Learning from Costa Concordia

The tragic events surrounding the grounding of the Costa Concordia provide an opportunity for maritime students to witness the potentially devastating consequences of navigational errors. The following research paper from the *University of Ljubljana, Faculty of Maritime Studies and Transport* shows how real life situations can be incorporated into maritime simulation

The sinking of the Titanic is such a celebrity event that normally it is best to avoid mention of it in scientific papers; but the coincidence of the Costa Concordia catastrophe occurring during the centennial year of that stunning wreck brings to mind legitimate thoughts and questions that scientists will naturally consider.

The Costa Concordia was not nearly as vaunted, nor did its owners claim unique qualities for the vessel, but it was in fact by volume the largest passenger vessel ever to sink (perhaps technically it only capsized, but had the water been deeper…).

Remarkably, in both cases recklessness on the part of humans was a factor. The Titanic should not have been travelling at speed in waters mined with icebergs; the Costa Concordia should not have been manoeuvring as a salute so close to an island shore.

Here, though, the stories begin to sail their separate ways. The loss of life caused by the sinking of the Titanic brought about innumerable new rules that would prevent that degree of catastrophe occurring again during peace-time conditions.

In the case of the Costa Concordia, options were readily available for the safe evacuation of the vessel, which was not going to capsize or sink as a result of the initial grounding. Had the anchors been dropped while the vessel was drifting it likely would not have capsized.

Most of the advances in shipbuilding and operating technologies of course have nothing to do with the sinking of the Titanic; over one hundred years technological advances are inevitable, especially in this era.

A question that the Costa Concordia brings to mind is whether human beings have caught up with their own technologies: are all seafarers fully equipped to manage such complex aids as the ECDIS system, for instance? And if they are, is the emphasis on operation of the vessel in some way stressed so that seamen are not prepared enough to properly respond to disasters?

We know now that the movement of the Costa Concordia after the initial collision was not a result of life-saving manoeuvres made by the captain; the ship was inoperable, drifting, subject to its own inertia and the vagaries of wind and current.

Only upon returning to the shallow waters of the same island were the anchors finally dropped, with the result that the ship grounded again, and now had enough holes in the hull that it would inevitably sink.

Learning

What can educators teaching technological subjects take from this? Most obvious is the absolute need to focus on the interaction between man and machine, so to speak; and perhaps to emphasise the dangers inherent in placing too much trust in technological advances and solutions to problems that remain affected by human beings.

Most effectively, such events may become the subjects, so that students in effect learn in an environment of enhanced realism, to some degree even in real time.

The maritime faculty of the University of Ljubljana, Maritime and Traffic Studies is well equipped with simulators and other advanced maritime facilities that we operate during research and teaching, and where possible, when combining the two. The recent accident of the passenger ship Costa Concordia was the latest 'opportunity' to use our resources to the fullest extent.

Sailing analyses was performed using the Transas NaviHarbour VTS and TransView software overlaid within the latest Transas SENC charts and simulation was executed using the Transas NTPro 5000 ship handling simulator.

Figure 1 – Different electronic charts and the ECDIS system identify shallow water area and several alarms are activated

Figure 2 – Show-off passage (Green dated August 14th 2011)

The sailing area was created out of SENC charts using the Transas Model Wizard Software, and finally the vessel model was created/adjusted using Transas Virtual Shipyard software.

The educational method suggested herein simply involves including students in the use of simulation during a real time accident scenario, for reviewing, questioning, studying, theorizing about, and simulating the Costa Concordia groundings eliminates the divide between the abstract and the real to such a degree that it is as if the students are on the bridge of the ship throughout the accident and its protracted aftermath.

And where that analogy doesn't hold, the learning environment includes getting first hand information from the Italian Coast Guard and even Search and Rescue (SAR) divers.

In this way, and this is important especially regarding the teaching of accident/incident response, students experience the subject as something more immediate, with more gravitas, than the usual abstractions.

The story of the Costa Concordia

The scientific method is a valuable corrective against mistaking impression for truth.

