The Society of Naval Architects and Marine Engineers

2023-2024
DR. JAMES A. LISNYK STUDENT SHIP DESIGN COMPETITION RULES

I. COMPETITION PHILOSOPHY

The principal objectives of the competition are:

- To stimulate interest in ship design as a career choice
- To increase the participating students' understanding of and competence in ship design

Secondary objectives are:

- To recognize and reward outstanding student design projects
- To provide an opportunity for outstanding student design projects to be presented to current students of ship design and the broader membership of the profession
- To provide feedback to faculty members teaching ship design that can assist them in identifying areas of instruction that need strengthening.

The selection committee's judgment is based solely on the material presented in the submitted design reports; therefore, the design reports' contents are all-important. The Committee is primarily interested in evidence that the students have achieved a good understanding of the design process, as indicated by the students' approach to their design, the validity and comprehensiveness of the work done, the critical design decisions made along the way and the rationale for those decisions including, in support of the most critical decisions, the trade-off studies performed.

The Committee does not desire elegant computer results produced by a sophisticated computer program, when no evidence is presented that the students have any understanding of the workings of the computer program used, its theoretical basis, its structure, restrictions on its applicability, the degree to which the program has been validated and accepted by the greater design community, etc. and when the computer results presented are not accompanied by any thoughtful discussion. While the use of sophisticated computer programs is not prohibited, their use will not gain extra credit for a submittal per se and can, in fact, detract from the final score if no evidence is presented that the students understand the program being used and the results presented are not discussed.

The work presented in the design report is the basis for the Committee's technical score for a project. In addition, the report itself is scored on organization, completeness, text and graphics. A report that is well written, has professional quality figures, tables and drawings, is well-organized and complete will score high. The Contest Rules clearly state the required contents of the design report and a copy of the score sheet that the judges use is included in the package. The report must clearly address each item of the desired contents for it to be deemed complete. The report should be structured so as to make it easy for the Committee judges to find the desired items in the report.

The most frequently observed deficiencies in the design reports received by the Committee over the years are:

- Some required design report topics are not addressed (or can't be found)
- Missing, illegible or poorly labeled figures and drawings (graphics from computer programs frequently need to have labels added or enlarged to make them suitable for a report)
- No explanation of the approach/methodology used for some analyses (i.e., the reviewer can't understand the calculations performed or the results of a computer program are presented with no evidence that the students understand the underlying theory)
- No rationale presented for some critical design decisions
- Internal inconsistency (for example different values are given for the same characteristic in different parts of the report
- No discussion of some important analytical results.
- Final report is not signed by all team members and certified by faculty advisor.
- Violation of the limit of 140 pages

II. GENERAL

All team participants must be current undergraduate SNAME student members. Each team must have an advisor who is both a faculty member of the university and a current SNAME member. **It is important to note that all members of teams entering the competition must be classified as undergraduates, and if working towards a combined Bachelor and Master of Science degrees, they must be in what is considered to be the undergraduate portion of their curriculum, usually defined as the first four years of their course of study**. Please contact the Committee Chair, Patrick Naughton, and Sofia Iliogrammenou if you have any questions regarding eligibility. They may compete as individuals or in teams of up to six persons.

1. Design projects that are developed in response to a formal classroom requirement are eligible for the competition as well as thesis projects or designs done independently of the curriculum.

2. More than one design may be submitted from a school, but an individual student may only participate in one design.

3. Students intending to enter the competition are requested to submit an Entry Form before starting work. Receipt of this form enables the contest sponsors to communicate with the students if the need arises.

4. The competing individuals or design teams shall prepare an Owner's Requirements for the design of an ocean-going ship of 500 or more tons full load displacement. The Owner's Requirements must cover the scope and adhere to the format of the Requirements issued with these Rules. Near-shore vessels capable of operating in open water are also acceptable as long as they meet the minimum displacement constraint and are capable of a voyage of at least 48 hours duration (this means accommodations and dining facilities must be provided). If you have any questions regarding the appropriateness of your proposed entry, please contact Patrick Naughton and Sofia Iliogrammenou. These Owner's Requirements must be submitted for approval prior to starting design work. They should be submitted together with the Entry Form. Alternatively, they should be emailed to Patrick Naughton and Sofia Iliogrammenou. They will either be approved or rejected by the sponsors in writing within 21 days of receipt. The final Owner's Requirements shall be

included as an appendix to the final design report. A Sample Owner's Requirements is available on the SNAME website as guidance only.

