MANOEUVRING

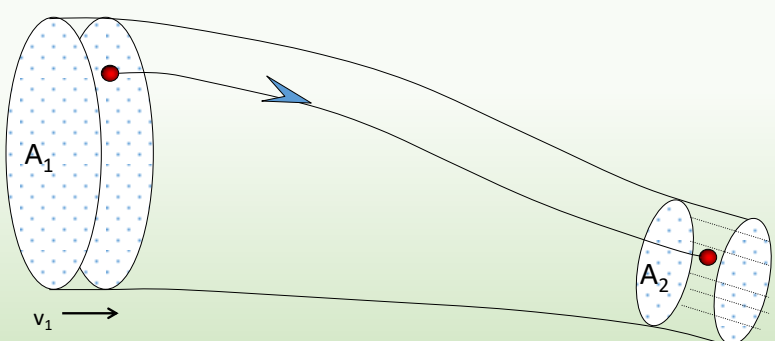
GZV/ GRADE II

3 COURSE BLOCKS

• 1	Grade I Repetition	Propellers, Rudders, Manoeuvring data, Watch keeping.
	Grade II	hydrodynamics, Twin Propellers + Configuration, Manoeuvring with twin props
• 2	Grade I Repetition	Some manoeuvres with current, wind, anchor. Storm and shallow manoeuvres, Taking pilot, Entering Harbour
	Grade II	Towing at sea. Tug use in port
• 3	Grade I/ II	Subjects still to discuss. Repetition Grade II subjects Exam preparation

Hydro dynamic forces

- Hydro dynamic forces are caused by fluids (here water) in motion to a body.
- Our vessel itself, the rudder, the propeller, (keel) are body's under influence of this fluid in motion
- Here there are two laws of importance:
  1. Continuity Law
  2. Bernoilli's Law



Continuity Law

The amount of water (A x v) passing a random cross section of a tube (river) per time is constant

When the tube gets narrower, the velocity of the liquid will increase

In formula: $A_1 \times v_1 = A_2 \times v_2$

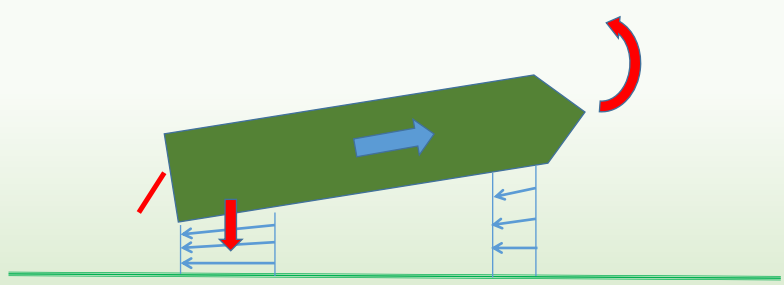
Bernoulli's Law

In formula: $\frac{1}{2}V^2 + P = \text{constant}$

Which means that:

When the water speed increases, the pressure will reduce

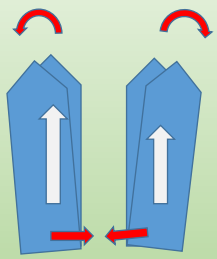
When the water speed decreases, the pressure increases



1. Continuity Law: A x v = constant: waterspeed forward shoulder < waterspeed aft ship
2. Bernoulli's Law : $\frac{1}{2}mV^2 + P$ = constant and v forward shoulder > v aft , which means P aft < P forward, causing banksuction

Hydro dynamic forces
Where/when also noticable:

- Interaction during overtaking and passing another vessel



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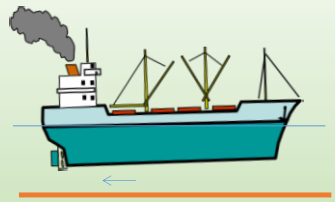

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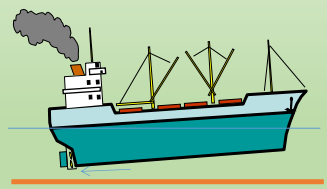


Squat =inzinking

Hydro dynamic forces
Where/when also noticable:

Shape of a propeller blade creating underpressure (Lift force)

Shape of a Duct or Nozzle around the propeller (again Lift force)

Shape of a rudder (creating Lift Force)

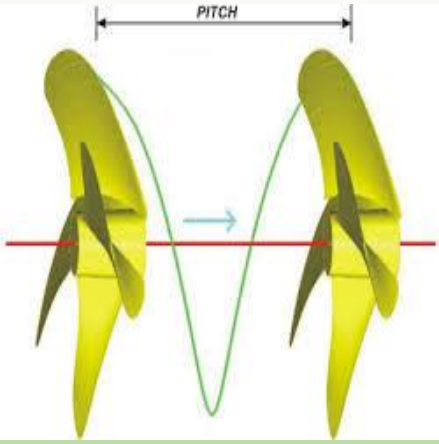
During altering course or turning

Propellers

See book for the items:

- The Pitch
- Propeller speed
- Slip
- Suction/Pressure plane
- Right/Left handed
- Fixed/Variable

Variable Pitch Propeller for Ships 4 Blades Adjustable.mp4



Right handed – fixed propeller

Ship's behaviour

Explain with the aid of drawings the movement of the stern (the bow follows in opposite direction)of a vessel equipped with a:

1. Fixed pitch propeller
   - Right handed (Rh)
     - Engine ahead
     - Engine astern
   - Left handed (Lh)
     - Engine ahead
     - Engine astern
2. Variable pitch propeller
   - Left handed *engine ahead as fixed Lh pitch,* ***engine astern as fixed Rh***
   - Right handed *engine ahead as fixed Rh pitch,* ***engine astern as fixed Lh***

Ship's behaviour

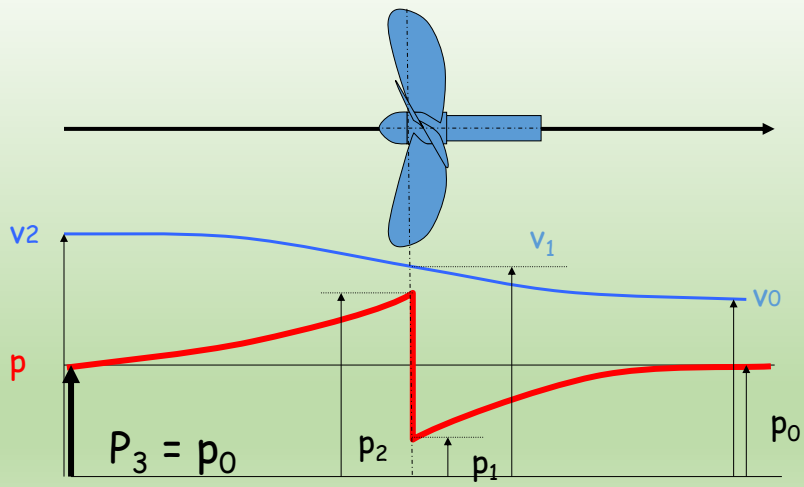
CONCLUSIONS:

