

# The Mechanics of High Speed Boat Accidents



LORNE CAMPBELL DESIGN

# Mechanics of Accidents...

- Underlying mechanical reasons behind certain aspects of the more common types of boat misbehaviour.

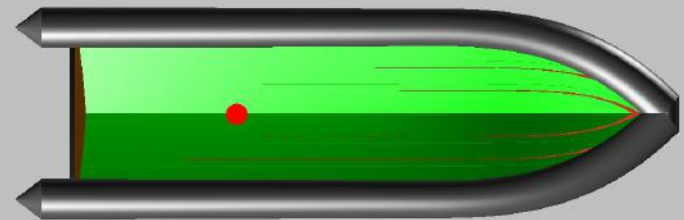


# Hooking!

- Most common fast boat accident.
- Related to ‘Broaching’, ‘Spinning’, ‘Bow steering’ ...
- ‘Broaching’ is the traditional term.
- ‘Spinning’ – often used by non-boating race commentators!
- ‘Bow steering’ – describes a boat which won’t run straight.

# Bow Steering!

- Marginal directional stability – constant input from the driver
- Flat running angle – forward CG
- Large yawing moment
- Loose steering!



# Hook!

- When bow steering gets out of control!



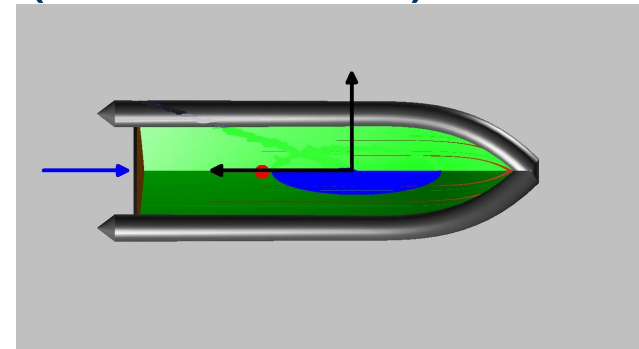
# Hook!

- ~ 45 + degrees from original course – doesn't answer the steering.
- Up to 180 degrees
- If lucky it stays upright
- Often it will roll!



# Hooking!

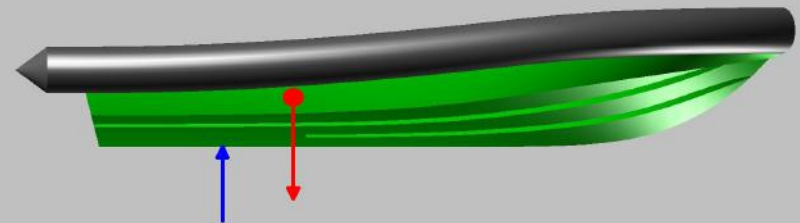
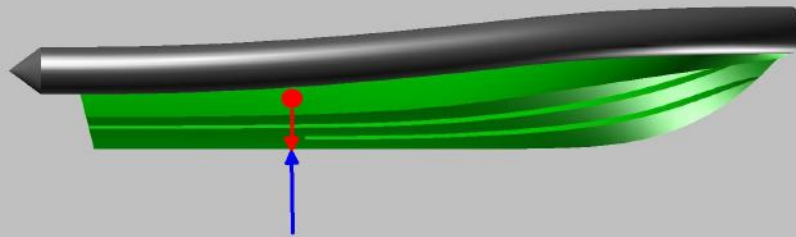
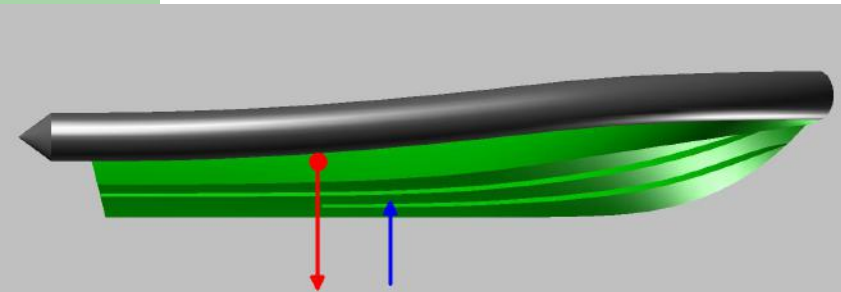
- Even if upright, crew are thrown – within or out
- Kill cord...!
- Usually when turning but can happen when straight
- Straight - porpoising – tripping (swell/wash)
- Prop torque



# Porpoising – A regular, rhythmic pitching motion:

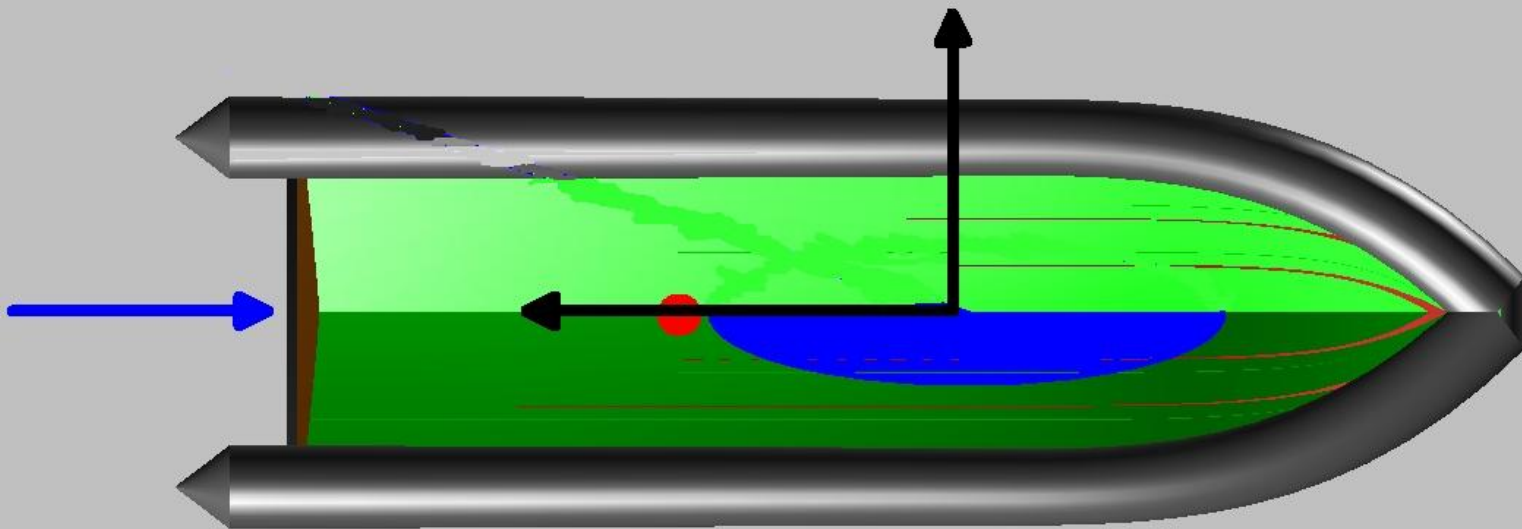
- Oscillation of the centre of lift, forward and aft of CG – planing angle related

Mild or violent  
– skip and trip! – Hook?

