SYSTEMS DIVISION

The Challenge

Your team has been commissioned to analyze, build, and test a freshwater piping system used on submarines. During this process, your team will also adapt a system to fit a modified installation area, reflecting real-world adjustments often required aboard ships. Deep under the ocean's surface, submariners depend on efficient and reliable freshwater delivery for everything from cooking and drinking to cooling electric systems. The systems must operate flawlessly in a confined space where leaks can quickly become critical.

Real World Examples

Submarine systems must be incredibly reliable. When you're submerged for months at a time, there is no room for failure. Engineers use valves, bypass lines, and smart layout design to ensure water flows where it's needed, even in emergencies. A very common occurrence in the construction of a submarine is a design alteration that can impact piping systems.

Things to Consider

Leak Prevention: This is one of the most critical aspects of piping design. A small leak might not seem like a major issue but in a submarine where every drop of water is accounted for and space is shared with sensitive equipment, even a minor failure could lead to significant complications. Be mindful of how joints and connectors are secured. You will need to test your system thoroughly to ensure it maintains integrity.

Compact Design: Space in a submarine is extremely limited; every inch of your system must be used wisely. Your piping must be routed in a way that avoids obstacles while still reaching every required destination. Avoid unnecessary crossings and overlaps and think three-dimensionally as you plan your layout. This includes designing how pipes will be supported as they are placed in the space.

Control and User Interface: These are important features of a well-designed system. Crew members who operate the system may need to act quickly during emergency situations. The piping system should be easy to manage with clear indications of where water is flowing. Consider what labels, color coding, or flow direction indicators help users understand the system quickly.

Flow Rate and Pressure: Efficient delivery also depends on water moving at the right speed and pressure. Consider whether your pipe diameters, layout, and fittings allow for appropriate water pressure and volume where needed.

This challenge begins by having you construct and test and existing freshwater piping layout, giving you a hands-on understanding of how water is currently routed through a submarine. As you build and observe the system in action, pay attention to how space, flow, and control are managed and where limitations arise. Once you've completed and evaluated the existing system, you'll have an opportunity to design a system without relying on existing piping layouts – which means you get to chart your own course. Imagine how water could move efficiently through a submarine rather than how it's been done before. You are encouraged to approach this challenge with creativity and originality, exploring unique ways to set up, route, control, and reroute water through a space. Your design should reflect problem solving and innovative thinking. Let that drive your solution.

The Digital Ship Challenge organizers would like to stress that the majority of work on all phases of the project is to be designed and constructed by the students.

Judging Criteria

The challenge involves components which will be judged: a digital engineering notebook, presentation binder, prototype iterations, presentation on the day of the competition, design and construction, and the demonstrated performance.

Constraints

The system must follow the blueprint provided and be capable of connecting securely to the freshwater supply provided. This includes using the designated materials, pipe diameters, connection types, entry/exit points, and water supply connections as specified in the blueprint. Teams will be required to construct both systems on the day of the challenge and connect securely to the freshwater supply provided.

The entire piping system, including all piping, fittings, and structural components, must fit within a 24" x 24" x 24" space.

Pipe markings are required in accordance with naval shipboard piping standards.

An initial test will occur to ensure that the system is watertight and has followed the original blueprint. A second test will occur to ensure that the new system is watertight and follows the blueprint provided by the team. The blueprint for the new system must include a materials list, all appropriate annotations, multiple views (top, front, right, left, and isometric), and notes or symbols indicating water flow and fittings.

You must provide an initial calculated flow rate (before ship alt), provide a new calculated flow rate post ship alt, and provide the delta with an engineering recommendation to close or equalize the delta.

For the ship alt, using the provided blueprint, redesign the piping system around the newly installed interference. It must fit within the 24" x 24" x 24" space.

*If the above constraints are not met, a penalty will be assessed. *

Team Registration

Team selection: Individual schools will determine how they will select their teams.
Maximum number of students per team is four.

Teams must submit their intent to participate by September 12, 2025. Teachers will need to submit this information online at https://forms.gle/zZ9QrVJomNrewJbc9.