5. Design reports shall be no more than 140 pages in length (including figures, tables, drawings, and appendices, but not including the cover sheet, table of contents, lists of tables and figures, or final Owner's Requirements). Large, folded prints of drawings are acceptable and need not be bound into the report but will be included in the page count. Material submitted which exceeds the 140-page limit will not be judged. A **minimum** font of 10 points is required for the report text, eight points is acceptable for use in figures and tables.

6. Reports shall be submitted via email to Patrick Naughton and Sofia Iliogrammenou. They should be in PDF format, and all large drawings need to be formatted to fit on an 11 x 17-inch (or equivalent) fold-out page and have a resolution of at least 300 dpi. **Reports must bear the name and signature of the design team leader and all participating members. The Faculty Advisor's signature and membership number must also accompany the report with a statement certifying that the work was done by the students. The Faculty Advisor's note does not need to be bound into the report**.

7. Designs submitted must be the work of undergraduate students. Any member of the design teams must have not yet received his or her baccalaureate degree when the work was done. Guidance may come from the Faculty Advisor or mentors, but it must be accurately referenced and acknowledged.

8. Prizes shall be $1,500 for first, $750 for second, and $500 for third, with the awards going directly to the students submitting the winning designs. Certificates will be presented to the winning design teams for display at their colleges or universities as well as for retention by the team members and faculty advisors. Not all prizes will be awarded if an insufficient number of high-quality designs are submitted.

9. If a design team withdraws from the competition, the team leader is requested to notify Patrick Naughton and Sofia Iliogrammenou via email promptly.

III. SCHEDULE

Significant contest dates are as follows:

Entry Applications and Owner's Requirements Due	**On or before March 1, 2024**
Designs Submitted	**On or before May 31, 2024**
Winning Teams Notified	**August 15, 2024**
Awards Announced and Presented	**October 14-16, 2024**

Designs received after the May 31, 2024, deadline will not be judged nor considered for an award.

IV. APPLICATION

Individuals or teams intending to enter a design in the Competition are urged to submit an Entry Form online.

The completed design report must be submitted via email to Patrick Naughton and Sofia Iliogrammenou on or **before May 31, 2024**.
The receipt of both Entry forms and final reports will be acknowledged by email.

V. DESIGN REPORT REQUIREMENTS

The quality of the technical work done is the most important factor in the design judging. No technical work, however, is of value unless it can be reviewed and used by others. Thus, the documentation of the design in the design report is of critical importance. In particular, the design report should accomplish the following:

1. Demonstrate a thorough understanding of the Owner's Requirements.

2. Describe the technical approach used to satisfy each of the Owner's Requirements, together with trade-off studies or alternative solutions that were considered and the rationale for the selection of the proposed design solution.

3. Identify technical risks and means to alleviate them.

4. Present descriptions, sketches, system analyses and discussion of techniques used in sufficient detail to permit technical evaluation of the design. A work breakdown structure shall be used to organize the report and design description to ensure all required aspects are covered. Specifically, the design report should address the approach taken for concept selection and the initial definition and sizing of the ship. In addition, the report shall include as a minimum:

    a. A summary discussion of the project including a Table of Principal Ship Characteristics (dimensions, payload, speed, endurance, complement, etc.). This should be the first item in the report.

    b. Weight estimate, in an accepted weight classification format, for three conditions:

        - Light Ship Condition: ship complete, ready for service in every respect including onboard repair parts, outfit, liquids in machinery at operating levels, but without any variable loads (Include proposed light ship design and construction margins.)
        - Full Load Departure Condition: Light Ship Condition plus complement, provisions, fuel, water, cargo, and other variable loads.
        - Arrival Condition: Full cargo, 10% fuel and other consumables.
          (Show all elements of each loading condition)

    c. Curves of Form and Floodable Length Curve.

    d. Trim and intact stability calculations for the full range of anticipated operating conditions.

    e. Damage stability analyses for selected limiting cases.

    f. Drawings (To be included in an appendix and not imbedded within the body of the report; see size requirements in Section II.7, General.):

- Lines Drawing with principal appendages
- General Arrangements, including inboard profile and deck plans (Main Deck, hold level, and deckhouse levels as a minimum).
- Capacity Plan defining individual cargo hold and tank capacities.
- Machinery Arrangement with accompanying list of principal components.
- Structural Midship Section with scantlings labeled and supporting calculations.

g. Speed/power analysis and SHP vs. speed curve.

h. Electrical load analysis with rationale for selection of ship service generators and emergency generators.

