Intuitive operation and pilot training when using marine azimuthing control devices

AZIPILOT

Report Title:

Deliverable 4.3:

Review of accident and incident reports

Contents

PUBLISHABLE EXECUTIVE SUMMARY

WP 4 Operational Practice is aimed at collating, reviewing and auditing available material that is relative to the operation of azimuthing control devices when manoeuvring ships in Pilotage waters.

Task 4.3 reviewed accident and incident reports for ships equipped with azimuthing control devices and specifically for their operation. The objective is to establish the type and commonality of various accidents and incidents. with the intention to discuss the perceived causes of the incidents as reported. Since an inherent safety threat will always exist with ship operations (for our discussion, manoeuvring operations) we must address the vulnerability factor in order to minimize the risk. Correctly identifying the actual cause of an incident will equip us better for a positive response in prevention. It is necessary to first read through the case histories from task report 4.3(1), in order to have the necessary background information for discussion in this report. The main area of focus includes:

- Survey of mistakes and discuss causes
- Review perceived and actual risk
- Discuss possible causes of perception gaps
- Explore possible recommendations for corrective action.

The task culminates in this report and constitutes one deliverable at M18 of the project. The review of accident and incident reports was conducted using published reports from Government Agencies forming part of the Marine Accident Investigators" International Forum whose Members include International Agencies conducting their investigations in accordance with the Code for the Investigation of Marine Casualties and Incidents (IMO Code) published by IMO in 1997 through its resolution A849(20).

Depending on the consequences of a Marine Casualty the Code classifies such incidents that have caused damage or danger as a Very Serious Casualty (VSC), a Serious Casualty (SC), a Less Serious Casualty (LSC) or a Marine Incident. Typically it is only VSC or SC that warrants a full investigation and is therefore available in the public domain. Only reports in which the operation of the azimuthing control devices has been highlighted as a factor are reviewed. Reports of accidents involving vessel propelled by azimuthing control devices but in which the operation of the azimuthing device was not a factor in the incident have not been considered. As a result of the number of Agencies involved published reports cover a period from 1991 through to 2009.

FACTUAL

The following is a brief précis of each report, in chronological order, where the operation of the azimuthing control devices was considered to be a casual factor in the incident.

Date of Incident: 6th January 1993

Location: Vancouver

Investigated by: Transportation Safety Board of Canada

Nature of Incident: Contact with Shore installation

http://www.tsb.gc.ca/eng/rapports-reports/marine/precedentes-earlier/m93w0001/m93w0001.asp

SYNOPSIS

On 06 January 1993, the BC Transit ferry "BURRARD BEAVER", on passage from Vancouver Terminal, Vancouver, to Lonsdale, North Vancouver, in reduced visibility, struck the Canada Place dock. There were 4 crew members and 121 passengers on board. The Master, mate and four passengers sustained minor injuries.

The Board determined that the "BURRARD BEAVER", upon departing Vancouver Terminal in poor visibility, struck the Canada Place dock due to a manoeuvring error. Contributing factors to the striking were a lack of appreciation of the special manoeuvring capabilities of the ferry and the need to maintain a listening watch which reduced verbal communication between the bridge team.

In a normal departure situation, the "BURRARD BEAVER" would make a gradual change of heading to port of approximately 37˚. The "BURRARD BEAVER" was departing from her berth and the "ORCA SPIRIT" was performing her usual manoeuvre in the basin to westward of her. No VHF R/T contact had been established between the two vessels.

The Master could see the radar presentation of Canada Place ahead and ordered the mate twice to alter course to starboard. Instead, the mate held to and increased the alteration to port believing that this was necessary to clear the "ORCA SPIRIT". The Master, realising the situation, intervened by altering the direction and thrust of two after propulsion units.

The position of the mate between the consoles and the layout of the engine controls precluded the Master from gaining access to the other two engines. However, this action

proved insufficient and, at a recorded time of 0748, the port side of the "BURRARD BEAVER" struck the north-east corner of the Canada Place dock approximately 20 m from the knuckle and between the fenders.

The speed of the vessel at the time of the striking was estimated by the Master and mate to have been between three and five knots.

MATE'S ACTIONS AND RESPONSE TO MASTER'S ORDERS

The mate concurs that the Master had twice ordered a course alteration to starboard and that he did not carry out the Master's orders. Although the mate intended to give a wider berth to the "ORCA SPIRIT" which was on his port side, he reportedly did not alter course to starboard since he believed that would cause the vessel's stern to swing closer to the "ORCA SPIRIT".

Although the mate maintained that he could not effectively monitor the radar screen because the Master had turned it away from him, the Master denies that such was the case. Despite this and the mate's concern for the course alteration to starboard, he neither indicated his concerns to the Master nor did he take a more appropriate, safer measure such as stopping or reversing the engines.

MATE'S APPARENT UNFAMILIARITY WITH THE VESSEL'S MANOEUVRING CHARACTERISTICS

The vessel's manoeuvring characteristics were such that a change in direction of a track could be effected without altering the heading. As the mate feared that a starboard course alteration would result in the stern of the "BURRARD BEAVER" coming closer to the "ORCA SPIRIT", it would suggest the mate's lack of appreciation of the vessel's manoeuvring characteristics even if the mate had been operating the ferry for the past eight years. This is further reflected in the mate being unable to provide exact information on the ferry's stopping distance.

FINDINGS INCLUDE:

The mate, who was at the controls and had the conduct of the vessel, did not carry out the Master's orders to alter course to starboard.

The mate could not see the radar screen but continued with a course alteration to port instead of stopping or reversing the vessel's engines to give more time to evaluate the situation.

The mate did not fully appreciate the manoeuvring characteristics of the "BURRARD BEAVER".

ANALYSIS

Upon departing Vancouver Terminal in poor visibility, the "BURRARD BEAVER" struck the Canada Place dock due to a manoeuvring error. Contributing factors to the striking were a lack of appreciation of the special manoeuvring capabilities of the ferry and the need to maintain a listening watch which reduced verbal communication between the bridge team.