- *The direction of the movement of the stern of the vessel is the turning direction (wheeling) of the propeller*
- *The wheeling effect with engine ahead is hardly noticeable, on astern however the influence is significant and important to know*

How the vessel moves forward, astern and stops

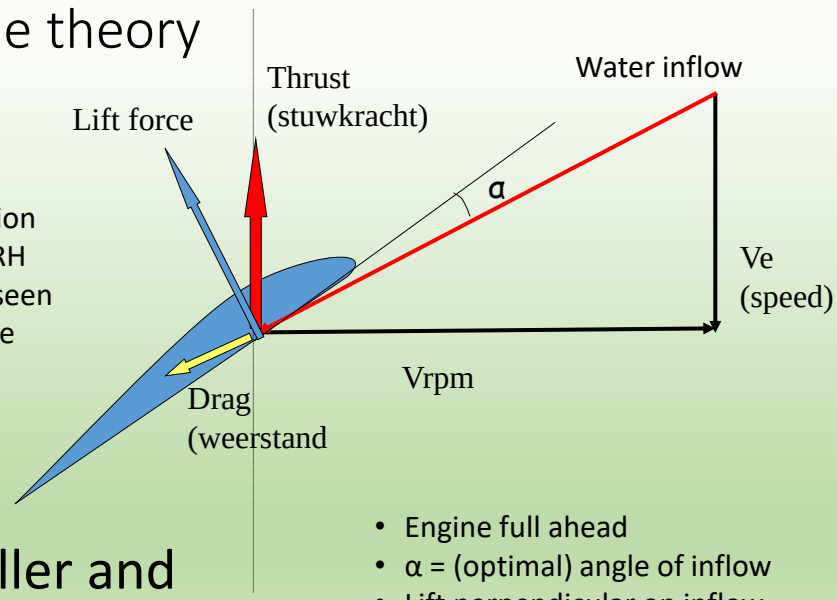
1. Impuls theory: thrust by giving energy to the water
2. Blade theory : thrust by Liftforce through optimal form of the propellerblade
3. Stopping by 'stopping on the Lift' or by astern propulsion

Impulse theory



1. The suction of the propeller will increase the velocity of the water from v0 till v1, until the water reaches the propeller
2. Because of the increase in speed the pressure will reduce from p0 to p1
3. The propeller will pass energy to the water, the velocity has already increased, therefore the supply of energy will effect an increase in pressure: p2
4. After the water has passed the propeller, the water pressure in the propeller wake will reduce again to the pressure of the surrounding water. p3=p0
5. As a result the velocity of the water will increase from v1 to v2. The propeller wash will contract, rotating and will cause an even spread of the water flow along the rudder surface

Blade theory

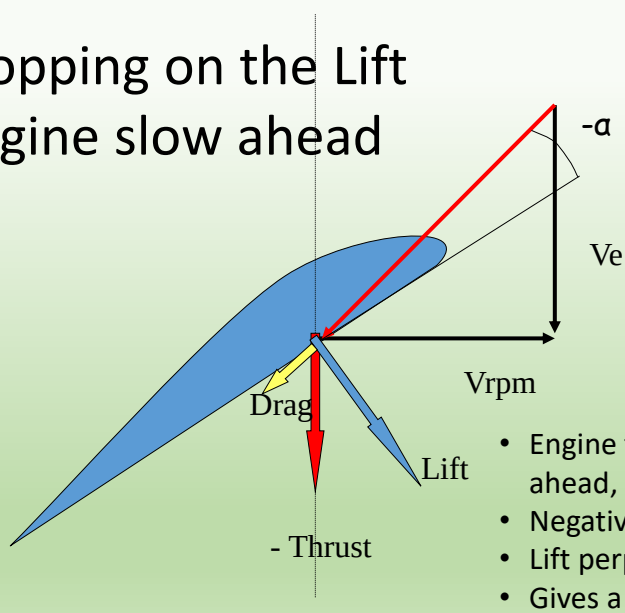


Cross section topblade RH propeller seen from above

Propeller and Bernoulli

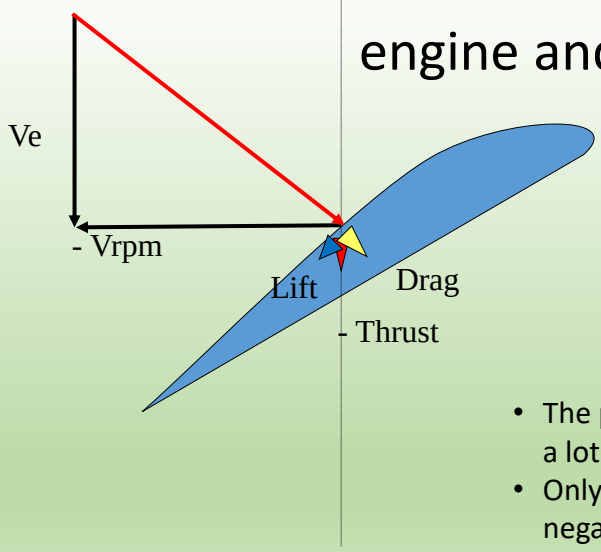
- Engine full ahead
- α = (optimal) angle of inflow
- Lift perpendicular on inflow
- Forward thrust

Stopping on the Lift
Engine slow ahead



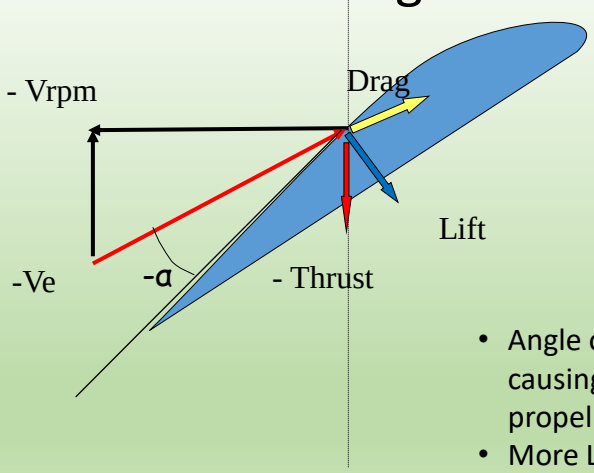
- Engine from full ahead to slow ahead, speed still high
- Negative inflow angle
- Lift perpendicular on inflow
- Gives a stern thrust while the vessel is steerable

