Project Corregidor:
Redefining Starfleets Emergency Research Starship Capabilities

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ABSTRACT

The USS Romulus is a conceptual Federation starship designed for long-range exploration and emergency response. Developed using **SolidWorks**, the project focused on advanced modeling techniques, parametric adaptability, and structural optimization. The design integrates a command saucer, engineering hull, and a detachable space station module, enabling extended missions and rapid response capabilities.

Challenges included modeling complex curved surfaces, achieving precise feature alignment, and maintaining design flexibility. Solutions involved strategic use of reference planes, parametric constraints, and adaptive surface modeling techniques. The final model is optimized for visualization, demonstrating innovation in starship design while adhering to Starfleet engineering principles.

Keywords: CAD modeling, Mesh, Revolve, Spline, Extrude,

1 THE STARFLEET ADVANCED ENGINEERING CHALLENGE

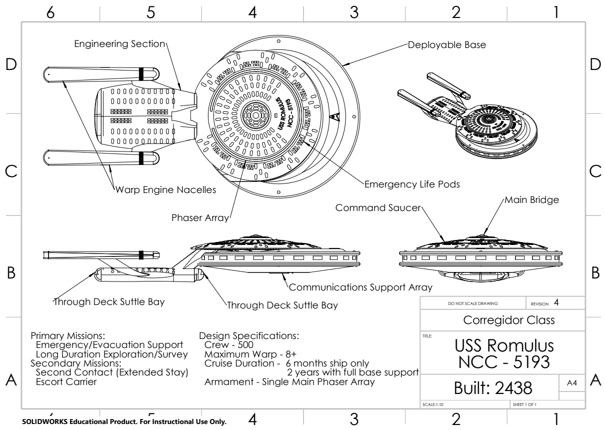


Figure 1: Technical schematic of the USS Romulus, detailing its engineering hull, command saucer, and mobile space station module.

The USS Romulus was developed for the Starfleet Advanced Engineering Challenge, a competition aimed at designing the next-generation Federation starship. This challenge required teams to develop a vessel optimized for long-range exploration, emergency response, and scientific research.

Using **SolidWorks**, our team implemented advanced CAD techniques to create a structurally sound, visually compelling model that meets both aesthetic and functional Starfleet requirements. The design integrates modular adaptability with engineering precision, ensuring flexibility for future mission demands.

2 NCC 5193 USS ROMULUS

The **USS Romulus** is a next-generation Federation vessel designed for extended deep-space missions and emergency response. The ship consists of three primary sections:

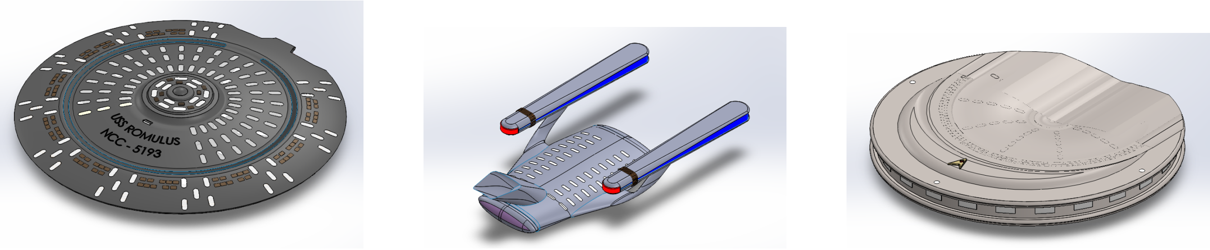
- **Engineering Section** Houses the ship's warp core, propulsion systems, and main support infrastructure.
- **Command Saucer** Serves as the primary operational hub, containing the bridge, crew quarters, and mission-critical systems.
- **Mobile Space Station Module** A detachable section capable of functioning as an independent research outpost or diplomatic hub.