COMMENT

It is worthwhile to consider the event from other perspectives, namely resource management. On the following page in tabular form is a list of events and their possible causes as viewed from a human resource perspective.

Key words/phrases:

- Challenge and response
- Situational awareness
- Create time
- Complacency
- Power distance
- Authority
- Mental model
- Hazardous thought
- Automation

ACTION TAKEN INCLUDES:

An out-of-service ferry has been used for hands-on training in manoeuvrability for ferry officers, and the crews have been drilled in passenger evacuation.

Analysis of Burrard Beaver incident

No.	Event	Human resource perspective
1.	The Mate concurs that the Master had twice ordered a course alteration to starboard and that he did not carry out the Master's orders.	Poor **Challenge - Response** environment. Both parties are at fault.
2.	Although the Mate intended to give a wider berth to the "ORCA SPIRIT" which was on his port side, he reportedly did not alter course to starboard since he believed that would cause the vessel's stern to swing closer to the "ORCA SPIRIT".	Though the Mate had been operating on board for the previous 8 years, he fell into a common trap of **complacency** and didn't **challenge** his concept of manoeuvring understanding. **Automation danger**: in the past the ship handling of the mate was perhaps satisfactory "It's doing what I want, so why question it".
3.	Although the Mate maintained that he could not effectively monitor the radar screen because the Master had turned it away from him, the Master denies that such was the case.	Poor **Challenge - Response** environment. The Mate should have insisted the radar screen be turned, if indeed it was he that had the conn. It is also not clear at this stage who had the conn. The report suggest the Mate did, though it had the Master exhibited more **authority** he should have steeped in and taken over if he felt it was warranted.
4.	Despite this and the Mate's concern for the course alteration to starboard, he neither indicated his concerns to the Master nor did he take a more appropriate, safer measure such as stopping or reversing the engines.	**Low authority** on behalf of the Mate, low **situational awareness**, possible **power distance** problem with the Mate not wishing to approach the Master. It is also possible the Mate found himself in a position of his stress and his **mental state increased to a +3**. If on the other hand he was not in such a stressed mental state he could have stopped the engines **to create more time** for himself.
5.	This is further reflected in the Mate being unable to provide exact information on the ferry's stopping distance.	This is standard information that all mariners who handle ships should know. **Complacency**, "it will never happen to me"(**hazardous thoughts**), and lack of a **challenge** to himself are the under lying causes.
6.	Instead, the Mate held to and increased the alteration to port believing that this was necessary to clear the "ORCA SPIRIT".	**Low situational awareness**, this clearing by such a margin was uneccesary.
7.	No VHF R/T contact had been established between the two vessels.	**Low situational awareness, lack of a shared mental model.**
8.	The "BURRARD BEAVER" was departing from her berth and the "ORCA SPIRIT" was performing her usual manoeuvre in the basin to westward of her.	Usual manoeuvre suggest a possible element of complacency exists.
9.	departing Vancouver Terminal in poor visibility, struck	Improper use of radar indicates a **lack of situational awareness** and **lack of a challenge** to himself, as all mariners have common procedures in restricted visibility, namely proper use of radar.

Date of Incident: 7th November 1995

Location: British Columbia

Investigated by: Transportation Safety Board of Canada

Nature of Incident: Collision with moored yachts

http://www.tsb.gc.ca/eng/rapports-reports/marine/1995/m95w0195/m95w0195.asp

SUMMARY
While departing from the Snug Cove ferry terminal and swinging to align with the channel, the ferry "MAYNE QUEEN" sheered into an adjacent marina, striking a floating dock and several small craft before coming to rest on contacting the shore. The floating dock was heavily damaged, with pilings broken, and one pleasure craft was sunk and several others suffered varying degrees of damage. The ferry sustained minor damage to one of her four propulsion units. No injuries were reported as a result of this occurrence.

SYNOPSIS
On the morning of 07 November 1995, on her second trip of the morning from Horseshoe Bay, the "MAYNE QUEEN" secured at Snug Cove at 0628. The passages had been uneventful and, as is the routine while loading at Snug Cove, all four RADs were aligned in the fore-and-aft direction to provide thrust to keep the vessel's No. 2 end, the forward end on arrival, under the ramp.

At 0638, after 72 vehicles and 165 passengers were loaded on board, the Chief Officer reported the deck clear, i.e. all cars parked, ramp lifted and mooring lines let go. The Master, who was at the arrival console, began the departure procedure. After declutching both pairs of RADs, he turned the joystick controlling the drives at the inshore end through 180° for an off-ramp thrust and repositioned the joystick controlling the outbound end drives to a 90° angle for an athwartship thrust, away from the wing-wall. He then went to the departure console, checked the RADs' dials, aligned the joysticks with the dials and pressed the transfer command push-button to take over control from the arrival console.

After the "console-in-command" light came on, the Master clutched in the RADs and applied approximately 30 per cent throttle to the forward RADs. This was followed, some five to six seconds later, by the application of approximately 10 per cent throttle to the stern RADs. This manoeuvre was intended to swing the vessel through the required 50° to port and to line her up on the outbound track. As the vessel started coming off the western wing-wall and heading to port, the Master commenced turning the joystick controlling the forward RADs to the "ahead" position, but the RADs' thrust direction

indicators did not follow; the forward RADs were still pushing the forward end to port, out of the channel and toward the marina.

When he realized that the RADs were not responding to his commands, the Master brought both joysticks to the declutch position. Reportedly, the RADs had been clutched in for approximately six seconds. The "MAYNE QUEEN" continued swinging to port, damaging and displacing the marina outer dock and moored pleasure craft, until the vessel's port forward RAD touched the seabed and the vessel came to rest with her hull in contact with the shore.

With the vessel stopped, the Master pressed the transfer command push-button for a second time and noted that the RADs' direction indicators now corresponded with the joysticks' alignment. Realizing that he had full control of the vessel, the Master ordered a check of the tanks and bilges. He then engaged the RADs, manoeuvred the vessel back into the main channel and proceeded on the passage. No crew was ordered to inspect the damaged pleasure craft but, reportedly, the Master made a visual inspection and determined that no assistance was needed prior to leaving the cove.