From fulll ahead Stop engine and full astern 1



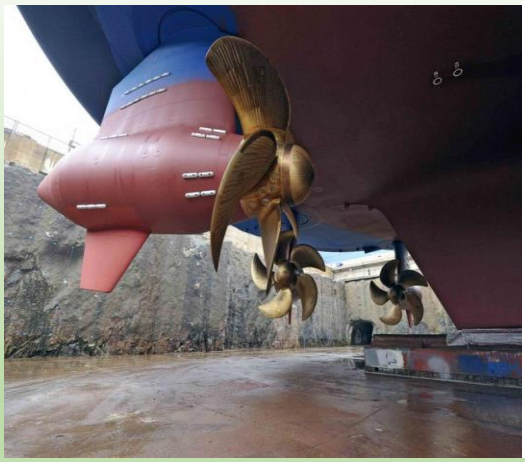
- The propeller stalls which causes a lot of turbulence behind it
- Only small or zero Lift and small negative thrust
- Vessel not steerable

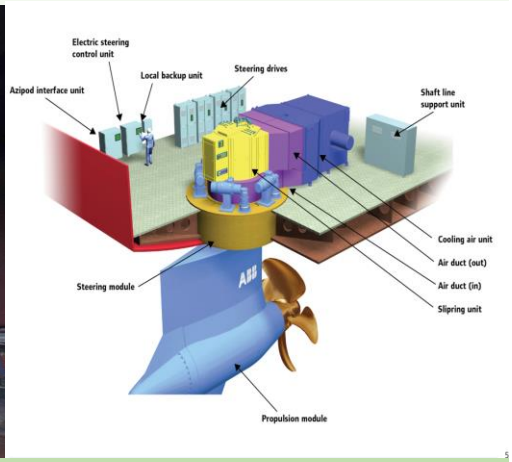
From fulll ahead Stop engine and full astern 2



- Angle of inflow becomes smaller causing a better flow to the propeller
- More Lift and higher negative thrust

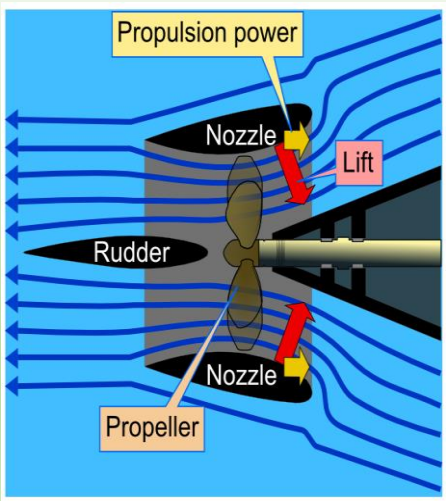
Type of Propeller - Azipod



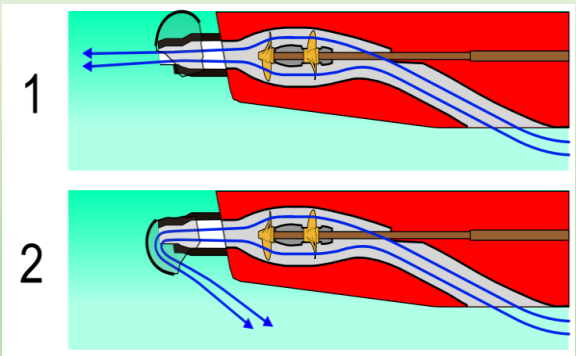


Veder-LNG-Carrier-Final-TM-P1-High.wmv

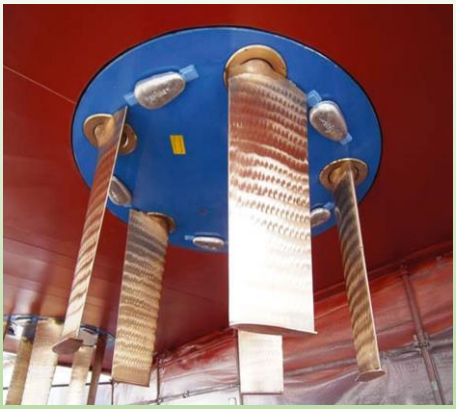
Type of Propeller - Propeller Duct-Lift

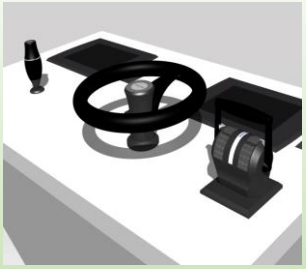


Type of Propeller - Water jet



Type of propeller- Voith Schneider



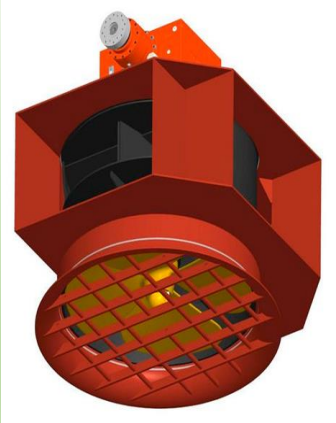


VOITH-SCHNEIDER-PROPELLER.mp4

Tugs and Ferries – twin prop

Bow Thrusters

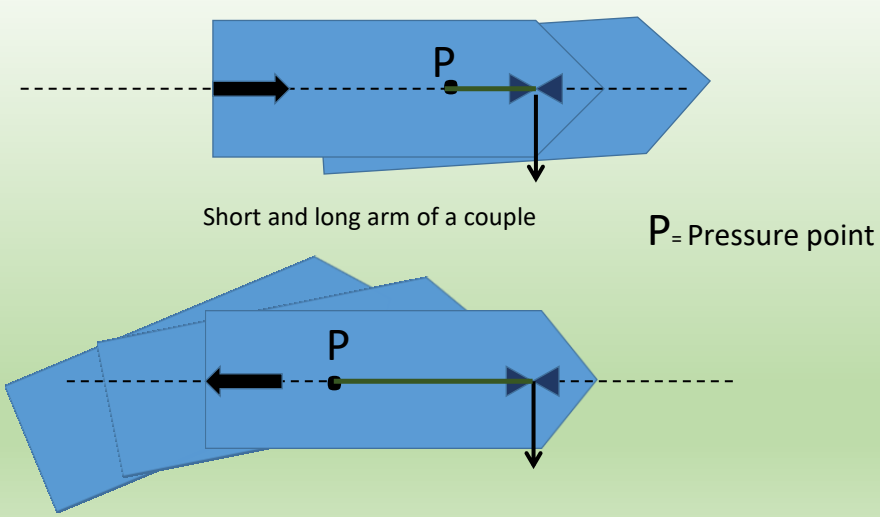
Bow- and stern thrusters



Bow- and stern thrusters

- Bow- and stern thrusters can only be used at lower speeds. WHY?
- Moving backwards, the bow thruster is a great help in steering. Why?
- Your vessel is equipped with both stern thruster and bow thruster. While proceeding foreward to the berth, you like the bow to move to starboard. Which thruster do you use to achieve this movement?