Statistical surveys, for instance, broaden perspectives from insulated pockets to include vaster populations, so that, for instance, a local community that fears it has a substandard educational system may, through a nationwide survey, find that its students are actually among the best educated in the country.

At times science must serve as a corrective against news stories, which are often based on collections of individual observations and impressions. This is worth stating here in the case of the Costa Concordia precisely because the disaster rapidly became a worldwide story focusing largely on the vessel's captain.

For the general public following the story, the captain's plummet to reprehensible agonistes became complete when he was quoted as saying that he found himself in a lifeboat by accident, having stumbled.

Yet this is precisely the point in the story where the student of the incident has the opportunity to learn the most general of truths: you must bracket away the emotions and examine the moment objectively.

The effect may be that one sees a precarious evacuation in which more than 3,000 people have already left the ship, those remaining likely in varying degrees of stress and panic, people fearing for their lives striving to turn disorder into minimal order—in short, a situation during which it is quite easy for someone take a fall, for this is one area – crowd management during crisis – that is impossible to simulate adequately.

At UL-FPP, alarms regarding the story were raised immediately upon hearing the initial version that the Costa Concordia grounded and subsequently the captain executed a manoeuvre that brought about the ship, returning it close to shore and grounding it again.

The question was: Why ground it again? Immediately the question arose as to whether the ship was under control at all at that point. The safer move would have been to drop anchors well before grounding again.

Of course, the image before us is of a giant, sinking ship, the captain rushing to the shallows in hopes of saving as many lives as possible. This is a good dramatic story, but it was clear that if the ship was sinking the manoeuvre itself would not have been possible.

So what happened? Our experts were asked to simulate the route of the Costa Concordia based on available AIS data, which gave the position of the ship at six minute intervals.

Later we received more detailed AIS readings so that the position could be charted at closer intervals, yet the initial data was sufficient to bear out our initial thoughts.

The vessel deviated rather suddenly and late from what would appear to be a normal route through the straits, veering towards the island of Giglio, began a gentle turn away from the island, just barely too late to avoid shallow water.

The vessel then grounded at 15 or 16 knots, slowed quickly to 8 knots, kept slowing, moved in a south-southwesterly direction, came to a near stop southwest of the port of Giglio, turned about, and drifted back to the northwest until it grounded again, at which point anchors were finally dropped.

Even at six minute intervals we could estimate the times involved: roughly fifteen minutes from initial grounding to the southwest-most extent of its drift, and about an hour before grounding again.

ECDIS and ENC

The captain was reported to have said that the rock or rocks the vessel hit were not on his charts. This was a good opportunity to put our students to work, having them collect as many charts of the waters off Giglio as possible.

They found that the rocks are charted on even the lowest resolution charts, and particularly on the chart and the ECDIS system that they were actually using on the Costa Concordia. In fact, the students could not find a chart that did not clearly indicate the rocks.

The following quote is from an article on the Costa Concordia accident in The Atlantic by Edward Tenner (Jan. 19, 2012):

Like aviation, seafaring is in the midst of major computerisation, with bridges in modern ships like Costa Concordia becoming 'glass cockpits'.

The transnational maritime trade union Nautilus International says that the technology at the heart of this - the Electronic Charts Display and Information System (ECDIS), which marries GPS and seabed sonar data in one screen - can be a problem.

First, it says that the data on seabed obstacles can be out of date; second, the system generates too many alarms that can lead mariners to ignore them.

"The ECDIS screens are only as good as the data that goes into them," says Nautilus spokesman Andrew Limington. "And there are major problems with their user interfaces and ergonomics."

ECDIS will soon be mandatory on all large vessels. Concerns about the system are fair and should be heeded; however, warnings about new technologies are always a good idea (for example, when radar was first introduced generally during the 1950s and many crews were unacquainted with the tool's limitations and relative motion, an actual increase in the number of accidents at sea ensued).

The ECDIS system requires trained users and yes, it is a complex system. On the other hand, to provide some context, fixing one's position using a sextant requires more knowledge and training.