ANALYSIS

The information provided by the Master and the sequence of events are consistent with the transfer of control from console No. 2 to console No. 1 not having been completed. The RADs responded to the clutch-throttle position of the joysticks but did not follow the rotation. However, this condition could not be duplicated after the accident.

Witness statements did not corroborate the Master's testimony that he disengaged the RADs before striking the marina dock. He maintained that the vessel was carried by the momentum she had gained while the RADs were clutched in for approximately six seconds during unberthing. However, it was observed during the investigation that more than 30 seconds of continuous athwartship thrust was required to swing the "MAYNE QUEEN" from the wing-wall to the outbound course. Additional thrust would be required to swing the vessel through the further 40° to contact the marina. In the existing conditions, it is considered that the vessel would not have struck the marina dock if the Master had declutched the RADs after six seconds.

The Master rotated the RADs to their departure settings on the arrival control console and then engaged them only after transferring control to the departure console. On the arrival console, the Master had set the joystick controlling the outbound-end drives to a 90 angle before transferring the control to the departure console. When the Master applied thrust at the departure console, the ferry commenced moving laterally off the dock and gained momentum. When he attempted to change the direction by using the joystick, the Master realized that he did not have control of the directional component of the drives.

If, on the other hand, the transfer of control from the arrival console to the departure console had been made with the controls in a fore-and-aft position, the loss of the

directional component of the drives would have become apparent as soon as the joystick was positioned at the 90 angle and before athwartship thrust was applied.

Because of the sequence and manner in which the controls were transferred, the Master did not become aware immediately of the loss of the directional component of the drives.

The Master had limited experience of the "MAYNE QUEEN" and was transferred from another vessel without any time being allotted for refamiliarization.

FINDINGS include:

Directional control of the vessel's forward propulsion was lost during the unberthing manoeuvre.

There apparently had been an incomplete transfer of propulsion/steering control from the arrival console to the departure console.

Evidence indicates that the propulsion was not declutched before the marina dock was struck.

The Master was not given a refamiliarization period before assuming operational command of the vessel.

The control system did not incorporate an alarm to warn the operator of an incomplete transfer of control between the consoles.

The lights identifying which console was in command were identical and did not readily indicate the status of the control system to the operator.

The instructions in the BCFC operation manual were at variance with the manufacturer's instructions for the transfer of control procedure.

CAUSES AND CONTRIBUTING FACTORS

The "MAYNE QUEEN" sheered into the adjacent marina when directional control of the forward propulsion was lost while unberthing from Snug Cove terminal. This was apparently due to an incomplete transfer of propulsion/steering control between the wheel-house consoles. Contributing to the extent of the damage was the fact that the forward propulsion was not stopped when control was lost.

SAFETY ACTION TAKEN

The control system on the "MAYNE QUEEN" has undergone a thorough check. Certain aspects of the system have been modified to eliminate the possibility of transferring propulsion without transferring steering. New placards have been affixed next to the transfer command push-buttons indicating the requirement for a 10-second depressing

period. The control indicator lights colours have been changed to green and red. Masters have been instructed to test-rotate the RADs before engaging propulsion.

The deck department has been refamiliarized with the propulsion controls, the airphone talk-back and the sound-powered phone.

The BCFC has reviewed its current policy with respect to the following:

- communications procedures following an incident, and
- familiarization/refamiliarization with the vessel for Masters and new crew members, with input from the fleet Masters.

Date of Incident: 27th April 1998

Location: Brisbane River

Investigated by: Australian Transport Safety Bureau

Nature of Incident: Collision between tug Austral Salvor and Tanker Barrington

http://www.atsb.gov.au/publications/investigation_reports/1998/mair/mair132.aspx

SYNOPSIS

The Barrington was in ballast and the tug Austral Salvor is a stern drive omni directional tug. A trainee tug Master was at the controls of the tug with a supervising tug Master close at hand. The tug approached within ten metres of the ship close to where she was to secure a line to the ship. The trainee tug Master adjusted the tug‟s speed to enable him to position the tug correctly off Barrington. While the tug was closing with the ship, the trainee tug Master was in the process of reducing the speed further, when he noticed the bow of the tug sheering to starboard towards the ship.

The tug Master took control of the tug and attempted to arrest the sheer. The sheer of the bow was halted, but the stern swung in and the tug rolled, making contact with the ship just above the waterline. The shell plating on Barrington was holed at the point of contact, in way of a fuel oil storage tank, spilling fuel into the river.

CONCLUSIONS

In handling the unilever to adjust the speed of the tug, the Trainee left on a component of starboard thrust, causing the bow to sheer to starboard.

The tug Master corrected the sheer of the bow to starboard. However, as the stern of the tug closed within four metres, interaction forces contributed to the tug‟s momentum towards the ship causing the stern of the tug to make contact with the ship‟s side.

The training regime, training manual and instructions provided for prospective tug Masters would seem to be comprehensive and were not contributing factors in this incident.

Date of Incident: 4th October 1999

Location: River Thames

Investigated by: Marine Accident Investigation Branch

Nature of Incident: Collision between ferry and bridge

http://www.maib.gov.uk/publications/investigation_reports/2000/symphony.cfm

SYNOPSIS

The Class V passenger vessel *Symphony* operates with a deck crew of three, plus a catering and entertainment crew of 12. She left her berth at Embankment Pier at 2000hrs on 4 October with 103 passengers on board, for a dinner cruise on the Thames. She was following her normal route upstream to Albert Bridge when the collision occurred. At about 2015, *Symphony* cleared Westminster Bridge and was approaching the centre arch of Lambeth Bridge. While manoeuvring, the starboard Schottel unit failed to respond to the controls. All indicators on the wheelhouse console, plus those in the engine room, showed normal. The Master reduced speed on the starboard unit and went full astern on the port Schottel unit. Despite these efforts, the vessel‟s forward starboard quarter struck the bridge support. As she continued to pass through the arch, the aft starboard side of the wheelhouse made contact with the underside of the arch, damaging the wheelhouse structure and smashing the forward and starboard side windows. As *Symphony* passed through the arch, the Master regained control and navigated the vessel over to the south side of the river, tying up on Lambeth fire brigade pier. At 0100, *Symphony* was towed to Gravesend for repairs. A subsequent investigation confirmed that there had been a steering failure on the starboard Schottel unit. The drive shaft for the feedback potentiometer had sheared, disabling the wheelhouse indicator. Under this condition, although the propulsion unit continued to operate, the lack of any stop signal from the feedback potentiometer caused the steering unit to rotate slowly throughout 360”. With no wheelhouse indicator, the Master did not know the steering unit was rotating (or in what direction). The propulsion control and alarm system gave no indication as to what the failure was.