i. Seakeeping analysis to demonstrate operability in sea state specified in the Owner's Requirements.

j. Area/Volume summary listing all internal ship spaces, including tankage and voids (molded deck area and volume for each space – totals to sum to "the total enclosed hull plus deckhouse" volume to demonstrate that the total enclosed volume is adequate to meet requirements). The summary should provide references to the other sections of the report where the area and volume requirements are derived for the different functional areas.

k. Manning estimate with rationale

l. Major HM&E systems and equipment descriptions and rationale. HM & E systems are non-propulsion and non-mission specific mechanical and electrical systems supporting ship operations such as heating, ventilation, and air conditioning, fire main, electric power generation and distribution, anchor handling, etc.) Rationale for the system weights and electrical power requirements used in the overall ship weight estimate and electric load analysis shall also be provided.

m. Propulsion plant trade-off study leading to selection of major components of the propulsion plant, i.e., prime movers, propulsors, control system and reduction gear (if provided).

n. Endurance fuel calculation.

o. Mission systems and equipment descriptions and rationale

- For combatant ship designs a description of the combat and weapons systems including a list of the major systems, their functions, and general capabilities. Rationale for the selection of major combat/weapons systems components (may be qualitative) and their integration into the overall ship design including topside configuration. Weight, volume, and electrical power estimates used for these systems in the overall ship design and their sources.

- For commercial ships a description of cargo/vehicle handling and stowage systems or passenger accommodations. For special-purpose ships (dredges, oceanographic ships, etc.) a description of their mission-related systems. Include a list of the major systems, their functions, and major capabilities. Rationale for the selection of major mission systems or for the size and arrangement of cargo handling equipment and cargo hold and hatch cover (if any) configuration and their integration into the overall ship design, including topside configuration. Weight, volume, and electrical power estimates used for these systems in the overall ship design and their sources.

p. Cost analysis: address both procurement cost for U.S. construction (hull, outfit and machinery) and ship operating and support cost.

q. Technical risk summary with risk mitigation approaches. This should be a qualitative discussion of the risk areas inherent in the design and should address technical and production risks including shortcomings in the design that would be addressed in the next design phase. The focus should be on design risk, not the operational risk after the ship is in service. Mitigation approaches could include, but are not limited to, further technical analysis, modeling and simulation, model testing, and prototype development and testing. This is an important area for those designs that may incorporate new technologies or represent a new use.

r. Final Owners' Requirements that form the basis for the submitted design shall be included as an appendix to the report but will not be included in the page count.

VI. DESIGN REPORT REQUIREMENTS FOR SUBMARINES

The following specific requirements address the unique aspects of submarine design and shall be used instead of those contained in Section V by teams submitting submarine designs:

1. Demonstrate a thorough understanding of the Owner's Requirements.

2. Demonstrate that a logical process was used in developing the design. Students are not expected to make the right choices in all cases; however, it is important to understand why the choices were made.

3. Describe the technical approach used to satisfy each of the Owner's Requirements, together with trade-off studies or alternative solutions that were considered and the rationale for the selection of the proposed design solution.

4. Identify technical risks, problem areas, and known shortcomings to the design.

5. Present descriptions, sketches, system analyses, and discussion of techniques used in sufficient detail to permit technical evaluation of the design.

Specifically, the design report should address the approach taken to sizing the ship and provide sufficient data to define the ship concept, including as a minimum:

a. Table of Principal Ship Characteristics (dimensions, surface and submerged displacements, reserve buoyancy, payload, submerged speed and endurance, operating depth, complement, etc.).

b. Arrangements, Volumetrics, Weights, and Ship Balance:

- Arrangements: Discuss the selection of the overall hull configuration (single vs. double hull, number of compartments, pressure and non-pressure hull shapes, number of platform decks, placement of military systems, etc.). Discuss the factors that influenced the selection of hull diameter(s).

- Volumetrics: Provide a buoyancy analysis for surfaced and submerged conditions. Discuss ever buoyant volume, main ballast tanks, free flooded volume, and surface trim.

- Weights: Provide a weight estimate in an accepted weight classification format including fixed and variable loads and growth margin(s).

- Ship balance: Account for weight limited versus volume limited design. Discuss longitudinal trim and trim lead and stability (GM and BG) and stability lead.

