	9.8	90.79	7.10
600	OUTFIT + FURNISHINGS	579.2	5.6	91.23	8.25
700	ARMAMENT	261.2	2.5	71.37	9.52
	L I G H T S H I P	7212.7	69.9	85.15	7.52
M21	PD MARGIN (WT = 2.1%) +	150.6		(KG = 2.1%) +	.16
M22	CD MARGIN (WT = 2.2%) +	161.1		(KG = 2.2%) +	.17
M11	D & B MARGIN (WT = 5.3%) +	396.8		(KG = 5.3%) +	.42
M23	CON MOD MARGIN (WT = 1.5%) +	112.3		(KG = 1.5%) +	.12
M24	GFM MARGIN (WT = .6%) +	44.9		(KG = .6%) +	.04
	LIGHT SHIP WITH MARGINS	8078.6	78.3	85.15	8.43
F00	FULL LOADS	2234.1	21.7	69.19	4.15
F10	SHIPS FORCE + EFFECTS	28.8		75.20	8.46
F20	MISSION RELATED EXPENDABLES	349.5		87.60	8.73
F30	SHIPS STORES	28.6		86.40	6.34
F40	FUELS + LUBRICANTS	1786.2		65.35	3.17
F50	LIQUIDS + GASES (NON FUEL)	40.9		63.31	3.27
F60	CARGO	0.0		0.00	0.00
	F U L L L O A D W T	10312.7	100.0	81.69	7.50





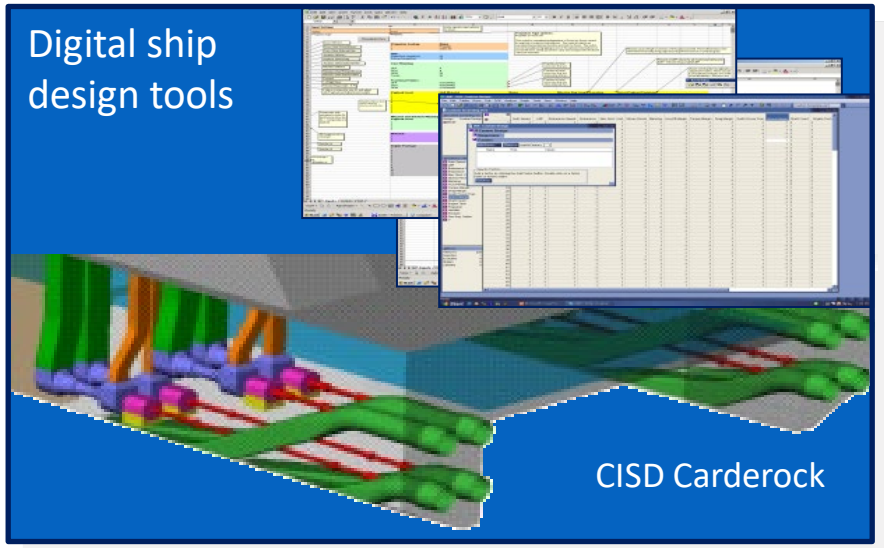




Centers for Innovation in Naval Technology

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.**



Sea Warfare & Weapons

Center for Innovation in Ship Design

People

- Educate and develop the next generation of naval engineers

Knowledge

- Advance the theory and practice of ship design
- Explore new and innovative ways to develop naval ships

Innovation

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

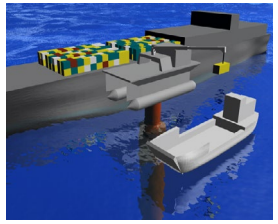
- ✓ Chartered by ONR, NAVSEA 05 & NSWC
- ✓ Funded through ONR NNR-NE Program & NAVSEA
- ✓ Located at NSWC Carderock
- ✓ Transition opportunities through NAVSEA programs & marine industry/university partners

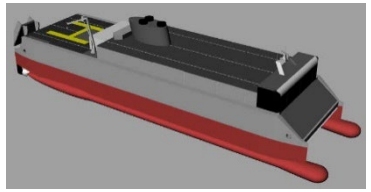
The hub of a national collaborative enterprise combining the best ideas and experience of government, industry, and academia in ship design

CISD *Mission*: Ensure the Future Capability (People, Tools &Knowledge) of the Nation to Develop Innovative Ship Designs to Effectively Meet Defense Needs

Focus Areas: Navy of the Future

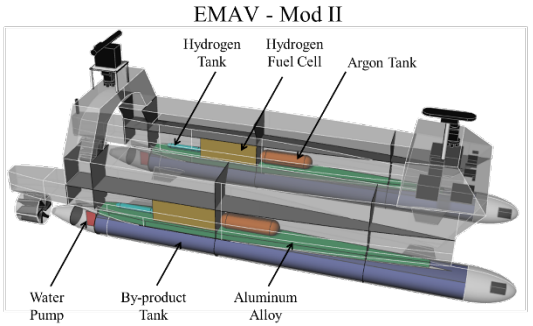
- Develop Future Ship Designers
- Knowledge Base / Design Tools & Processes
- Future Ship & Ship Design Technology Needs
- Develop Innovative Ship Design Concepts



