Mental models in confined waters

Sharing planned intervals for timely challenge and response

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Accidents in confined waters are often the result of intentions and actions not being challenged in due time, despite all formal bridge resource management tools being applied. So, what is missing? How can we ensure that the level of information exchanged on the bridge is detailed enough to enable unambiguous and timely challenge and response?

In order to meet these challenges, a new concept is required for navigation and manoeuvring in confined waters. By defining critical navigational elements (ie cross-track distance, speed, rate of turn, drift angle etc.) in terms **of an interval of values** – rather than single values – we can remove any ambiguity about when it is appropriate to challenge whoever is conning the vessel.

This concept addresses many concerns raised by safety investigators around the world. In its accident report M12W0207, investigating a vessel striking a coal terminal, the Transportation Safety Board of Canada maintained that *'the absence of a detailed, mutually agreed-upon passage plan deprives bridge team members of the means to effectively monitor a vessel's progress, compromising the principles of bridge resource management'*.

Critical navigational elements should be identified and specified by:

- **An interval of planned values** that represent normal operations. If everything goes according to plan, none of these values will be exceeded.
- **No-go** area/values that cannot be exceeded (ie non-navigable waters, breakwaters, speeds beyond or below which it is impossible to control the vessel). If the no-go value is exceeded then the ship is either aground or has had an allision or collision.
- **The reserve:** the difference between planned values/areas and no-go values/areas. This represents the safety margin available for a specific critical element. The reserve can be used intentionally in order to adapt to unplanned situations, such as traffic or changes in environmental conditions. It may also be used unintentionally due to conning errors.

For this concept to work effectively, critical navigational elements must be agreed and shared in due time before navigating in confined waters. The analysis of real world data from ships' sensors and high fidelity simulators are essential tools to define the critical elements of a challenging manoeuvre in such a level of detail.

It is important to keep the number of critical elements as low as possible. Applying the concept of the interval of values to all possible navigational elements in confined waters may defeat the overall aim of the concept itself, which is to prevent accidents caused by intentions and/or actions not being challenged in due time.

Case studies – using the reserve intentionally

In Figure 1, the 'critical element' is the ship's position, which is specified by the planned corridor either side of the ship's track. Ship A is leaving the planned corridor and entering the reserve as a result of an alteration of course to starboard. The reserve here is being used intentionally – and quite correctly. Indeed, the reserve can and should be used as soon as the person conning believes it is reasonable to do so, for example to avoid impeding the passage of a ship constrained by its draught.

The person conning should make the bridge team aware of their intention to use the reserve by using the **thinking aloud** technique. This technique is based on verbalising – **before** the action is initiated – the intended action, the reason behind it and the expected outcome. In this way the critical elements are made available for either confirmation or challenge by other team members.

With reference to Ship A, an example of thinking aloud could be:

- Plan: *'I intend to alter course to starboard'*
- Reason: *'To avoid impeding the passage of Ship B, which is constrained by its draught'*
- Outcome: *'I will navigate outside the planned corridor with a cross-track distance not more than 200m right of the track'*.

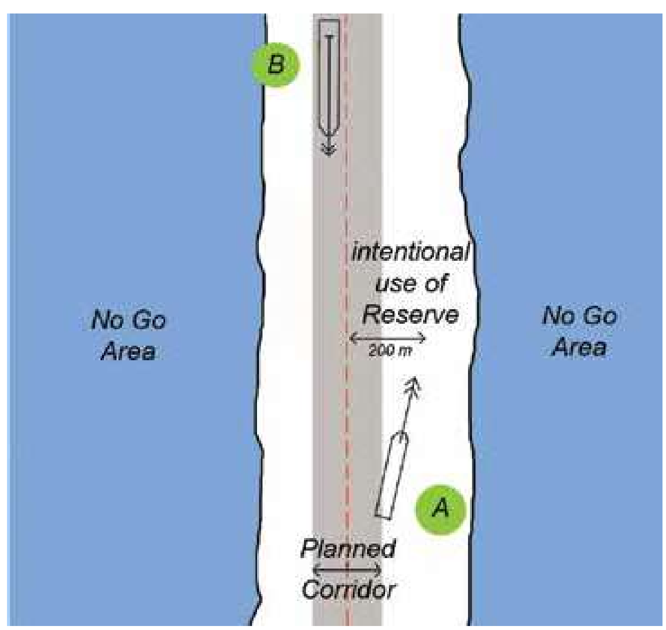

Figure 1: Intended use of the reserve to avoid impeding another ship

Another example of use of the reserve is the need to slow speed over ground when approaching another vessel at a difficult bend in a tidal river (Figure 2). Vessel 1 has the tidal stream against it, and may need to slow down to 3 knots until Vessel 2 has passed clear. This may take the speed over ground outside the interval of planned values – say between 5 to 6 knots – but such reduction would certainly be considered a reasonable use of the reserve.