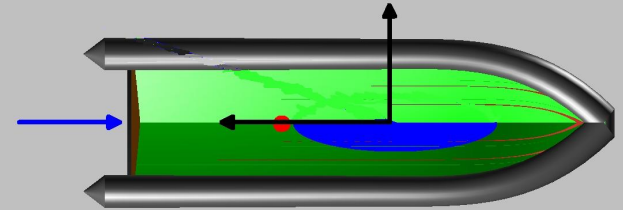




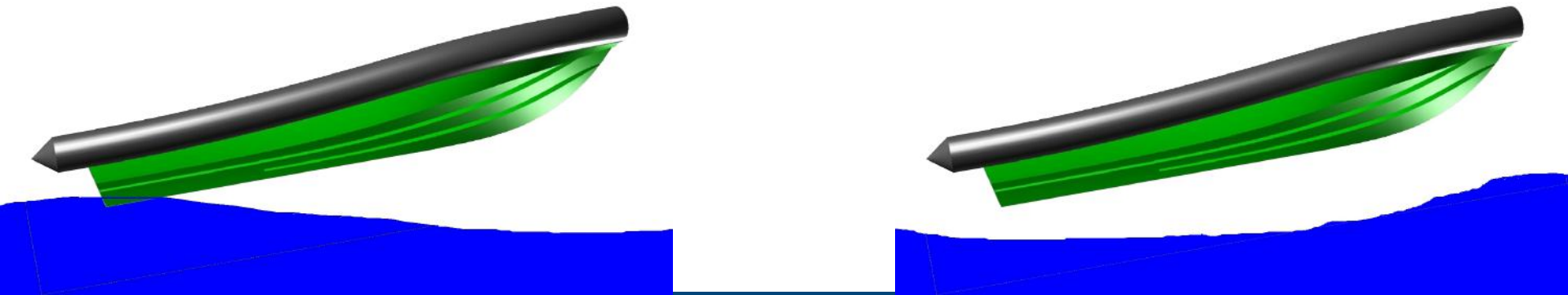
# Straight Line Hooking Forces...



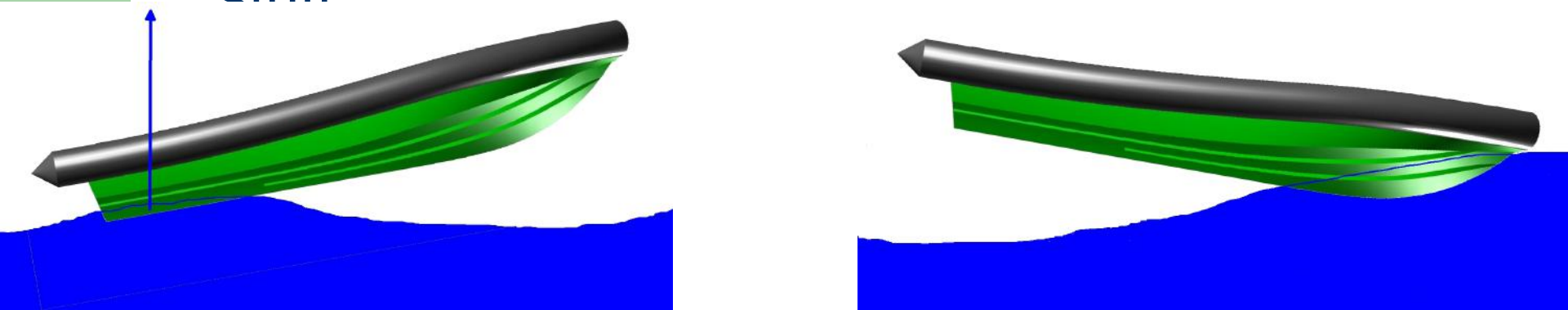
# Seaway!



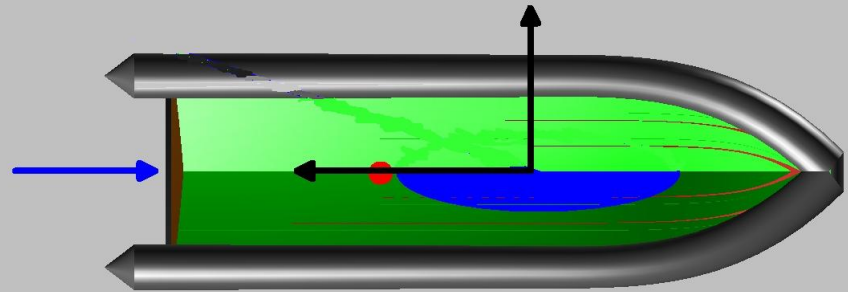
- Head to sea – Drives in – holds bow down
- Following sea many trim out...
- But can make situation worse!



- Following sea – better ride – trimmed out – running faster – bow light
- Lift off 1<sup>st</sup> wave
- Catch stern on 2<sup>nd</sup> one
- Trip and dive into 3<sup>rd</sup> – classic ‘trip and stuff’