CAUSE

The vessel suffered a loss of steering control on the starboard Schottel unit as a result of the failure of the feedback drive shaft This loss of control and the resultant directional instability caused *Symphony* to make a series of low speed contacts with Lambeth bridge.

CONTRIBUTORY FACTORS

Loss of a feedback signal from the Schottel unit to the unit directional control system, not only caused the unit to continue to rotate, but also caused the wheelhouse indicator to remain fixed in its original position.

Examination of the feedback drive shaft of the starboard Schottel unit confirmed that the soldered connection between the original shaft and the extension had sheared. With no visual or audible indicators of the problem available to the Master, immediate corrective response was not possible.

The loss of steering, combined with all instruments reading normal, is not a predictable emergency situation. The proximity of Lambeth Bridge, the effect of the tidal stream and the confused signals as to the condition of the vessel were all significant factors in the accident.

Date of Incident: 13th April 2002

Location: British Columbia

Investigated by: Transportation Safety Board of Canada

Nature of Incident: Malfunction of automatic steering control for right angle drives

http://www.tsb.gc.ca/eng/rapports-reports/marine/2002/m02w0061/m02w0061.asp

SUMMARY

At around 1820, whilst discharging cars at Gabriola Island, British Columbia, the *Bowen Queen* spontaneously backed off the dock, causing the shore-mounted vehicle ramp to fall below the level of the vessel‟s vehicle deck. There was a gap of about four metres between the ferry and the ramp, however the deck crew acted promptly to stop the discharge of vehicles. There was no injury.

The *Bowen Queen* is a double ended ro-pax coastal ferry. Propulsion and steering is by means of four right-angled drive (RAD) units, one at each corner of the hull. The RADs are of the azimuth turning type, free to rotate through 360° and are independently powered by unidirectional diesel engines, via fluid couplings. They can be directly controlled from two locations in the wheelhouse or from the engine room. When in regular service, the RADs are controlled from the wheelhouse.

The *Bowen Queen* departed Nanaimo Harbour for the scheduled crossing to Descanso Bay, Gabriola Island. When in position at the dock the Master aligned all four RADs in the pushing in‟ direction, the shore ramp was lowered and the discharging of foot passengers and vehicles commenced .After docking, the Master was alone in the wheelhouse and working at the chart table, when the Chief Officer entered the wheelhouse to relieve him. He checked that the joysticks at both the „live‟ and the „non active‟ control consoles were in the same angular position and after verifying this, moved toward the chart table, as the Master began to descend the wheelhouse stairs. At this time the Chief Officer noticed that the vessel was moving astern. He alerted the Master who immediately ran toward the „live‟ control console to find that the vessel, now some four metres off the dock, had begun moving toward it again, although no one had altered the control settings.

The astern movement of the ferry caused it to part its mooring lines and the shore ramp to fall below the level of the car deck. In the wheelhouse, the Master had declutched all four

RADs, rotated the two forward legs so that they would provide a braking action and then re-clutched them in. The vessel was backed away from the ramp and did not make contact with it. It was then taken about 30 m away from the dock, where the four RAD units were operationally tested to determine the cause of the malfunction. When none was found, the ferry returned to its berth

ANALYSIS

Each RAD unit has its own set of PCBs and transducers and one control head (joystick) controls two RADs. However, both electrically and mechanically, the two RADs are completely isolated from each other. The only common point is the control head itself and the main driving gears, cams and shafts within it. While the cause of the ferry moving away from the dock and then quickly back toward it again, was not determined, the automatic steering control system has been known to behave erratically on several occasions. Interviews with the crews of British Columbia Ferry Corporation (BC Ferries) vessels fitted with similar RADs and steering control systems, show that all nine vessels have a similar history. It appears that these RADs will, suddenly and without warning, spontaneously rotate independently of the command signal. Sometimes the RAD legs rotate through 360° and stop of their own accord, although most times they continue turning until the engine is shut down. There have been numerous instances where one RAD leg has spontaneously rotated. While it is not unknown for two RADs to spontaneously rotate simultaneously, these instances are comparatively infrequent.

The effect of such a rotation on a vessel under way, would be to move the vessel off course. For a vessel in dock, the effect would depend on the number of RAD legs that rotated. The rotation of one leg would just make the ferry move sideways - the net forward thrust would always be greater than that of the rotating leg and the ferry would continue to push against the dock. The effect of two legs rotating would be dynamic and would change with the changing angular difference between the forward and after pairs of legs. It would also be a function of the thrust being produced at each propeller shaft and of the ricocheting wash off the wing walls of the dock. Trials were later conducted on the *Bowen Queen* when the vessel was lined up in dock and all four legs were pushing against it. Both the forward and after pairs of legs were separately rotated and on both occasions it was found that the vessel moved out of the dock. Rotation of the forward legs caused it to move straight out; while rotation of the after legs caused it to first move sideways and bear against the floating wing wall.

FINDINGS AS TO CAUSES AND CONTRIBUTING FACTORS

Spontaneous rotation of either the forward or after pair of right-angled drive (RAD) units caused the vessel to back off from the dock and return toward it.

While the definite cause of the RAD malfunction was not determined, information points to the defective printed circuit boards in the automatic control systems.