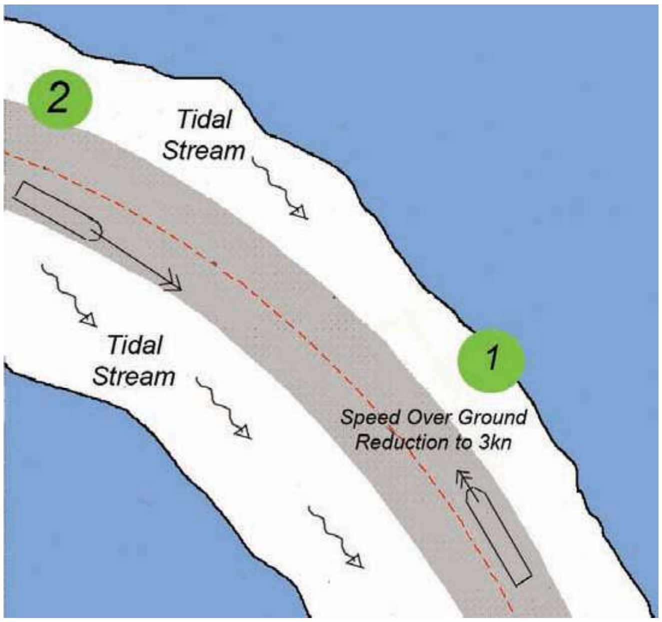

Figure 2: Intended use of the reserve when slowing down in a tidal river

This shows that reserves need not apply to spatial values only. For example, the drift angle could be used as a critical navigational element by defining an interval of planned (normal) values and an extreme value, which – once exceeded – will cause an unacceptable swept path in a narrow channel. All drift angle values outside the normal interval, but still within the extreme one, make up a safety margin to use only under abnormal or emergency conditions.

Unplanned use of the reserve – when to challenge

This planning methodology aims to allow the flexibility a shiphandler needs to manoeuvre without being constrained by unrealistically strict parameters. At the same time, it removes any ambiguity about whether it is appropriate to challenge whoever is conning the vessel.

Let us consider the unintended use of the reserve (see Figure 3).

When the ship is in Position 1, the cross-track distance (measured from the conning position) is right of track. The entire ship is within the **planned corridor**, without using the reserve. When the ship is in Position 2, the cross-track distance is zero (conning position on track), but the stern is on the edge of the planned corridor. When the ship is in Position 3, the cross-track distance is only slightly left of track – but the ship's port quarter is well within the reserve, with not much space left before the stern of the vessel crosses the safety contour and enters the no-go area.

In principle, critical elements planned according to this concept can be used as a baseline not only for thinking aloud, but also for **challenge and response**.

Before turning, the person conning would express their intentions as follows:

- **Plan:** *'I intend to turn keeping the conning position right of track.'*
- **Reason:** *'Because I want to keep the port quarter within the planned corridor.'*