Equipped with **Warp 8-capable nacelles**, the vessel ensures rapid deployment for emergency operations. The command module can detach and remain in orbit while the main vessel travels to high-priority locations, enhancing mission flexibility. With a crew capacity of 500 and the ability to accommodate up to 2,000 passengers, the USS Romulus is well-equipped for scientific, diplomatic, and humanitarian missions.

3 STARSHIP ENGINEERING PIPELINE

The development of the USS Romulus followed a structured engineering pipeline to ensure precision, adaptability, and design continuity. Key areas of focus included structural integration, parametric modeling, and final optimization for visualization.

3.1 STRUCTURAL INTEGRATION AND DESIGN REFINEMENTS



(a) Command Saucer (b) Engineering Hull (c) Mobile Station Module

Figure 2: Key structural sections of the USS Romulus, highlighting primary engineering and design elements.

The USS Romulus was modeled in **SolidWorks** using a structured, **component**-**based approach** to maintain proportional accuracy and seamless integration between hull sections.

Engineering Section: The hull was constructed using lofted surfaces with multiple cross-sections. The shuttlebay was formed using offset surfaces before extruded cuts defined the entrance. Warp nacelle pylons were developed via **sweeps** along 3D sketches, with fairing interfaces blended using **boundary surfaces** for smooth aerodynamic transitions.

Command Saucer: Due to its fully curved surface, all features such as windows and escape pods were placed using projected sketches onto reference planes. **Circular patterns** ensured even distribution, maintaining symmetry.

Mobile Space Station Module: Designed as a parametric, detachable component, the docking mechanism was modeled with precise constraints, ensuring secure attachment to the main vessel.

3.2 PARAMETRIC ADJUSTMENTS AND FEATURE CONTINUITY

To maintain adaptability and structural coherence, the USS Romulus was developed using a **parametric modeling approach** in SolidWorks. This allowed for rapid adjustments without disrupting key features.

- **Reference Geometry** Multiple **datums, planes, and axes** guided consistent feature placement, ensuring uniform alignment of components.
- **Circular and Linear Patterning** The **Circular Pattern** tool ensured escape pods, windows, and hull reinforcements were evenly spaced, reducing manual adjustments.
- **Feature Relations for Seamless Adjustments** Parent-child dependencies allowed structural modifications to automatically propagate throughout the model.
- **Spline-Based Surface Adjustments** The nacelle pylons and engineering hull fairings were optimized using **curvature continuity constraints**, ensuring smooth transitions.

These parametric techniques enhanced the models flexibility, stability, and scalability, reinforcing Starfleets standard for adaptable vessel design.

3.3 FINAL MODELING AND OPTIMIZATION

Figure 3: Final rendered model of the USS Romulus, showcasing the completed design and structural refinements.

After primary structural development, the model underwent refinement to improve its visual accuracy and technical precision.

- **Surface Refinement** Variable-radius fillets and curvature blends were applied to nacelle pylons and saucer edges for smoother transitions.
- **Detailing and Feature Placement** High-precision cuts and boss features added docking ports, paneling, and sensor arrays.
- **Alignment and Proportional Adjustments** Final proportional tweaks ensured that the center of mass and structural symmetry remained intact.
- **Decal Placement and Rendering** Registry markings, insignias, and material textures were applied for accurate visualization.

The final model balances **engineering precision with aesthetic detail**, making it suitable for both competition submission and realistic rendering.

4 LESSONS FROM THE FINAL FRONTIER

Developing the USS Romulus provided valuable experience in advanced CAD modeling and workflow optimization. Utilizing almost all available features to create the model in Solid works such as; wrap for flat to curved diagram translation, angling planes and using split line techniques to create curved surface extrusions, and creating a lofted surface with 4 cross sections.

Reference Planes for Curved Surfaces

Placing features like windows and escape pods on the saucer required reference planes for accurate projection. This prevented distortion and ensured precise alignment.