- Trim and intact stability calculations:
    - Surfaced and submerged righting arms.
    - Transverse stability changes during submergence (plot KB, KM, KG and virtual KG)

- Submerged equilibrium analysis. Discuss capacity/location of variable ballast tanks to adjust for various load and moment conditions in different seawater densities. Define the relevant equilibrium points and develop an Equilibrium Polygon.

c. Controllability analysis. Discuss the submerged operating envelope and near-surface depth keeping. Describe the placement and sizing of control surfaces.

d. Drawings (Same requirements as outlined in Section V, Design Report Requirements):

    - Lines drawing with principal appendages.
    - General Arrangements, including inboard profile and deck plans, and outboard profile and plan.
    - Machinery Arrangements with accompanying list of principal components.
    - Control/Operations Room Arrangements.
    - Weapons Spaces Arrangements.
    - Structural drawings for pressure hull, holding bulkheads, and non-pressure hull.
    - Curves of form.

e. Resistance and powering analysis for submerged and snorkeling conditions. Describe the various components of total resistance. Discuss propulsive coefficient (PC).

f. Area/volume summary listing all internal ship spaces (within the pressure hull). In addition, discuss selected outboard spaces, i.e., sail, casing, MBT, and free floods as applicable. List all tankage, internal and outboard.

g. Manning estimate. Discuss the basis for the manning estimate used in support of the design.

h. Structural analysis. Discuss basic pressure hull structure (shell plating, stiffeners, holding bulkheads, and end closures), material, pressure hull calculations (define failure modes), and operating and collapse depths. Discuss non-pressure hull structure requirements and design. Discuss cost, producibility, and maintenance implications of selected structural geometry and material.

i. Major HM&E systems and equipment characteristics and descriptions: propulsion, electrical, hydraulic, air, water, ship control, life support, main and variable ballast, and escape and rescue.

j. Major Command/Control and Mission Payload systems and equipment characteristics and descriptions: navigation, sensors (radar and sonar), communications, weapons and launchers (loading, storage and launch), fire control system, and personnel lockout (as applicable).

k. Propulsion plant trade-off study and electrical load analysis leading to selection of major components of the propulsion plant, i.e., prime movers, batteries, AIP, generators, propulsion motor(s), propulsor(s), control system, and fuel requirements. Relate to notional patrol, i.e., address speed of advance, range, indiscretion rate (ratio of the time at periscope depth snorkeling to the total operating time), balance speed (speed at which maximum AIP power = propulsion plus hotel loads), time on station, fuel endurance, and hotel load.

l. Cost analysis: address both procurement cost for U.S. construction and ship operating and support costs. Provide a construction cost estimate with supporting assumptions. Assess the cost uncertainty associated with any new technologies.

m. Major technical design risk summary with a discussion of possible risk mitigation approaches. Also discuss design issues which would be addressed in future design iterations. For a combatant submarine discuss stealth and survivability. Although specific design requirements and engineering data for these key submarine attributes will be difficult to obtain and, hence, to incorporate into a student design, discuss how these factors might significantly alter the results.

VII. FACTORS FOR JUDGING

1. Technical Content (75 points)

Correctness of theory, validity of reasoning used, computational accuracy, breadth and depth of analyses, and apparent understanding of the subject, as evidenced by the quality and compliance of the response to the Owner's Requirements. Completeness and quality of principal drawings as defined in Section V, 4f or Section VI, 5d and described in Section II, 5 are important parts of this category. In addition, although the use of a parent design in developing the design is acceptable, it should only be used as a starting point (i.e., using features of an existing design without change will result in zero points for the applicable section).

2. Documentation (13 points)

The effectiveness of the design report as an instrument of communication is a strong factor in the judging. Organization of the report, clarity, completeness of design rationale and technical data, proper English usage, and use of figures and tables, including labeling, are major considerations. The text should be grammatically correct, succinct, clear, uniform, and easily readable. Small fonts in the body of the text are not desirable. A table of contents is required (not included in the page count), and lists of tables and figures are desirable (also not included in the page count).

3. Overall Quality and Originality (7 points)

The design should reflect innovative thinking, but at the same time should reflect sound systems engineering and design. It shall also be able to be produced within a reasonable cost. An innovative solution that defies the laws of physics or requires significant increases in the state-of-the-art will not be favorably judged.

(NOTE: Innovative design solutions are encouraged and will be positive factors in the evaluation, provided that the design report realistically identifies their potential advantages and disadvantages, their technical risks and uncertainties, and means to alleviate these risks and uncertainties.)

4. Compliance with Owner's Requirements (5 points)

The naval architect who fails to make every effort to satisfy the Owner's Requirements will soon be seeking another profession.