Marine Weather Reporting at Maine Maritime Academy, a New Course, a New Approach

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"We've got strong meridional flow. Basically everything is flowing around this very large High in the mid-Pacific. This large trough will be digging rapidly over the next two or three days. We have the **M/V Eisenhower** going from San Francisco to Yokohama. This system has been building slowly, but looks like it might intensify rapidly now. This storm is forecast to produce nine meter seas, and 50 knot winds. On Wave Watch the storm shows up very well, showing it forming quickly."

"We've been passing under the High, so we've had following winds pretty much the whole way, so far. We'll keep going south for a while. It's basically the sailing ship route, and it's been working well for us so far this trip."

"We're going from Surigao Straits to Los Angeles, on the **M/V Richard T. Matthiesen**, fully loaded. We're going to follow the great circle track for now. We're ahead of schedule so far. We are still well south of the 5640 meter line on the 500 millibar map. We're thinking the 500 millibar flow may be moving back toward zonal flow before long. That would put the storm track farther north by later in the week. In that case we can probably stick to the great circle track."

"We have also had pretty good weather so far, we've been pretty lucky. It was a little dicey when we first started out, but it's good now. We're going from Yokohama to San Francisco. We're on the great circle, and we're already over the top. I think we'll be all right."

You may think that sounds like the operations center of an ocean routing company, but it's not. It is actually coming from a classroom at Maine Maritime Academy, where our future mariners are conducting "virtual voyages."

Every day the students, working in pairs, download a full suite of marine weather fax maps from the National Weather Service's Marine Prediction Center. Studying these maps, they make routing decisions for a chosen ship, or vessel, on a route of their choosing. Twice a week the class meets for two hours, and discussions flow around the room, comparing strategies, successes and failures. When one of these students says "man, did we get hammered last night," they are not referring to a visit to a bar. They are referring to having encountered 30-foot seas and force-10 winds in the Winter North Atlantic.

The idea for this course sprang from a 5-day course I took in the spring of 2001, sponsored by the Sea Education Association of Wood's Hole, Massachusetts, and conducted by the Maritime Institute of Technology and Graduate Studies (MITAGS) of Linthicum Heights, Maryland. In this course, entitled Heavy Weather Avoidance, mariners are taught to avoid severe weather by instructors Michael Carr and Lee Chesneau.

Midshipman Jeff Musk conducting a map discussion using the surface and 500 mb maps of the North Atlantic.

I had been teaching Meteorology at Maine Maritime Academy in Castine, Maine for about nine years, and although I was teaching it to mariners, and I am myself a mariner, I have always known that I was not covering enough material on simply interpreting weather maps. Given the time constraints of the course and the necessity of covering the fundamentals of meteorology in that time frame, I only got to spend about three weeks looking at surface analysis maps, and only about two days looking at the upper level, 500-millibar maps.

After taking the course with Michael and Lee, I knew I had to do something about this. Before the five day course was over, I had a rough outline of the course I wanted to develop at Maine Maritime, and I had developed what would be the key component of that course. The one advantage I would have over the MITAGS course would be that I would have the students for fourteen weeks, and this enabled me to run weather routing exercises in real time, using real weather data. I dubbed the idea a "Virtual Voyage" and decided to prepare the whole course around that concept.

The Virtual Voyage goes like this: The students pair up and choose a ship they would like to operate. Since we have a mix of students who are working toward 200-ton, 500-ton, and unlimited tonnage licenses, some will choose large ships and some will choose smaller vessels including tugs, yachts and even sailing vessels. With the ship chosen, they write up a discussion of the ship's characteristics, including whether or not they have "vulnerable" cargo (such as deck cargo), an approximation of the vessel's stability characteristics, the applicable load line zones they will transit, and any particular issues their ship might have that would affect their routing decisions.

For example, one group is on a car carrier, which is particularly sensitive to seas from ahead or astern, and is most suited to winds and seas on the beam. Another group is routing the Greenpeace ship **Rainbow Warrior**, which is a 160-foot auxiliary sail vessel, so they are looking for favorable sailing conditions. One group is on the **Richard T. Matthiesen**, a tanker, loaded, while another group is on the same ship but in ballast. The latter group will have to consider whether or not to take on storm ballast.