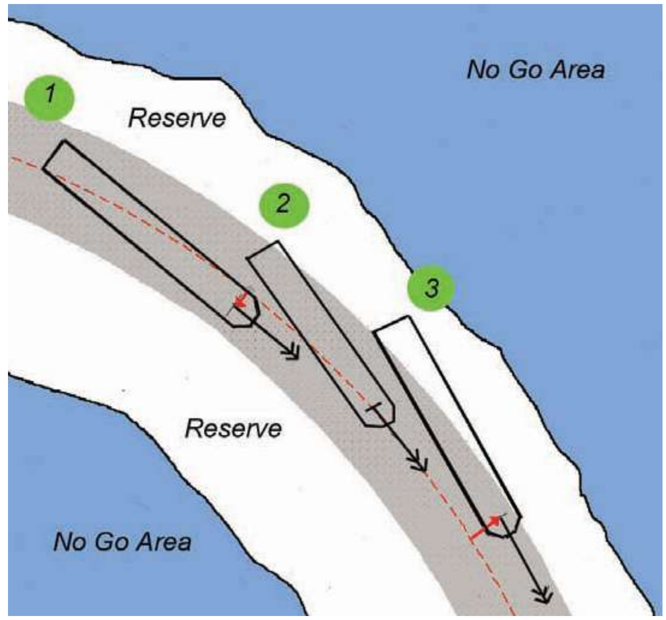

Figure 3: Unintended use of the reserve - a basis for timely challenge

- **Outcome:** *'The* cross-track distance *will be between 0 and 40m right of track.'*

Now let us assume that the ship is drifting into Position 2 due to an unexpected current, and the person conning is not acting promptly on it. As soon as it is apparent that the cross-track distance will move left of track, any other team member should intervene by probing – 'What is your intention?' – and/or alerting, 'The cross-track distance is now zero and the port quarter is going outside the corridor.'

If the response to probing and alerting does not satisfy the team member who has concerns, then the challenge needs to be expressed using words that raise attention such as 'I suggest' or 'I recommend'. The following expression would constitute an outcome-based challenge:

'I recommend bringing the conning position right of track as initially planned.'

Outcome-based challenge

It is important that any challenge focuses on the outcome rather than on the specific action needed to control the ship. This is to avoid the person conning becoming fixated on the specific instructions given by the person challenging, especially if the challenger has more authority within the team. If the challenge included specific instructions, it could lead to a situation where the person with the conn waits for the next instruction before acting. This could mean a 'de facto', but not formal, taking over of the conn.

To avoid distractions and to retain the level of communication essential on the bridge – especially during critical navigational phases – any challenge should be timely and triggered by the intended or potential use of the reserve.

Planning an interval of values is particularly useful for berthing/unberthing manoeuvres. For example, the ship's heading could be one of the critical elements during the approach to the berth. Expressing this as an interval between two headings – rather than a single heading value – would define the interval of reasonable angles of approach to the berth. An example of this situation is shown in Figure 4.

If the heading is outside the interval of planned values, suggesting that the person with the conn should adjust the ship's heading may be more convenient than offering specific instructions on how to achieve the end result. If the outcome-based challenge is made in due time it

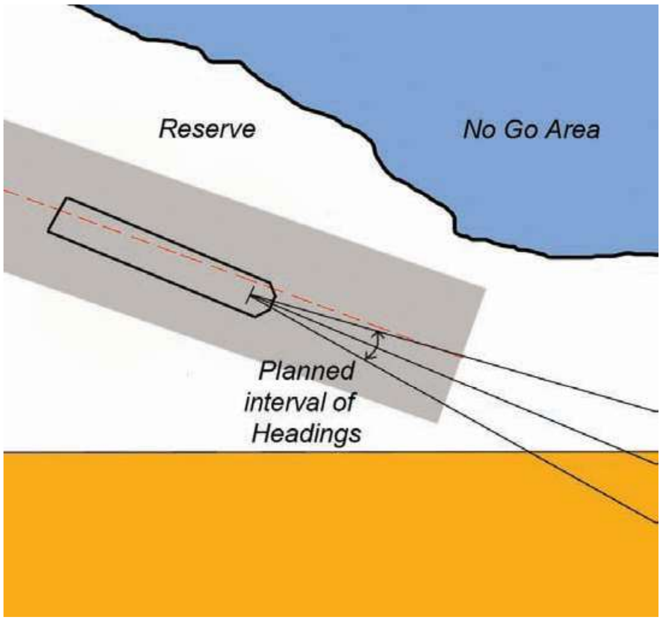

Figure 4: Planning an interval of headings to approach a berth

may be possible to let the shiphandler give orders as independently as possible.

Defining critical navigation elements in terms of interval values allows bridge team members to share detailed mental models more effectively and to present **essential, timely** and **unambiguous** challenges and responses. By no means is the concept meant to constrain shiphandling within fixed limits. On the contrary, using an interval of planned values (rather than single values) and permitting any reasonable use of the reserve allows the necessary flexibility and discretion to handle a vessel in confined waters.