

Project Management and Engineering ROV Notebook

(Excerpts from Introduction to Underwater Technology & Vehicle Design by Harry Bohm and Vickie Jensen, Draft July 20, 2001. This material is based upon work supported by the National Science Foundation under Grant No. 0085345)

Participation in constructing the team ROV will count as half your grade or 250 points. The Project Management and Engineering Project Notebook counts as the other half of your grade or 250 points and should include the following:

- Pre-design Phase
 1. Mission Statement
 2. Mission Requirements
 3. Performance requirements

- Design Phase
 1. Conceptual Design
 2. Detail Design

- Post-Design Phase
 1. Construction
 2. Testing, Trials, Demonstrations
 3. Operations

- Final Report: Evaluation & Improvements

- Appendices
 1. Meeting Notes
 2. Design Ideas
 3. Research Results
 4. Product Information
 5. Addresses of Suppliers
 6. Experimental Results
 7. Conversations and Contact Information
 8. Photographic Journal (Illustrate each phase with at least one photo and a narrative)

PRE-DESIGN PHASE

Mission Statement:

- An objective (find the aircraft/recover the black box)
- A location (in the sea)
- A time frame for getting the task done (ASAP!)
- Resources (use any available equipment)

Sample Mission Statement: Develop a small, inexpensive, quick-to-build ROV to aid in teaching basic sub sea science, underwater technology and ROV operation. It should be able to operate in a classroom test tank or swimming pool, or off the shore of a pond, lake, river or ocean, in depths up to 33 ft (10m). It should be capable of retrieving small objects from the bottom and raising them to the surface.

Mission Requirements:

Designers use the term **operational parameters** to describe the tasks and work environment of the ROV if it is to fulfill its mission successfully. These include (and should be included in your notebook):

- Timeline: (include planning, purchasing, building, testing, etc.)
- Depth (max)
- Environment and Geographic Location:
 1. Where is the operations area and what type of water will it work in?
 2. What other special factors such as currents, temperature, water clarity and ambient light will be encountered?
 3. What is the bottom like?
 4. Are there any ecological issues that may affect the design and operation of the ROV? These include pollution, acoustic noise levels, vibrations, sediment disruption (jetting operations), oil from hydraulic machinery, generation of magnetic fields that might attract or repel sharks (they have been known to bite electric cables), and lights or jettisoned batteries that might harm local wildlife.
 5. What kinds of weather (season; time of day or night) can be expected during the operations?
 6. What wave heights and wind velocities might the ROV encounter during launch and recovery ops?

- Tasks: What does the ROV have to do under the water? What type of operation is this to be (sampling, observation, search and recovery, etc.)? What needs to be found? Does it need to be recovered? If so, what is the weight of the object(s) to be recovered? How many are there? What dangers do the objects pose? Do they require special handling? Think about launch, piloting and recovery.
- Launch and Recovery: How will the ROV be lowered into and taken out of the water? How will the vehicle get through the air/water interface? If hand-launched, what structural features such as a rigid grab handle on top of its float or a rounded base so as not to cut into the fabric of an inflatable boat will be used?
- Operational Support: What is needed to support the operations? Do operators need boats, barges, docks, aircraft, cranes, lift bags, compressors, generators, a control shack, trucks, crew or all of the above?
- Budget: List structure, thruster, ballast, electrical, video, lighting, navigation sensors, payload and other parts. Include item, amount, supplier name, address and phone number and cost. (Include product information and notes on conservations when applicable in the appendix.)
- Safety: Are all the materials and power sources safe to use by inexperienced operators, including children? What safety qualifications are required for operating the vehicle, and who is qualified to do so? Are there any special hazards to the environment from the materials used to build or operate the ROV? What hazards might be encountered in the operations area? What procedures are required to maintain the vehicle in a safe operating condition?

Performance Requirements:

- Depth
- Approximate Size
- Approximate sir weight
- Maneuvering requirements e.g. up, down, forward, reverse; turn right and left; spin right and left.
- Power (volts and amps)
- Propulsion: describe motors
- Structure: describe frame and fittings; brackets, junction box, etc.
- Tether: length and makeup e.g. three pairs of thruster conductors.

DESIGN PHASE

Conceptual Design:

➤ Propulsion

1. What horizontal speed is required?
2. What vertical speed is required?
3. What is the total mass of the vehicle?
4. What is the weight of the vehicle in water?
5. What is the total drag on the vehicle at maximum forward speed?
6. What is the drag of the tether?
7. What rate of turn is required?
8. What total thrust is required?
9. What degrees of freedom does the vehicle require for maneuvers?

➤ Power

1. What is the total wattage required for the thrusters?
2. What is the total wattage required for lights and other sub-systems?
3. What length of tether is required?
4. What size power conductor is required in the tether?
5. What is the total power drop in the tether?
6. What is the source voltage?

➤ Structure

1. What is the maximum depth/pressure the vehicle has to withstand?
2. What is the total air weight of the vehicle?
3. What is the size of the vehicle?
4. What is the shape of the structure?
5. What is the style of the structure?
6. What is the exact amount of drag the structure will have? (See Chapter XX to calculate drag coefficient)
7. What type of ballast system is to be used?
8. What is the stability requirement for the vehicle?

Detailed Design (Functional Specifications):

- Depth
- Size
- Air weight
- Floats:
- Weights
- Maneuvering
- Power
- Propulsion
- Structure
- Sensors
- Tether
- Operation area
- Endurance
- Navigation (sight or sensors e.g. cameras)

Detailed (Working) Design: In this phase, designers produce a complete set of shop drawings, assembly drawings and component procurement lists. This phase is also the time to fine tune the budget, take delivery of parts, determine exactly when certain phases of the project are to be completed (deliverables) and begin to organize a construction schedule. Attention to detail is very important. Overlooking even one small sub-system or detail can cause a major delay. **See Chapter 4 p. 18 for details on putting together a shopping list. Please include the following in your notebook:

- Illustration: Completed ROV
- Illustration: Control Box
- Illustration: Light
- Illustration: Camera
- Displacement Calculations (if applicable)

POST DESIGN PHASE

Construction:

➤ Skills

1. Solder small electric circuits and conductors
2. Follow wiring schematics and devise a wiring layout for the vehicle
3. Understand construction sketches
4. Strip and splice wires, use heat shrink and cable ties, run conductors neatly and logically
5. Measure DC voltage, current and resistance with a millimeter
6. Sketch plans on graph paper
7. Drill and tap a hole for a threaded fitting
8. Other

➤ Tools

➤ Parts

1. Structure Parts
2. Thruster Parts
3. Ballast Parts
4. Electrical Parts for Tether and Control Box
5. Video Camera Parts
6. Optional Underwater Lighting
7. Optional Navigation Sensors
8. Optional Payload Work Tool

*For **Testing, Trials, Demonstrations** and **Operations** include a narrative summarizing what happened.

FINAL REPORT

This should be a reflective essay summarizing what you have learned, your personal evaluation of the experience, your successes, mistakes, and suggestions for Improvement.

APPENDICES

- Meeting Notes
- Design Ideas
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