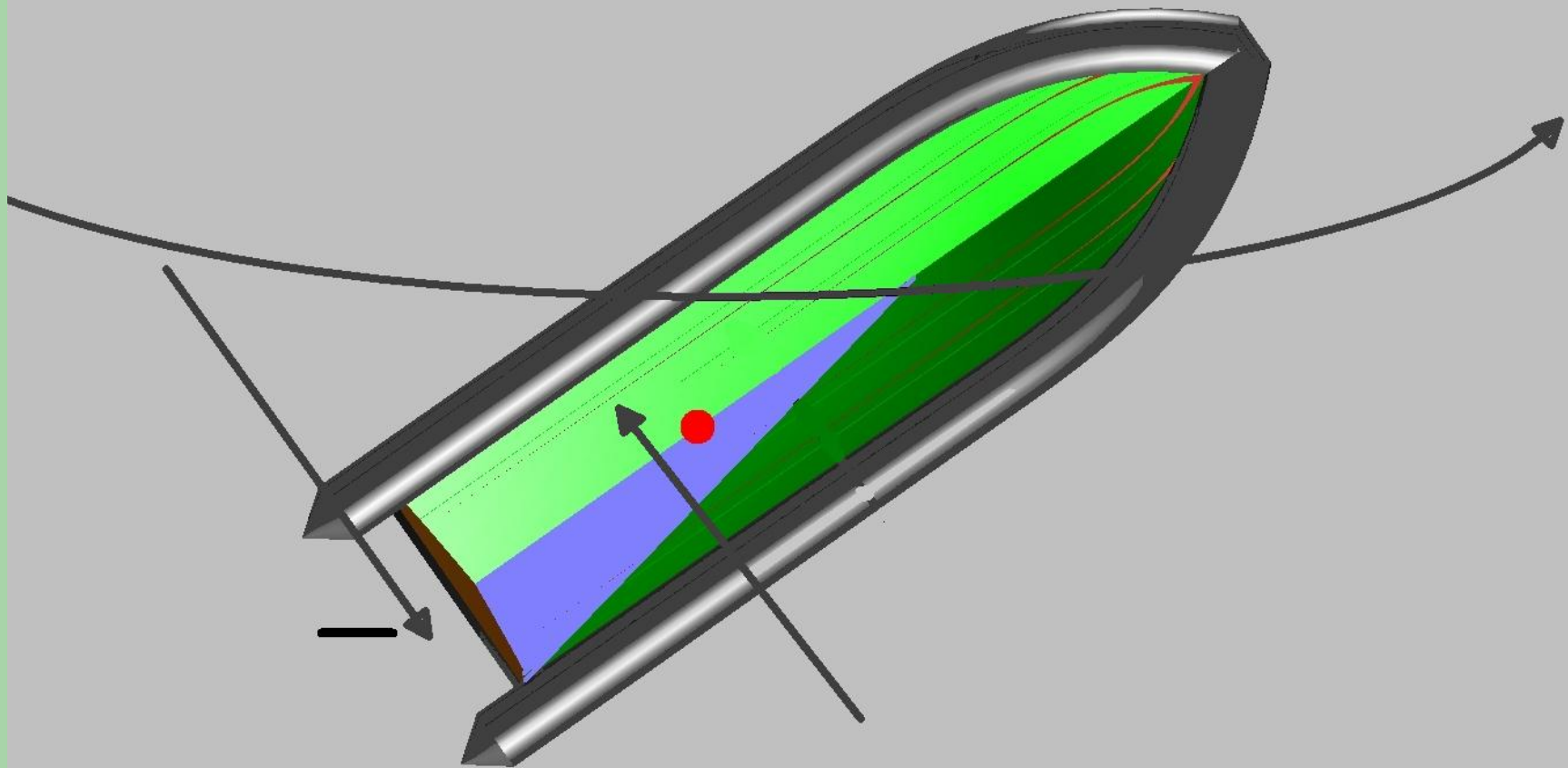
# Mechanics!



- Bow into 3<sup>rd</sup> wave with stern in air
- Any yaw (prop torque/walk – steering input)...
- Possible violent hook! As with porpoising ‘skip and trip’
- Trim in, or to neutral, often OK in following sea
- Craft flat – low tripping forces
- Needs ‘recovery’ lift in bow!

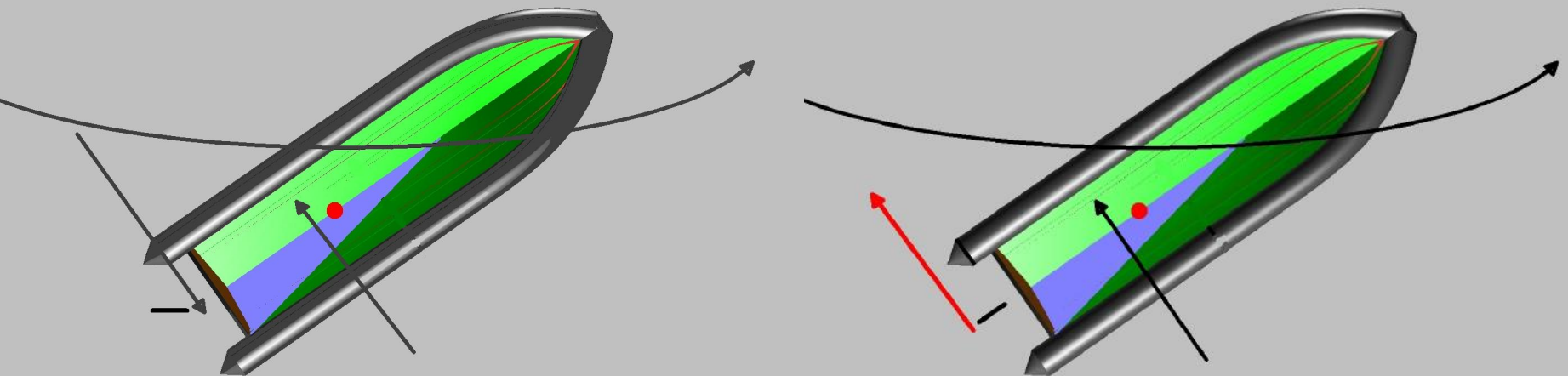


# Turning – Normal turning is by a controlled imbalance of forces...



# Controlled turning:

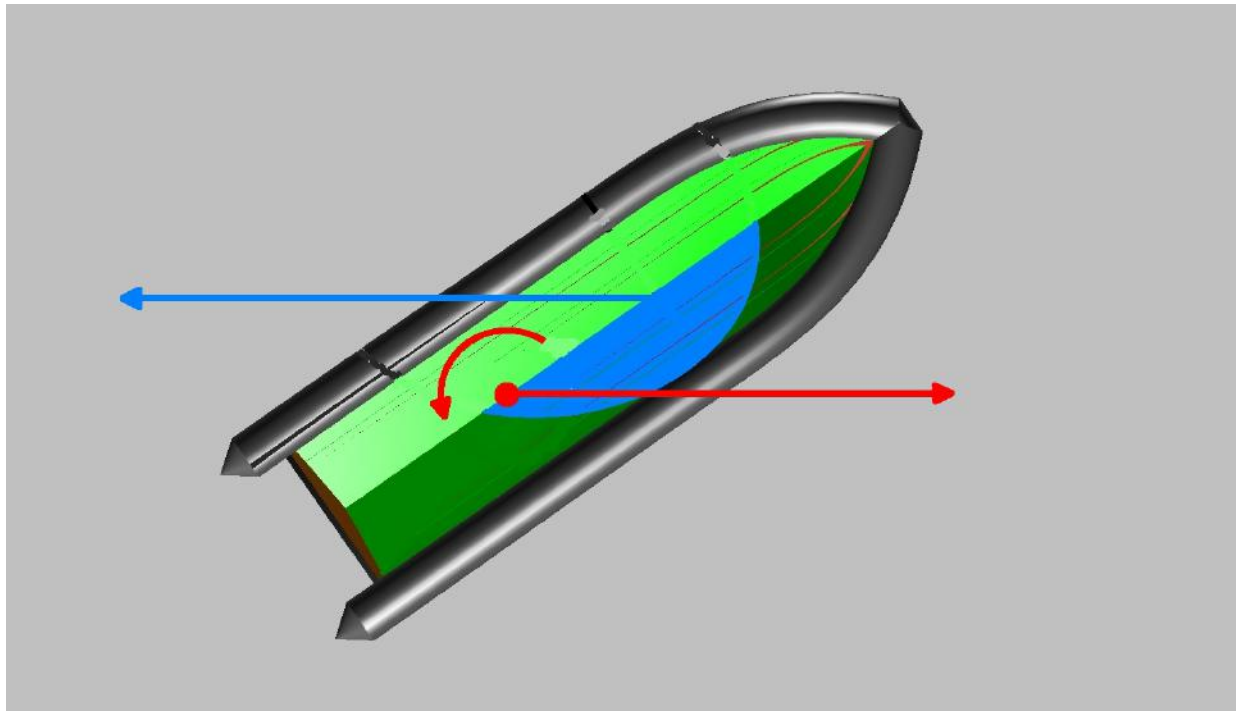
- Steering centralised – aft side force reverses
- Properly trimmed craft (calm water) straightens naturally anyway – but less quickly...



