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Ship to Ship and Ship to Shore Interaction

Causes and Effects

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Learning Objectives

- The principle behind interaction – Bernoulli
- Types of interaction – ship/ship & ship/shore
- Factors affecting interaction

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Types of Interaction

Ship/Ship

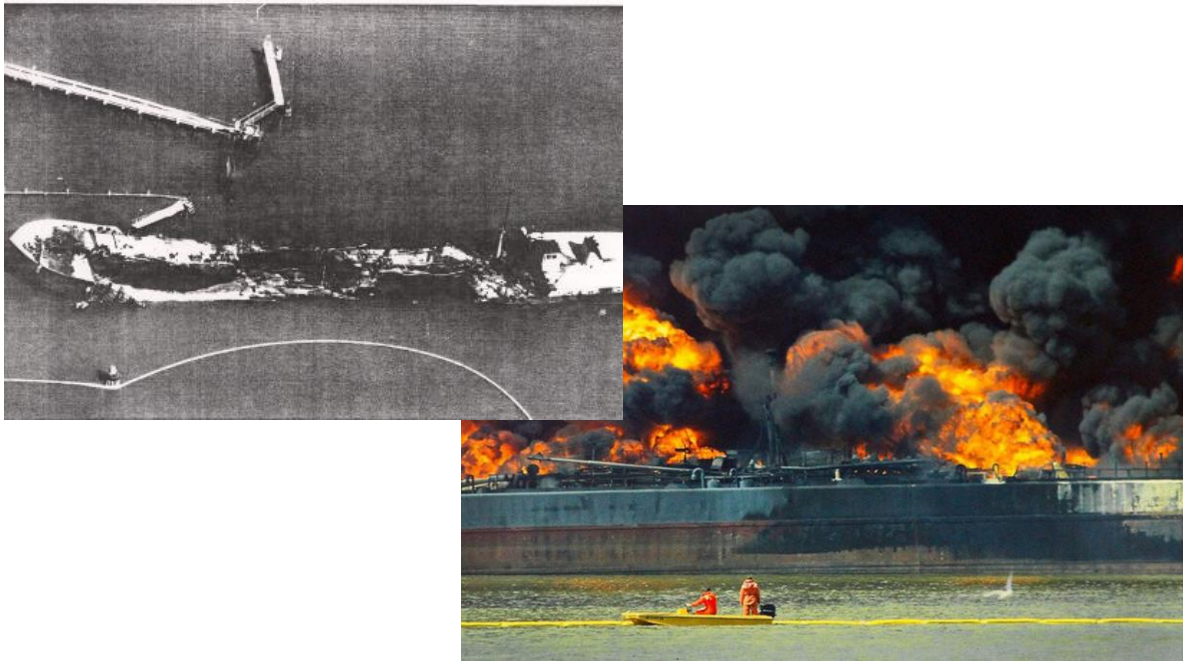
- Passing
  - Both Underway
  - One Ship Moored
- Overtaking
- Working in Proximity (e.g. ship & tugs)

Ship/Shore

- Bank Effect
- Squat

Consequences – Passing Vessel

$$$$



Source: M Live

Passing Ship

- 16 Sep 1990
- MOORED:
  Tanker U.S. JUPITER, cargo of gasoline; Bay City, Michigan
- 10,900 DWT; Length 116m.
- PASSING: BUFFALO; 17,500 DWT, Length194m; Speed about 4.2 kts; Gap of about 18m.
- JUPITER had all but one mooring line break, the discharge hose broke and the resulting fire caused 1 death,
- 18 injuries, JUPITER was a total loss and the pier was damaged.