Date of Incident: 13th April 2005

Location: River Mersey

Investigated by: Marine Accident Investigation Branch

Nature of Incident: Collision between tug and vessel

http://www.maib.gov.uk/publications/investigation_reports/2005/thorngarth.cfm

SYNOPSIS

At about 0210 on 13 April 2005, the UK registered tug *Thorngarth* was assisting the Liberian registered chemical tanker *Stolt Aspiration* and acting as bow tug. The two vessels collided when *Thorngarth* was attempting to recover her position ahead of *Stolt Aspiration*.As a consequence of the impact, *Thorngarth* was holed below the waterline and sustained significant structural damage. *Stolt Aspiration* was approaching Alfred Lock, the entrance to the Birkenhead Docks on the River Mersey. To assist in passing through the locks, the services of two tugs were utilised, and a Pilot was on board the tanker. The tug *Thorngarth* was to act as the bow tug, with the tug *Ashgarth* assisting aft. Both tugs were designed to tow over the bow, and the standard approach for the bow tug is to meet the ship „bow-to-bow". The tug passes her gear up to the ship"s forecastle, and then quickly reverses away from the bow of the ship to take the weight of the towing gear. It thus tows stern-first. This is not an unusual manoeuvre and is performed by many tugs around the world. While carrying out this manoeuvre, *Thorngarth* initially correctly positioned herself right ahead of *Stolt Aspiration*, and passed her messenger line up to the forward mooring party. The tug then started to move away from the ship, but began to turn slightly to one side. The turning effect was countered and the tug closed the port bow of the ship. Position ahead of the ship was regained by increasing engine power. Once ahead of the ship again, the tug started to turn once more. This again was countered, but this time the tug approached the starboard bow of the ship. In recovering from this position and move ahead of the ship, the tug ended up across the bow of *Stolt Aspiration*, which then struck *Thorngarth* on its starboard side. *Thorngarth* crossed the Mersey to berth at the Princes Landing Stage to assess the damage and land the engineer to an ambulance.

The accident was caused by the tug Master"s lack of familiarity with the tug, and the lack of training in the particular manoeuvre he was required to perform. This was one of a number of similar incidents involving tugs in a period of 4 months. All were attributable

to the lack of training and familiarisation of the tug Master with the tug, and the particular task required of him. This prompted the MAIB to issue Safety Bulletin02/2005 highlighting the need for an assessment of the "tug to task"allocation before each towing operation, and ensuring that tug Masters are fully trained. A recommendation has been made to major tug operators, the British Tugowners Association (BTA), and the PMSC (Port Marine Safety Code) steering group. The recommendation is aimed at encouraging discussion between all parties when deciding the optimum allocation of tugs for all manoeuvres within a port, and the level of crew experience required for each task. A further recommendation has been made to the BTA to encourage its members to ensure that the movement of personnel between tugs is closely monitored, and that training and expertise of tugs" crews is matched, and is consistent with the type of tug and its expected task requirement.

COMMENT

The following details in tabular form indicate a list of events and their possible causes as viewed from a human resource perspective.

Analysis of Thorngarth

No.	Event	Human resource perspective
1.	In both cases, the tug Masters had a wealth of experience in tug operations within their respective ports. However, both were operating tugs with unfamiliar propulsion systems and manoeuvring controls, and attempting manoeuvres with which they were not entirely familiar.	Excessive experience can lead and individual towards a feeling of **complacency**, and also an **attitude** suggesting "I can do anything". There can also exist, an element of **reluctance** to admit a new task is not fully understood. Not only the task in this case but also the manoeuvre with this type of propulsion unit. At this point we can also consider the training requirements as established by the company. If proper procedures are not in place to ensure training is executed satisfactorily then this can be considered as a **blunt end error**. Many times individuals are able to apply their skill and avoid the resulting **sharp end error**, but as the reports indicates this was one of those times.
2.	The tug then started to move away from the ship, but began to turn slightly to one side. The turning effect was countered and the tug closed the port bow of the ship. Position ahead of the ship was regained by increasing engine power. Once ahead of the ship again, the tug started to turn once more. This again was countered, but this time the tug approached the starboard bow of the ship.	The repeated error making should have alerted the tug captain to admit perhaps he was not at the correct skill level to attempt this type of manoeuvre. At the **risk of being embarrassed** he continues but with an unsatisfactory result. This should be seen as an internal **challenge** and rejection of a **hazardous thought**, "maybe I can do it". During the attempted tries one can expect the chain of thought inside the tug captain may very well be along the lines of "what is it doing now?" This is a common **automation** problem when we are faced with technology with which we do not fully understand.

Key words/phases:

- Complacency
- Attitude
- Reluctance

- Blunt end error
- Sharp end error
- Embarrassed
- Challenge
- Hazardous thought
- Automation

OTHER INCIDENTS

Two similar accidents occurred elsewhere within the UK, within 4 months of the collision between *Thorngarth* and *Stolt Aspiration*. In the first, a tug was operating as the stern tug in moving a ship astern. After being asked to pull the ship‟s stern to one side, the tug found it could not regain its original position, and collided with the ship‟s stem. The second incident occurred when a tug, acting as the bow tug in a berthing operation, was manoeuvring to pass its towline to the ship. Once the line had been passed to the ship, the tug intended to move ahead of the ship, but collided with her bulbous bow. In neither case were there any injuries or pollution caused.

In both cases, the tug Masters had a wealth of experience in tug operations within their respective ports. However, both were operating tugs with unfamiliar propulsion systems and manoeuvring controls, and attempting manoeuvres with which they were not entirely familiar.

COMMENT

As we have seen from the previous examples the more obvious problems of understanding the technology of a new propulsion unit is only part of the problem. In depth analysis reveals a host of other problems related the Human resource management.

CONCLUSIONS (include the following)

The accident occurred when the tug Master of *Thorngarth* was adjusting his position ahead of the ship and, due to his unfamiliarity with the tug, misjudged the amount of control movement required.

Although the change of personnel from tug type to tug type is a necessary part of the flexible operation of a tug fleet, doing so without extensive initial or ongoing familiarisation training, where the complexities and nuances of control of different tug types can be properly understood and practiced by the personnel concerned, will inevitably increase the risk of mistakes being made during operational situations.

