THE BRIDGE

The Bridge is a Navigational Aids and Ship's Bridge Simulator; replicating the layout and navigational instrumentation present on a modern ship's bridge. As you will see, this simulator also replicates, using real imagery, the scenery associated with major ports throughout the world.
Passages in and out of Dublin, Liverpool, Dover, Calais and ports around Glasgow can be undertaken as if for real on several different types of vessel.
The purpose of this simulator is to train both professional and part-time mariners in the use of new forms of navigation equipment and to learn how to handle a vessel in any situation.

In the last decade marine navigational aids have changed considerably both in capability and in sophistication. Heretofore, the practice of marine navigation was more related to calculating position using compasses, sextants, paper charts and a variety of manual and sometimes time-consuming methods. Nowadays, however, navigation is more related to the practice of position monitoring thanks to the acceptance of computer and satellite technology and their quick introduction onto modern ships and smaller vessels. The speed of these systems permit a large degree of automation in the guidance of vessels, however, modern professional and part-time mariners are still taught and expected to be proficient in traditional techniques in order to check their systems and be prepared for when the power goes off!!!!

On Our Bridge are all the instruments you would encounter in a modern ship's bridge, trawler's wheelhouse or yacht's charthouse. The concerns of the navigator in all cases are to ensure that his/her vessel is interacting safely with the immediate environment and other vessels, bearing in mind weather and tidal conditions and all other hazards associated with following the planned route.

VHF Radio
The invention of radio as you can see in the display about Marconi in Crookhaven had great benefits for the seafarer. Emergencies and accidents at sea could be reported immediately. As radio became more popular the airwaves became so busy that a frequency, which could be used by fewer people, was needed for use in emergencies. So Very High Frequency radio marine channel was developed as a licensed service with an annual fee. Around our coastline Channel 16 is still used as an international calling and distress channel in addition to more modern arrangements using Channel 70. Our radio is on Dual watch, meaning that it is listening to both Channel 16 and Channel 23 where the Irish Coast Guard broadcast Weather and Navigation warnings on a regular basis. This radio is not simulated and any broadcast heard, including distress broadcasts, is for real.

Barograph.
The barograph is an aneroid barometer with a facility for continuously recording the changing air pressure. Unlike mercury barometers in which mercury changed level depending on the weight of the air on it (higher for high pressure and lower for low), aneroid barometers have a drum containing a vacuum sealed at a particular air pressure. As the air pressure changes, the drum expands and contracts. In the barograph, a pen attached to the lid of the drum draws ups and downs on a rotating sheet of graph paper.

Changes in air pressure are related the movement of air in our atmosphere. High-pressure areas (greater than 1013 millibars or hectopaschals) are those areas where there is an inflow of air in the adjacent atmosphere. Similarly areas of pressure less than 1013 millibars or hectopaschals are low-pressure areas where there is an outflow of air. High-pressure zones (anticyclones) are associated with fair weather while fronts and low-pressure zones (depressions) are associated with wet, stormy weather and high winds.

The barograph is still used aboard many vessels nowadays, not so much to record accurate pressure, but more to show the tendency of atmospheric pressure. For example a sudden decrease in pressure and a resulting dip on the paper graph would be a very strong indication to the mariner that high winds are on the way.

Clock or Ship's Chronometer

For seafarers a clock is not just to tell the time, it is an important part of navigation. Many will be familiar with Harrison's long struggle to invent a timepiece that would be accurate aboard a ship given that ships are subject to excessive movement. For those with an interest in these matters, the award-winning book 'Longitude' by Dava Sobell is recommended as a very informative and easily read explanation of the development of time for measuring longitude at sea. It remains the practice in marine and air navigation to define position by reference to Latitude and Longitude, Latitude traditionally being listed first as it was always the easier to calculate. The calculation of Longitude relied on measuring one's movement east or west of the start point very accurately. This could only be done well if time could be measured easily i.e. showing a relationship between ship's movement and the east to west movement of the sun or indeed of any other heavenly body. Harrison's Chronometer greatly assisted the calculation of Longitude in conjunction with the Octant, the astrolabe and most recently the Sextant.