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Consequences – Squat

$$$$

Squat

- 7 August 1992 – Martha's Vineyard, off Rhode Island.
- QUEEN ELIZABETH II; Length 294m, Beam 32m. Speed; 25 Knots
- Series of gashes, cracks and dents along 400 feet of the hull !
- NTSB estimated squat of between 4.5 and 8 feet
- $20 Million USD

Consequences – Subsequent Damage

More than just the cost of ship damage	
• Damaged hull	• £
• Broken lines (+ snapback personal injury risk)	• £ (+ £££, USA ££££!)
• Vessel breakaway	• £ - £££
• Damaged loading equipment	• £ - ££
• Damaged fenders	• £ - ££
• Damaged terminal structure	• ££
• Damaged gangway	• £
• Environmental spill & cleanup	• ££ - £££
• Loading delay	• £ - ££
• Terminal Business Interruption	• £££

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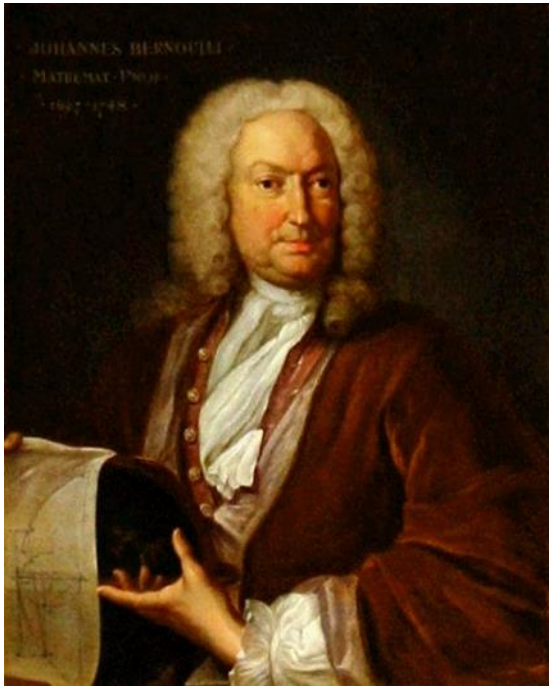
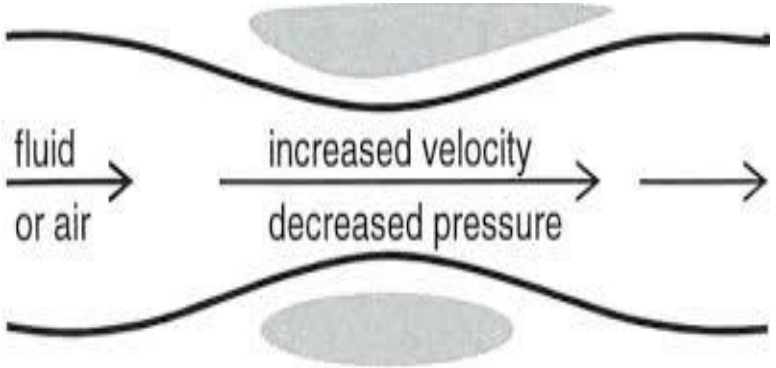
Bernoulli's Theorem

Conservation of Energy



Daniel Bernoulli, *Hydronamica* 1738



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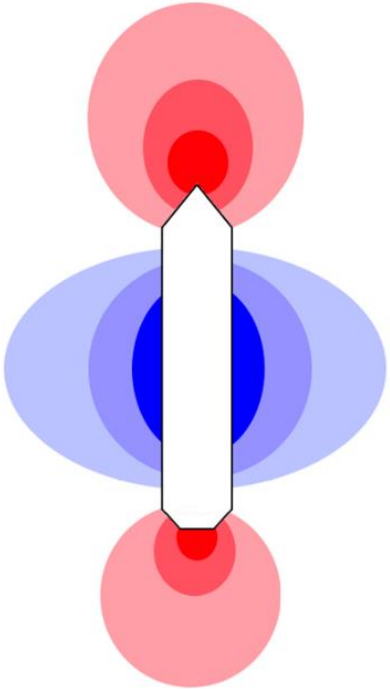
Pressure Fields Around a Ship

Hydrodynamic Pressure



Open water v restricted water

Different pressure distribution in open water v restricted water, but a ship moving ahead will always generate a pressure field.