They then choose an ocean. For starters, we are working in the North Pacific and North Atlantic, but I hope someone will venture into the Southern Hemispheric waters. Finally they decide on a departure point and a destination. I assign the departure date, and we all get underway at the same time.

The students work on a Pilot Chart, and they start by laying out the least-distance track, typically the great circle route. They then study any material they can find to plan the route they will actually sail. They use the Sailing Directions; the British Admiralty publication 136, Ocean Passages For The World; various privately published sailing and cruising guides, and any other material they can find. With all of that, they start looking at the real time weather maps about two days prior to departure. On the day of departure they lay down a voyage track that they feel represents the best route for the present conditions.

They then lay down a comparative track. If they are sailing on the great circle track, they use a rhumb line or composite track for comparison. If they decide to sail on a rhumb line, or go well to the south on a "bucket" route, they use the great circle track for comparison. In any event, they must write up a justification for their chosen route. They also prepare an estimated time of arrival (ETA) and a description of the weather they anticipate.

For the next couple of weeks, they will plot their ship's position every day at noon GMT, both on their chosen route and on their comparison route. By transferring their position from the Pilot Chart to the surface analysis map, they evaluate the wind conditions they should be encountering. They also transfer their position to the sea state analysis map and determine the sea condition. With this information, they look at a polar velocity plot for the ship they are on and determine the speed they expect to make good in those conditions.

The polar velocity plot is a circular graph of speed made good in various sea conditions. To prepare these I sit down, (either in person or on the phone) with someone who has a significant amount of experience on a particular vessel and ask what speed they would expect to make good in the given conditions. For example, in force-8 winds and 12-foot seas, the ship might be able to maintain full speed when these conditions are from abaft the beam, but as the wind and seas draw forward of the beam, she might have to reduce from a sea speed of 16 knots to 12 knots. Since this occurs gradually, we will draw a curve that goes from 16 knots to 12 knots as it approaches dead ahead. We do this for various conditions, from calm weather up to force-12 winds and 40-foot seas. These curves look very different for different types of vessels. See figures 1 and 2. (We do not try to quantify the speed reduction due to wind, even though this can be significant. We simply don't have enough data on these ships to quantify everything, so we use an approximation. On ships with a great deal of windage, I do encourage them to approximate the wind factor, but it will be a rough guess at best.