Bowthruster and steering torque

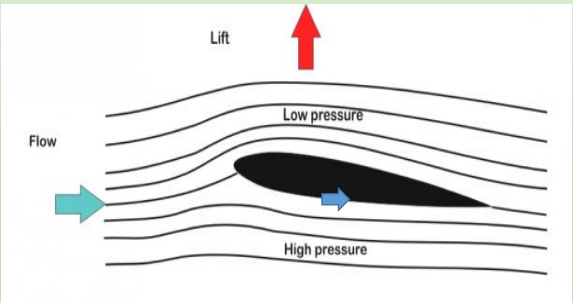


RUDDERS

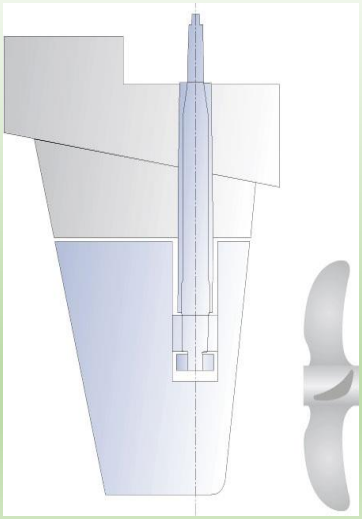
Must give:

- An effectively wake bent
- With a minimal drag = small rudder angles, achieved by a wing shaped profile giving a Lift force

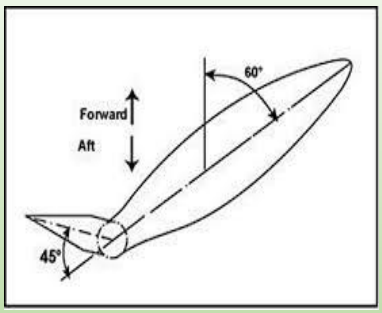
vertical foil



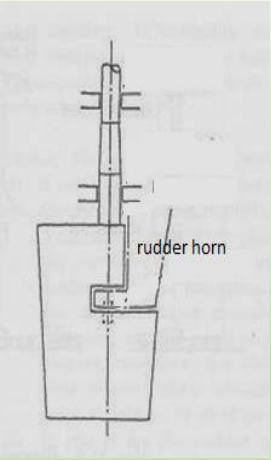
Rudder types – Spade rudder



Rudder types – Flap rudder



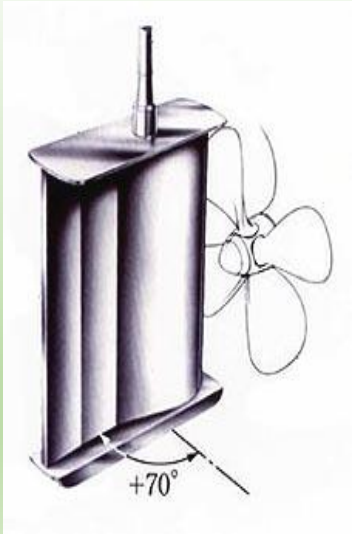
Rudders - Mariner Semi Balance Rudder

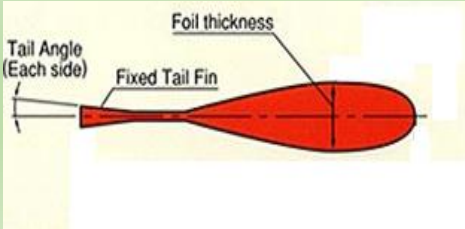


Upper part: Wing Profile (compare with Oertz rudder)

Lower part: Balance

Rudders – Fishtail Rudd





Rudder and forces

- What movements makes a vessel after giving starboard rudder

  1. Leaning shortly over to starboard
  2. Turns to starboard
  3. Tranverse movement to port (kick)
  4. Leaning to port during turn
  5. Loss of speed

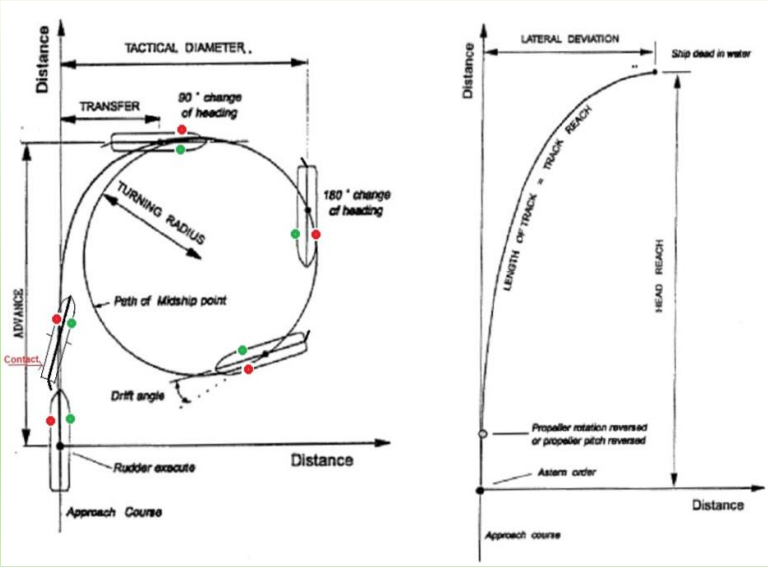
- Explain with the book these movements of the ship

Manoeuvring data

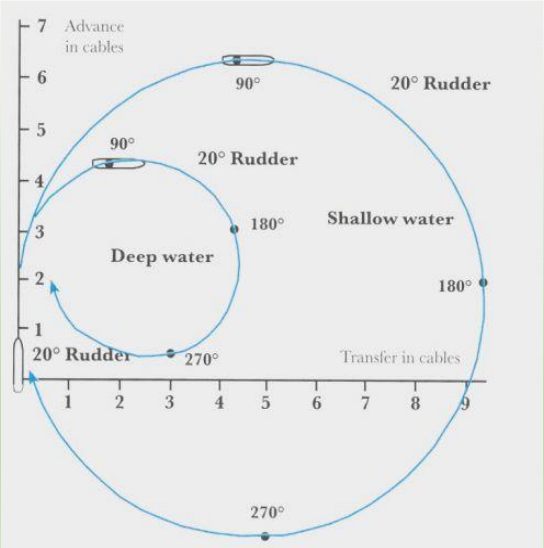
- Turning circle — *difference deep and shallow waters !*
- Stopping distance — *in the formular: mv^2 high speed means large stopping distance!*

  compare this distance with advance turning circle !
- Speed tests
- MOB manoeuvres tests — *Williamson turn tests both SB Port turn on bridge poster*
- Zig zag tests — *For checking course stability*