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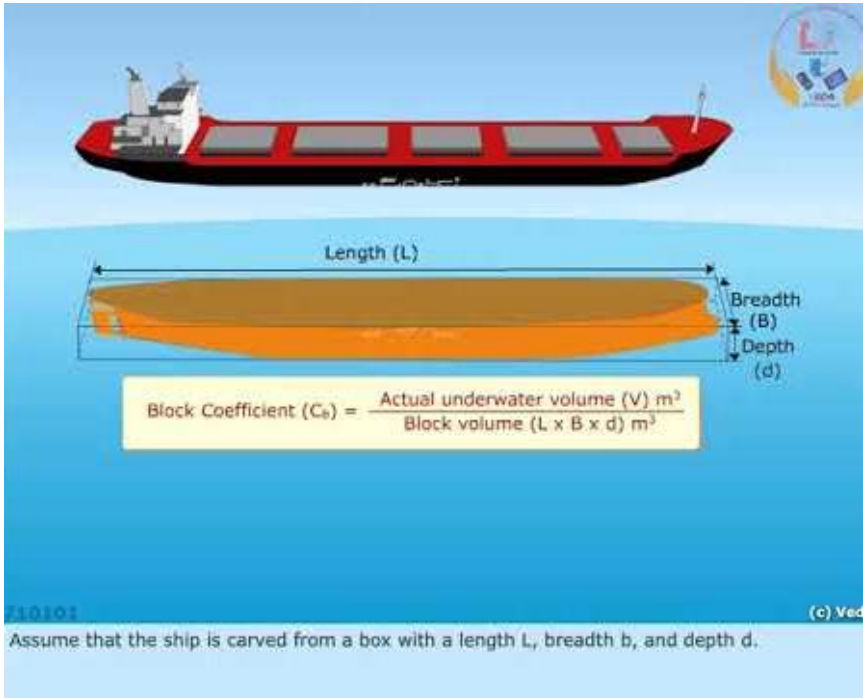
Contributory Factor – Block Coefficient

Typical Factors

- ULCC tanker – 0.850
- Container ship – 0.575

Block Coefficient



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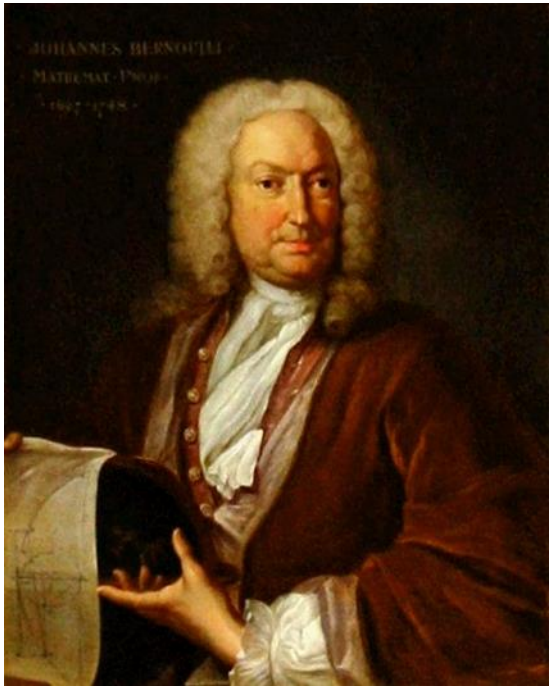
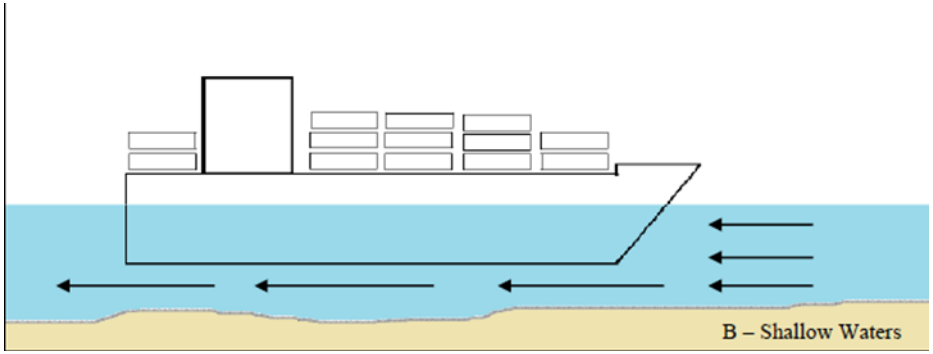
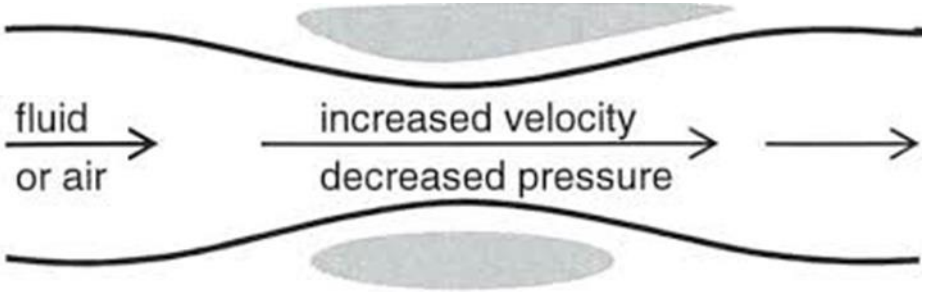
Interaction - Squat