The sextant is an instrument designed to measure angles very accurately - typically to a 10th. of a minute. It does this by using a system of mirrors. Light from a distant object, such as a star or lighthouse, is reflected by the index mirror down to the horizon glass and from there back down to the telescope. Only half of the horizon glass is silvered so that the observer can look through the telescope and the horizon glass at the same time. The effect is to look two different directions at once. Moving the index arm can change the angle between these two directions and it can be read off a scale. The main index scale is written in degrees and minutes are shown on the micrometer drum for precise adjustment.

In calculating a vessel's position, a sextant is used to measure the angle between the observer's horizon and a heavenly body, such as the sun, moon, planet or the 57 navigational stars. Once this angle is known, a spherical triangle created between the observer, the Pole and the Body can be resolved by traditional spherical trigonometry and the result compared to an estimated position, which can be adjusted accordingly. This is only possible knowing accurate time, having an estimated position and referring to the nautical almanac which documents the position and movements of all the heavenly bodies used for navigation.

Mariners still carry sextants and yacht masters and professionals alike are still required to be able to use them in the event that modern equipment fails to function.

Aneroid Barometer

This works on the same principal as the barograph but is used more to measure actual pressure as an indicator of expected weather.

Within the earth's atmosphere, depressions and anticyclones are continually developing and dying. Some last a day or two; others (in particular, large anticyclones) can last for weeks. The depressions that affect Western Europe develop over the Atlantic Ocean where cold polar air meets warm tropical air and they move east steered by the river of air in the stratosphere. The boundary between the two is called a pressure front. As the buoyant lighter warm air (high pressure) rises over the denser heavier cold air (low pressure) and the cold air gets under the warm air. The warm front comes ahead of the cold air and as the front builds, the two get energy from each other, they swirl around each other and the winds strengthen. As the air collects and gets heavier the pressure drops; the wind blows harder, the clouds thicken and the rain starts.

Air masses are like mountains and valleys but instead of using contour lines to map them, lines of equal pressure above sea level are used. These lines of pressure are called isobars. They join areas of equal barometric pressure. Pressure is measured in millibars or hectopaschals. A steep change in pressure between adjacent isobars means a strong wind and small change means a light wind.

Long before meteorologists understood about the workings of depressions, sailors used barometers to warn them about approaching storms. A rapid drop in air pressure was a sure sign of bad weather to come. The barometer is still the most predictable way to predict storms for the amateur meteorologist.

GPS

The development of GPS (Global Positioning System) by the US Government started in 1973 and it became fully operational in 1995. Having been first used for military purposes in the first Gulf War in 1991, GPS has been rapidly adopted for many civilian uses, most notably for marine navigation. Nowadays, standard GPS can offer the user position accuracy of 15 metres or better and this is possible anywhere in the world, irrespective of weather or time of day.

The GPS constellation consists of 24 satellites orbiting at an altitude of 11,000 miles. Each satellite continuously transmits a coded signal on two microwave frequencies - roughly 10 times higher than marine VHF and - including a message that says 'I am here' and 'the time is now'. The codes on the two frequencies are different and only one, called the CA code (for Coarse Acquisition) is available to civilian receivers.

The signal takes time to travel from the satellite to the receiver, so it is received slightly later than it is sent. Microwaves, like any other radio waves, travel at an almost constant speed of 300,000 Kilometres per second, so the difference between the time of transmission and the time of reception corresponds to the distance between the satellite and the receiver. If the signal arrives one tenth of a second after it was sent, the receiver is 30,000 Km from the satellite - that is, it is on the surface of a sphere with a radius of 30,000 Km, centred on the satellite. If the same thing is done simultaneously with the three satellites, then position of the receiver can be pinpointed.

Marine Navigation in coastal regions very often requires position accuracies better than those possible from ordinary GPS. To provide these accuracies, The Commissioners of Irish Lights provide a Differential GPS service, which broadcasts corrections to the GPS Satellite signals, and position accuracies of better than 1 meter are now possible using these corrections. The corrections are broadcast using a medium wave transmitter and the tall mast behind this Centre is one of three in Ireland and 12 between the UK and Ireland. There are many similar stations in Coastal areas of the US, Australia, New Zealand and much of Northern Europe. For this reason Mizen Head is an important location for the safety of Navigation in Northern Europe.

