Steering and Controls
What are we going to learn in this lesson?

• Identify and describe the function of components of shift/throttle systems.

• Identify the types and advantages/disadvantages of powerboat steering systems.

• Identify the types and advantages/disadvantages of sailboat steering systems.
Reading Assignment

HBTW, pp. 58 - 68
Cables and Controls
Three Basic Control Systems

- Mechanical Controls
- Electronic/Mechanical Hybrids
- Electronic Controls
Mechanical Controls

- The traditional way of controlling shift/throttle functions

- Push/pull cables connect the control head at the helm station with the engine and transmission.
Cables and Cable Routing

• Cable Bend Radius:
  – Tight radius adds to operating force and shortens cable life.
  – Recommended minimum bend radii:
    • 20 Series: 4"
    • 30 Series: 8"
    • 40 Series: 8"
    • 60 Series: 10"
    • 80 Series: 12"
  – The absolute minimum bend radius is typically 5", but bigger radii extend cable life and improve cable efficiency.
  – Every 90 degree bend will increase the input effort by 20 percent.

• Cable Supports: Control cables should be run and supported separate from electrical wiring, plumbing, etc.

• End Connections:
  – Cable end move in the same plane as the object being moved.
  – Cable should be aligned with mid-point of load travel. Not at the tangency point or at the ends of travel (refer to TeleflexMorse Fig. 8 on page 4).
Mechanical/Electronic Hybrid Controls

- Electronic control head or remote sends electrical signal to interface module (black box) in engine room.

- Interface module converts electrical signal to mechanical motion

- Traditional mechanical cables (push/pull) control conventional shift/throttle mechanisms on engine/transmission
Electronic Controls

- True Electronic Controls

- "Fly-by-Wire" Electrical signal controls shift and throttle directly via internal programming.

- This is the direction controls are (rapidly) heading in.
Control Head Geometry

• Single vs. Dual Lever Controls

• Top vs. Side Mount Controls units

• Throttle: red top

• Shift: black top
Control Heads

Top Mount Controls

Side Mount Controls
Powerboat Steering
Two Basic Steering Systems

- Mechanical
- Hydraulic
Mechanical Steering

• Used on small outboards and sterndrives.

• Two helm assembly types:
  – Rotary helm
  – Rack and Pinion helm

• Push/pull cables connect the helm assembly to the engine/drive

• Very high horsepower/ high speed installations use two cables (“pull-pull”) and tie rod to eliminate “play”
Mechanical Steering Systems

Outboard Mechanical Steering

Mechanical steering uses the same type of push-pull control cable as engine controls (page 58). In rotary steering (top figure), the cable wraps around a drum connected to the steering wheel. The drum may be directly connected for 1:1 steering or geared so that a turn on the drum corresponds to several turns of the wheel.

Rack-and-pinion steering also uses a push-pull control cable, but the rotary drum is replaced by a pinion gear on the steering shaft that drives a rack (linear gear). The number of turns of the wheel for the full stroke of the control cable depends on the diameter and number of teeth on the pinion gear.

SeaStar HPS™ Rotary

SeaStar HPS™ Rack and Pinion
Hydraulic Steering Systems

Single-Station Hydraulic Steering

Dual-Station Hydraulic Steering

From HBTW
Hydraulic Steering Systems

- Typical steering systems used on large powerboats

- Major Components:
  - Helm pump
  - Hydraulic lines
  - Slave cylinder
Helm Pump

- Dual acting pump

- Check valves in pump usually prevent rudder feedback into steering system.

- Great for large powerboats, not so good for sailboats.
Slave Cylinder

- Double acting hydraulic cylinder.

- The slave cylinder must be sized to handle the rudder torque.

- We will learn to calculate rudder torque in a later class.
**Mechanical Advantage vs. Sensitivity**

- The ratio of the volumes of the helm pump and the slave cylinder pump determine the mechanical advantage of a hydraulic steering system.

- A big slave cylinder and a small helm pump means lots of mechanical advantage (making it easy to turn a heavily loaded rudder) but also lots of turns lock-to-lock (steering is NOT very sensitive).

- Typical turns l-t-l:
  - “Quick” steering: ~3 turns lock-to-lock (l-t-l)
  - “Moderate” steering“: ~ 5-1/2 to 6 turns l-t-l
  - “Slow: steering: > 6 turns l-t-l
Power Steering

• Power assisted hydraulic steering systems are typically used on very large powerboats (and often on large outboards and sterndrives).

