DESIGN DIVISION

The Challenge

Your team has been contracted by a naval innovation task force to design and construct a functional submarine capable of stealth operations beneath the surface of the ocean. The submarine must be able to conduct a controlled dive, travel a designated distance underwater, and surface, simulating the essential capabilities of modern underwater naval vessels.

Real World Examples

The word submarine means 'under sea'. Some of the first submarine designs date back to the 16th century. While military submarines, like the Columbia and Virginia class built right here in Hampton Roads, are typically the largest and most common example, there are many different types. Civilian submarines come in various sizes and shapes and are used for inspecting underwater cables, surveying oil and gas structures, or exploring the seabed.

Things to Consider

Buoyancy and Ballast: How will you control your submarine's ability to dive and surface without sinking? Investigate how submarines use ballast tanks or air displacement to manipulate buoyancy. Consider different options to control buoyancy during operation.

Stability and Balance: A stable submarine should stay upright while underwater. Consider how weight distribution and center of gravity affect rolling or tilting. How will your design maintain balance while diving and surfacing?

Underwater Navigation: How will your submarine move through the water? Will you use propellers, fins, rubber-band propulsion, or other creative methods? Your submarine must travel in a specified direction for a set distance – think about hydrodynamics and drag.

Controlled Resurfacing: Your submarine must resurface on demand in a controlled manner, not pop up chaotically or too quickly. Explore ways to delay surfacing or trigger it on command (e.g., time-based release, manual trigger, or buoyant material deployment). How does Archimedes' principle apply to this?

Pressure and Water Proofing: While you're not diving to deep-sea levels, your submarine may still face leaks or pressure issues. How will you waterproof your design and ensure critical parts stay dry when submerged?

Testing and Iteration: Submarine systems can be complex – expect to test, fail, and improve multiple times. Track your trials carefully, noting what works and what doesn't, and reflect changes in your engineering notebook.

This challenge is not limited to existing submarine designs – explore bio-inspired shapes, stealth profiles, or futuristic concepts. Submarines have evolved drastically over time; your design can too. You are encouraged to think creatively and innovatively to design and develop a submarine that excels in all aspects of the challenge. Exploring innovative ideas for the submarine's construction materials and processes is also highly encouraged.

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

Overall length: Not to exceed 30”
Overall beam (width): Not to exceed 24”
Overall height: see below

Vessel must have a superstructure visible on the top of the vessel.

The depth of the freshwater tank will be 30”. The height of your submarine must be set so that the submarine can completely submerge and not touch the bottom of the testing tank. Any wiring/tubing used for ballasting or power/propulsion must be between 7 and 10 feet long and extend outside of the testing tank. Teams cannot use wiring/tubing to manually push or pull their submarine through the water or be inside the pool themselves. The submarine must travel straight inside the channel and without climbing or diving.

Teams will not be able to touch their submarines once in the testing tank. All sources of propulsion must be below the surface of water. Judges will be placing the vessel into the testing tank.

Submarines will be required to travel a distance of 3 feet through a channel that measures 3 feet wide without touching the sides.

*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

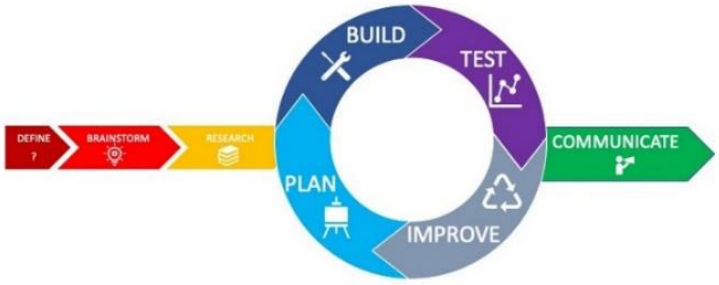
Intent to Participate	September 12, 2025
Teacher and Mentor Meeting	October 10, 2025
Mentor sessions at schools	As scheduled
Mid-Year Workshop at OERI	December 18, 2025
Digital Engineering Notebook online submission	April 17, 2026
Prototype drop off	April 17, 2026
Digital Ship Competition at OERI	April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

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	All Divisions: Notebook Updates • Final test results	10

March 25, 2026 11:59pm	• Design validation • Documentation of final construction • Clean CAD drawings, material list, wiring/flow diagrams, etc. Ensure all constraints are met	

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 11:59 pm**	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.
15	Visual documentation of work: Includes clear photos and videos showing prototyping, iteration, and testing. Images and videos must be inserted directly into the digital engineering notebook either embedded into the slide/document or a direct hyperlink (that has been made shareable).
20	Clarity & Readability: 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.
20	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.
20	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 & Readability: 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.

Design

Max. Points	Criteria
40*	Overall beam (width): Not to exceed 24”
	Overall length: Not to exceed 30”
	Overall height: Submarine must be fully submerged and not touching bottom of pool
	Vessel must have a superstructure and be visible on the top of the vessel
	Must have some kind of mechanism to facilitate the submergence of the vessel
	Must have a propulsion system self-contained to the vessel. No dragging or pushing the vessel along with outside force
	Must have some kind of steering system that keeps the submarine straight in the channel
20	Creativity and innovation: Ship design exhibits creative and innovation solution and demonstrates a unique and thoughtful approach to solving the challenge.
20	Quality of construction: High quality construction with attention to detail and precision, it is durable and reliable.
20	Finish and appearance: The finished ship has an aesthetically pleasing appearance and the overall finish and surface quality meets or exceeds expectations.

*If any of the above criteria are not met, all points (40) will be deducted. *

Demonstrated Performance
*Time limit for the demonstrated performance will be 15 minutes. Teams cannot exceed this time.

Max. Points	Criteria
45	Vessel floating with the superstructure upright above water and not listing for 30 seconds. Active ballasting and depth control is allowed (no pulling or pushing of vessel using tubing and wiring). Points awarded as follows: Floating without touching the bottom 15 points, superstructure remains above the water 15 points, no rolling or listing 15 points 1 minute allotted for initial ballasting.
45	Submerge the vessel to a point where the entire vessel (not including any apparatus (i.e. tubing or wiring) used to remotely control ballasting or navigation) (removed fully) below the water's surface without touching the bottom. Maintain this static position with superstructure upright and not listing for 30 seconds. Active ballasting and depth control is allowed (no pulling or pushing of vessel using tubing and wiring). Points awarded as follows: Able to submerge: 15 points, maintain depth 15 points, no rolling or listing 15 points 1 minute allotted for ballasting and depth control
45	Vessel travels the designated distance (3 ft.) remaining submerged using the self-contained propulsion system. The vessel's bow will be aligned to the start line, and the full vessel must travel the designated distances (i.e. stern must cross all distance markers). Active ballasting and depth control is allowed during travel (no pulling or pushing of vessel using tubing and wiring). Points are awarded as follows: 15 points for stern passing all distance markers, 15 points for staying within the channel during travel, 15 points for remaining submerged, not touching the bottom or surfacing 1 minute allotted for ballasting/adjustments prior to travel – vessel must remain in water and untouched 5 minutes allotted for traveling designated distances.
45	Vessel will resurface to where the vessel is floating with the superstructure upright above water and not listing for 30 seconds. Points awarded as follows: Floating without touching the bottom 15 points, superstructure remains above the water 15 points, No rolling or listing 15 points 1 minute allotted for ballasting