The instrument shown on the wall is giving an accurate indication of the location of GPS satellites overhead at any particular time. This GPS is not simulated and is giving a real Latitude and Longitude position for our Centre as calculated from the GPS satellites.

Anemometer

The anemometer is used to measure wind speed and direction. The most common form used is the spinning cup anemometer invented in 1846. As the cups rotate, the spindle triggers an electrical contact so that the number of rotations in a given time is recorded and wind speed thereby calculated. The instrument shown is not a simulator, however real wind speed and direction may not be accurately shown as wind eddies falling from the hill behind do adversely affect our spinning cup sensor on the roof.
At sea wind speed and direction are key information for deciding a course and monitoring weather conditions, particularly on a yacht.

Chart, Bow Dividers, Parallel Rulers and Compass Rose.

Charts, the basis of navigation, cannot be excluded from modern navigation methods. Electronic charts that are acceptable for professional navigation do still not cover many areas of the world. As a result many ships are still required to carry paper charts kept fully up to date by the navigator.

Bow Dividers can be used in one hand and are useful for measuring distance on a chart. The needle sharp points give precision.

Parallel Rulers - to be used by the mariner to plot or calculate direction from the compass rose on the Chart.

Compass Rose on a chart has a graduated outer ring of 360 marks at 1° intervals showing direction with respect to true north on the chart. Most have a second ring, slightly skewed from the outer ring, showing directions relative to magnetic north. As a journey rarely runs north - south, planned courses rarely run through the middle of a Compass Rose. So to transfer the courses and bearings around the chart it is necessary to use an instrument like the Parallel Rulers.

Traditional Parallel Rulers are two straight rulers joined with pivoting arms, which allow the rulers to be moved apart while keeping their edges parallel. They can be walked across the chart while preserving their alignment. They are usually of the Captain Field pattern with the degrees marked anticlockwise.

ECDIS or Electronic Chart Display and Information Systems

The first monitor of the Navigational Aids Simulator shows an Electronic Chart Display. This is a most remarkable and only recently internationally approved development in marine navigation with many benefits for safety at sea. This system makes it possible to plan a passage and follow it using a computer-based chart display. The monitor shows the chart with the journey pinpointing the ship as it moves over the charted waters. Also, the Chart Information element of the system provides the navigator with information about lights, navigation marks and other marks of interest encountered in a passage. The system also shows tidal heights and tidal streams adjacent to the vessel. This information previously had to be looked up in or calculated from one of the numerous maritime publication held and maintained to date onboard all types of vessels.

The electronic chart system is fully integrated with the radar on the far right and other ships and hazards can be taken from the radar display and overlaid onto the chart for assessment of all dangers on one display.

Our ECDIS system also includes one other elaborate radio navigation aid - that is a computerised Navtex receiver. Navtex is a facility provided by coastal authorised, used to broadcast navigation warnings and weather forecasts, which, after reception, are displayed on our electronic chart automatically. These broadcasts are received from all over the world as well as from the famous radio station at Valentia Island.

This overlay is not simulated, it is a real system, and so navigation or weather warnings shown are for real!!!

Ships Controls and Sensors

The center computer screen simulates many of the instruments, controls and sensors, which have to be monitored carefully on the bridge of a modern ship. The ship's course and speed can be monitored here as well as the depth below from an echo sounder. A Differential GPS, Loran C radio navigation receiver and a direction finder are also simulated here and these allow the same functionality as the real instruments calculating the ship's position, which is then represented on the electronic chart. This computer also allows the navigator to control the ships lights and siren, call for the assistance of tugs and manually work ships mooring lines or anchors when entering or leaving port. This computer can also access the ships steering controls and the Autopilot set to steer an accurate course or even a complete passage.

This console also allows the navigator to change the view of the visual screens so that he can look astern or to either side or even get an enhanced view using binoculars-all of the things that are readily available to a mariner on a real vessel!

Real Controls

Although the ship's speed and direction can be controlled using the centre console, all vessels have manual controls for sensitive movements in restricted waters. The helm allows a helmsman to steer a given course and the visual scene changes to reflect the course chosen. Similarly, the Morse throttle controls on the main panel are used to change speed both ahead and astern and changes in engine sounds reflect the engine revolutions chosen. As with many large ships, engine speed can also be adjusted using the telegraph controls on the left-hand side of the main panel. Here the navigator rings on a speed such as 'slow ahead' and an engineer in the engine room would respond by changing the engine revolutions to ensure slow speed ahead.