**If side force at stern disappears – no balance.**

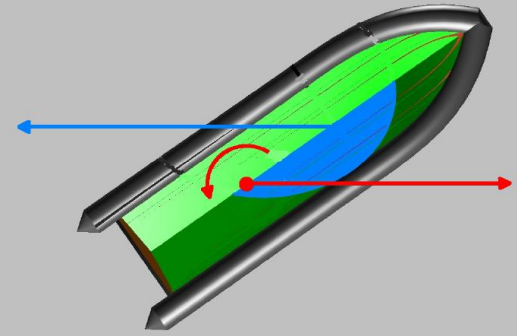
**Hooks usually happen in turns...**

- Spins around the CG
- Wet area moves forward as front slows compared with stern!

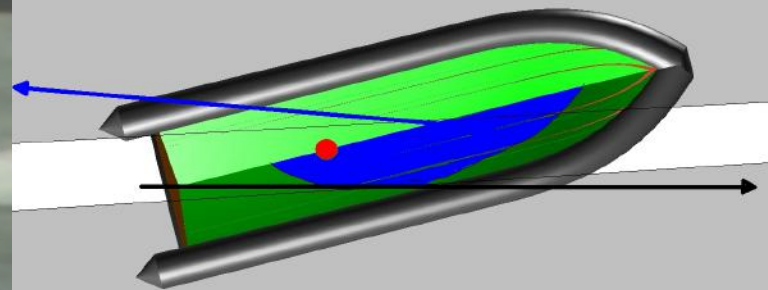




# Why loss of grip aft?

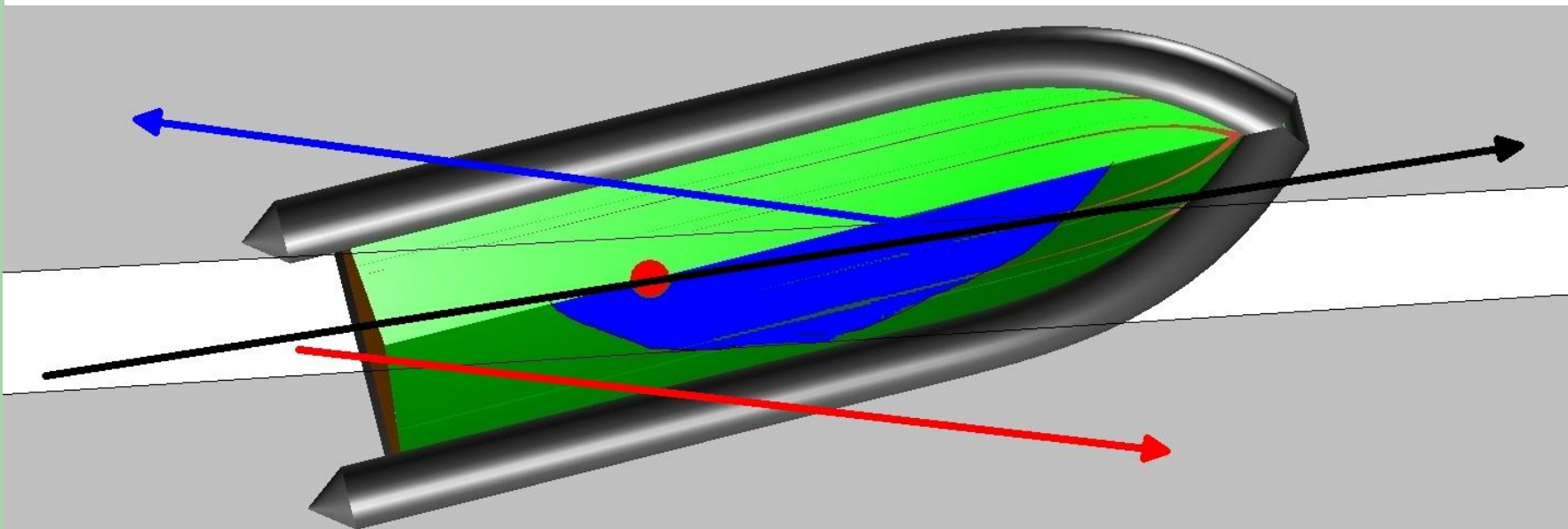


- Craft trimmed too flat – lateral pressure far forward
- Encountering a wave or wash when turning – particularly when following another craft closely
- Banking angle too steep!
- Powerful engine – low prop!



# Encountering a wash while turning...

- Hull crossing wash (black line direction) but also crabbing because it is turning. Situation is worse when the encounter angle is small since most of the pressure is on one side and appreciable time is spent with keel on top of wash with surrounding parts of the craft lifted clear!



# Washes and waves...

- Washes are dangerous...
- Choppy water – driver concentrating – speed reduced – trimmed down.
- Calm water – trimmed out – speed higher. Wash can surprise driver
- Don't cross at shallow angle – especially when turning!