Remember Bernoulli !



Shallow Water Squat





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Interaction - Squat

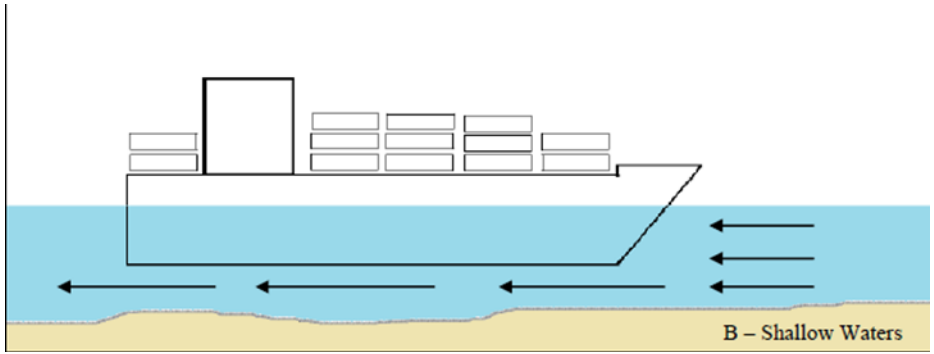
Factors

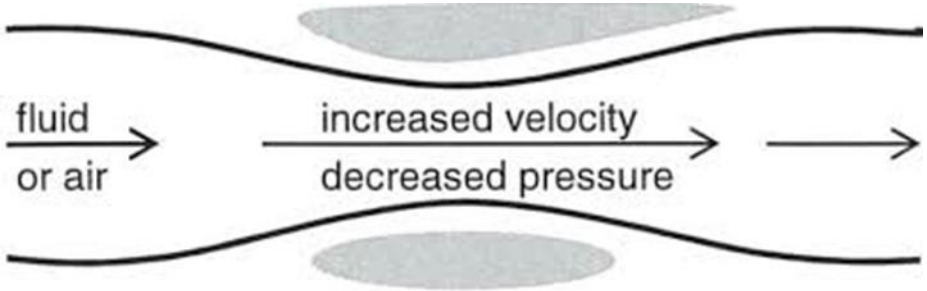
Accelerated Flow Under the Keel = Reduced Pressure

Ship squats down (and can trim):

- Tankers & Bulkers trim by the bow
- Container/LNG trim by the stern

Shallow Water Squat





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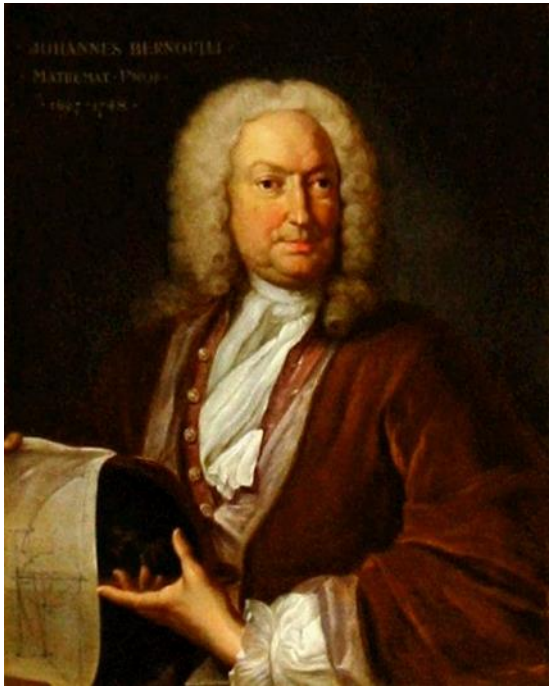
Interaction - Squat