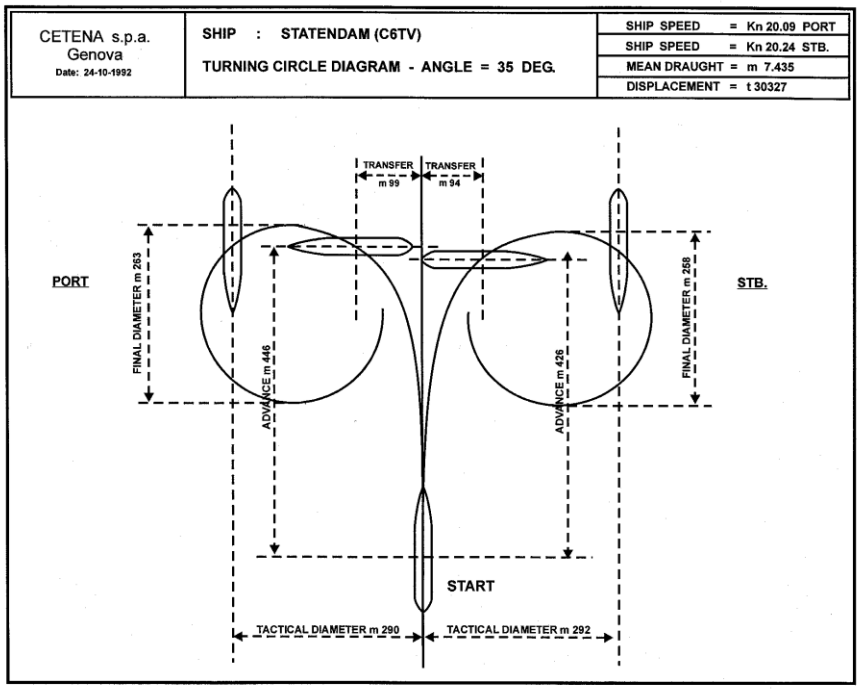
Turning circles – stopping distance



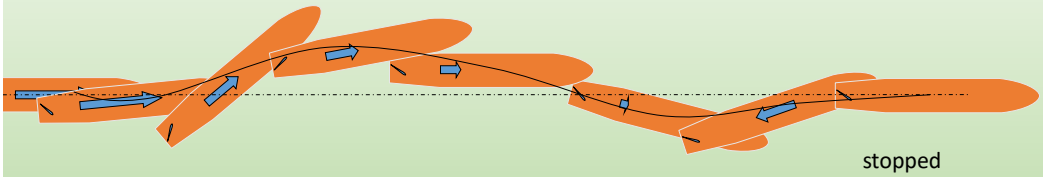
Turning circles – shallow and deep water



1. Why diameter turning circle larger in shallow water.
2. Why speed reduction less in deep water?

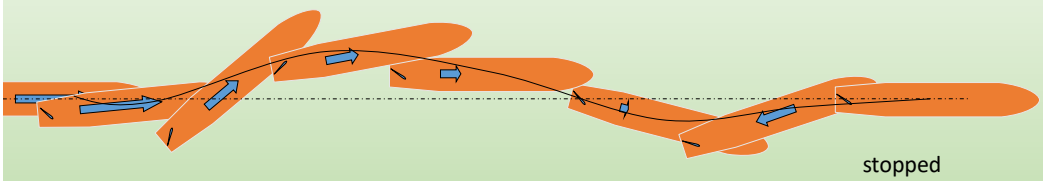


Controlled stop in narrow waters with engine and low frequency rudder cycling



By using the Stopping on the Lift principle(reduce revolutions of the propeller step by step) as well as speed reduction by the drag of the rudder and vessel. The final astern manoeuver should be given to stop the vessel and to turn the vessel into the original heading (depending left/right prop)

Controlled stop with engine and low frequency rudder cycling *(only effective on deep water)*



Chapter 4 Standing and handing over the Watch

The watch

- Standing the watch is taking care of navigation and act when needed
- Responsibility even when captain is on the bridge.
- Know the captains standard orders
- Warn the captain instantly upon any doubt as to safety
- Watch keeping while pilot on board!
- Anchor watch
- How to hand over the watch

The watch

- Handing over the watch
  - be in time to consider the oncoming navigation
  - Handing over: al relevant information as course(s), speed, drift, ships, lights, dangers, and so on
- Heading and course both given in figures 150 = one five zero
  - What's the difference between heading and course
- REPEAT ALL and what does it means
  - Hard a starboard
  - Starboard 30
  - Steady

Starboard a bit
Ease to 20
Steady as she goes

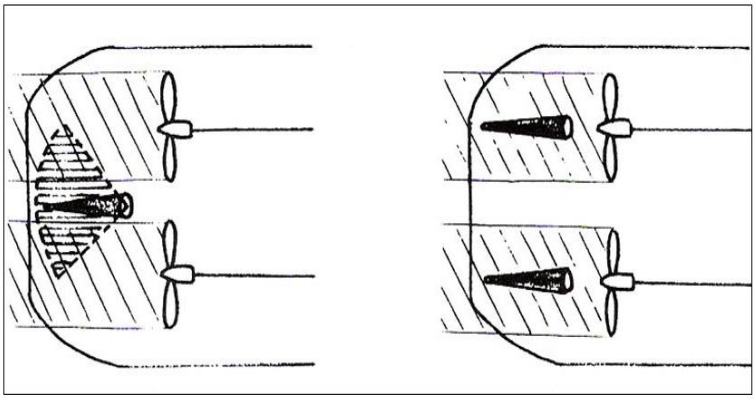
Starboard a bit more
Midships
Course 3 4 5

GRADE 2 TWIN SCREW

- Twin propellers (two screws) improve
  1. operating reliability and 2. maneuverability.
- With twin props the shafts mostly are at equal distance from the center line. The further the shafts are away the easier the ship will turn