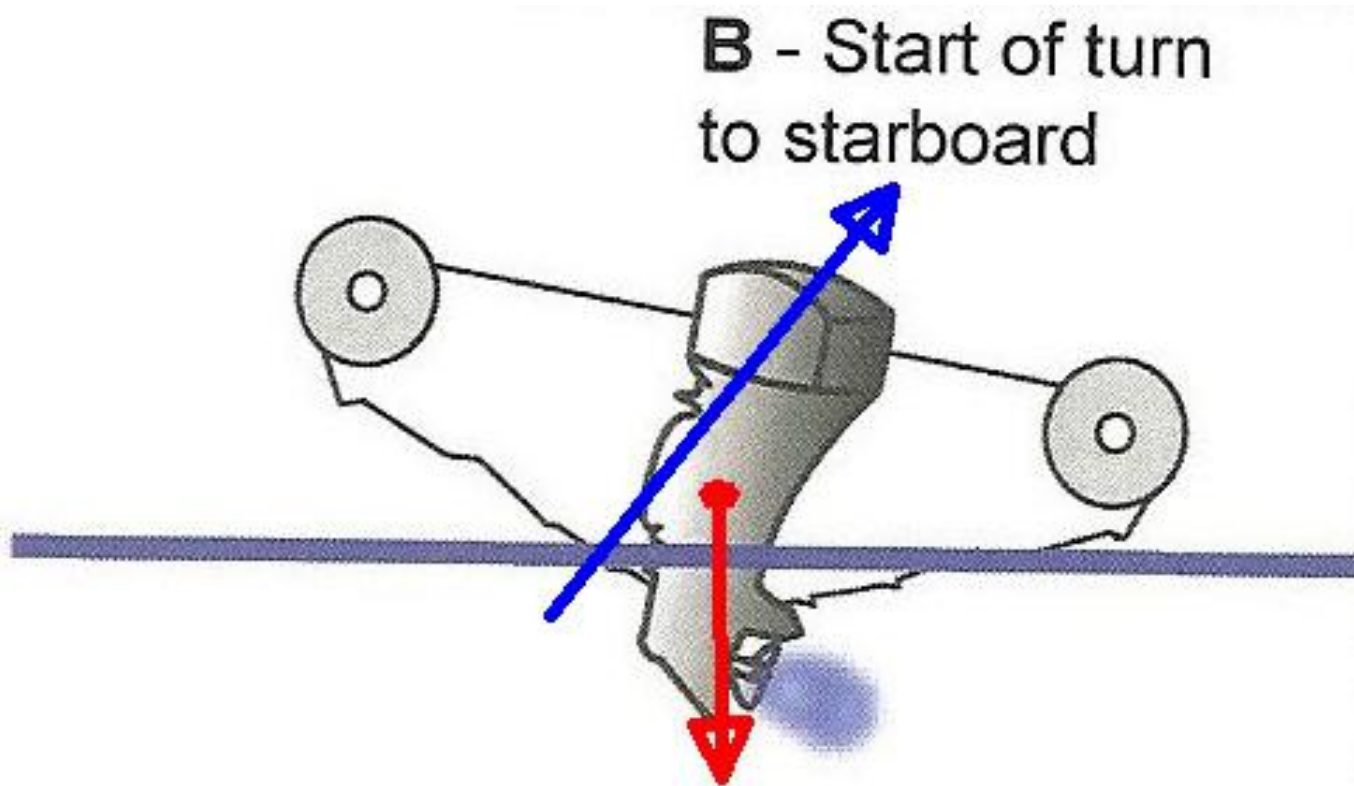
**Trying to stand on a narrow footprint on top of a wash can cause roll instability!**



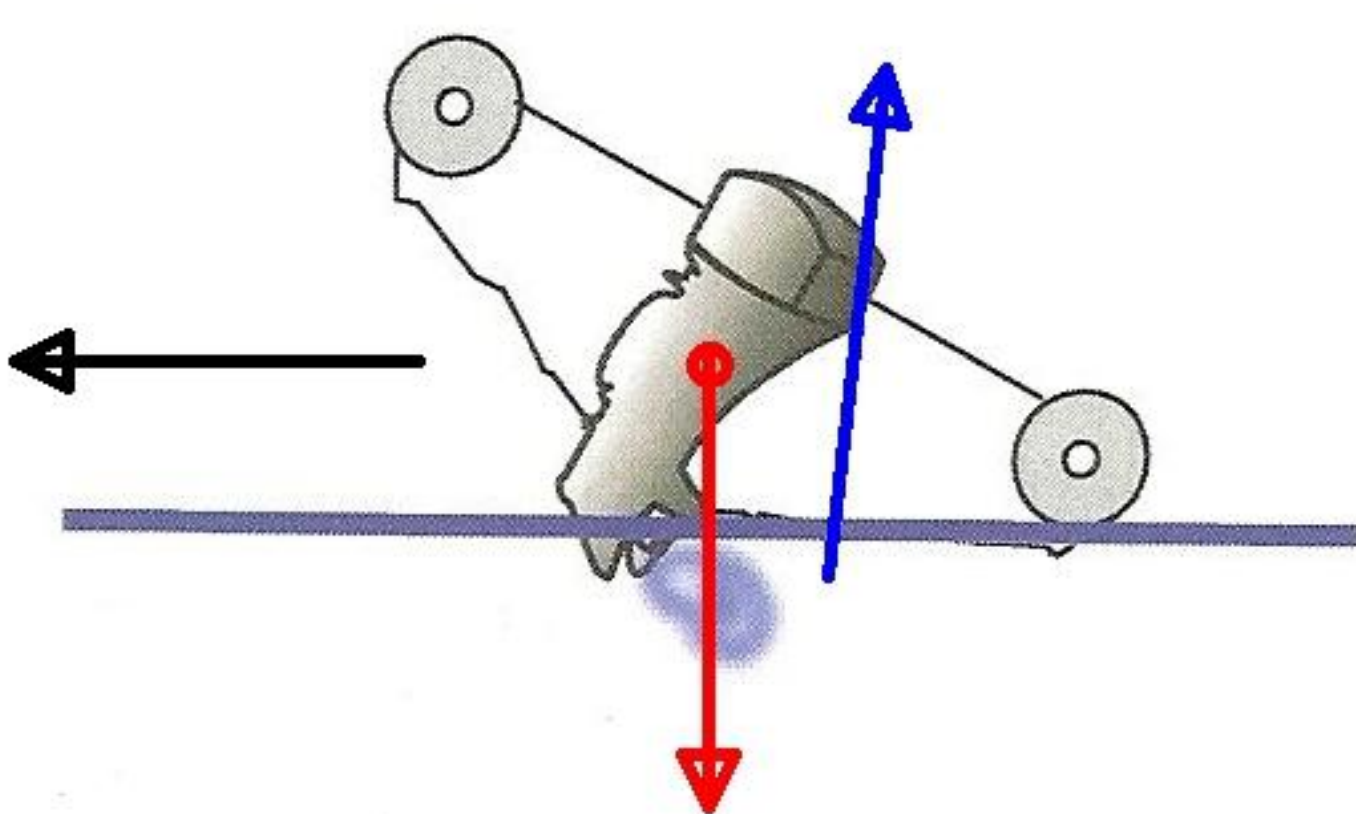
# Steep heel angle in turns...