• The power of the helm pump is multiplied by an engine driven hydraulic pump (similar to an automotive power steering system).
Hydraulic Lines

• Copper tubing is traditionally the best material to use for hydraulic lines to avoid a "spongy" feel in the steering system.
• Rigid copper tubing requires a flexible hose lining between the rigid tubing and the slave cylinder
• Flexible hose must be designed not to bulge under the pressures (up to 1000 psi) of a hydraulic system.
Bleeding the System

• A "spongy" steering feel probably means there is air in the system and the system needs to be bled.

• Often proper bleeding of the system requires opening bleed screws at the slave cylinder, rotating the helm pump "full lock" in one direction, closing the bleed screw, and then repeating the process in the other direction.

• Modern vacuum systems are available that permit a single technician to properly bleed a hydraulic steering system.
SeaStar Capilano Helm and Cylinder
Sailboat Steering
Sailboat Steering Systems

• Chain and Wire

• Rack and Pinion

• Traditional
  – Rack & Pinion
  – Worm Gear

• TILLER!
Chain and Wire

**Megayacht & Custom Systems**  
*See Page 6-7*

Edson has the experience and knowledge to design and build custom systems for boats from 18' (5.5m) to 200' (60m) and up.  
- Custom Wheels  
- Fabricated quadrants to meet specific rudderload requirements.  
- Megayacht systems.  
- Multi-Speed and Geared reduction systems.  
- Dual-Wheel Systems.

**Chain & Wire Systems**  
*See Pages 12-27*

Time-proven, reliable system that has been used on thousands of boats for over 80 years.  
- Classic, Vision Series™ and Internal Pedestal designs available.  
- Quadbrant, Radial Drive™ and Center Cockpit Installations.  
- Adjustable, easily maintained, spares parts readily available worldwide.  
- Most versatile system.  
- Large variety of Wheels and Accessories.  
- Highest quality marine-grade stainless, bronze and aluminum components.  
- Tiller-to-wheel conversion kits available.  
- Designs for over 3000 sailboats.

Rack & Pinion

**Geared CD-i Systems**  
*See Pages 10-11*

Edson’s updated version of the classic rack and pinion system utilizes a simple, direct linkage from tiller to wheel.  
- Exceptional feel  
- Easy installation.  
- For boats up to 50' (15.25m).  
- Classic, Vision Series™ and Internal Pedestal designs available.  
- Large variety of Wheels and Accessories.  
- Highest quality marine-grade stainless and aluminum components.  
- Tiller-to-wheel conversion kits available.

**Steering Components & Accessories**  
*See Pages 28-39*

Enhance your steering with our full selection of components and accessories.  
- Autopilot Tiller Arms  
- Engine Controls  
- Pedestal Guards  
- Wheel Brakes  
- Compasses

Worm Gear

**Traditional Systems**  
*See Pages 40-41*

If you are building or refinishing a classic yacht, Edson’s Traditional Wheels and Gear Steerers are still available, but constructed of modern materials and methods which were not available when first built.  
- Worm Gear Steerers  
- Rack & Pinion Steerers  
- Traditional Ships Wheels

**Steering Wheels and Accessories**  
*See Pages 42-51*

Edson’s selection of yacht wheels add distinction and value to any boat. A large variety of sizes and styles will fit the look of your boat no matter what the style.  
- Stainless Destroyer Wheels  
- Teak Rim Wheels  
- Bi-Spoke Wheels  
- Custom Carbon/Wood Laminate Wheels  
- Traditional Yacht Wheels  
- Wheel Accessories
Chain-and-Wire

- Also known as Cable and Pulley
- **Very sensitive, good feedback for well-balanced sailboats**
- Popular in North America
- **Do not over-tighten steering cables!**
- Quadrants vs. Radial Drives
Edson's time-proven, reliable system that has been used on thousands of boats for over 80 years.

- Strong, dependable and time-proven design.
- Classic, Vision Series™ and Internal Pedestal designs available.
- Quadrant, Radial Drive™ and Center Cockpit Installations.
- Adjustable, easily maintained, spare parts readily available.
- For boats with rudderposts that have considerable rake.
- Most versatile system.
- Large variety of Wheels and Accessories.
- Highest quality marine-grade Stainless, Bronze and Aluminum components.
- Tiller-to-wheel conversion kits available.
- Designs for over 3000 boats.

Note: All Edson pedestals are designed to use Edson’s exclusive Hex Head Aluminum Bolts. Pedestals built prior to February 1999 use flat head bolts. See page 33 for Mounting Bolts.