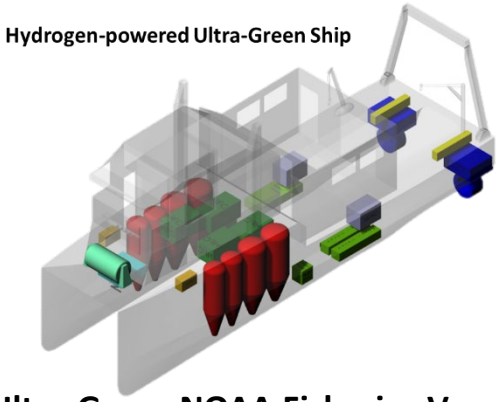


Center for Innovation in Ship Design (CISD)
NSWC Carderock

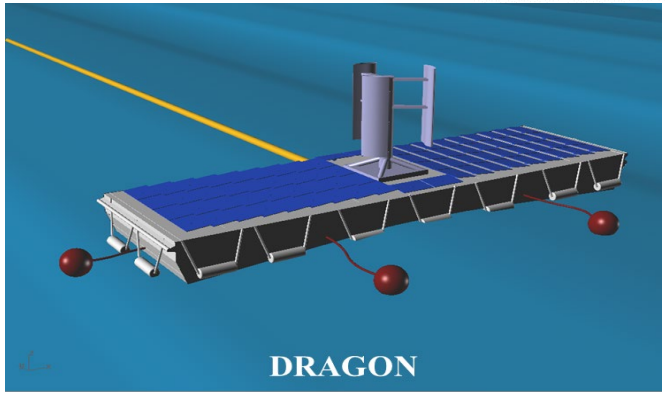
Examples of Research (2016-2017)



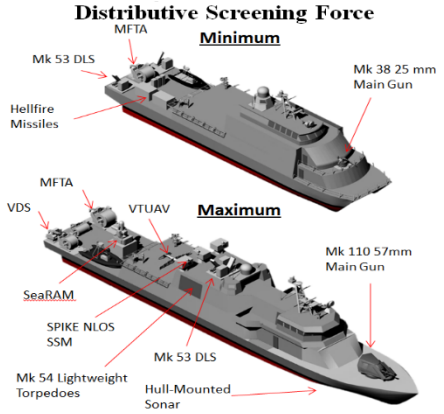
Electronic Module Autonomous Vehicle Mod II



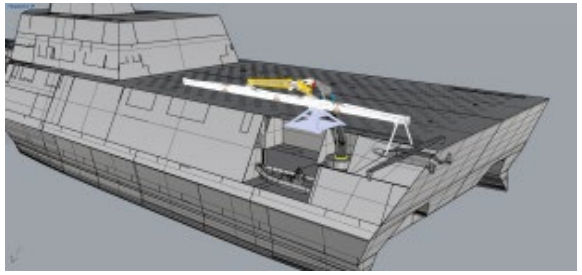
Ultra-Green NOAA Fisheries Vessel



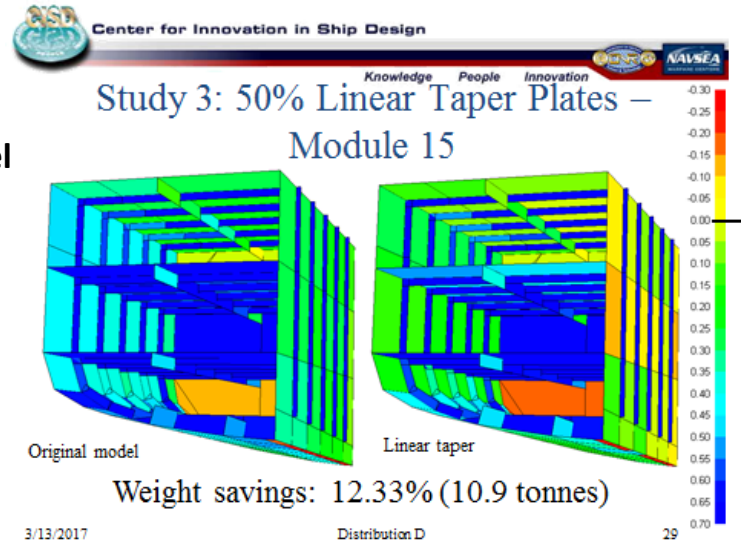
Desalination Renewable Alternative Green Ocean Network (DRAGON)



Distributed Screening Force



SideARM Unmanned Air Vehicle Ship Integration



Structural Optimization for a 3D printed Ship

OUTREACH AND EDUCATION

Department of Defense
DoDSTEM
Science · Technology · Engineering · Mathematics

Sea Warfare & Weapons

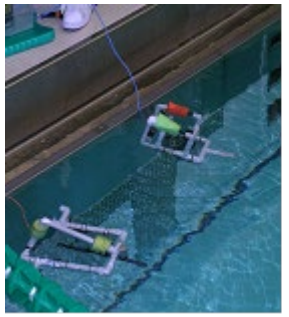
Outreach/ Education

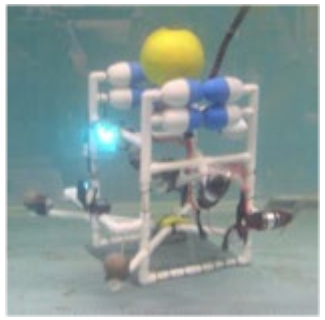
Objective:

- 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

Pathway to the Workforce

1

Awareness

Promote awareness of Naval S&T content, skills, and careers

2

Interest

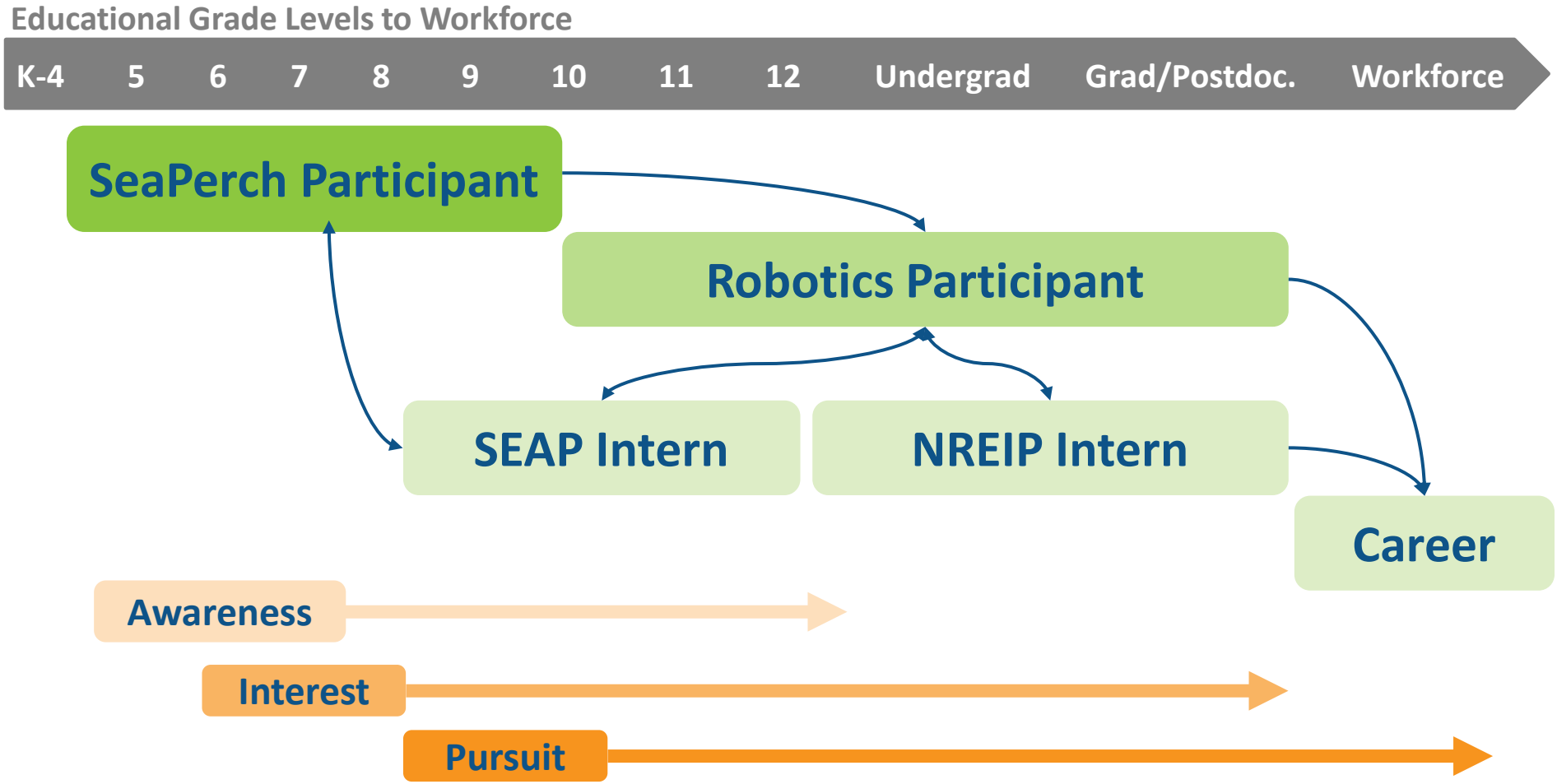
Identify topic areas and disciplines to explore further

3

Pursuit

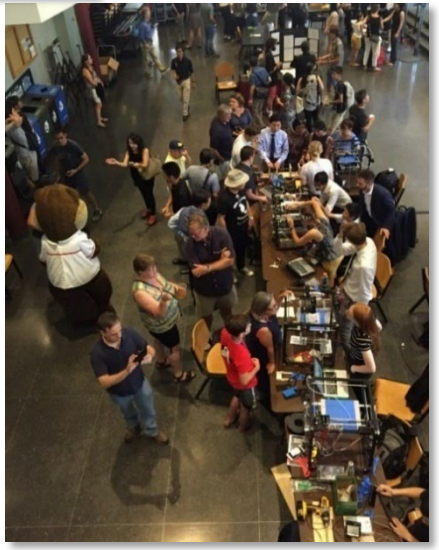
Seek opportunities to work or study in a particular field

The pathway is nonlinear with many points



Sea Warfare & Weapons

MIT Beaver Works Summer Institute



- **BWSI was started in 2016 to fill a need : project-based STEM curriculum with focus on AI and CS skills**
- **BWSI Core :**
  - **No cost to students, any talented and passionate students able to attend**
  - **Project-based with teamwork**
  - **Scientists and engineers actively working in research as instructors**
  - **Teams are motivated by competitions and capstones projects**
  - **Blended learning approach for best results**

BWSI is a transformational STEM experience for students through project-based learning

– **"It was an incredible and life-changing experience for everyone that has the privilege to attend" (Class of 2016 student)**

Sea Warfare & Weapons

MIT Beaver Works Summer Institute

4-week virtual program for high school students (11 July – 7 August 2022) – Class of 2022

BWSI Kwajalein

- Four-week virtual STEM program for talented High School rising seniors
  - 360 students from 240 schools (31 states)*
  - 149 female students (41%)
- 13 hands-on, intensive project-based challenges
  - Autonomous RACECAR Grand Prix
  - Autonomous Cognitive Assistant
  - Autonomous Air Vehicle Racing
  - Autonomous Underwater Vehicles Challenge
  - Build a CubeSat
  - Unmanned Air System – Synthetic Aperture Radar
  - Data Science for Health and Medicine
  - Remote Sensing for Disaster Response
  - Serious Game Design and Development with AI
  - Assistive Technology
  - Embedded Security and Hardware Hacking
  - Cyber Operations (new course)
  - Quantum Software
- Women's Networking Dinner
- 2 DEI in STEM Workshops and a DEI Essay Competition
- In-person programs at Kwajalein**
- Live webcasted final event – over 17k viewers

* BWSI 2022: 360 students: 60 students from 45 schools in MA, Kwaj is not included in the number of States

** Autonomous RACECAR Grand Prix

Sea Warfare & Weapons

Veterans To Energy Careers (VTEC)

VTEC Veterans To Energy Careers

Where opportunity begins. Our interns receive front line experience for front line jobs.