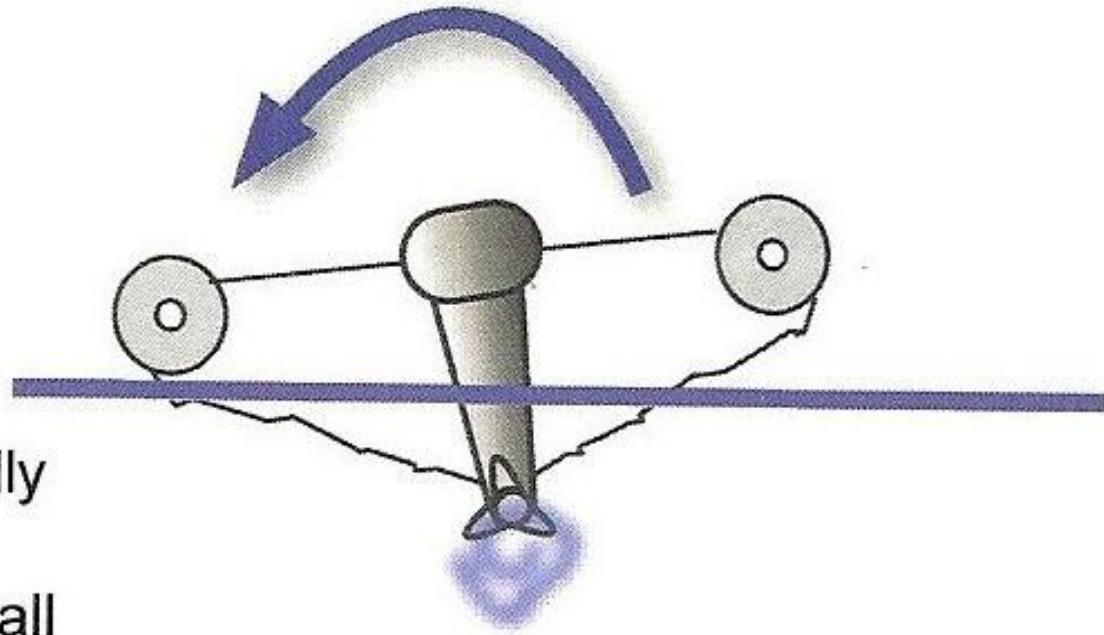
# Craft is initially stable...



**But - keel aft can lift clear on some craft - stern slides**



# Stern skips sideways and rolls upright – stops suddenly on landing – a ‘Side Dump’ !



E - Keel has dug into water and the boat has rolled rapidly back upright and initially to port - resulting in ejection of all occupants

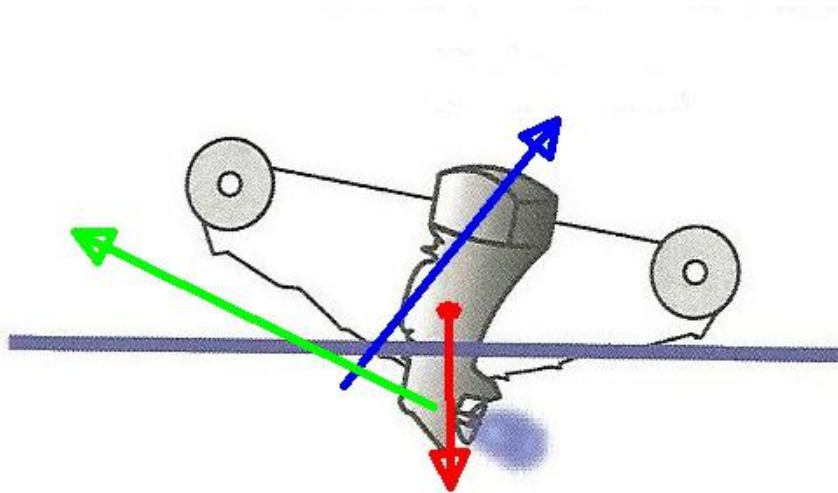


# Boat has also changed course...

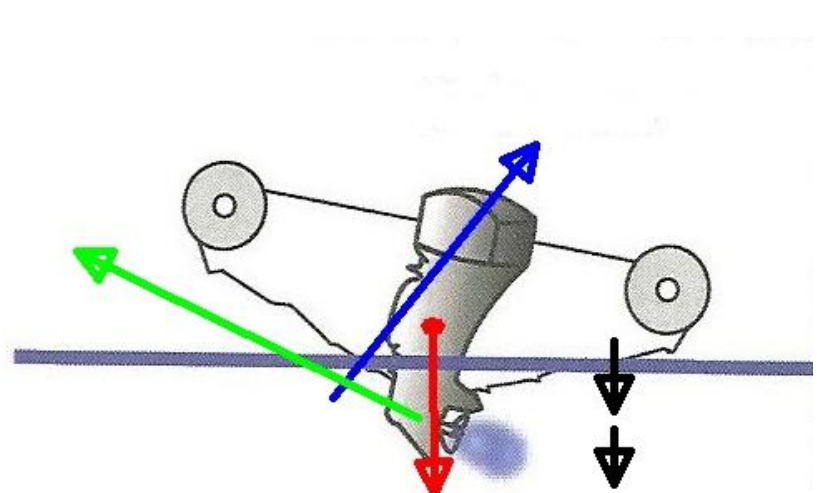
- Boat jinks to Starboard
- Crew follow original course!
- Low topsides – they go over
- High coaming – they land on top of each other
- Kill cord...

# Why do some craft heel more?

Normal heel



High heel angle

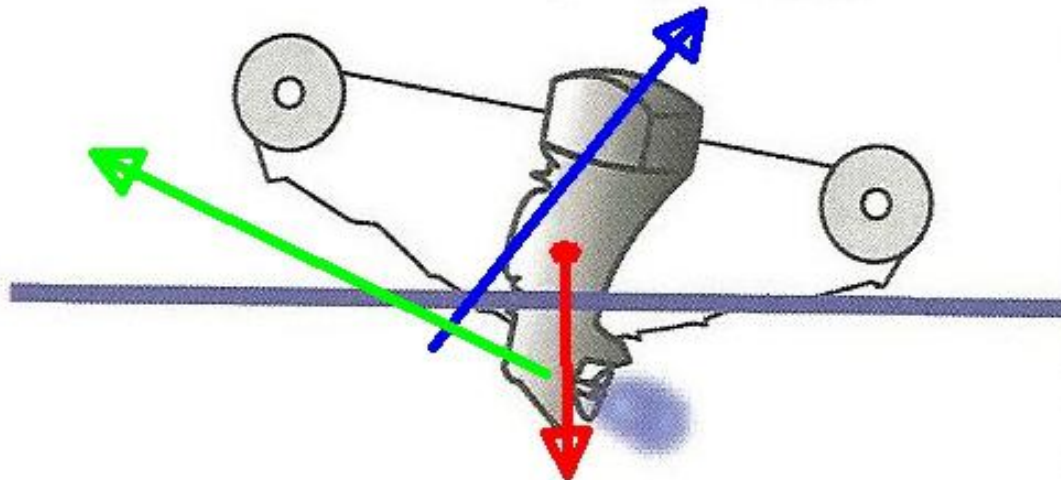


Some craft can create a suction force out at the chine due to curved surfaces and 'Coander Effect' !