For additional information on Chain and Wire Steering Systems, visit www.edsonmarine.com and download Edson’s 10-page Engineering Bulletin #281: CHAIN & WIRE STEERING SYSTEMS PLANNING, INSTALLATION AND MAINTENANCE GUIDE.

www.edsonmarine.com
Traditional Quadrants
Pedestal Rack and Pinion

- Good feedback
- Popular in Europe
- Drank link routing can be difficult
CD-i™ Geared Steering Systems

Edson's classic Rack and Pinion system utilizes a simple, direct linkage from tiller to wheel. All CDi Geared Steerers feature exceptional feel, easy installation and a wide range of mounting options.

- For boats up to 50' (15.25m).
- Classic, Vision Series™ and Internal Pedestal designs available.
- Large variety of Wheels and Accessories.
- Highest quality marine-grade Stainless, Bronze and Aluminium components.
- Tilt-to-wheel conversion kits available.
- 360° Circular Rack Gear – 3 Times the Life Span of Conventional Rock Gears.
- 1.8 Wheel Turns Hard Over to Hard Over through 72° of rudder travel.
- Clearnon Compensator Gears for Ultra-High Strength.
- Gear teeth easily accessible for lubrication and inspection.
- Large 3/4”/83 mm Torque Tube for Superior Strength, Stiffness.
- Turnbuckle-Style Drag Link for Easy Adjustment.
- Large 3/4”/69 mm Diameter Stainless Bearings for Long Life.
- CE Compliant.
- Low Maintenance.
- Tapered wheel shaft only.

Wheel
Compass Binnacle
Pedestal
Pinion gear
Rack (gear)
Torque Tube
Output Lever
Drag Link
Tiller Arm
Rudderstock

Installation Requirements

Maximum Rudder Bake = 20° from Vertical
Working Angle of Drag Link = 10° Max. from Horizontal with Rudder Affixed.
Max. Rudder Torque Load = up to 3400 ft lbs (497 mkg)
Typical Installations Suitable for All Cockpit Sailboats up to 50 Feet LOA (15.25m)

Rudder Stops and Edson's Stop Ring
Rudder Stops are a mandatory fitting for any steering arrangement. They insure that loads transmitted through the rudder never exceed the design limit of the steering pedestal and gear. Edson's Integral Stop Ring/Bracket Plate provides an alternative to conventional rudder stops that is much simpler to install and adds additional reinforcement to the cockpit sides. All Edson Stop Rings are marked with angle indicators for easy installation and alignment and allow for 72° of total rudder travel. Note: Conventional rudder stops and cockpit reinforcement should still be installed in conjunction with this stop ring whenever possible.

www.edsonmarine.com
Traditional Steering Gear

- (Direct) Rack & Pinion
- Worm Gear
Direct Rack & Pinion Steering

- No drag link
- Good feedback
Worm Gear Steering

• Traditional “schooner” steering gear
• Very powerful and rugged
• No rudder feedback!

  – Steering wheel (and rudder) stay in a position until the wheel is moved.
  – Helm can be left without boat changing course, BUT no feedback helping to sail boat.
  – This can be a blessing on a poorly balanced boat, or a boat with a very heavy helm, or if you need the helm to self-tend for short periods of time (workboats).
Worm Gear Steerers

- Classic Design - used for over 100 years on traditional boats.
- Extremely rugged
- No rudder feedback - designed for long-keeled cruisers.
- Rugged construction of bronze alloys and stainless steel.
- 1" Stainless Wheel Shaft fits all Edson Steering Wheels.
- Replaceable Babbitt threads.
- Stub shaft for easy installation of an autopilot.
- Sizes for boats from 35° to 85° (10 to 26 meters).

WHEN ORDERING: Worm steerer installations must be well designed and well thought out from all standpoints. The system is mounted at 90° to the rudderpost and is rigid at this point. Should you require a different angle to your wheel, refer to Edson’s #679 Shaft Universal. The #629 Self-Aligning Bearing supplied with the gear must be well bolted down to a timber or strong moldment. It is recommended that the top of the wheel rim be 31° (79 cm) to 33° (84 cm) up from the cockpit floor. This will allow you to stand beside the wheel without reaching down to it, and will put the wheel at a convenient height when sitting in back of it or alongside it.

When ordering, advise Edson of the rudderpost bore diameter, keyway size and keyway position - these will be machined by Edson. You will note the standard “A” dimensions on the schematic drawings which relate to shaft length. If a longer or shorter shaft length is required, please advise. If in doubt as to steerer size or if the boat is heavy, go to the next larger size. Do not compromise on the size.