Project Completion Process

Teachers and mentors will create a schedule for the mentors to meet with the students to provide feedback and complete check-ins. This can be done in person or virtually. A project guide including mandatory milestones will be provided.
A mid-year workshop will be scheduled in December. During this session students will have the chance to ask questions regarding the challenge, participate in Maritime Connect, and receive feedback on their progress. All

teams and team members should plan to attend with documentation and prototype iterations. Lunch will be provided.

The Digital Ship Challenge will take place April 25, 2026, at OERI (formerly VMASC). Doors will open for registration at 8:00 am and the opening ceremony will begin at 8:45am. Teams should bring their completed design to the competition ready to be tested and be prepared to present. Full details about the day of the event will be emailed to teachers after the registration deadline.
Project Submission: Digital Engineering Notebooks and Prototypes are due April 17, 2026, by 4pm. Prototypes are to be dropped off at OERI for judging prior to the challenge. Teachers, please make arrangements with Jennifer Renne to drop off the prototypes. Digital Engineering Notebooks will be submitted online. All other criteria will be judged at the event, which will culminate in the demonstrated performance on April 25, 2026.

Schedule of events

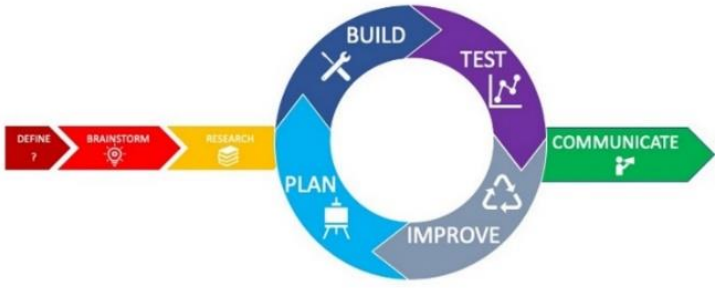
Intent to Participate	September 12, 2025
Teacher and Mentor Meeting	October 10, 2025
Mentor sessions at schools	As scheduled
Mid-Year Workshop at OERI	December 18, 2025
Digital Engineering Notebook online submission	April 17, 2026
Prototype drop off	April 17, 2026
Digital Ship Competition at OERI	April 25, 2026

If you have any questions, please contact Jennifer Renne at jrenne@odu.edu or 757-817-9975.

Scoring Criteria

The scoring for each component of the challenge will vary. A breakdown of scoring will be provided before the challenge. The information below gives an indication of what the judges will be looking for in all aspects of the competition. For maximum points, all criteria for each component must be fulfilled.

Digital Engineering Notebook:
Each team will create a digital engineering notebook that formally documents, in chronological order, all of the team's work throughout the challenge. This digital notebook serves as a comprehensive record of your planning, designing, prototyping, and testing and should follow the VDOE Engineering Design Process.



Your digital notebook should include **everything** you do or think related to the challenge – no detail is too small. Be thorough and intentional as you capture your progress and decisions.

This includes, but is not limited to:

- Brainstorming pages
- Sketches and technical drawings (CAD)
- Models/Prototypes pictures and videos
- Research notes and references
- Project calendar/schedule
- Roles and responsibilities of team members
- Calculations
- Budget & Materials
- Daily log
- Safety procedures (if applicable).

The technical drawings should be complete with appropriate annotations, material list and parts identified. The technical drawings should be printed on A size template and be scaled appropriately. Teams should be submitting orthographic and isometric drawings. Teams may should include other plans that relate to their challenge as appropriate.

Your digital notebook must be:
-Clear – Explain your thinking and design decisions
-Detailed – Include supporting data and thorough descriptions
-Organized – Use consistent formatting, section labels, and visual clarity

Be sure to include a title page, table of contents, and any references (citations in APA format).

The digital notebook will be used as a key tool during project checkpoints throughout the year. These checkpoints will serve as formal review moments where teams will earn points for submission. Staying current and organized in your digital notebook is essential to success throughout the year.

Presentation Binder:
In addition to the digital engineering notebook, each team is required to submit a physical binder that includes key artifacts from their design process (from the digital engineering notebook). This binder will support your presentation.

Your binder must include the following:

- Sketches
- CAD Drawings
- Code
- Calculations
- Any other documentation you believe strengthens your final presentation

Note: Not all items listed may apply to every challenge. Teams should include only the documentation that is relevant to their specific project.