This can often be corrected by sharp edges to separate the flow.

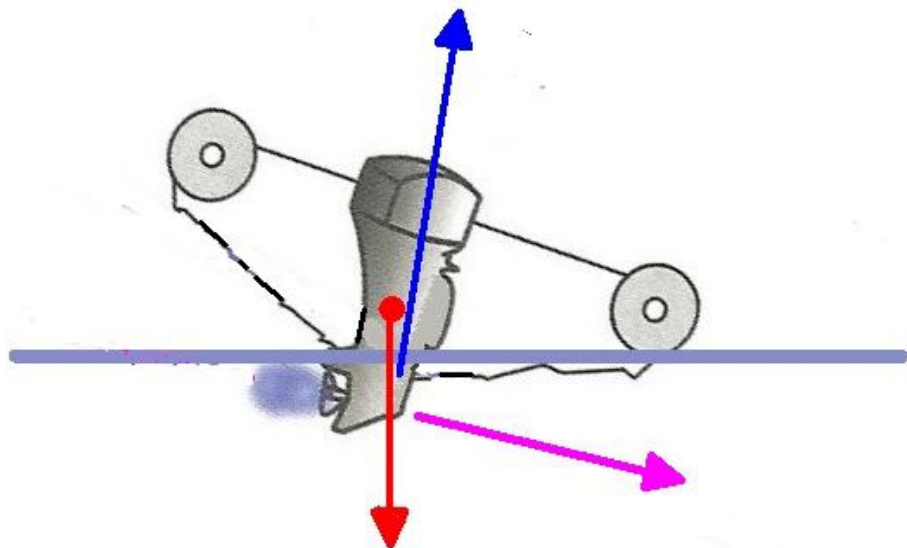
# Heeling Forces in turns:

- Sometimes the thrust of a very powerful engine with the propeller set low can cause a high heel angle -



# Danger of 'Opposite Lock' ...

- If tail slides and craft hooks to Starboard
- Reaction is to turn hard to Port...
- This sets up an opposing roll moment –



# Driver must know his boat!

- Learn the boat – progressively...
- If it gets ragged, don't push further
- Don't say - 'I am determined to find the limits of this boat'
- – Often followed by accident
- – finally he has found the limit!

Learn your boat and  
respect the sea!

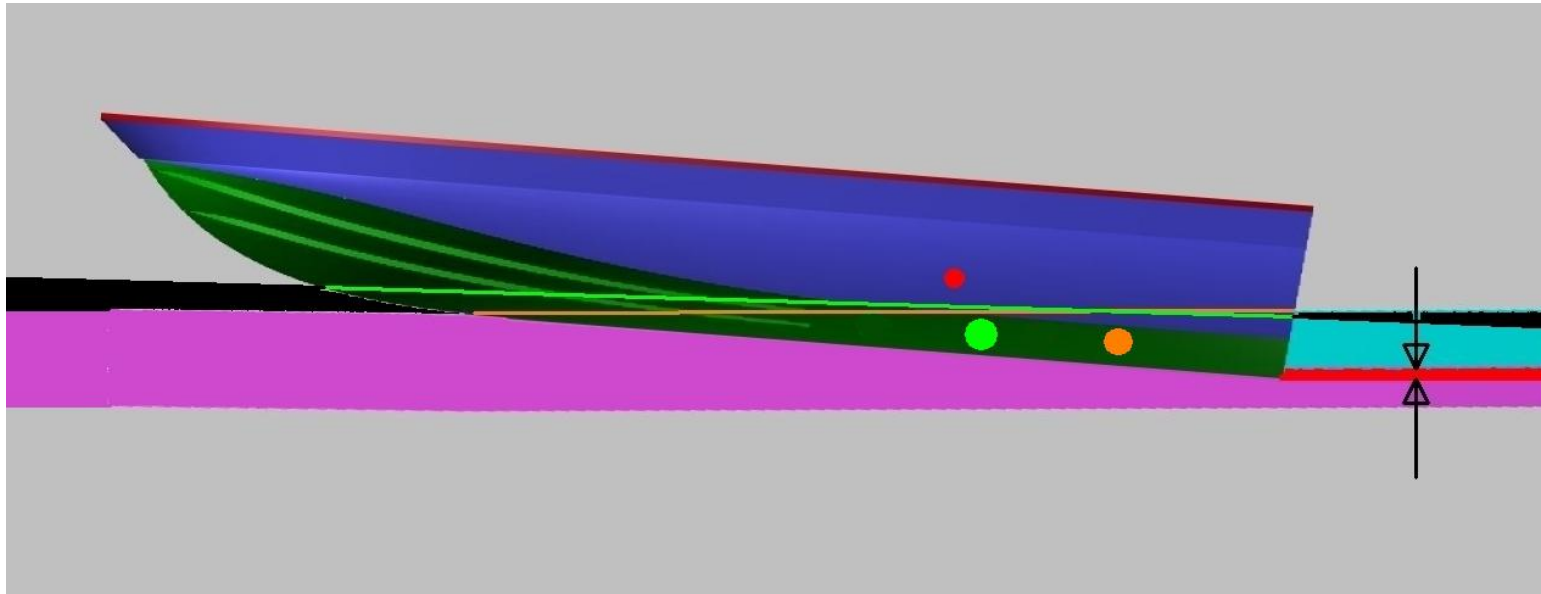


# Turning:

- High speed, trimmed out, craft has little grip.
- Before turn – settle into water – throttle off & also (maybe!) trim in
- Non-stepped hulls – probably trim in... It is a nuisance – but we are used to it!
- Stepped hulls are different (why shouldn't they be?) – be very careful about trimming the drive in – learn the boat's characteristics!

