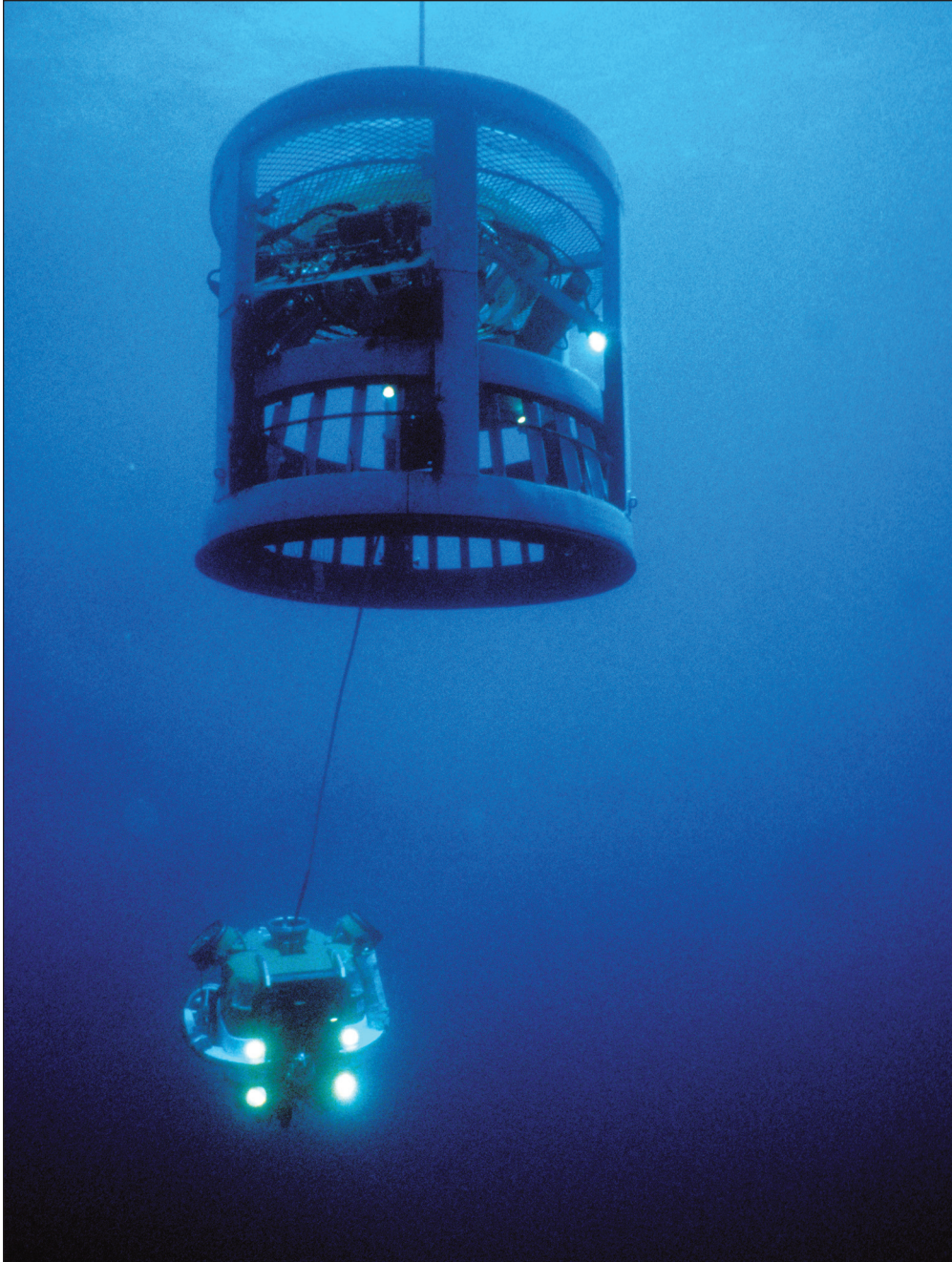


# Chapter 7



## Moving and Maneuvering

# Chapter 7: Moving and Maneuvering

## Stories From Real Life: Finally, the Practical Submarine

### Chapter Outline

1. **Introduction**
2. **The Basics of Moving a Vehicle through Water**
  - 2.1. Newton's Laws
  - 2.2. Forces on Underwater Vehicles
  - 2.3. Combining Forces
3. **Estimating Thrust Requirements**
  - 3.1. Theoretical Approach
  - 3.2. Empirical Approach
4. **Producing Thrust**
  - 4.1. Electric Thrusters
5. **An Introduction to Electric Motors**
  - 5.1. Types of Electric Motors
  - 5.2. Anatomy and Function of a Brushed DC Motor
6. **An Introduction to Propellers**
  - 6.1. How a Propeller Works
  - 6.2. Types of Propellers
7. **Building Your Own Thrusters**
  - 7.1. Choosing a Motor
  - 7.2. Waterproofing a Motor
  - 7.3. Attaching a Thruster
  - 7.4. Selecting and Attaching a Propeller
8. **Thruster Placement**
  - 8.1. Analysis of a Common Three-Thruster Arrangement
  - 8.2. Analysis of Some Common Four-Thruster Arrangements
  - 8.3. Analysis of a More Elaborate Thruster Arrangement
  - 8.4. A Checklist for Thruster Placement
9. **Chapter Summary**

### Chapter Learning Outcomes

- List and describe the physical forces affecting underwater vehicle motion.
- Determine how much thrust is required to propel your vehicle through the water at a particular speed.
- Describe how electric motors and propellers work and explain how to match a prop with its motor to maximize the output thrust and efficiency.
- Design an electric thruster capable of propelling a small vehicle at depths of up to 10 meters (33 ft).
- Describe various options for thruster placement and identify the simplest configuration that will meet your mission's requirements for maneuverability.

**Figure 7.1. cover: Moving in a Fluid World**

*Moving through a three-dimensional fluid world presents unique challenges and opportunities. This ROV, a modified RCV 150, upgraded with fiber optics, high definition cameras, and enhanced hydraulics, is used by the Hawaii Undersea Research Laboratory to scout targets for full investigation and sampling using the human-occupied submersibles Pisces IV and V.*

Image courtesy of Terry Kerby, Hawaii Undersea Research Laboratory