- **Objective:** ***Provide student veterans pursuing STEM degrees an opportunity for a smooth transition from the military, through college, into the workforce or graduate school.***
  - *Provide opportunities for students to bridge the gap between classroom learning & industry standards through internships focused on research & development with renewable energy projects across the nation.*
  - *Provide career development coaching & training for program participants to identify & build their professionals brands, & leverage their brands to build networks that lead to professional opportunities.*

- **Approach or Tasks**
  - *Provide individualized mentorship resulting in a job placement rate of 99% prior to graduation.*
  - *Provide internships with world class research facilities including NIWC Pacific, NPS, NAVFAC EXWC, NSWC Carderock, NSWC Indian Head, NSWC Philadelphia, ESRDC, ASU, California UCs & CSUs & other Universities nationwide.*

- **VTEC Outcomes/Historical Data**
  - *VTEC alumni outcomes – 166 alumni employed by 121 companies and/or government entities*
  - *VTEC Internship Placements – VTEC interns have been placed into 246 internships with 28 VTEC partnering organizations (some VTEC interns have had multiple internships*
  - *Complete date in back-up slides*

Sea Warfare & Weapons

Naval Undersea Research Program (NURP)

FY22 Performers: NUWC (NPT, KPT), NSWC (IH, CD, PC), NIWC, NRL, NAVAIR, ARL/PSU, UMASS-D, VA Tech, UCLA, UC San Diego, URI, Utah State Univ, BU, MSU, Purdue Univ., Univ FL, Texas State Univ, Clarkson Univ, Univ VA.

Warfighter Payoff/DoN Relevance/Scientific Impact

Projects span several thrust areas with focuses on developing Undersea Weapons technologies:

1) **Autonomy** 2) **Guidance and Control**

3) **Power & Energy** 4) **Hydrodynamics** 5) **Projectiles**

6) **Corrosion/biofouling**

- Workforce Development in Undersea Weapons as part of NNR.

Attendees at the NURP Review, Keyport, WA

Objectives

- Increase the number of engineers and scientists in Navy laboratories developing undersea weapon and vehicle technology
- Contribute to the revitalization of the laboratories
- Build connections between laboratories and academia

FY22 Accomplishments:

- The program supported 19 students in FY22.
- The Navy labs hired 5 students in 2022, 1 student was hired by Government contractor and 2 stayed in academia.
- The NURP program generated:
  - 34 presentations/posters
  - 9 student awards
  - 9 referred publications
  - 1 patent disclosure
  - 3 partnerships (EPA)

Sea Warfare & Weapons

Naval Enterprise Partnership Teaming with Universities for National Entrepreneurship (NEPTUNE)

Objective:

The NEPTUNE program aligns university research with the National Defense Strategy (NDS) and establishes entrepreneurial practices to accelerate delivery of university-derived technologies and products to the defense and commercial sectors. NEPTUNE's outreach component involves the education of naval personnel across active duty and reserve military, ROTC and veterans.

Solution:

Projects have a period of performance of 2 years, with a technical performance up to 18 months, with early prototype/product demonstrated at the end. Hacking for Defense (H4D) methodology is used in the proposal development and research approach to the problems.

Project Manager(s): Maria Medeiros, ONR333

Technical Approach:

Program participants will engage in interdisciplinary research aligned to National Defense Strategy (NDS) problems. Each selected project will have at least one Problem Sponsor, and a research team consisting of University researchers and military or veteran students.

Performers: MIT, Purdue, UC Davis, Arizona State Univ, URI, Stanford Univ, Carnegie Mellon Univ, NPS, USNA, CMU, Cornell, additional school to be added in 2023

FY22 Accomplishments:

- 47 students support (33 military/veterans)
- 12 awards / 9 Patent Disclosures/ 13 Publications/ 1 Book
- 33 collaborations
- Employment in STEM fields: 12 Industry, 9 Gov't, 5 Academia
- 3 Companies founded, 1 Licensing NEPTUNE Technology

Sea Warfare & Weapons

Let's Go Boys and Girls, Inc.

Margaret Shea-Moore

Objective

- LETS GO's provides support and resources to students from in underrepresented communities from 9th grade onwards, including those transitioning into the workforce for the first time. Designed to give young people interested in STEM careers the life skills they need to succeed, this program begins at the 9th-grade level, offering tailored modules that help participants develop essential job-related and life skills.

Let's Go site visit to Baltimore Harbor

Approach / Engagement with Navy

- Support LETS GO STEM Scholars in ONR SEAP and NREIP internships.
- Support LETS GO STEM Scholars in non-ONR internships.
- Launch and complete Assistant Instructor STEM and Workforce Readiness internships.
- Initiate applications with 2022 ONR SEAP and NREIP students wishing to return in 2023.
- Data analysis of STEM Competition Team students for 2022 launch of LETS GO Alumni Connect (LAC) project in Fall 2022.
- Develop data plan for LETS GO Results Based Accountability (RBA) system.

FY22 Accomplishments:

- Launched organizational RBA data plan
- Conducted survey outreach to 113 alumni, 22% response rate
- Launched fall workforce development programming, 28 students have received mentoring and support
- Supported 11 college students (1 alumnus, 2 new to program, 8 returning) in applying to SEAP internships at NSWC Carderock, AFRRI, NRL, and NMRC
- Supported 11 high school students (9 new to program, 2 returning) in applying to SEAP internships at NSWC Carderock
- Initiated recruitment partnership with internship department at Anne Arundel Community College.

Expanding Capacity for STEM Careers in Higher Education

Rachel Doyle, Gail Niemczyk

Sea Warfare & Weapons

Objective:

RIOPC's performance goals are aligned with U.S. Navy goals of "Investing in human capital through coordination of learning opportunities for the civilian workforce." These goals include:

- **Workforce development**: Increase the number of Rhode Islanders who are trained for high-demand, high-wage jobs aligned with Rhode Island's advanced manufacturing, financial, and information technology sector strategies
- **Equity:** Eliminate equity gaps and ensure that greater numbers of low-income individuals, racial and ethnical minority groups, and women participate in workforce training and higher education programs in our Westerly, Woonsocket, and Central Falls higher education and industry centers
- **Attainment:** Advance the number of Rhode Islanders with postsecondary degrees and credentials to reach a 70% attainment goal by 2025 (currently at 53%).