All materials should be clearly labeled and organized to reflect progression of your project. This binder will be judged during the final presentation.

Prototype Iterations:
All stages of your design, from initial concepts to the final product, should be thoroughly documented in your digital engineering notebook. This includes:

- Photographs of all physical models and prototypes (e.g., paper, cardboard, 3D printed, etc.)
- Images should show multiple angles and include captions or explanations describing what each view represents
- Descriptions of design changes and the reasons for those changes
- Testing documentation such as written observations, data, and video clips of prototypes in action

All prototypes will be submitted ahead of the challenge and used in the final presentation. Be prepared to explain how your design evolved throughout the project.

Presentation:
Each team will deliver a 7–10-minute presentation at their assigned time. All team members should be dressed professionally and be prepared to speak about any aspect of their project including their individual roles during the project. Following the presentation, judges will have an opportunity to ask questions.

As part of the presentation, teams are required to use their presentation binder and prototypes. They will be available for pick up the morning of the event. Judges will expect students to reference these materials when discussing:

- Key stages of the design process
- Final design decisions and how the design evolved
- How the prototypes and final design performed during testing and the demonstrated performance at the challenge
- Lessons learned and improvements

To encourage creativity, public speaking skills, and real-time communication skills, PowerPoint, Google Slides, or other digital presentation software are not permitted during the presentation. Teams are encouraged to think outside the box and find engaging ways to share their journey.

Demonstrated Performance:
This is the most exciting part of the Digital Ship Challenge! Each team will have the opportunity to demonstrate that their hard work has resulted in a design that can successfully meet the challenge. First, second, and third place will be awarded based on total points achieved.

Design and Construction of the final project: Judges will be looking for the following:

-Achievement of design specifications and constraints.
-Creativity and innovation of design.
-Quality of construction.
-Finish and appearance.

The Depths Await – Design, Test, and Dominate

Schedule of Checkpoints

Each checkpoint is worth points towards the team's overall score. Teams are required to submit the following documentation by the date and time listed. All documentation must be submitted to receive points. No partial points will be awarded.

Checkpoint Date and Time	What needs to be submitted	Points
Review Challenge and Overview of Digital Engineering Notebook **October 22, 2025 11:59pm**	All Divisions: Initial section of the digital engineering notebook including: • Title Page with team name and school division • Table of contents page • Challenge Interpretation and problem summary • Preliminary team roles and schedule Team mentor/teacher should confirm student understanding of challenge and constraints	10
Research and Brainstorming **November 24, 2025 11:59pm**	All Divisions: Notebook Updates • Research Notes (depending on division) • Brainstorming sketches or concept drawings • Notes on materials or systems being considered	10
Mid-Year Workshop **December 18, 2025 Time TBD**	All Divisions: In-person attendance at the mid-year workshop. Bring to the event: • First iteration prototype(s) • Talking points/questions	25
Refined Design and Prototypes **January 14, 2026 11:59pm**	All Divisions: Notebook Updates • Revised Sketches • CAD Drawings • Updated material list • System layout/plan • Refined prototype photos • Notes from testing/troubleshooting Prototype should demonstrate key function(s): • Design Division: Dive/surface mechanism • Systems Division: Piping layout/connections • Tech Division: Messaging and sensing partially working	20
Refined Prototypes and Testing **February 11, 2026 11:59pm**	All Divisions: Notebook Updates • Update of testing trials • Problems identified and design iterations • Adjustments to drawings, layouts, code, etc. Include photos or video clips of prototype testing	20

Final Design Build and Test **March 25, 2026 11:59pm**	All Divisions: Notebook Updates • Final test results • Design validation • Documentation of final construction • Clean CAD drawings, material list, wiring/flow diagrams, etc. Ensure all constraints are met	10

Presentation Preparation
 	
April 3, 2026 11:59pm
	All Divisions:
	Presentation outline submitted
	• Prepare for your oral presentation (7-10 minutes)
	  • Must include information from notebook, design construction, testing, and the day of the challenge results
	  • Practice answering judging questions
		10

Digital Engineering Notebook and Prototype Submission **April 17, 2026 4pm**	All Divisions: In person drop off at OERI • Submit all physical models and prototypes All Divisions: Online submission of Digital Engineering Notebook	10
Digital Ship Challenge **April 25, 2026 Time TBD**	All Divisions: In person event at OERI	N/A

Each team will be provided with a folder on Google Drive where they will be uploading documents for each checkpoint. The mentor, teacher, and students on the team will have access to the folder. This can also be used as a way for mentors to give feedback to students. The VDMC team will be accessing the folder after the submission date for a checkpoint and scoring what has been submitted.

