ENGINEERING

Ships Made From Models

Miniature model ships are made from blueprints and tested in water at the Navy's Taylor Model Basin in Washington before any ship is constructed.

By MARTHA G. MORROW

➤ WARSHIPS of an atomic-age Navy are afloat near Washington today. Slim, sleek, cutting the waters of an inland "sea," they are models of ships to be.

Boys who like to build models envy the serious scientists whose life work it is to test submarines and seaplanes, motor boats and aircraft carriers, landing barges and luxury liners. These are all tried out in miniature even before detailed plans are put upon the drawing board.

Looking like an elongated super-Quonset hut nestled in a suburban valley west of Washington, the Taylor Model Basin is the longest and best-equipped experimental basin in the world. Here millions of dollars are saved by building and rebuilding small wooden versions of ships of the future.

No ship's keel is laid for the Navy until a working model is pulled through the waters of the model basin and passes stringent tests. Because the performance of a finished ship can acccurately be forecast from tests tried on wooden models, more efficient ships ply the seas to give the United States a fleet second to none.

Model Is Hollow

The ship model employed in these tests is usually about 20 feet long. Without superstructure, it is hollow and fashioned from layers of Western pine glued together. A rough profile of the ship is first cut in the wood. With planes, sandpaper and infinite patience, this is shaped to represent the outer surface of the ship's hull. From keel to deck, the ship is made to scale, conforming to the blueprint specifications to within a hundredth of an inch.

The ship is painted to preserve it and help the model slide through the waves, then weights are added to give the proper water line and center of gravity. The model is then ready to be towed over one of the main basins to test the shape of the hull and determine the power needed to drive the full-size ship.

The model is pulled at various speeds underneath a carriage that looks like a bridge on wheels. Starting from rest, the carriage slowly acquires the required speed and keeps it uniformly throughout the test. The model, sliding through the water, produces waves such as would be formed by a full-size craft. The actual resistance of the miniature ship in pounds and hundredths of a pound is measured as it cuts through the water.

The proper locations of bilge anti-rolling keels and other appendages are determined by the way in which the water flows around the model. These appendages cannot cut across these lines of flow without tending to slow down the ship.

The model is painted white, then small holes are bored at strategic places. Hydrogen sulfide in solution is fed through these holes. When the model speeds across the water, this acid leaves dark lines on the exterior of the hull, indicating the lines of flow of water.

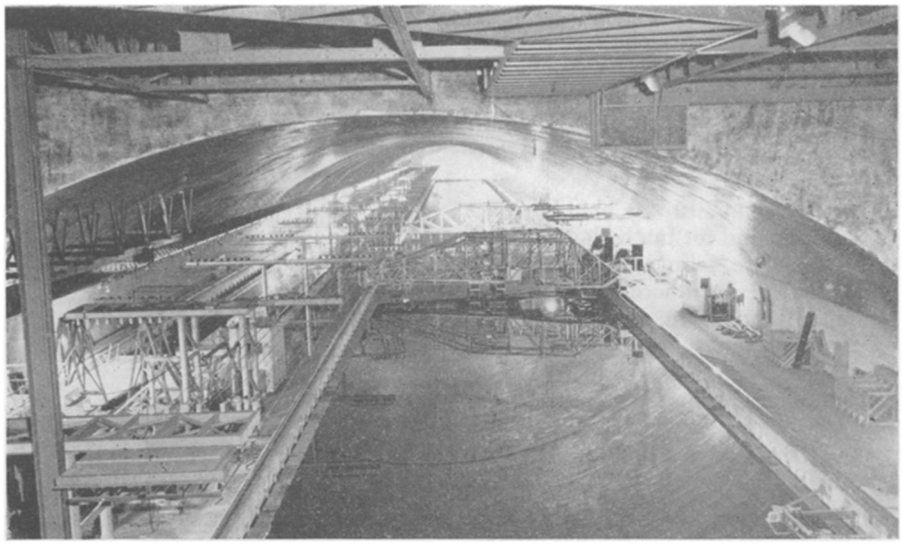
During the self-propelled test, the model is driven under its own power along the basin with small model propellers. An operator in the carriage moving overhead regulates the speed of the ship. From this test even more accurate measurements are secured of the power needed for specific speeds to be obtained by the full-size vessel.

Experiments conducted at the basin showed that certain ships would drive easier by extending the bow in a blunt or rounded form below the water. By incorporating the bulb bow, the enormous bow wave usual in such ships was greatly reduced, with a corresponding reduction possible in engine power.