Bernoulli



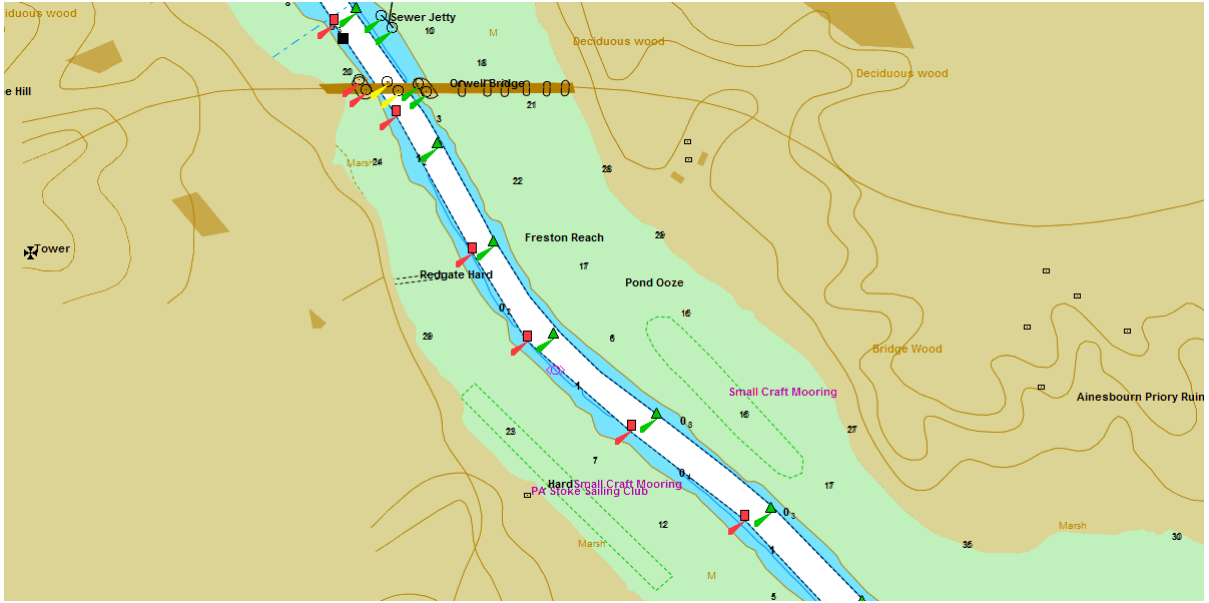
How to calculate Squat

- Calculated values in ship tables
- Standard UKC based on experience - e.g., 10%
- Dynamic UK clearance systems that allow for heel of a vessel

Interaction - Squat

Signs of Squat

- Loss of steerage
- Loss of speed
- Vibration
- Increased turn diameter
- Wake breaking/rollers



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Interaction - Squat

Not always a negative !!

ALLURE of the SEAS - 2010

Passing below Great Belts Bridge in Denmark

Went under the bridge at 22 knots (full speed) giving it another 30cms of squat

50 cm clearance !!!!