Partners:

WESTERLY EDUCATION CENTER

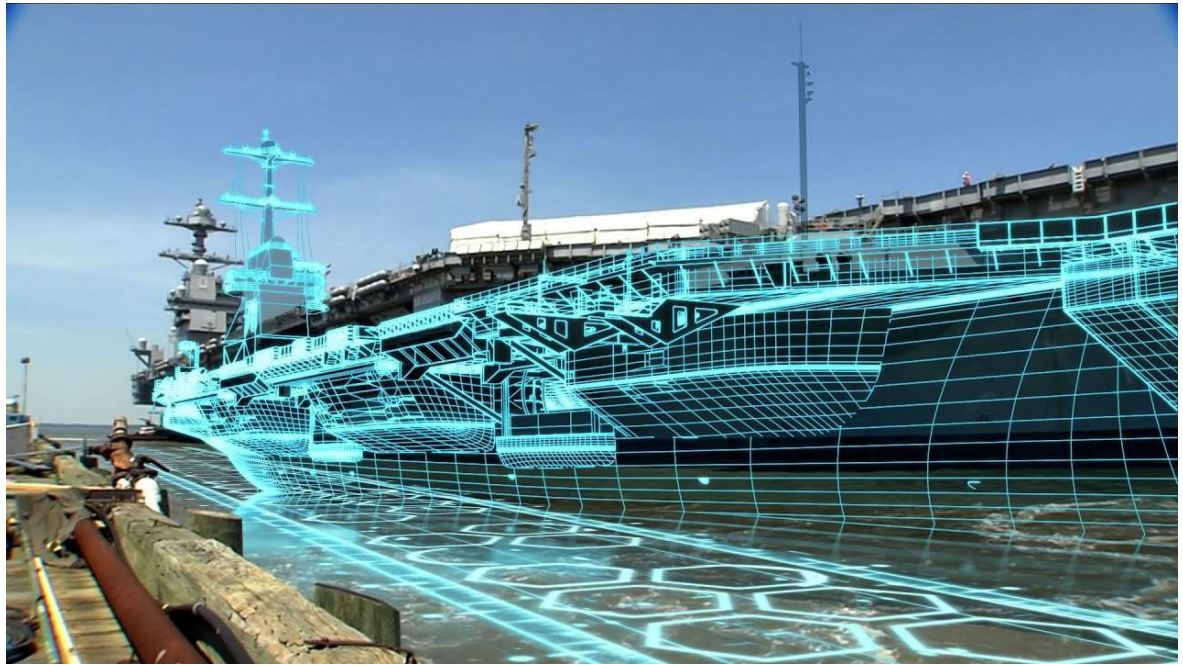
Rhode Island Office of the Postsecondary Commissioner

GENERAL DYNAMICS
Electric Boat

FY22 Classes/Trainings/Cohorts/etc.

- Pipefitting - 7
- Maritime Electrical - 4
- Sheet Metal - 2
- Paint - 4
- Rigging - 3
- Radiography - 2
- Boat for Women - 3
- Boat for Vets - 1

MANUFACTURING
DIGITAL ENGINEERING



ManTech Investment Strategy

Two Focus Areas:

1. Major Acquisition Platform Affordability

2. Capability Acceleration

NAVY MANTECH

Investment Strategy

1. Major Acquisition Platform Affordability

PEO (Subs)	PEO (CLB)	PEO (Ships)	PEO (USC)	PEO (Carriers)	PEO (JSF)	PEO (A)
VIRGINIA Class	*COLUMBIA Class*	*DDG 51 Class*	*FFG(X) Class* (Initiating)	*CVN 78 Class*	*F-35*	*CH-53K* (Ramping Down)

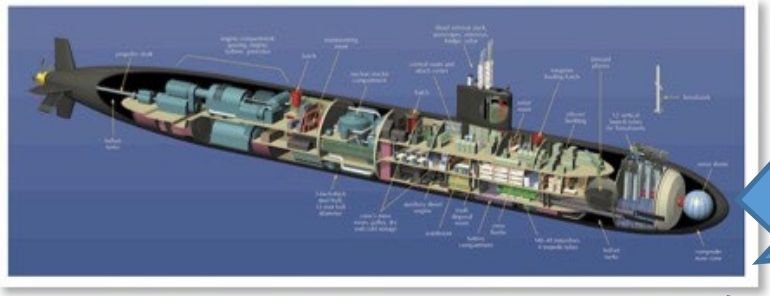
2. Capability Acceleration

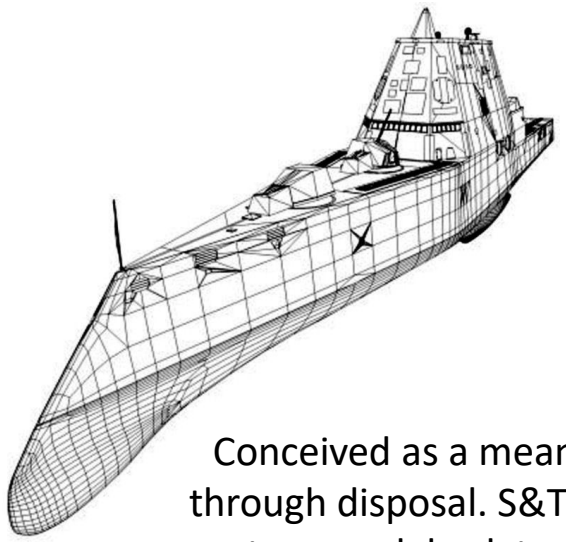
- Supports CNO direction to get capabilities to the fleet faster