Achieving Consistent Cuts on Curved Surfaces

To maintain uniform cut lengths, sketches were projected onto the curved hull, allowing even extrusions across the model.

Structured Surface Modeling

The engineering hull was designed using lofted surfaces and swept profiles. Planning tool sequences in advance reduced complexity and improved workflow efficiency.

Balancing Aesthetics with Functionality

While optimized for rendering, certain areas were more visually refined than functionally manufacturable. Future designs should integrate manufacturing-friendly CAD principles.

Strategic Tool Selection

Fillets, variable-radius blends, and adaptive parametric constraints played a key role in maintaining stability. Proper tool selection minimized errors and revision time.

These lessons enhance our ability to tackle complex CAD projects with greater precision and efficiency.

5 COMMAND REVIEW SELF-ASSESSMENT

The USS Romulus project tested our skills in advanced modeling, parametric adaptation, and collaborative problem-solving.

Project Strengths

- **Advanced CAD Techniques** Effective use of lofts, sweeps, and parametric constraints ensured design continuity.
- **Feature Accuracy** Strategic reference planes and projection techniques maintained proper feature alignment.
- **Rendering and Presentation** High-resolution renders and animations enhanced the visual impact.

Challenges and Areas for Improvement

- **Complex Surface Modeling** Multi-curved surfaces required iterative refinements.
- **Balancing Detail vs. Usability** Some elements were more visually optimized than manufacturable.
- **Time Management** Refinements took longer than expected; future projects would benefit from more structured planning.

Final Takeaways

This project reinforced the importance of structured workflows, adaptive modeling, and strategic problem-solving. The USS Romulus exemplifies innovation and precision in CAD-based starship design.

References

[1] K. Chang, *Product Design Modeling using CAD/CAE*, ser. The Computer-Aided Engineering Design Series. 30 Corporate Drive, Suite 400, Burlington, MA 01803: Academic Press, Elsevier Science & Technology, February 2014.

[2] ——, *e-Design: Computer-Aided Engineering Design*, revised 1st ed. 30 Corporate Drive, Suite 400, Burlington, MA 01803: Academic Press, Elsevier Science & Technology, 2016.

Appendix A - Supplemental Figures

Figure 4: Full technical schematic of the USS Romulus, including internal structures and detailed component breakdown.

Figure 5: View of the Warp 8 Nacelles

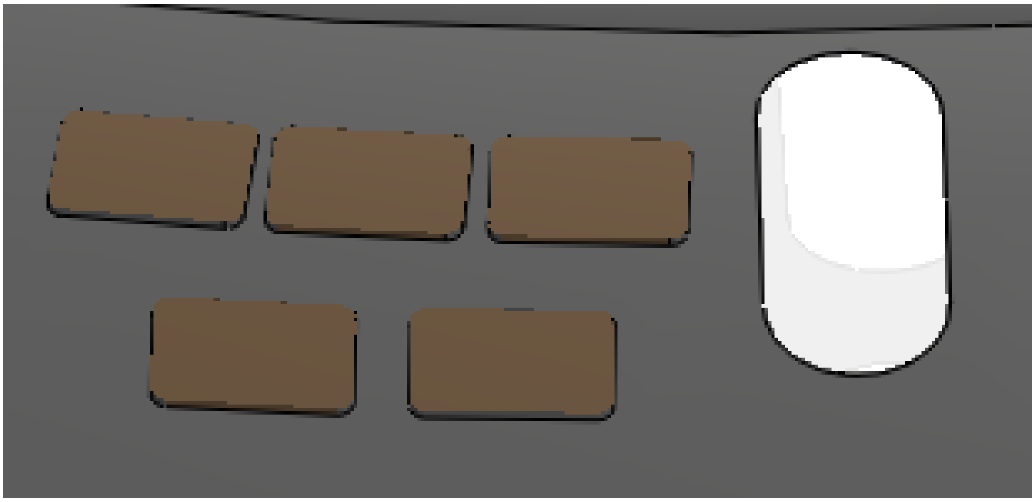


Figure 6: High-resolution view of the escape pods and windows.