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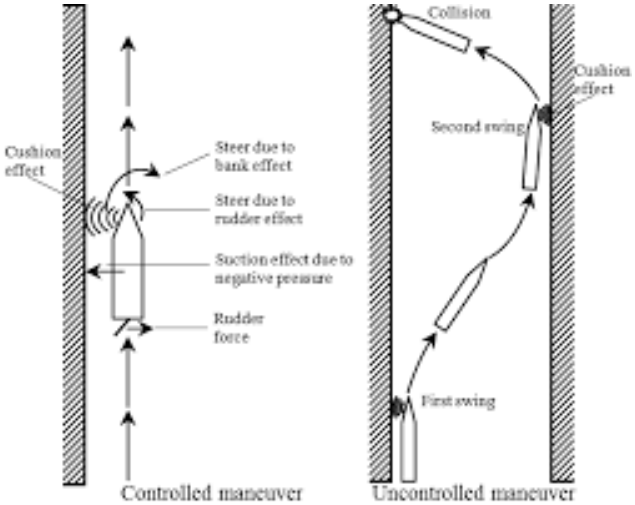
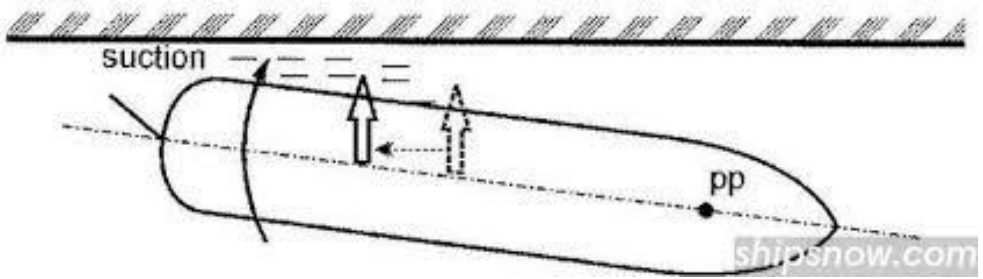
Interaction – Bank Effect

Pressure Wave & Bernoulli



Suction at Stern



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Passing Ship Interaction – One Vessel Moored

Sequence

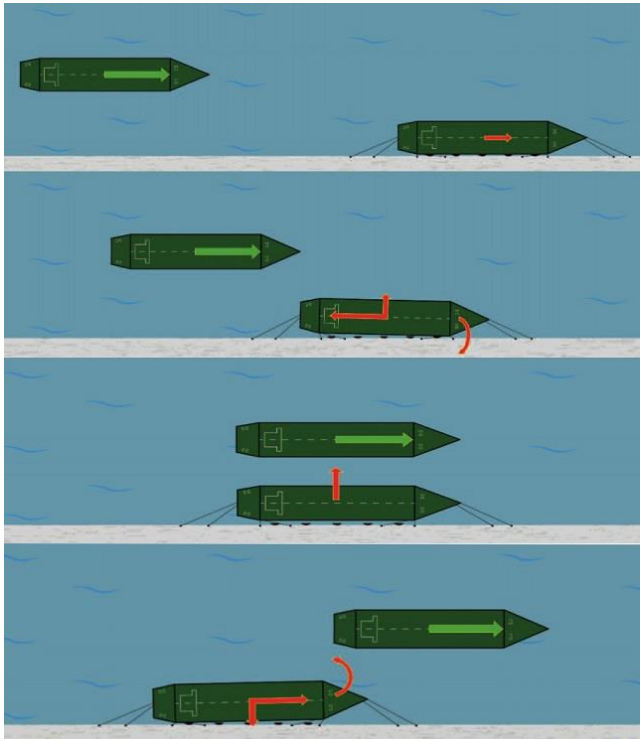
Main factors:

- Speed & passing distance, UKC, berth type

Other factors:

- Hull shape, displacement of vessels

Sequence of Effect Passing Ship



Source : W.of E P&I

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Factors – Passing a Ship on a Berth

Forces affected by

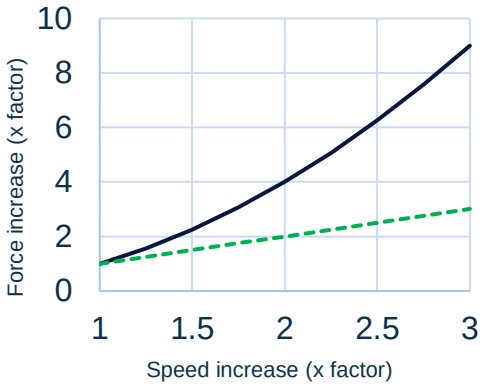
Passing Vessel

- Hull type & size
- Draft & UKC
- Speed through water
- Passing distance (separation)
- Channel bathymetry

Moored Vessel

- Hull type & size
- Draft & UKC
- Mooring arrangement & equip.
- Line material (stretch)
- Line pre-tension
- Berth bathymetry