In addition, ECDIS integrates charts, radar, GPS, sonars, met stations, log, etcetera, but these also are on hand separately should the system in some way malfunction.

Changing course

To return to the story of the Costa Concordia, as soon as we obtained wind data for the time of the accident we were certain of the general nature of the event, that the ship grounded, continued forward under its own momentum – albeit at a slightly different angle – that eventually the inertia played out, the wind – NNW at 8 knots – became the main factor in moving the vessel, the vessel was turned, and slowly drifted back to the island where it grounded again.

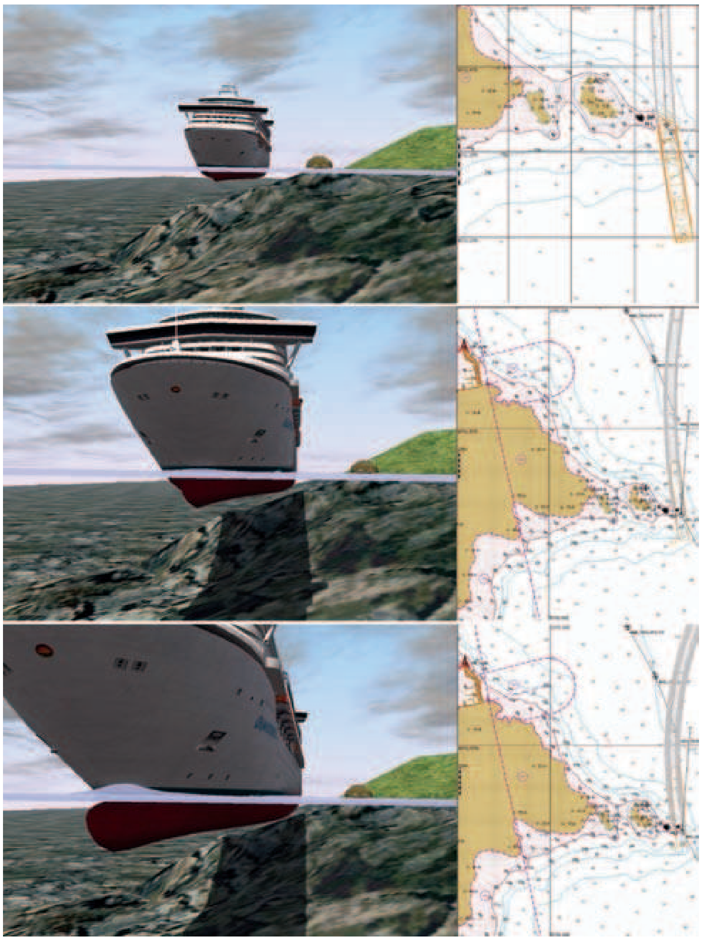

Figure 3 – Dangerous approach towards shallow water, timing, positions and bathymetry analyses

The timing was, again, roughly fifteen minutes from the first impact until the ship came to a stop and turned, and about an hour before the ship foundered and the anchors were dropped.

One question that was easily solved through access to AIS archives was whether the CC was following a pre-established course at all.

Of course, the pre-established route (passage plan) would not lead to the rocks in question, but if there were a route very similar to that of the CC the accident may have been more explicable.