Today's Digital Engineering: Platforms

DEFINITION

An integrated digital approach that uses authoritative sources of systems' data and models as a continuum across disciplines to support life cycle activities from concept through disposal



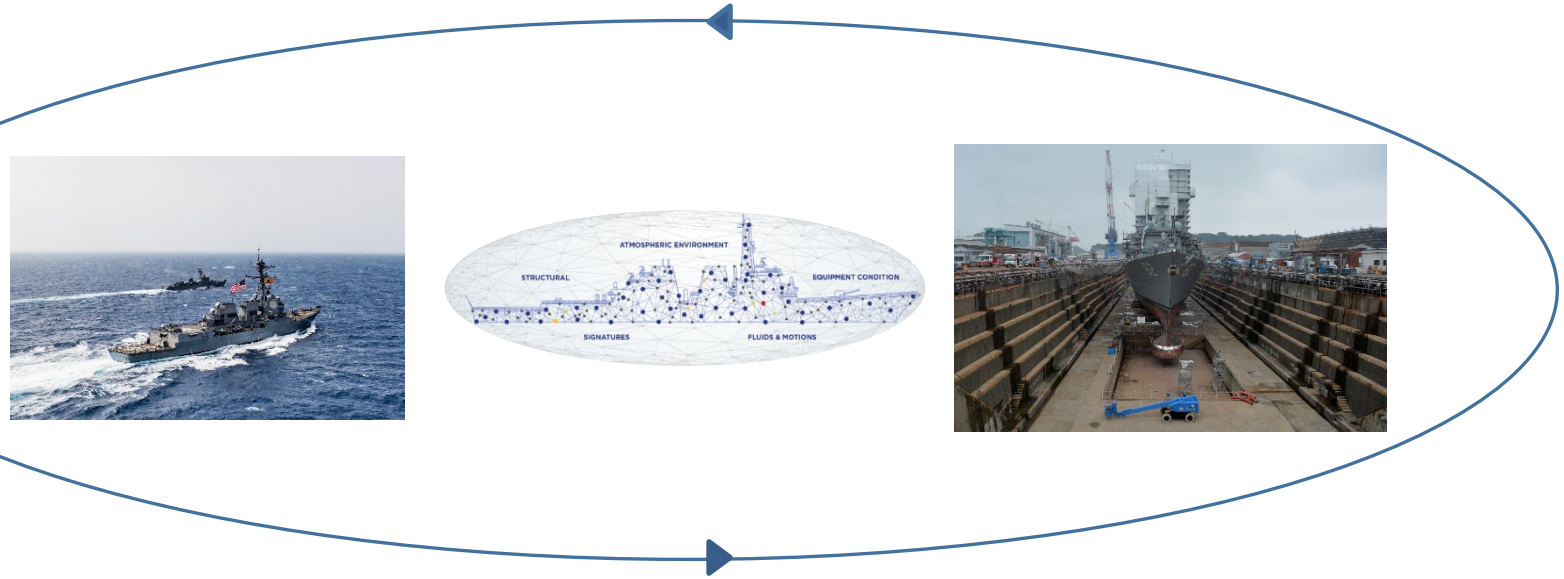


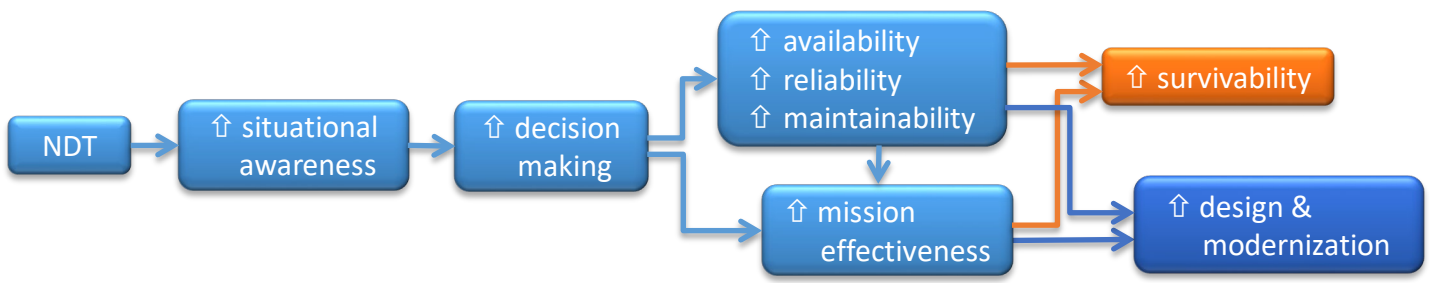
1. Formalize the **development, integration and use of models** to inform enterprise and program decision making
2. Provide an enduring **authoritative source of truth**
3. Incorporate **technological innovation** to link digital models of the actual system with the physical system in the real world
4. Establish supporting **infrastructure and environments** to perform activities, collaborate, and communicate across stakeholders
5. Transform a **culture and workforce** that adopts and supports Digital Engineering across the lifecycle

Conceived as a means of enabling "systems" from concept through disposal. S&T naturally enters in the development of system models, data, and data science needed to determine maintain ground truth of a system's capabilities based on its current state where the real and virtual worlds are linked.