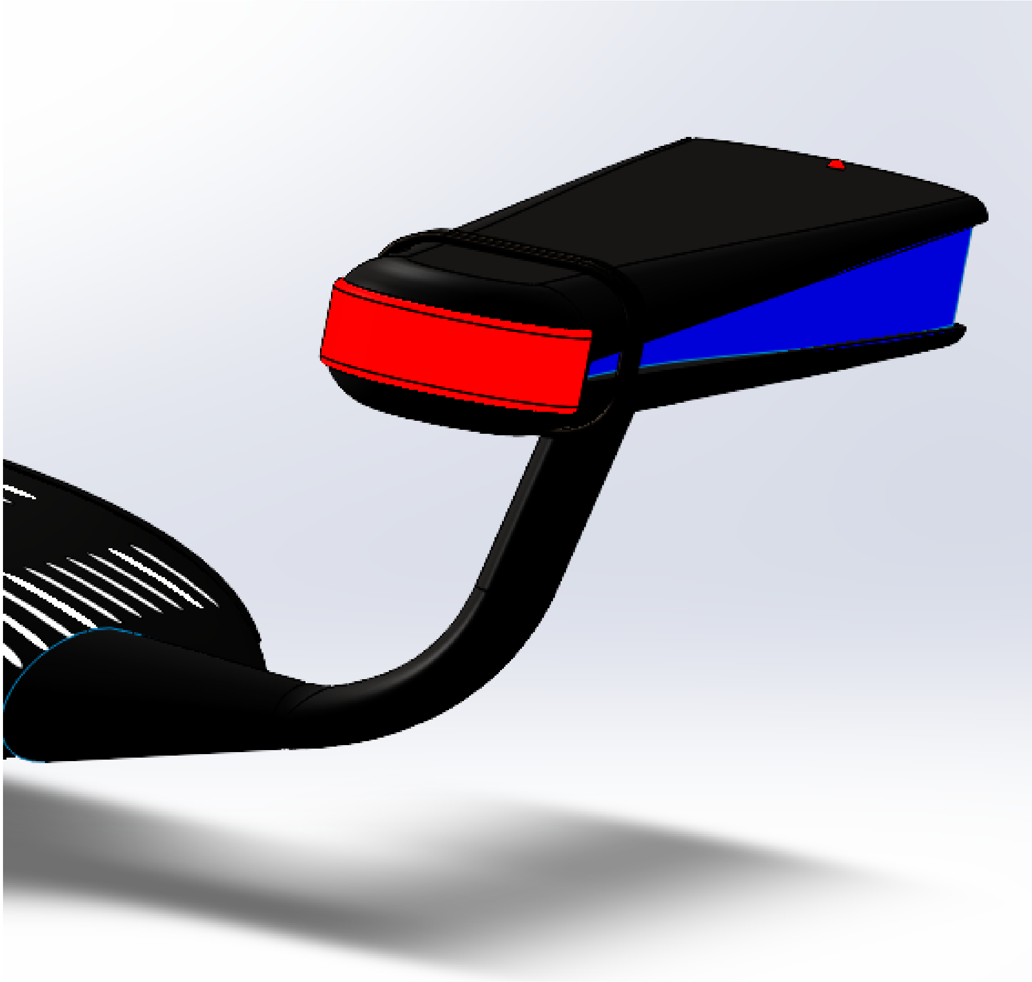


Figure 7: sleek swept back curves anchoring the nacelles

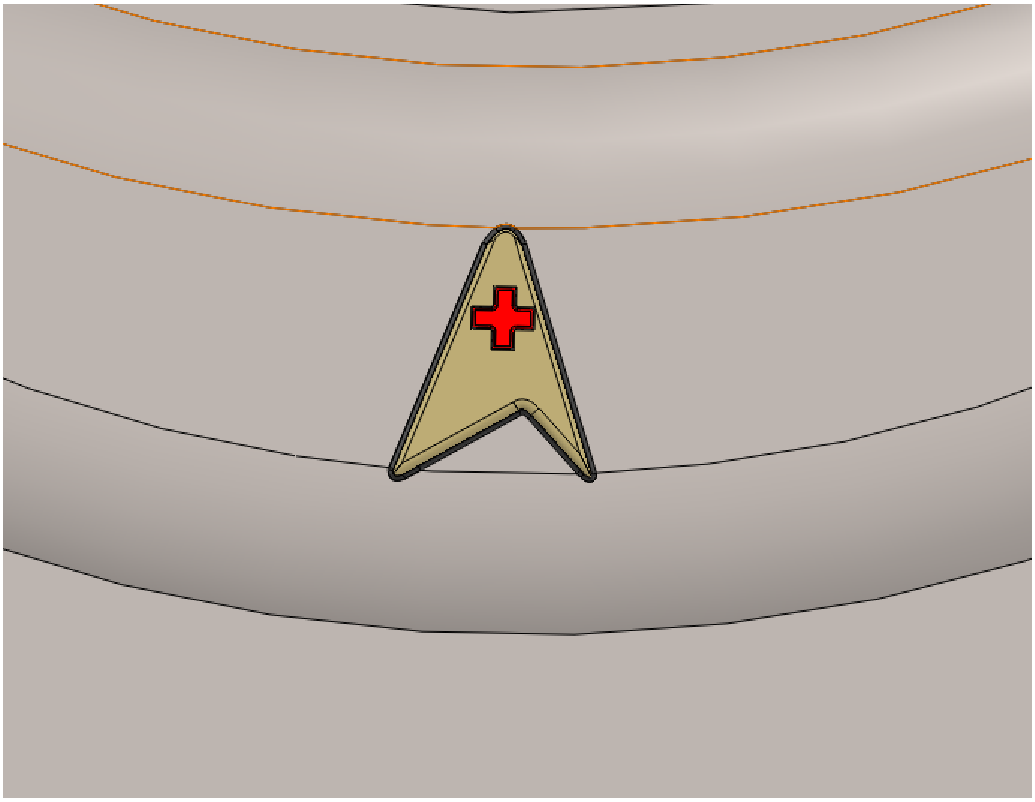