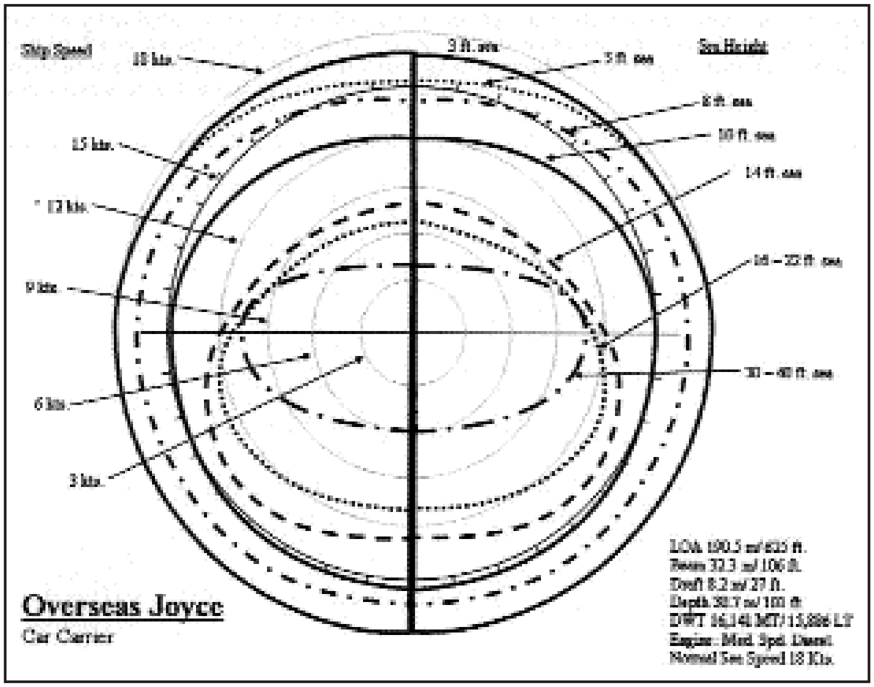

Figure 1: Polar Velocity Plot for the car carrier Overseas Joyce. This was prepared with help from Mr. Chuck Zenter, Second Mate. In this diagram you will note that although her sea speed is 18 knots in good conditions, she slows down substantially in any head seas. She also slows down in following seas, when her rocking horse motion allows her propeller to emerge and race, causing overspeed trip on her main engine. The concentric circles of the plotting sheet represent ship's speed in 3-knot increments, and the plotting sheet is oriented in a ship's head up orientation like a head up radar display. As an example, note that in a 16- to 22-foot sea, her speed varies from about 7 knots for a head sea, to a maximum of about 13 knots when the seas are just abaft the beam, and then back down to about 11 knots when the seas are from astern.

Once the students have determined the speed they expect to make good in the given conditions, they must allow for the current they are encountering. They pick the currents off the pilot chart and estimate the speed reduction based on the angle at which the current is hitting them. This reduction (or addition, if the current is fair) is taken from (or added to) the speed calculated for wind and waves. They now have a speed of advance.

Since these students have a great deal of other homework to do for other courses, I only require them to perform this operation once per day, using the 1200 GMT weather map suite. They presume that the speed of advance just calculated will apply for 24 hours. The next day they repeat the process, and so on for the duration of the voyage. After each day's run is plotted, they make a decision to continue on course or deviate to avoid bad weather, adverse currents, or to get a lift from more favorable conditions.

They must perform the same calculations for their comparative route. They slow down or speed up their ship on the comparative route using the same polar diagrams, but they do not deviate from the comparative route. That ship stays on course unless severe weather requires it to heave to or run before the wind and sea.In this way, they have something to measure their success or failure by. At the end of the trip they can see if their decisions brought them to their destination ahead of their comparison ship, or if the comparison ship encountered severe weather that they avoided by their good judgment.

Once they have made all these calculations for the day, they are allowed to fire up their complimentary copies of the Orion routing software, provided by WNI Ocean Routes Inc., and see what a computer solution for their track looks like. This program digests a daily weather data report from Ocean Routes, and runs numerous track solutions to solve for the best route. They are not allowed to change their route based on this information, but they are encouraged to see what another solution looks like. This way, they have yet another track to which to compare their route. They can also run an animation feature in this program which will project their ship and the weather data ahead in time to see how the wind and wave fields will change and affect them down the road.

For their final report, they compile a day by day discussion of their weather analyses and decisions with an overview of the conditions encountered by both ships (theirs and the one on the comparative route). They must summarize the number of days of weather above force 6, and number of days of reduced speed. If they encountered any severe weather,