Navy Digital Twin (NDT) as an Enabler

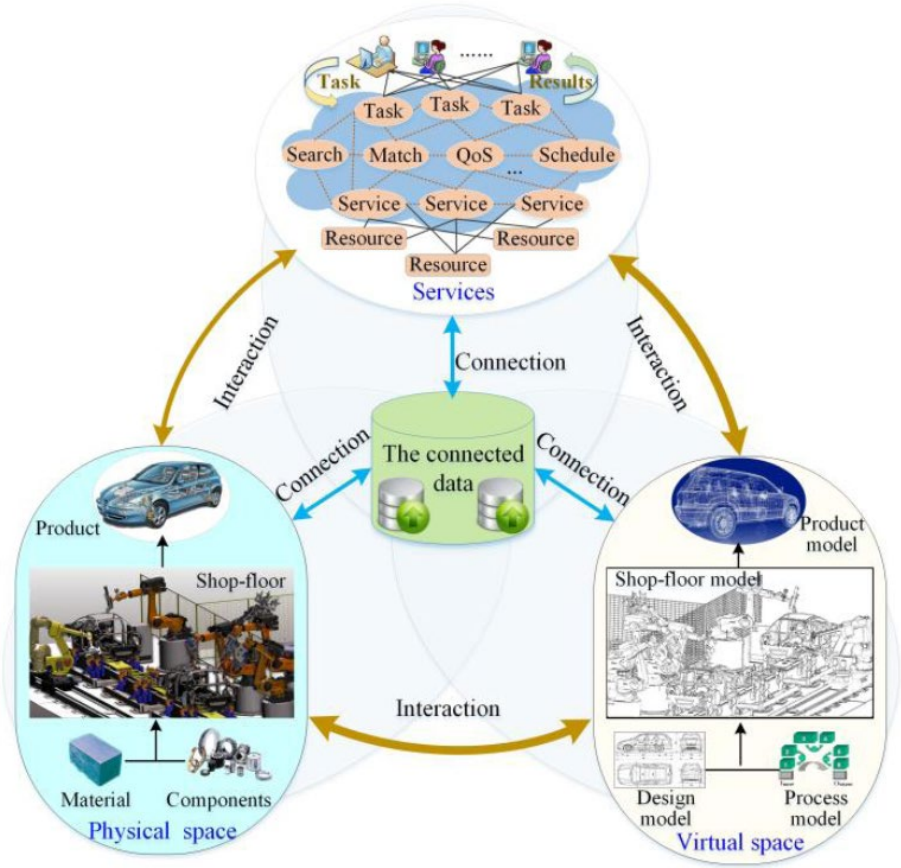
NDT IS A MEANS TO ENABLE A MORE COMPREHENSIVE UNDERSTANDING OF SHIP CONDITION





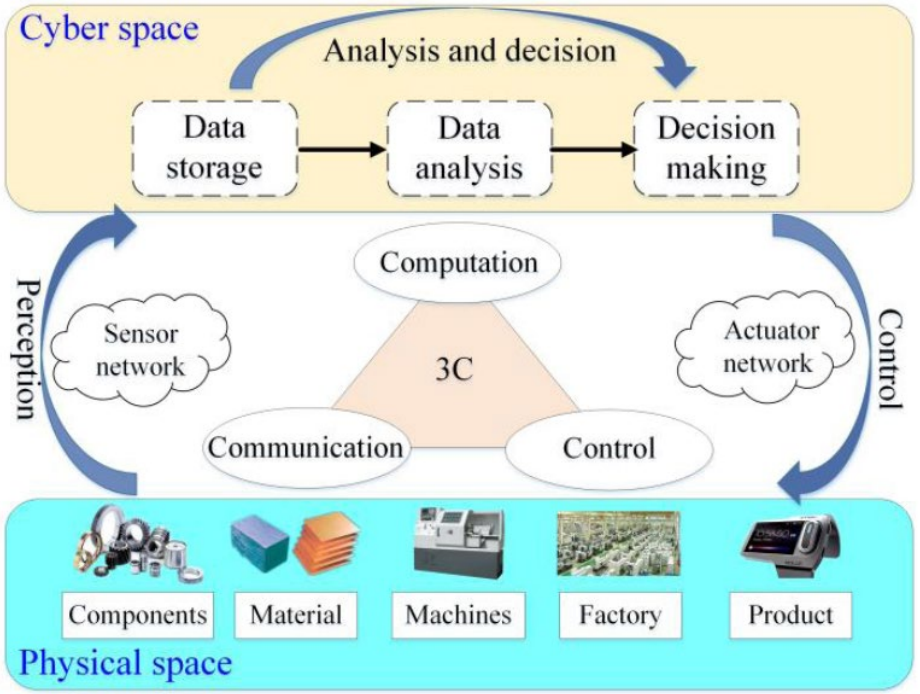
Manufacturing

- Design Innovation
  - How does DE enhance the ability of government/industry to innovate on designs?
- Acquisition
  - Model of acquisition will be needed to understand interaction between specifications, contracts and model-based approaches change
  - How does increased data/model exchange between government and industry change the lifecycle?
- Fabrication/Integration
  - Improvement in fabrication and integration



Near-Future Manufacturing

Cyber-Physical Interplay



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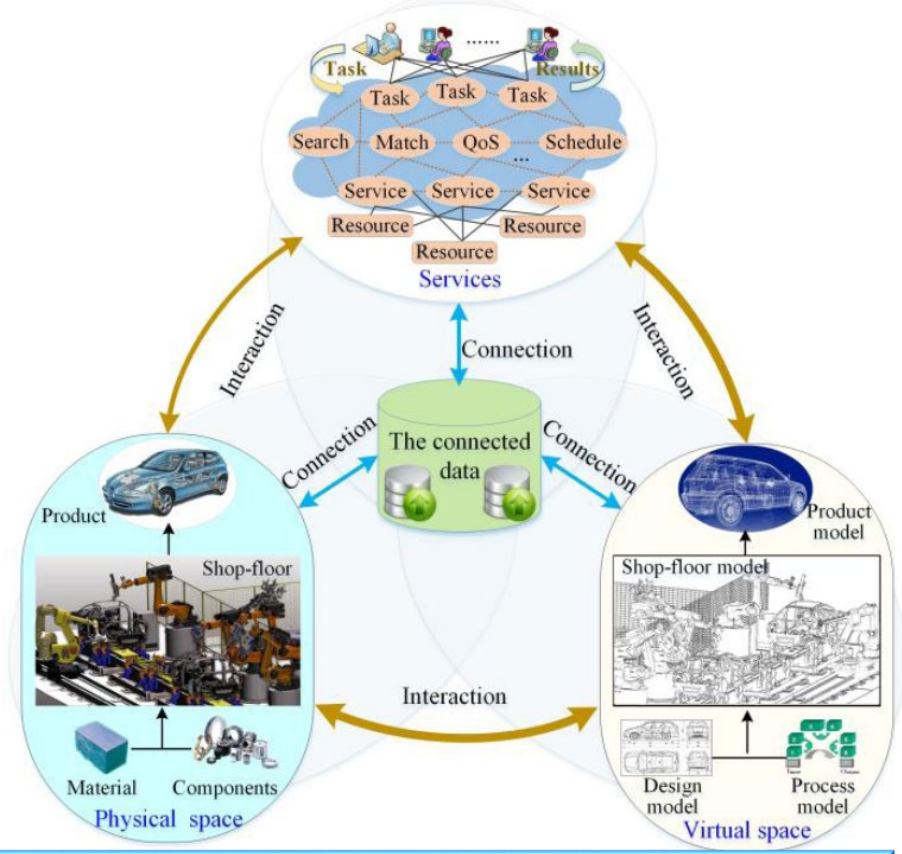
The Digital Twin