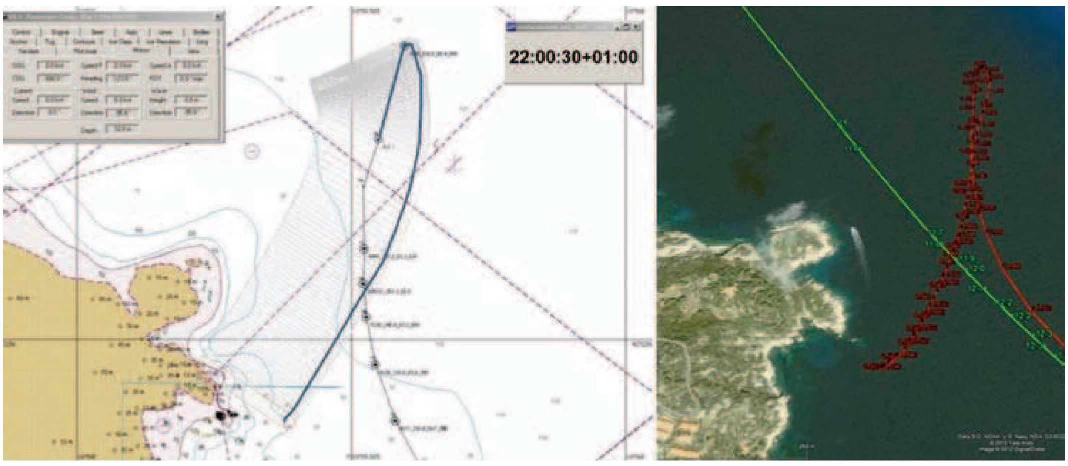

Figure 4 – Previous (green) and last Costa Concordia passage (red) at right side and at left side wind based drifting simulation towards the island resulting in a second grounding/collision which corresponds to AIS based drifting positions at the right side

What we found was that, first of all, in Winter, the ships of this cruise line generally don't go through the straits in question at all, rather they go around the western side of Giglio.

Further, we found that in the last year only one (the same vessel) passenger vessel passed near the island, presumably performing a 'salute manoeuvre', but did so on what appears to be a pre-established course, aiming toward the island all the way from Civitavecchia.

The Costa Concordia, on the other hand, had plotted a course like all previous courses through the straights, only deviating as it neared a position parallel to the island.

This deviation led to a contradiction that increased the likelihood of an accident: 1) while the steering was on what is known as a 'tourist' setting – that is, as gentle a turn as possible, as people may still be dining and so on, 2) the turn required was much more acute than it would have been had the 'salute manoeuvre' route been followed (see Figure 2, previous page).

Many irregularities stand out in this accident scenario, none stranger than that the Italian Coast Guard contacted the distressed vessel rather than the other way around.

It seems that the Maritime Rescue Sub-

Figure 5 – Port side aperture at engine room location

Center of Livorno was contacted first of all by a Carabinieri station that was informed indirectly by a passenger.

The Coast Guard began to understand the complexity of the situation looking at the AIS even though the master of the ship in the beginning declared that there was not any problem on board.

A sinking ship usually sends mayday signals. Why didn't this one? (Could it be because when releasing a mayday message the company must pay damages to passengers?)

Our theory is that the ship was not sinking. First of all, when we took note of the size of the hole in the hull caused by the grounding, some 40 to 50 meters maximum, and the location, towards the stern, it seemed likely that the ship had lost propulsion because of the flooded engine room, but that it would not have sunk – for one thing there are no transversal bulkheads in this engine room.

But the ship did eventually sink (founder, capsize); why was that? For an answer we sought information from the SAR divers, and after a few days received our answer.

On the starboard side of the ship were several penetrations caused by the second grounding, enough to prevent the ship from remaining upright under any circumstances.

In the end, of course, this means that many lives were saved by the capsized ship's proximity to land; yet, we believe that had the anchors been dropped, say, half an hour earlier as the ship drifted slowly (under 1 knot) towards land, no lives need have been lost at all.

Conclusion

Naturally many questions remain about this accident, and there is the likelihood that some of our conclusions will turn out to have been mistaken: for one thing we must wait for the report from the assessment party, the team in charge of assessing the accident.

One key issue will be the continuous monitoring of the AIS track or automatic system to detect abnormal behaviour in the routes of vessels. So not only have there already been many learning opportunities available from examining the event, new learning opportunities will continue to arise.

In addition, this case will be used as lecture material for such matters as stability calculation as well as post-accident contingency planning and response.

The nature of the case, of course, its sensational aspects in particular, will provide a natural allure for students. They have already learned that the scientific narrative can be a corrective. DS

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A PDF of the original research paper, ***The Wreck of the Costa Concordia as Learning and Research Laboratory****, including a full list of literature references, can be downloaded from http://tinyurl.com/costacon.*