Date of Incident: 10th March 2006

Location: Southampton

Investigated by: Marine Accident Investigation Branch

Nature of Incident: Collision between ferry and Link span

http://www.maib.gov.uk/publications/investigation_reports/2006/red_falcon.cfm

SYNOPSIS

The ro-ro passenger-vehicle ferry *Red Falcon* made heavy contact with the linkspan at Town Quay, Southampton. Eleven people - 8 passengers and 3 Red Funnel employees were injured as a result of the accident, and some of the vehicles on board were damaged.

The vessel was powered by two engines which each drove a five bladed Voith Schneider propulsion unit, one of which was located forward and one aft on the centreline of the vessel.

Two days before the accident, a loose securing bolt was discovered on the charge air cooler of the aft engine, and further loose bolts were subsequently found. The company‟s engineering superintendent made the decision that it was safe to continue to run the engine, on reduced power as necessary, until it was operationally convenient to undertake a permanent repair.

The Master had the conduct of the vessel for departure from Cowes for which the Voith Schneider units were synchronised. However, once clear of the Cowes fairway, the Master elected to desynchronise the Voith Schneider units, which meant that both units were operating but had to be controlled independently.

This decision enabled the forward engine to be run at full power while the aft engine could be run at reduced power as per the engineer‟s requirements. In this configuration, the Master expected to be able to make the maximum speed for the passage and hopefully to make up some of the lost time.

The Chief Officer came to the bridge as the vessel entered Southampton Water, and he took over the steering from the AB. He also took over the conduct of the vessel at that point. He was not informed that the Voith units were desynchronised.

As the vessel approached Town Quay, the Chief Officer began to reduce speed by adjusting the pitch setting on, what he believed to be, both of the Voith units. In fact he was only adjusting the pitch of the aft unit, and failed to notice that the forward unit was still operating at full power. Thus, although the vessel‟s speed reduced slightly, she continued to approach the linkspan at a much higher speed than usual.

With *Red Falcon* very close to the linkspan, the Chief Officer informed the Master that the speed was not reducing as expected, whereupon the Master suddenly remembered that the propulsion units were desynchronised. The Master quickly put the units back into synchronisation, but not before contact with the linkspan occurred.

CONCLUSIONS

Operating the vessel with the Voith Schneider units desynchronised

The Master‟s decision to desynchronise the units was, in isolation, understandable. He would have done all he reasonably could to bring the vessel back onto schedule.

However, the fact that he had received training in this mode only a few times in the 12 years he had been on the vessel, and had only rarely operated with the units desynchronised, was a contributory factor in the accident.

Neither the Master nor the Chief Officer had recently undertaken the company specified training in operating with the engines desynchronised.

Control console ergonomics

The fact that the Chief Officer, an experienced mariner, did not immediately realise that the Voith Schneider units were desynchronised, suggests that the existing indicators are insufficiently clear.

Date of Incident: 10th December 2006

Location: Milford Haven

Investigated by: Marine Accident Investigation Branch

Nature of Incident: Collision between Tanker and jetty

http://www.maib.gov.uk/publications/investigation_reports/2007/prospero.cfm

SYNOPSIS

Prospero was approaching No. 2 Jetty, of the Semi Logistics terminal, Milford Haven, when the Master suddenly and without warning lost control of the vessel‟s podded propulsion system. This caused the vessel to make contact with the jetty‟s infrastructure, resulting in material damage to both the jetty and the vessel before control was regained.

As the vessel approached the jetty, the Master transferred the conning position from the centre to the port control console in preparation for berthing the vessel port side alongside.

When *Prospero* was within 100 metres of the jetty, at a speed of 1.2 knots, the control lever then moved, with no manual input, to approximately 70% of full power. As the pod had been positioned to keep the vessel‟s stern clear of the jetty, *Prospero* very quickly increased speed and her bow swung to port. The Master attempted to pull the control lever back to zero but the power remained at 70% and *Prospero*‟s stem struck the concrete deck of the jetty, shortly after which the flare of the bow made contact with the steel gantry support of the jetty‟s oil loading arms.

While he was unable to control the pod‟s power, the Master still had control of its direction, and he rotated the unit to move the vessel‟s head to starboard and operated the bow thrust to push the vessel‟s bow off the jetty. This brought the vessel parallel with the jetty, but with the power still at 70%. The Master attempted to regain control by transferring control back to the central console and selecting the push button power control function, but this was not successful. The Master then ordered the vessel‟s anchor to be let go and he turned the pod towards the stern to reduce the vessel‟s headway.

Shortly after this, and for no apparent reason, the power returned to zero. However, while the Master was still evaluating the situation the power increased again to 70% and the vessel accelerated astern towards the jetty. The Master was again unable to regain control. The Pilot warned the personnel on the jetty to vacate the area, shortly after which the vessel‟s port quarter made heavy contact with the first of the mooring dolphins to the

west of the jetty. She then continued astern to make contact with the second dolphin, resulting in material damage to both the vessel and the mooring dolphins.

By transferring pod control to the engine room and back to the wheelhouse, the Master was able to regain control of the pod and stabilise his vessel until tug assistance arrived and *Prospero* was moved to a nearby jetty.

When *Prospero*‟s primary propulsion control system failed, the Master was not alerted to the failure and did not detect that the system had automatically switched into a reversionary mode of control. In his subsequent actions he was, to some extent, fighting the control system and was unable to prevent his vessel colliding twice with the jetty; once forward and once aft.

When built, *Prospero*‟s propulsion system had been innovative, and the owners had benefited from an extended warranty. These two factors resulted in the owners depending heavily on the manufacturers for all aspects of product support. The lack of in-house maintenance procedures, inadequate system knowledge by ship‟s officers and shore staff, and weak SMS and onboard system documentation, overlaid on a propulsion system for which, when introduced, no dedicated technical standards existed, resulted in a vessel whose resilience to defects and emergencies was significantly weakened.

TRAINING

The need for dedicated training of the deck officers on specialist or unusual types of craft has long been recognised in some areas of the marine industry, e.g. high speed craft and dynamically positioned (DP) vessels. Such training is usually focused on the Master and Chief Officer, but encompasses the OOW to some degree. Without structured in-depth training that included all of the propulsion capabilities and limitations (including back-up and emergency modes of operation), the Master was placed in a position of total reliance on the correct operation of the propulsion system.