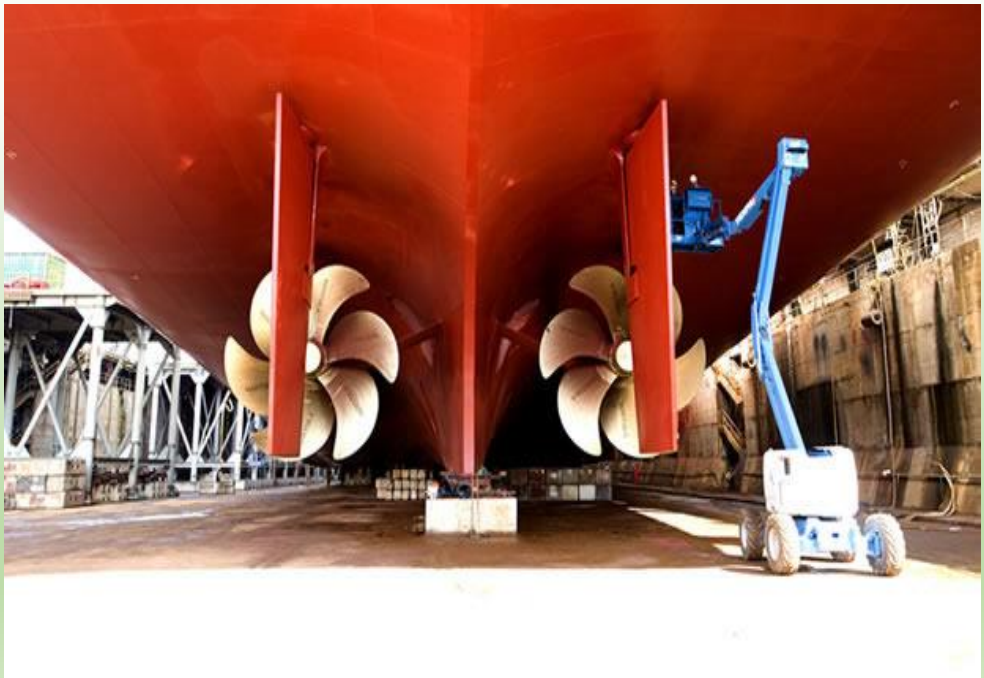
- The propellers can be in turning or outturning . Fixed or variable.
- Most vessels are equipped with outward rotating fixed propellers, or inward rotating variable propellers. WHY?
- The maneuverability is improved when the vessel is equipped with a rudder after each propeller and a bow thruster

Twin propellers / Rudder configuration

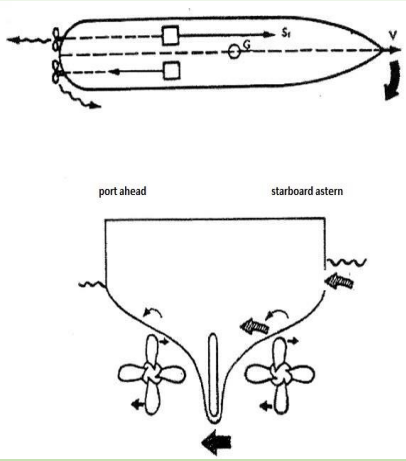


Single rudder is situated on the center line between the two propellers:
even with hard over is rudder partially or wholly out of propeller wash

Very poor single rudder response at very slow speeds.

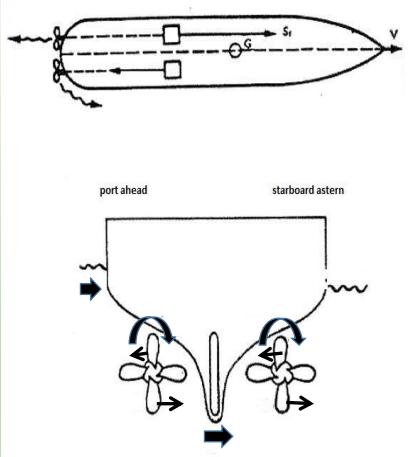


Out turning fixed propellers - one rudder



- Port propeller left handed
- Starboard propeller right handed
- Turn over starboard with port engine ahead and sb engine astern
- Two momentums are effecting the propeller:
- One because of one propeller reversing while the other one is still in forward gear
- The other one due to wheeling propeller effect.
- Both momentums together will increase the turning.
- With slow speed the rudder to starboard has none or little effect

In turning fixed propellers - one rudder

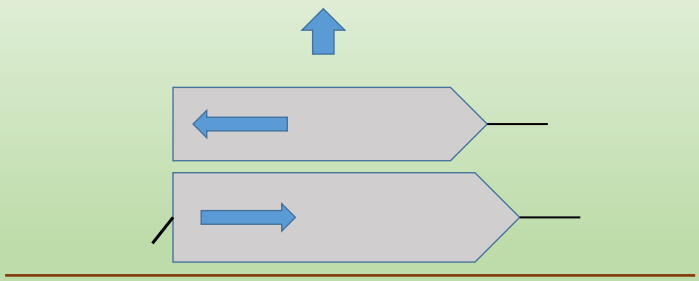


- Port propeller right handed
- Starboard propeller left handed
- Turn over starboard with port engine ahead and sb engine astern
- Two momentums are effecting the propeller:
- One because of one propeller reversing while the other one is still in forward gear
- The other one due to wheeling propeller effect ***but now counteracting***
- So both will oppose each other and therefore making turning more difficult or even impossible

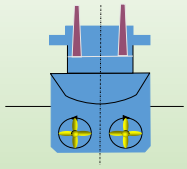
Mooring and unmooring twin screw

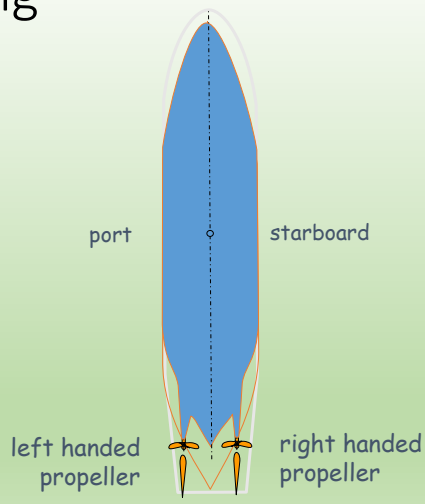
- Fixed inturning
- Fixed outturning
- Variable pitch inturning
- Variable pitch outturning
- With
  - one or two rudders
  - bowthruster or bow-and sternthruster
  - bowsprit
  - Non parallel propeller shafts
  - With the aid of lines

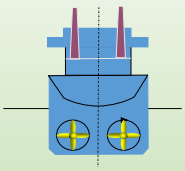
Unmooring



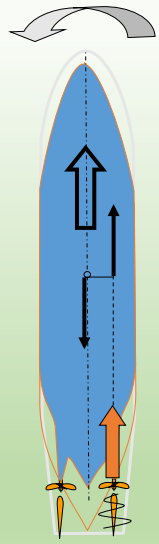
conventional twin screw ship fixed-outturning