Scoring

Digital Engineering Notebook

Max. Points	Criteria
5	Title Page: Clearly states the name of the challenge, team name, team member names, name of school.
5	Table of Contents.
10	Chronological documentation: Provides record of all team activities related to planning, designing, production, and preparation for the challenge. It should clearly demonstrate the progression of work overtime.
50	Content: Should include (but not limited to) brainstorming pages, pictures of hand drawn sketches, technical drawings (CAD – including orthographic, isometric, and any additional plans that relate to the challenge as appropriate), code (as applicable to the challenge), prototypes, testing documentation, calendar/schedule, roles, calculations, budget, daily log, safety procedures (if applicable). It should cover all aspects of the engineering design process. Drawings should reflect that the design meets the criteria provided.
20	Clarity: All components of notebook should be clear and understandable. Pictures, diagrams, charts, videos, etc. should be labeled and explained effectively.
15	Detail and organization: The notebook should be well-organized and exhibit a high level of detail. It should provide insights into the thought processes and decisions of the team while following the flow of the engineering design process.
5	References: If external sources are used, they should be appropriately cited in APA format.

Prototypes

Max. Points	Criteria
20	Designs from inception to final product are displayed (this includes all models or prototypes).

Presentation

Max. Points	Criteria
10	Appropriate attire: All team members should be dressed professionally and on time for presentation.
15	Knowledge and preparedness: All team members should demonstrate a comprehensive understanding of all aspects of the challenge. They are well-prepared to speak on any part of the challenge.
10	Presentation duration: Team presents in the 7–10-minute time frame.
15	Content: The presentation features content from the presentation binder, prototype iterations, and results of demonstrated performance (if possible).
10	Engagement and confidence: All team members should display confidence and be engaged while presenting. This includes maintaining eye contact, using a clear and audible voice, and conveying enthusiasm.
10	Question and answer session: All team members should be prepared to answer questions from the judges after their presentation. Responses should be knowledgeable and reflect a deep understanding of the project.

Presentation Binder

Max. Points	Criteria
5	Title Page: Clearly states the name of the challenge, team name, team member names, name of school.
15	Content: Sketches, CAD Drawings (orthographic, isometric, and any other applicable to challenge – printed on A size completed templates), Code, Calculations, any other documentation you believe strengthens your final presentation *Note: not all items listed above apply to every challenge. Teams should include only the documentation that is relevant to their specific project.
10	Clarity: All components of notebook should be clear and understandable. Pictures, diagrams, charts, etc. should be labeled and explained effectively.
15	Detail and organization: The notebook should be well-organized and exhibit a high level of detail. It should provide insights into the thought processes and decisions of the team while following the flow of the engineering design process.

Demonstrated Performance – Part 1

Max. Points	Criteria
15	All pipes are marked in accordance with naval shipboard piping standards
10	Piping system fits inside 24" x 24" x 24" space
20	System follows original provided blueprint (measurements, fittings, placement, etc.)
20	System is watertight
15	Quality of Construction: Clean pipes, clean joints
10	Flow rate of original blueprint

Demonstrated Performance – Part 2

Max. Points	Criteria
15	All pipes are marked in accordance with naval shipboard piping standards
10	Piping system fits inside 24" x 24" x 24" space
20	System follows redesigned blueprint (measurements, fittings, placement, etc.)
55	System Blueprints contain: -All appropriate annotations -Front, Top, Right, Left, and Isometric Views -Materials List -Notes or Symbols indicating flow and fittings
20	System is watertight
15	Quality of Construction: Clean pipes, clean joints
20	Flow rate of redesigned blueprint and engineering recommendation