Reaction affected by



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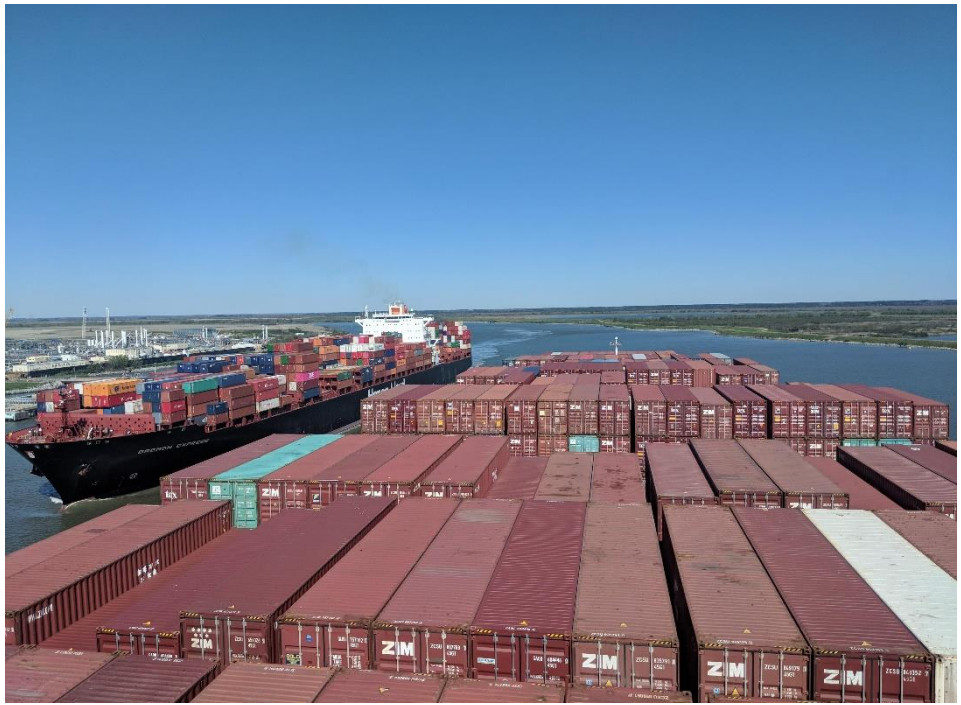
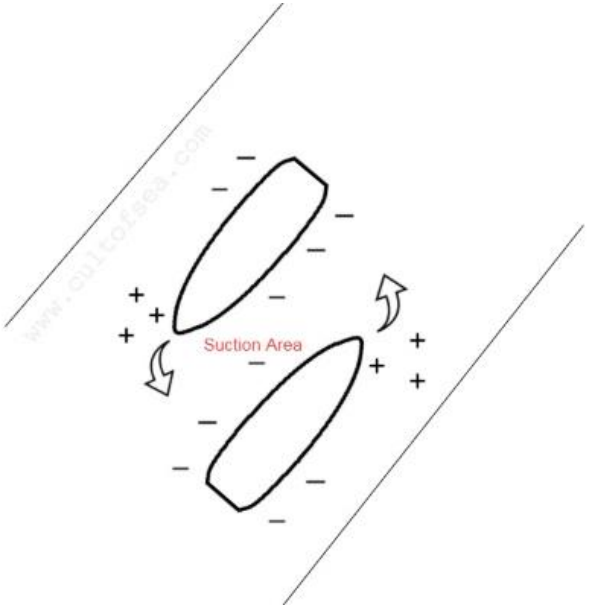
Passing Ship Interaction – Opposite Directions