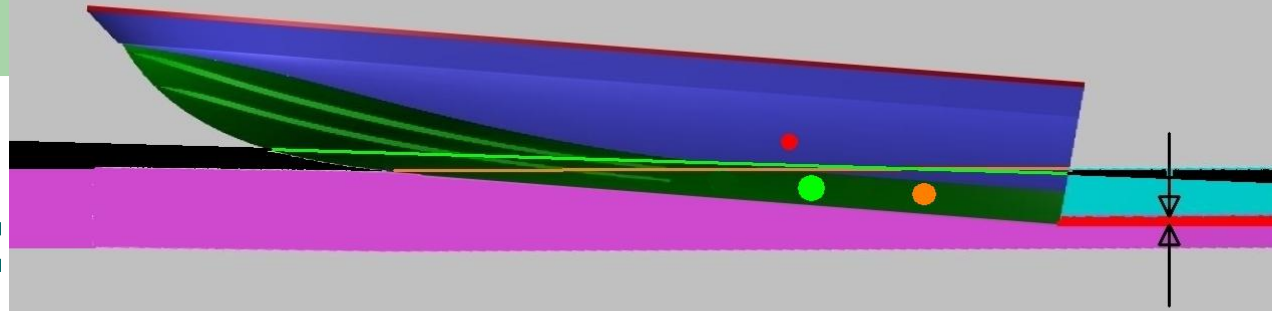
# Non-stepped hull has more built in directional stability:

- Light and trimmed out, lateral CP a long way aft...
- ...difficult to turn – just crabs sideways...
- So – to turn, it helps to move CP forward a little by trimming in & reducing throttle (for sinkage):

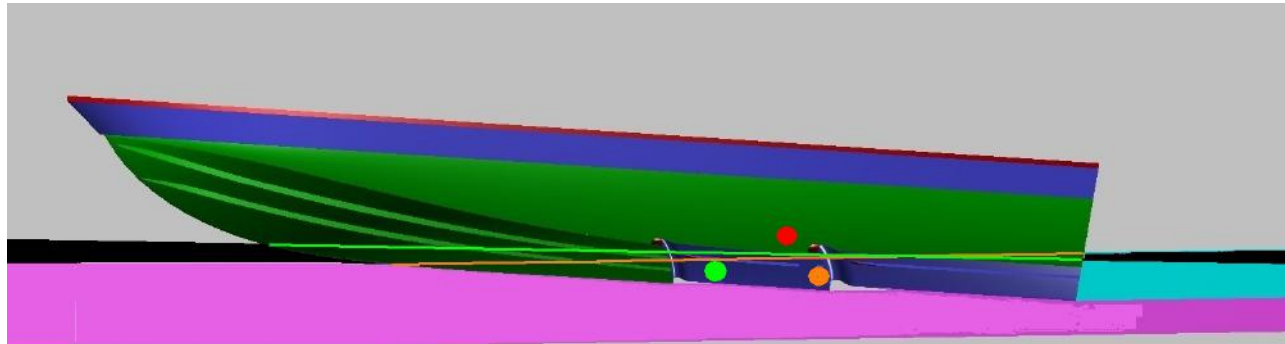




# Shielding:

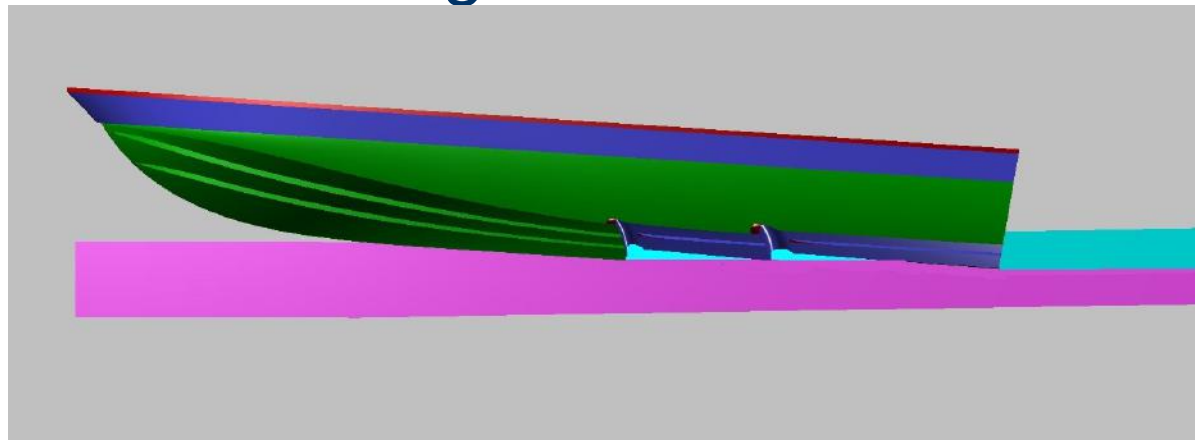


- Blanking effect on aft surfaces on a stepped hull means less lateral wetted surface aft –
- Stepped hull without drive trimmed in already has a lateral CP further forward than non-stepped hull – so less ‘in trim’ needed – if any!
- It can be overdone!

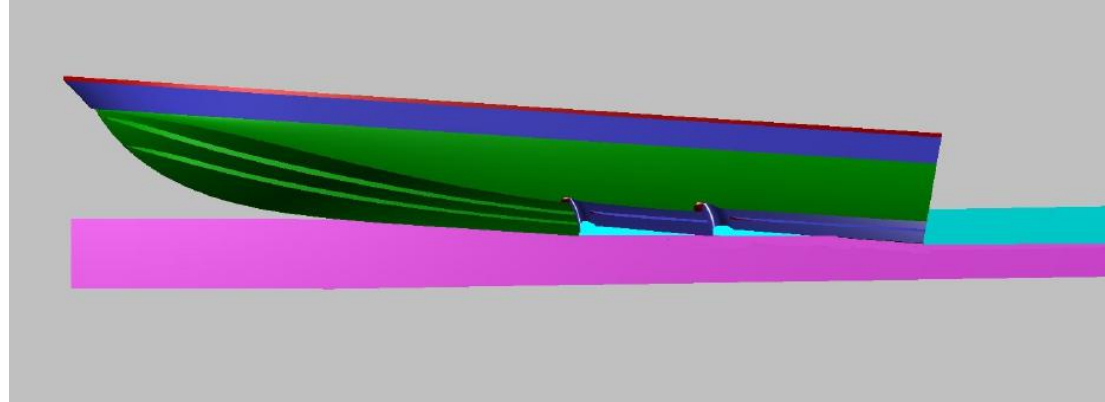


# Hooking accidents with stepped hulls!

- Either:
  - – too much in trim
  - – too much speed for turn
  - – or a design which has gone for maximum drag reduction without thought for directional stability!
- All of them!



# Compromise!



- Deep steps positioned aft – more drag reduction – but more shielding!
- Practical step design compromise: Useful gain in performance while retaining adequate directional stability!
- All design is a compromise...
- But driver must appreciate the difference between stepped and non-stepped.

# Thank you!



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