THE ACCIDENT

The root cause of the initial failure of the pod controls has not been found; however, it is suspected that out of range signals in the propulsion control system caused the system to automatically supplant the primary control levers with the back-up buttons.

When *Prospero*‟s primary propulsion control system failed, the Master was not alerted to the failure and did not detect that the system had probably switched into a reversionary mode of control automatically. In his subsequent actions he was, to some extent, fighting the control system and was unable to prevent his vessel colliding twice with the jetty; once forward and once aft.

The lack of in-house maintenance procedures, inadequate system knowledge by ship‟s officers and shore staff, and weak SMS and system documentation, overlaid on a propulsion system for which, when introduced, no dedicated technical standards existed, resulted in a vessel whose resilience to defects and emergencies was significantly weakened.

CONCLUSIONS

Practical experience of the shipboard operation of the propulsion system proved that the presentation of the alarms and reversionary controls on the propulsion system had the potential to confuse an operator who was not fully trained on the SSP system.

The Master had received no dedicated training in the propulsion system, and was insufficiently familiar with reversionary mode operation and emergency drills.

Date of Incident: 17th February 2008

Location: River Humber

Investigated by: Marine Accident Investigation Branch

Nature of Incident: Grounding

http://www.maib.gov.uk/publications/investigation_reports/2008/sea_mithril.cfm

The UK registered cargo vessel *Sea Mithril* weighed anchor at the entrance to the River Humber just before midnight on 17 February 2008. A Pilot boarded and, following a brief exchange of information during which the Pilot advised that he was not familiar with the control of the vessel‟s azimuth pod propulsion system, the Master went below to rest leaving the Chief Officer with the Pilot on the bridge for the start of the vessel‟s river passage.

At 0215, the visibility reduced to about 20 metres and the Chief Officer called the Master and Chief Engineer in accordance with the vessel‟s standing orders. When the Master arrived on the bridge, he changed from automatic to manual steering and sat at the steering position. Apart from the Master, none of the ship‟s crew was able to manually control the vessel‟s azimuth propulsion units. The Pilot monitored the vessel‟s position using the single radar display fitted on the bridge with the Chief Officer assuming the role of lookout.

The passage continued in very poor visibility. Shortly after 0400, as the vessel approached Flixborough Wharf on the River Trent, the Pilot advised the Master to reduce engine speed. Soon afterwards, the forward lookout saw the loom from the deck lights of a vessel moored on the wharf appear out of the fog. He called the bridge via his radio and informed the Master in Russian that there was a ship close off the port bow. There was then a series of loud exchanges in Russian between the Master and the AB, during which the Master further reduced the engine speed and altered course to starboard away from the lights.

By 0410, *Sea Mithril* was clear of the moored vessel but, almost immediately, the forward lookout reported the lights of a second vessel on the port bow. Again the situation was discussed by the Master, the Chief Officer and the AB in Russian and the Master manoeuvred the vessel to increase the passing distance. The Pilot heard the exchanges between the Master and crew, but he was not aware of their concerns over the proximity of the moored vessels, or the Master‟s changes to the vessel‟s course and

speed.By the time *Sea Mithril* had cleared Flixborough Wharf, her speed had reduced to about 2.5 knots over the ground and she was being swept bodily towards the left-hand bank of the river by the flood tide. The Pilot initially advised the Master to steer to starboard to negotiate the next bend in the river but when he noticed the vessel‟s speed indicated on the radar display, he advised the Master to „speed up‟ and to „come more to starboard‟. Reed beds were then seen to port, and a few moments later the vessel momentarily touched the river bottom with her stern near the left hand river-bank. The Master quickly put the azimuth controls to full ahead and to starboard. The vessel turned sharply and began to head across the river towards shallows in the middle of the river, and although the Master put the engine controls to port, the vessel ran gently aground at 0425. The Pilot advised that the vessel would re-float without difficulty on the rising tide but this advice was ignored by the Master who applied full astern power. After several minutes, the Master was informed by the Chief Engineer in Russian that water was spraying from the port azimuth oil vent in the engine room. The Pilot was not made ware of this problem.

The vessel re-floated at 0447 and, with her engines operating at full astern, she slewed back across the river and again momentarily grounded stern first before control was regained and she was berthed alongside.

SAFETY LESSONS

On this occasion, the lack of support and teamwork was highlighted by a number of factors including:

The Pilot was the only person monitoring the vessel‟s position.

The Master was the helmsman and was therefore unable to maintain a command oversight of the situation or liaise effectively with the Pilot.

Communication between the Pilot and the Master was poor; the Master was not aware of the proximity of the moored vessels and the Pilot was not aware of the manoeuvring undertaken by the Master or the problem with the port azimuth unit.

The ship‟s crew had not adequately planned the passage from the anchorage to the vessel‟s intended berth.

The more detailed, larger scale chart of the area was not made available to the bridge team.

When manoeuvring during mooring or other operations in close proximity to other vessels or . dangers, it is not unusual for Masters to steer vessels themselves in hand steering. This is necessary to ensure sufficient control is maintained. However, other situations which require hand steering to be used, such as restricted visibility, also tend

to require a Master‟s undivided attention and skills of command, which is not possible if he is the helmsman. It is therefore essential that all vessels have sufficient crew, other than the Master, who are competent in the use of the steering and propulsion systems fitted, regardless of their complexity.

Date of Incident: 14th May 2008

Location: Valetta Harbour

Investigated by: Marine Accident Investigation Branch

Nature of Incident: Contact with quay

http://www.maib.gov.uk/publications/completed_preliminary_examinations/completed_preliminary_examinations_2008/queen_victoria.cfm

SYNOPSIS

On 14 May 2008, the passenger cruise ship Queen Victoria came into contact with Pinto Wharf while berthing in Valetta, Malta. The vessel sustained damage to her stern plating above the waterline; the wharf was also damaged

The berthing operation required the vessel to be turned through 180° before mooring port side to. At the start of the turn, the Captain controlled the azipod propulsion units and bow thrusters from the bridge‟s centre console, but once the berth was open on the vessel‟s port side, he moved to the port wing console accompanied by the embarked Harbour Pilot and the Staff Captain.