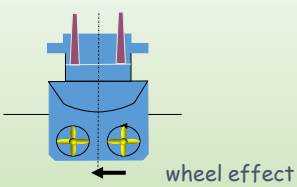




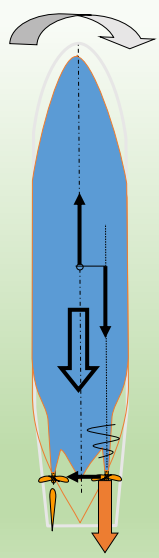


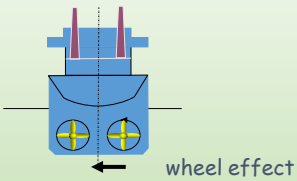
one propeller (sb) working ahead

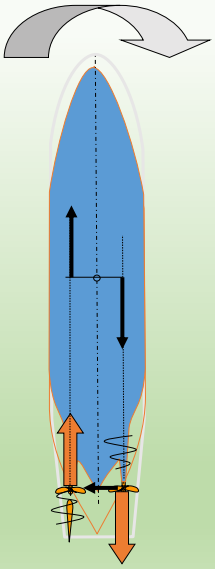




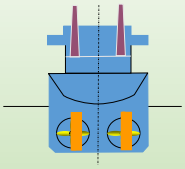
one propeller (sb) working astern

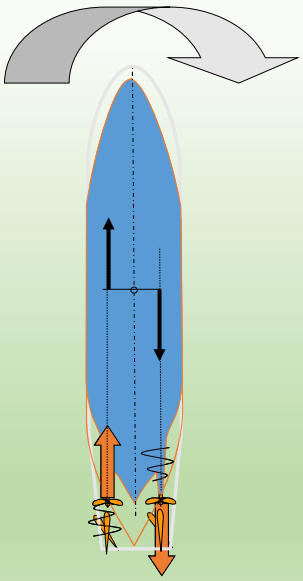






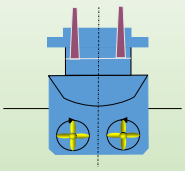
one propeller (sb) working astern, the other propeller (port) ahead

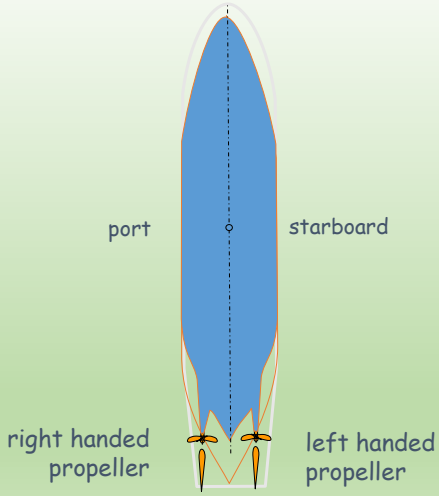




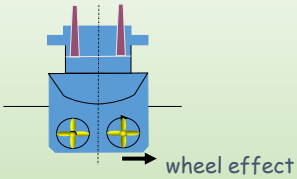
when the rudder force is also applied the vessel will rotate like this

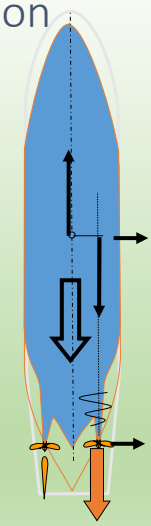
Inward turning fixed pitch propellers





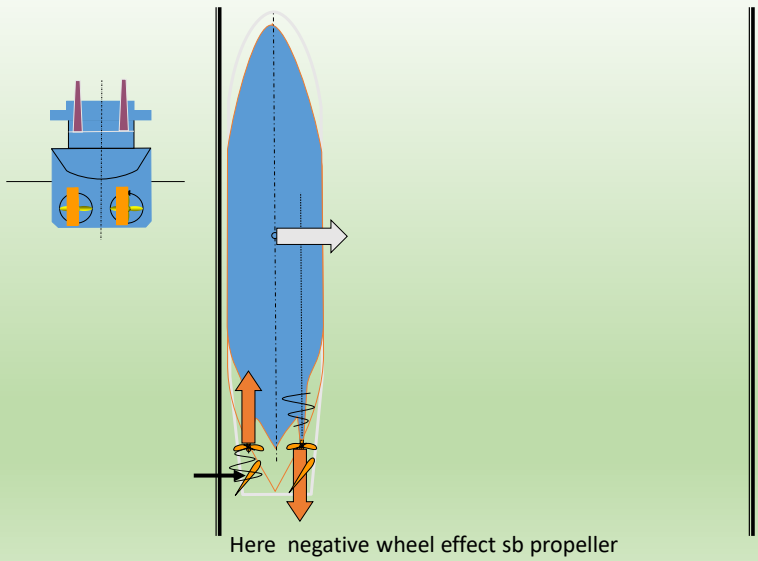
Inward turning fixed pitch propellers one propeller (sb) working on astern





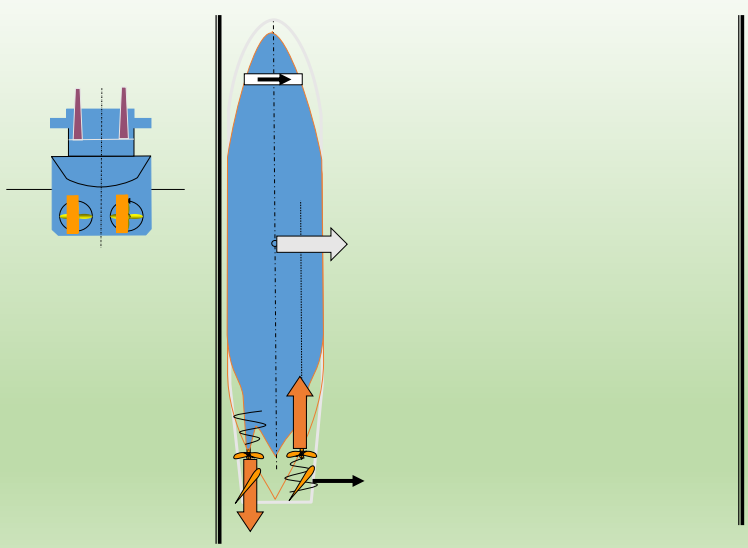
When the vessel has inward turning propellers the momentum between the two propellers is outweighed by the wheel effect

Traverse with outward turning propellers without bow thruster



Here negative wheel effect sb propeller

Traverse out turning props with the aid of a bow thruster



Here positive wheeleffect port propeller

How to Manoeuvre with Your beauty with one rudder-twin outturning controllable pitch propellers and bowthruster

