RANGER Class Technical Report – Design, Materials, and Task Management

Introduction

This report synthesizes the technical documentation of multiple RANGER class teams competing in the 2025 MATE ROV competitions. The focus is on three key aspects: **design philosophy**, **materials selection**, and **task/project management**. By comparing diverse approaches across teams, we highlight common strategies, innovative practices, and trade-offs.

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1. Design Approaches

Triton Robotics (Seattle, WA)

- **Europa ROV**: Robust, nimble, and versatile with modular thruster placement and vertically adjustable arms.
- **Enceladus Float**: Precision buoyancy engine with bladder and pump system for depth profiling.
- **Design Philosophy**: Iterative prototyping, failure as learning, custom-built over off-the-shelf.
- **Innovations**: Custom pneumatic manipulators, multiple movable cameras, modular electronics enclosures.

Future Gadget Lab (Sidwell Friends School, DC)

- **Mako ROV**: Acrylic-based frame with watertight cylinder and six thrusters.
- **Design Philosophy**: Trade studies to evaluate frame materials, propulsion, and intake mechanisms.
- **Innovations**: Three-camera system, onboard electronics with Raspberry Pi 5, Newton Subsea Gripper with 3D-printed modifications.

Hephaestus Robotics (X Academy, Santa Cruz, CA)

- **Talos V ROV**: Compact aluminum GoBilda channel frame with six vectored thrusters.
- **Design Philosophy**: Modular design for rapid reconfiguration, offloading computation topside to reduce latency.

- **Innovations**: Precision mode for delicate maneuvers, binary search algorithm for current limiting, 360° photosphere camera system.

Washington Latin Sea Lions (Washington, DC)

- **ROV**: Compact scorpion-like PVC frame with Lego-based hydraulic claw.
- **Design Philosophy**: Minimal resources, recycled materials, adaptable design.
- **Innovations**: Resin-waterproofed automobile backup camera, dual hydraulic claw with rotation capability.

Warrenton Aquatic Robotics – The Rays (Oregon)

- **BattleBot V2 ROV**: Octagonal frame with eight thrusters, modular electronics canister.
- **Design Philosophy**: Mind maps, trade studies, and reuse of X-Rail aluminum extrusion.
- **Innovations**: MARV machine learning system for photogrammetry and object detection, dual Blue Robotics claws, custom ballast system.

Red Sea Robotics (KAUST School, Saudi Arabia)

- **Tyrone IV ROV**: Precision-cut aluminum frame, six T200 thrusters, Newton Subsea Gripper.
- **Design Philosophy**: Sustainability through reuse of Tyrone III components, modularity for adaptability.
- **Innovations**: Four lift thrusters enabling roll/pitch control, streamlined electronics capsule, enhanced buoyancy system.

SeaGuardians (TEACH, Tennessee)

- **BOB ROV**: Aluminum extrusion frame with seven T200 thrusters in vectored configuration.
- **Design Philosophy**: Balance between innovation and affordability, recycling thrusters and cameras.
- **Innovations**: Custom pneumatic claw, multi-camera system, compact tether with pneumatic lines.

Geneseas (St. Francis High School, Sacramento, CA)

- **Andromeda ROV**: Reduced-size aluminum T-slot frame, six thrusters, advanced electronics.
- **Design Philosophy**: Emphasis on reliability, serviceability, and ease of operation.
- **Innovations**: Custom USB hub supporting eight cameras, RealSense stereoscopic camera, streamlined Remote Piloting System.

2. Materials Selection

- **Frames**:
  - Carbon fiber rods + ABS (Triton Robotics).
  - Acrylic sheets and tubes (Future Gadget Lab).
  - Aluminum GoBilda channels (Hephaestus Robotics).
  - PVC pipes and recycled Lego (Washington Latin Sea Lions).
  - X-Rail aluminum extrusion + PLA mounts (The Rays).
  - Precision-cut aluminum beams + acrylic panels (Red Sea Robotics).
  - Aluminum extrusions (SeaGuardians, Geneseas).
- **Electronics Enclosures**:
  - Aluminum tubes for thermal conductivity (Triton).
  - Acrylic watertight cylinder (Future Gadget Lab).
  - Aluminum rectangular enclosures (Hephaestus).
  - Resin-encased backup camera (Sea Lions).
  - Sealed aluminum canister (The Rays).
  - Blue Robotics watertight capsules (Red Sea, SeaGuardians).
  - Polycase housing with 3D-printed supports (Geneseas).
- **Propulsion**:
  - Mix of T100/T200 thrusters (Future Gadget Lab).
  - Six T200 thrusters (Triton, Hephaestus, Red Sea).
  - Eight thrusters with vectored setup (The Rays).
  - Recycled motors (Sea Lions).
  - Seven T200 thrusters (SeaGuardians).
  - Diamond Dynamics thrusters (Geneseas).

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3. Task and Project Management

- **Triton Robotics**: Four-phase schedule (brainstorming, core systems, mission-specific builds, final integration). Independent community team with strict protocols.
- **Future Gadget Lab**: Weekly meetings, pool practices, progress chart, messaging chat for updates.
- **Hephaestus Robotics**: Structured ELT leadership, subsystem task breakdown, Trello and Slack for coordination.
- **Washington Latin Sea Lions**: Weekly club meetings, bake sales for fundraising, corporate sponsorship late in season.
- **The Rays**: Departmental division (ROV, Float, Writing), mind maps, work breakdown structures, internal teaching.
- **Red Sea Robotics**: Gantt chart scheduling, WhatsApp for daily communication, Google Drive for documentation.

- **SeaGuardians**: Division into ROV, Float, Props teams; rigid schedule; Discord and Google Drive for communication.
- **Geneseas**: Two-tier leadership (FLT + ELT), Project Management Tool (PMT), weekly leadership meetings, mock competitions for training.

Conclusion

Across the RANGER class, teams demonstrate diverse yet convergent strategies in design, materials, and management. **Design philosophies** emphasize modularity, adaptability, and iterative prototyping. **Materials choices** balance cost, strength, and sustainability, with aluminum and acrylic dominating. **Task management** relies on structured schedules, leadership hierarchies, and modern collaboration tools. Together, these approaches showcase the ingenuity and resilience of student-led engineering teams tackling complex marine robotics challenges.