Once on the port bridge wing, the Captain adjusted the main engine controls to arrest the vessel‟s movement astern. However, this had no effect because the control of the azipod propulsion units had not been transferred to the port console. The vessel continued to move astern until contact was made with the quay. Shortly afterwards, the bridge team realised that the control of the propulsion units had not been transferred. This was rectified and the vessel was then manoeuvred alongside without further difficulty.

ACTION TAKEN:

Carnival UK. has investigated the accident. Recommendations made in its investigation report covered:

- The implementation of the company‟s Bridge Team Command and Control procedures and training.

- The issue of a fleet cautionary notice identifying the lessons learned from this accident.
- The procedures for the transfer and testing of propulsion control.
- The feasibility of fitting synchronous or follow-up systems.
- The size of the azipod control indicator lamps fitted to the control consoles.
- The review of the visual displays fitted on the vessel‟s bridge wings.
- The insulation of noisy equipment on the port bridge wing.
- The inclusion of Masters in bridge and console design processes.

Item (3) – "Discuss possible causes of perception gaps"

2.1 Approach

Perception gaps in this context can be said to originate partly from lack of knowledge and partly form experience with respect to human resource management. When investigating the cause of an incident the individual must have sound theoretical knowledge and also have had an opportunity to apply the theory in a practical way. Using the previous WP task 4.3 (2) cases as a reference we will discuss some areas where a perception area can exist.

2.2 Perception gaps

It should be realised that perception is very individualist and can be affected by a number of factors. Considering the individual; regardless of the theoretical knowledge he/she possesses, his/her ability to analyse a situation or report will depend upon a number of factors, physical and or mental.

Physical:

- Sleep deprivation
- Fatigue
- Drugs & alcohol
- Hunger & thirst
- Physical discomfort
- Illness and disease

Mental:

- Momentary and situational stress
- Worry or anxiety
- Motivation

If we assume the previous groups of physical and mental factors do not exist in our analysis situation, then our only other element to consider is knowledge. Knowledge of theoretical information, and practise in its application are vital in proper objective analysis.

As identified in WP 4.3(2) there were various incidents in each case history which depending upon one"s perspective can have been caused by a number of factors. When we consider incidents and their causes we must look beyond the purely physical (e.g. "he understands the ASD system and thus couldn"t manoeuvre correctly") and consider the human element. Using the human element as the starting point one can see that:

- The individual should have challenged him/herself with respect to knowledge of the ASD system
- The individual should feel free to admit a lack of knowledge and should be supported in this action. This can be linked to the company"s culture.
- The company should develop better procedures for ensuring the necessary training and education has been achieved. This lack of a proper tried and tested procedural requirement is termed a "Blunt end error" and originated from the main office.
- There will most likely be an element of power distancing between ranks such that one higher up on the hierarchy scale is reluctant to admit lack of knowledge or ability.

There are many more elements here, but what is clear is that the possible causes of perception gaps are quite clear. If for this conversation we discount the individual effect due to physical or mental factors, we are left with education and training in resource management as the real gap in the individuals perception of why incidents occur.

SUMMARY TABLE OF INCIDENT REPORTS

	Date	Vessel	Type	Ship Type	Nature of Incident	Main cause	Other cause(s) (contributory)
1	06/01/93	Burrard Beaver	RAD"s	Ferry	Contact	Manoeuvering error	Poor communications
2	07/11/95	Mayne Queen	RAD,s	Ferry	Collision	Transfer of control issue	Failure to shut down power
3	27/04/98	Austral Salvor	ASD	Tug	Collision	Manoeuvering error	Trainee had con
4	04/10/99	Symphony	Schottel	Passenger vessel	Collision	Failure of feedback shaft	Proximity of fixed structure and current
5	13/04/02	Bowen Queen	RAD"s	Ferry	Malfunction	Spontaneous rotation of RAD	PCB Failure
6	13/04/05	Thorngarth	ASD	Tug	Collision	Manoeuvering error	"Tug to task"
7	10/03/06	Red Falcon	Voith	Ro-ro	Contact	Voith units were desynchronise	Mate unaware of desynchronisation
8	10/12/06	Prospero	Pod	Product Tanker	Contact	Transfer of control issue	No training received
9	17/02/08	Sea Mithril	Azipods	Cargo vessel	Grounding	Hand steering in Fog	Poor communications
10	14/04/08	Queen Victoria	Azipods	Cruise Liner	Contact	Transfer of control issue	Poor procedure/training

Note: In the MAIB report into the Prospero reference is made to three further incidents:

1. Antwerp Locks, 6th May 2006: PROSPERO"S sister ship the BRO SINCERO involved in a collision with the ELECKTRON. Loss of control caused by a broken connection inside the electric shaft cabinet resulting in a failure of the pod maneuvering control lever.
2. Brofjorden, Sweden, 10 March 2007:PROSPERO experienced a loss of control of the pod caused by fitting of an uncalibrated spare part to the gauss system
3. St Petersburg channel 23 April 2007: PROSPERO grounded following loss of control caused by a fault in the hydraulic system of the azimuthing gear

CONCLUSIONS

The above summary shows that while no one fault exists in all the incidents there is some commonalty in that manoeuvring error and transfer of control issues are relevant in 60% of the incidents.

In the incidents highlighting manoeuvring error as a factor the reports recommend further training and familiarization as being necessary despite the individuals having considerable experience at sea this has not always been onboard the vessels involved in the incident.

In the incidents highlighting transfer of control issues the reports recommend improved onboard procedures and an improvement in equipment knowledge for the ships officers.

The number of incidents investigated is minor when compared to the total number of Very Serious and Serious Incidents available for inspection. It was expected that more incidents would have occurred due to an expected lack of appreciation by personnel of the special characteristics of azimuthing propulsion and inadequate onboard procedures.