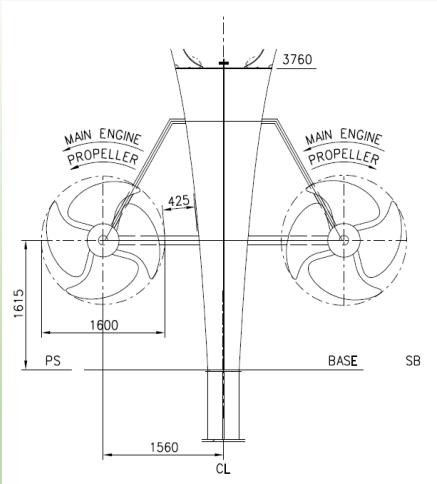
Particulars Clipper Oman and China

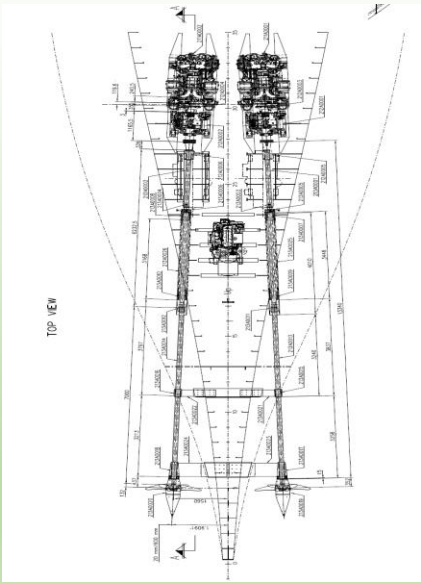
- One rudder
- Twin propeller Controllable pitch outturning
- The propeller shafts are not parallel to one another
- A bow thruster

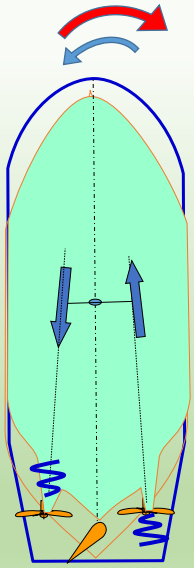
The best maneuverable ship are equipped with

- Twin rudder. A rudder after each propeller
- Twin Controllable pitch in turning or fixed outturning
- The propeller shafts parallel
- A bow thruster

Propellers Clipper



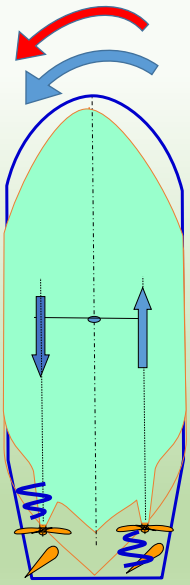




Turning over port without bow thruster Clipper

- Weak engine momentum
- Counter acting wheeling effect
- Rudder no effect

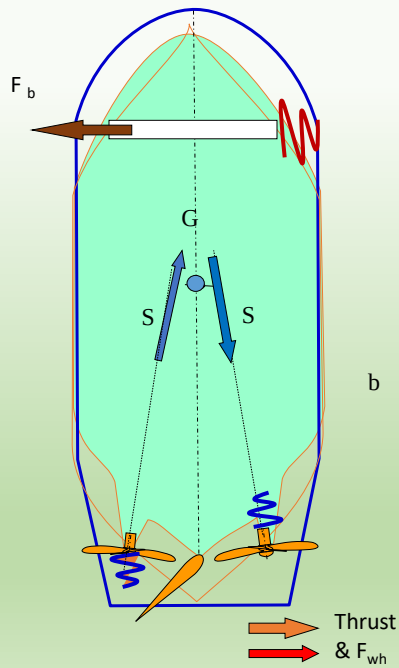
Clipper: 1 rudder 2 outturning contr pitch



Turning over port without bow thruster Other

- Good engine momentum
- Positive wheeling effect propellers
- Rudder helps to turn

Other: 2 rudders 2 inturning contr pitch



NOW TURN OVER PORT 2

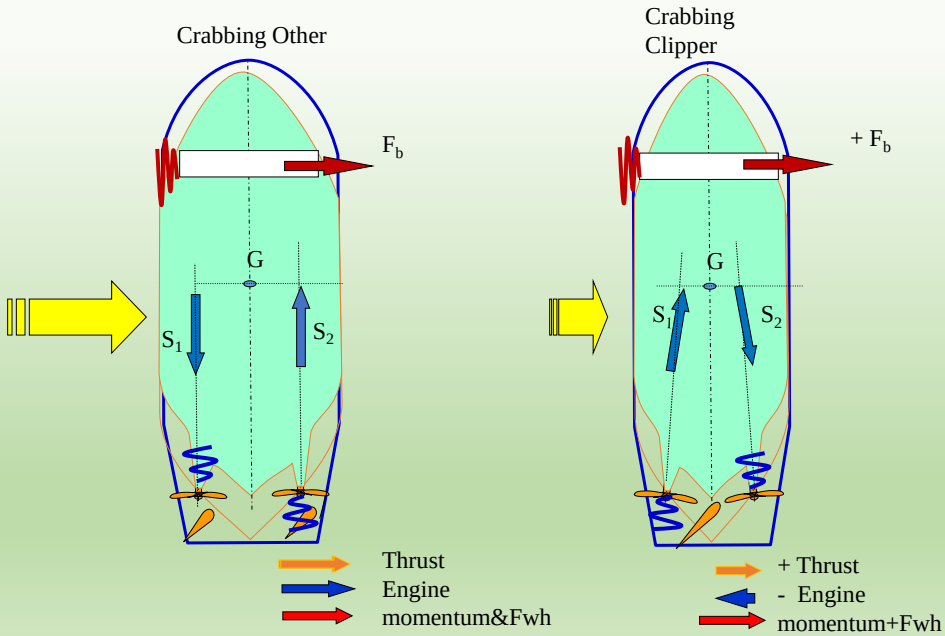
Rudder hard to port

Port engine ahead

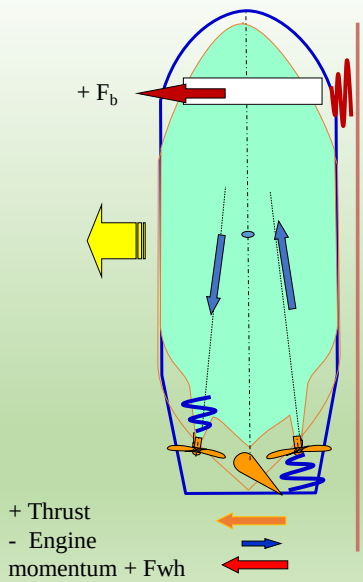
Starboard engine astern

Bowthruster to port

1. The engine momentum is negative but small
2. The wheel effect of the starboard propeller is positive (Fwh)
3. The rudder together with port propeller gives a positive momentum (Thrust)
4. Bow thruster to port helps the turn at slow speeds ($F_{b)}$



UNMOORING CLIPPER



- The rudder hard to starboard
- Starboard engine Pitch Ahead)
- Port engine Pitch Astern
- The Starboard engine and starboard rudder turn the stern off the quay and cause a forward movement
- The port engine prevends the foreward movement and also the propeller pushes the vessel further from the quay while the propellor wash comes between the vessel and the quay
- The bowthruster pushes the bow away from the quay

BLOCK II

- 2nd Grade TOWING at Sea
  Dangers Tug use in port

- 1st Grade Mooring/unmooring/anchoring manoeuvres
  Shallow and narrow waters. Entering breakwaters with cross current. Taking pilot and more pArtly to be done in BLOCK III