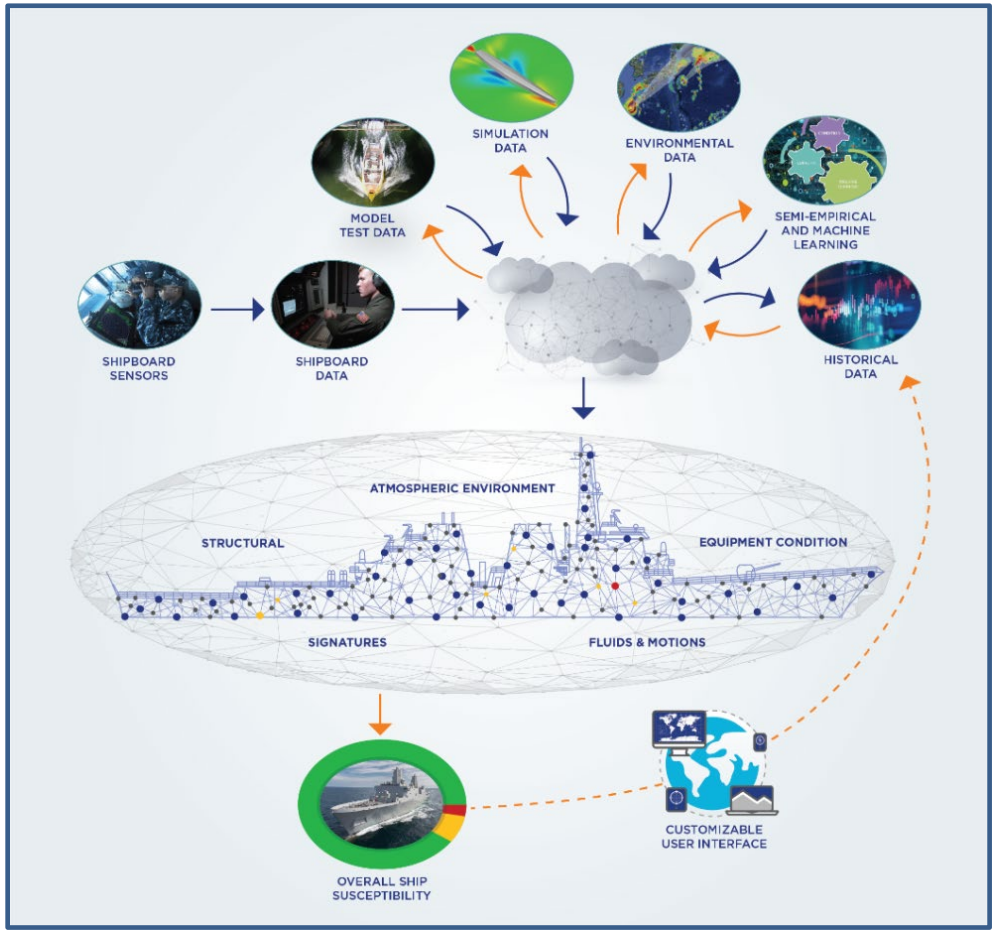
Consider an analog for Undersea Warfare – USW as a dynamic data-driven application system (DDDAS)[2]:

- Data assimilation can change the models and/or scales of the computation
- The application controls the data collection based on the computational results
- Results in more precise predictions, more useful visualizations, and faster and more effective effects generation

1. Qi, Q., et. al., *Modeling of Cyber-Physical Systems and Digital Twin Based on Edge Computing, Fog Computing and Cloud Computing Towards Smart Manufacturing*, Proceedings of the ASME 2018 13th International Manufacturing Science and Engineering Conference, June 2018.
2. Douglas, C., *An Open Framework for Dynamic Big-Data-Driven Application Systems (DBDDAS) Development*, Procedia Computer Science, **29**, 2014.

Next Steps

- Navy Digital Twin (NDT) is a virtual representation of a platform that contains our best understanding of condition based on data and modeling
- NDT enables many capabilities (CBM, SHM, etc), allows for insights that traditionally aren't obtainable, and is ripe for augmenting ISEA decision making
- digital twins can deliver enhanced warfighting performance to the fleet
- Future applications include: mission planning, asset management, logistical planning, platform design, battle damage assessment, sensor integration and data management



Speed at the Point of Need

ONR's supports NSRP and "Speed at the Point of Need" primarily in three areas:

- **Ship Design –** ***"design for requirements and manufacturability"***
- **Outreach and Education –** ***"the right workforce for the Naval Enterprise"***
- **Manufacturing / Digital Engineering –** **"reduce costs, advance manufacturing technology, and increase Ao"**

We support NSRP to ensure the Navy has the needed capability when it needs it, where it needs


Thank-You!