MAINTENANCE: For maintenance of all Edson Steering Systems we recommend using #30 oil on all pivot points, and water pump grease on the worm itself and on the grease fitting on the center of the steerer. Check the flange alignment by loosening the four bolts on the top of the steerer and check as you would on a propeller shaft coupling. The 90° angle is extremely important and this point will cause binding if not correctly aligned. Inspect and oil frequently.

Edson’s Meteor Worm Steerer. This steerer was originally designed for Kaiser Wilhelm’s Yacht Meteor which was designed to race against Britannia. The Meteor is a rugged steerer with “twin” arms for optimum strength and is designed for boats in the 45-65 foot (13.7-19.8 meter) range with room both forward and aft of the rudderpost. Wt. 128 lbs (58.1 kg). Order #390-1.

Meteor Worm Steerer

Edson’s Robinson Worm Steerer. This steerer features the same rugged construction and “twin” arms as the Meteor Steerer but has larger gears to give you more turns of the wheel hard-over to hard-over. The Part No. 380 Steerer is designed with the “worm” on the aft side of the rudderpost and requires a minimum of 35° (89cm) aft rudderpost. It is recommended for boats in the 65-85 foot (19.8-25.9 meter) range. Wt. 230 lbs (104.4 kg). Order #380-2.

Robinson Worm Steerers

Edson’s Robinson Worm Steerer. This is virtually identical in design to the Part No. 380 Steerer with the major difference being that the “worm” is located forward of the rudderpost. This makes the Part No. 382 ideal for boats with limited space aft of the rudderpost and is recommended for boats in the 65-85 foot (19.8-25.9 meter) range. Wt. 230 lbs (104.4 kg). Order #382-2.
Edson Worm Gear Steering Unit
Worm Gear Steerers

Simplex Worm Steerers

WORM AFT OF RUDDERPOST
Edson's Simplex Worm Steerer. Designed for the traditional cruising sailboat. There are three sizes available to suit boats from 22' (6.7 m) to 55' (16.8 m). Part No. 370 Worm Steerer is configured with the actual gear working on the aft side of the rudderpost. Size 00 requires a minimum of 14½” (36.2 cm) and size 1 requires a minimum of 19” (48.3 cm) of space aft of the rudderpost, which is shown as the "C" dimension on the chart below.

Order #370 (Specify Size).

Edson's Simplex Worm Steerer. Same as Part No. 370 except that it is supplied with a universal assembly and an extra bearing, and the "A" dimension is about 2½” (6.4 cm) longer than the Part No. 370 fixed shaft steerer.

Order #371 (Specify Size).

WORM FORWARD OF RUDDERPOST
Edson's Simplex Worm Steerer. Edson engineers designed this steerer with the working gear on the forward side of the rudderpost. This feature allows you to install this steering system on a yacht having as little as 5” - 6” (12.7 cm - 15.2 cm) of space aft of the rudderpost (see "C" dimension in chart below), depending on the size of the worm gear.

Order #372 (Specify Size).

Edson's Simplex Worm Steerer. Same as Part No. 372 except that it is supplied with a universal assembly and an extra bearing and the "A" dimension is about 2½” (6.4 cm) longer than the Part No. 372 fixed shaft steerer.

Order #373 (Specify Size).

PART #370 DIMENSIONS

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Edson #370
With Autopilot

Three typical Simplex Worm Steerer installations

INSTALLATION: The following guidelines should be observed when installing an Edson Worm Steerer:
1.) Make sure that the height of the top of the wheel rim is approximately 32” (81.3 cm) off the cockpit sole.
2.) Design a helmsman's seat to cover and protect the worm gear and that allows easy access to the gear for inspection and maintenance. The height of the helmsman seat should allow you to firmly plant your feet on the cockpit sole so you do not cut off the circulation in your legs.
3.) When installing the rudderpost flange to the flange on the worm gear, the alignment is as critical as the alignment of your propeller shaft coupling. You should check with a .002” (.05 mm) feeler gauge. Improper alignment will cause binding at the extreme ends of travel.

WHEN ORDERING: Please supply Edson with the diameter of the rudderpost and the key size. Also, if you would like a shaft length ("A" dimension) shorter or longer than standard, please specify, otherwise we will ship standard length shafts.
Rudder Stops

• All steering systems should be fitted with rudder stops, +/- 35 degrees
Carbon Fiber Rudder Stocks

- Provide galvanic isolation (an E-Glass "wrap" works fine) between bronze/aluminum tiller arms/quadrants and carbon fiber rudder stocks!
Installing Autopilots

- Usually requires a separate tiller arm