Passing Ships



Bows then Sterns Pushed Apart



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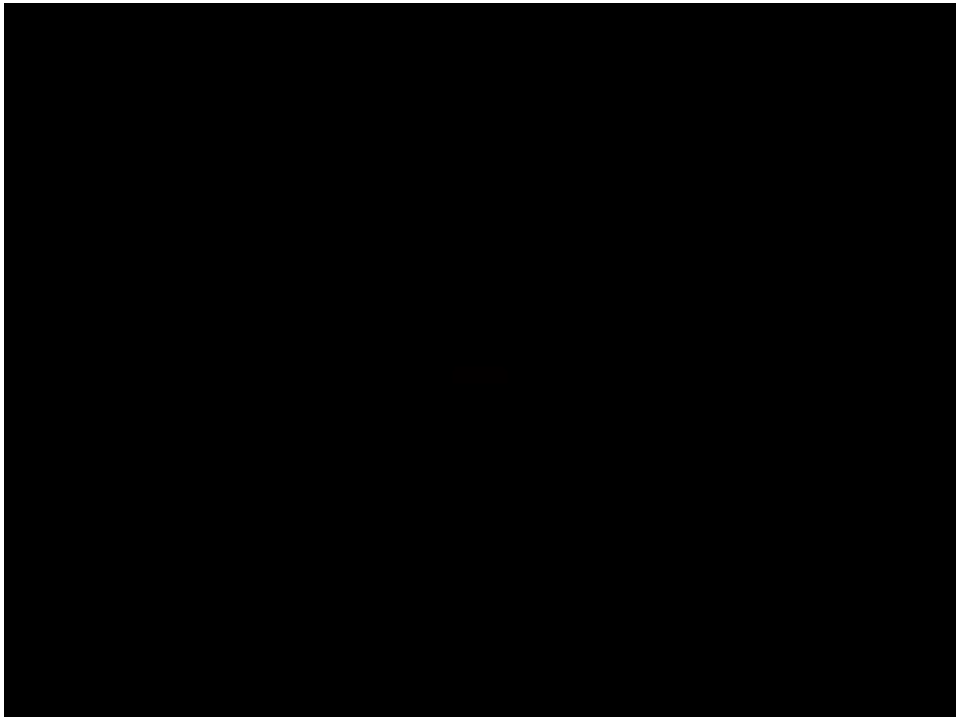
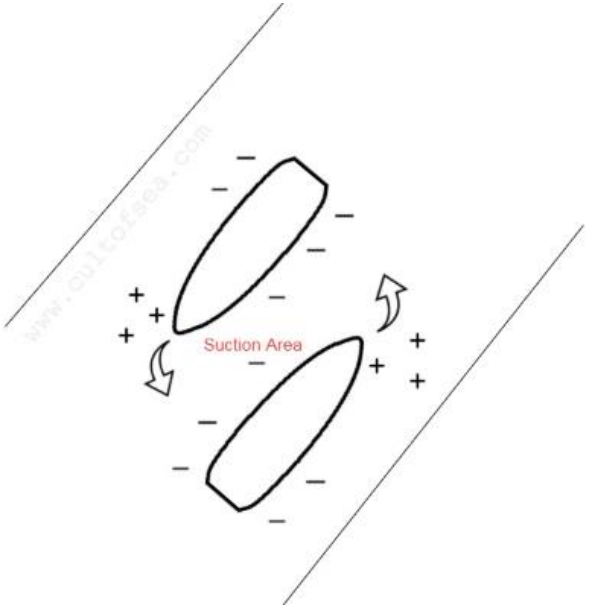
Passing Ship Interaction – Opposite Directions

Passing Ships – Texas Chicken Maneuver



Source: Port Revel, YouTube

Bows then Sterns Pushed Apart



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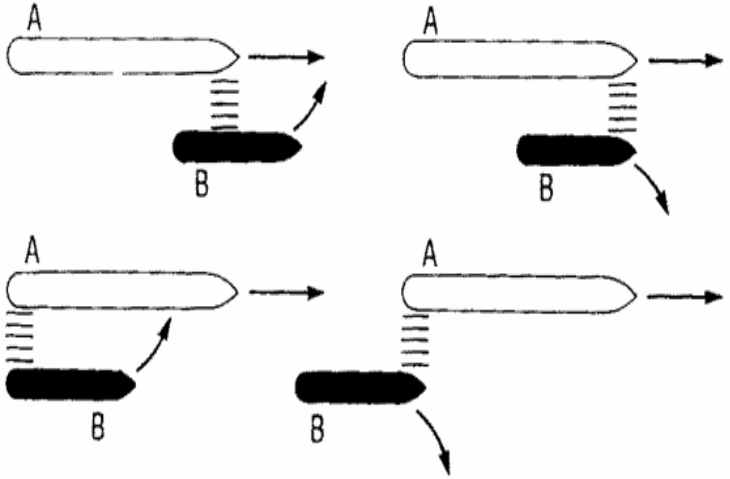
Passing Ship Interaction – Overtaking

Passing Ships

Bows then Sterns Pushed Apart



Source: YouTube

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