The main panel also allows manual control of the Autopilot and, depending on the type of ship chosen, control of bow and stern thrusters, which permit sideways movement of the ship for berthing and unberthing.

Compass

Direction at sea is measured using a compass - essentially an instrument which points to magnetic north and its main axis goes on pointing north regardless of the movement of the boat around it. Most ships would have at least two compasses. A compass like the one on the Simulator would be used to measure heading. This compass is not connected to the Simulator - so the reading it is giving is for Mizen Head. It is sitting in a ring or gimbals that allows it to remain level whatever the swell.

Compasses make use of the fact that the earth has a magnetic field as though a huge iron bar is embedded in its core, aligned with its north-south axis. So any magnet that is free to swing tends to line itself up with the earth's magnetic field. In marine compasses, several straight needle-like magnets or a single circular magnet are mounted underneath a circular card with a scale of degrees or compass points marked on it. The whole thing is suspended in a bowl filled with a mixture of water and alcohol, which slows the movement of the card; to reduce the swinging that would be caused by the movement of the ship.

Nowadays lager ships would also have a gyrocompass that uses the properties of a gyroscope to remain aligned to True North. This type of compass is simulated on the centre controls for steering the vessel.

Radar - Radio aid for detection and ranging

This instrument is simulated on the right monitor and its purpose is to allow the navigator to detect and view other vessels, floating hazards, land and navigation buoys. Once they have been detected, the information can be used to assist with navigation and help make decisions in relation to the avoidance of collisions with other vessels or hazards.
The basic principle of radar is that it transmits pulses of energy and measures the time that elapses before the echo of each one returns if it has reflected off a target. Radar uses extremely high frequency radio waves called microwaves in order of 9.5 GHz (9500MHz) and with a wavelength of about 3cm. Radar's microwave pulses are focused into a beam by a rotating aerial and transmitted horizontally through 360° around the vessel.

So radar is able to measure the range of a target from the time it takes a microwave pulse to make the out and back trip. It can also measure the target's bearing from the direction that the scanner is pointing when a pulse leaves. This information is used to build up a picture on the display monitor, which is a called PPI, or plan position indicator because it looks like a plan or a bird's eye view of the vessel's surroundings.

Our simulator can replicate one of three different radar models and as with most modern radars, due to digital technology, it can also do many of the calculations that were previously done long hand by the navigator. All of the vessel's course and direction sensors, as well as our GPS position, feed into the radar, which can then calculate the speed and course of detected vessels automatically. This makes our simulator into an ARPA device, more than just radar but rather an Automatic Radar Plotting Apparatus as well as everything else. Our monitor can also take data from real radar if required.

The ARPA can also output data for overlay onto the Electronic Chart System to help the navigator have all the data on one display for quick decision-making.

Visualisation
On the three screens is real imagery of real port scenes, which have been turned into computer graphics. The image generation system features real time production of marine visual scenes with own ships, traffic ships, cultural objects, environmental effects, visibility and illumination effects shown in full compliance with international requirements set out for training by the International Maritime Organisation.

An entire range of visual conditions may be displayed, showing all variations from day, through dusk to night and from clear visibility, through haze to thick fog, represented in any combination.

Each ship's mathematical model incorporates an accurate movement in 6-degrees-of-freedom. Additional sub-models are provided which allow proper reaction of the ship to external forces such as wind, current, sea, tugs, mooring lines and interaction with other vessels and the environment.

Our simulator has five ship models that can be added to suit any training requirements. The present models are, a container vessel, a car/passenger ferry, a trawler, a stern trawler and a rigid inflatable boat (RIB)

Instructor Station

The Instructor Station is the key element of the simulator. It provides the instructor with the tools and facilities for total control over all stages of simulator operation including generation, modification and editing of trainee exercises. Additionally, the instructor can monitor and check trainee performance both during an exercise and afterwards using the debriefing facility. The passage you are now seeing on the simulator has been recorded in real-time and is being played back using the instructor station.