Figure 8: Starfleet logos incorporated in the ship

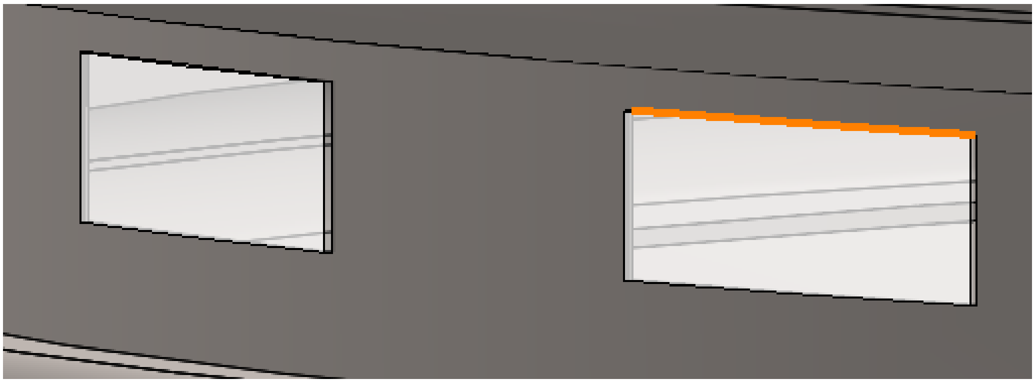


Figure 9: glass windows for viewers to see out and LED light sources inside.