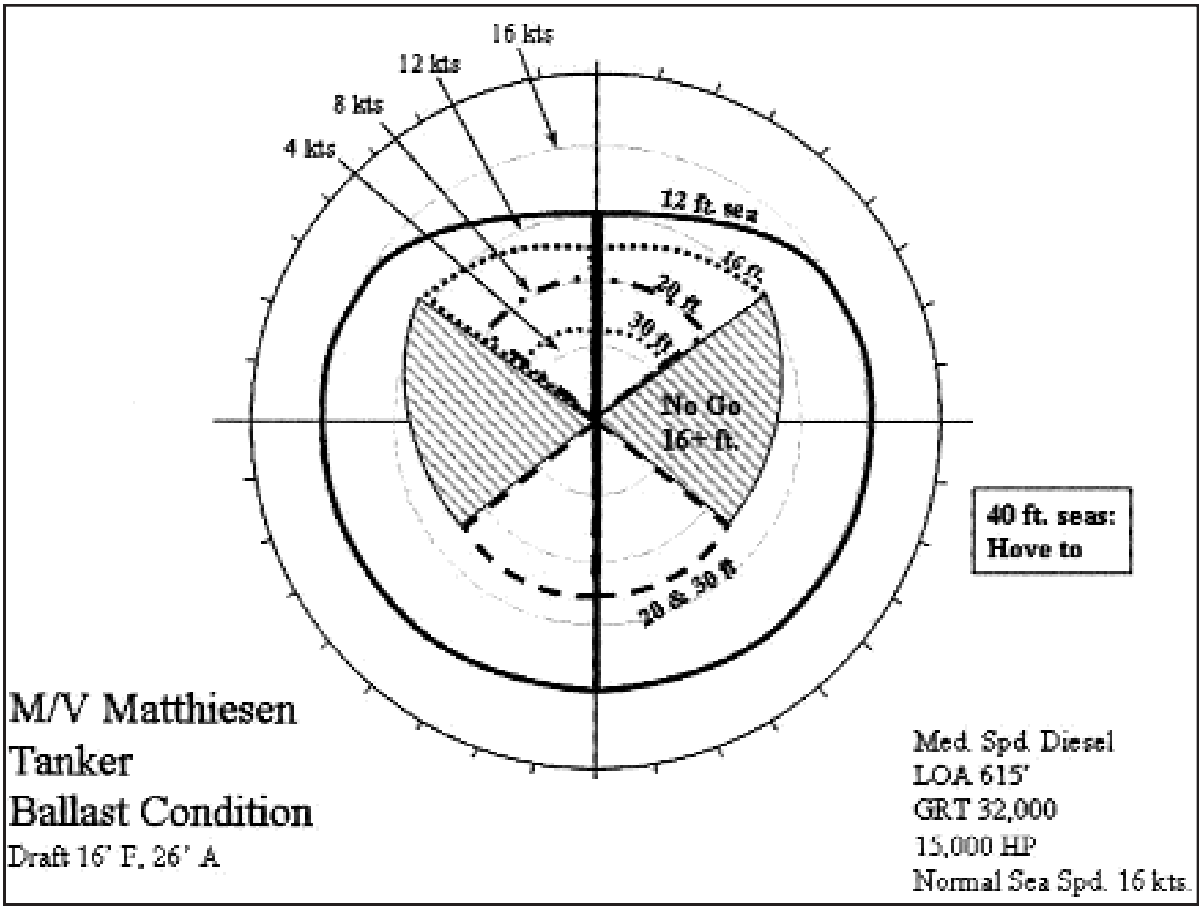

Figure 2: Polar Plot for M/V Richard T. Matthiesen, in this case in ballast. This plot was prepared with help from Captain Ralph Pundt, who served as her master for 6 years. Note that in sea conditions of over 16 feet he would not allow his ship to get beam to the seas, and in seas of over 40 feet he would heave to. We also prepared a plot for this same ship when loaded, and naturally it looks quite different.

they must decide if they might have incurred any cargo damage, ship damage, or personal injury to crew or passengers.

These students have concluded that they don't ever want to make a routing decision without having a 500-millibar map at hand, and preferably not without a full suite of 500-mb, surface, and wind/wave maps, including the analysis, 48- and 96-hour forecasts for each. They have become quite adept at glancing over the various maps and picking out the trends, tying the surface features to the 500-mb features, and considering the ramifications of significant wave height versus maximum wave height potential. They know now that they can use the surface and 500-mb maps to plan for the next 5 days, the 500-mb trend to look a couple of days beyond that, and the Pilot Charts for the rest of the voyage.

The students have also discovered the trove of information available to them on the Internet. While this resource is not available to many ships at sea yet, when it is, these mates will know where to look to find QuickScat Scatterometer derived wind fields, Wave Watch III wave model animations going out 10 days, superstructure ice accretion forecasts, and any number of other valuable additions to the basic weather forecast information.

During this course I have been fortunate to have had first class help from the folks at the Marine Prediction Center, MITAGS, WNI Ocean Routes, Inc., Locus Weather, Marine Computer Systems, and others in the private sector who have come all the way to Castine, Maine to give us guest lectures and materials to work with. They are all contributing to preparing these students to be better mates and masters who will make better decisions and bring the next generation of ships into port faster, with less damage, and with the cargo in better condition. ⚓