Three Towing Tanks

Under the arched roof of the Taylor Model Basin are three enormous towing tanks, each designed for a particular kind of work. Models of large ships are towed or self-propelled in the large deep-water basin. This is 963 feet long, 51 feet wide, and 22 feet deep; an extension now nearly completed will make it 2,775 feet long.

River and harbor craft are tested in a shorter shallow-water basin that joins the large tank. This basin is 303 feet long, 51 feet wide and 10 feet deep. Its depth, however, can be varied to represent rivers, canals and channels likely



CRYSTAL-CLEAR—The water in the shallow-water basin and deep-water basin where ship models are tested at the Navy's Taylor Model Basin reflects the arched ceiling.

to be encountered by barges and tugboats under test.

The far end of the shallow-water basin swings around in a J shape. This is especially useful in testing a ship's ability to twist and turn when evading a torpedo.

PT boats, seaplanes and pontoons are tested in the high-speed basin that runs parallel to the large basin. This is 1,168 feet long, 21 feet wide and 10 feet deep. So that torpedoes and other high-speed craft can be run at full speed, the length of this basin is being greatly increased. When completed this winter, with the extension it will be three-fifths of a mile long. The carriage will be capable of running 70 miles an hour—a real thrill for those who climb aboard.

So that all measurements will be absolutely accurate, the carriage rails running along both sides of each tank follow the curvature of the earth. This means that the midpoint of the high-speed basin is about five-eighths of an inch higher than the ends. The rails had to be set with this fantastic accuracy because the actual forces involved in towing the models are so small that if gravity had a chance to work on the carriage, it would invalidate the results of the test.

Still Water in Basins

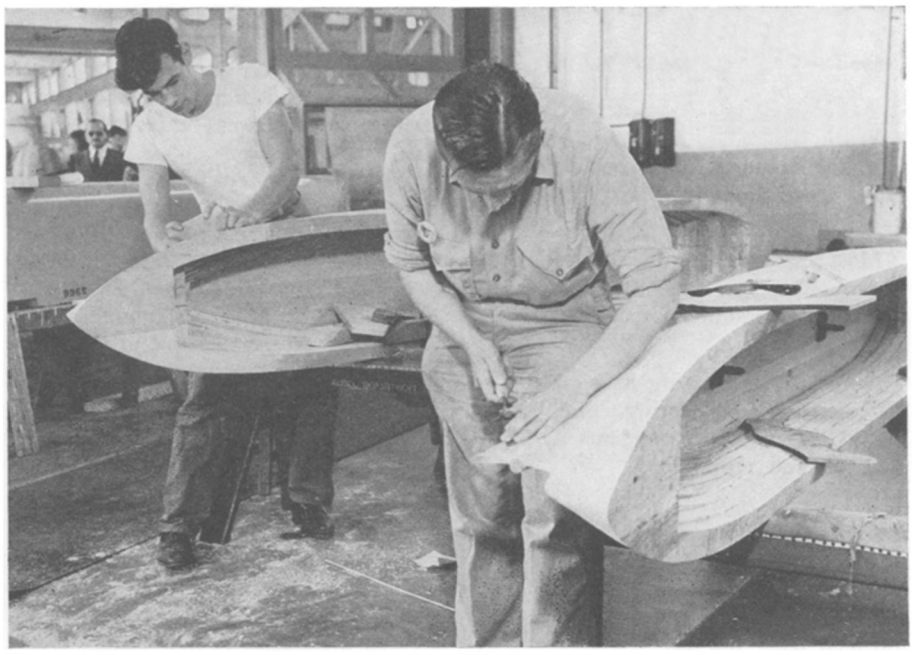
In each of these three basins, the model is towed through water of mirror-like stillness. In the circulating water channel, on the other hand, the water flows with river-swiftness and the model is held stationary while measurements are taken. Here tests may be conducted for an indefinite period. Floats, mines and torpedoes in particular are tested in the circulating water.

The water channel consists of an open-top test section 22 feet wide and 60 feet long in which flows a stream of water nine feet deep. The model can be viewed and photographed through windows in the walls and bottom of the channel.

An exact copy of the propeller of a full-size boat is tested in special water tunnels. In these water circulates at a known speed through a closed circuit. The propeller is mounted on a motor-driven shaft projecting into the test chamber.

Photographs are taken through glass port-holes in the sides. The air pressure above the water in the test chamber is lowered by vacuum pumps so that the combined effect of atmospheric and water pressure on the model will be in proportion to that of the full-size propeller.

The effectiveness of the propeller is determined by watching the formation of water-vapor cavities or "bubbles" on the propeller blade surface. These are made visible by means of stroboscopic illumination—flashes of light timed so as to make the moving blade seem to stand still. Too many bubbles signal the need for a change in size or shape of the blades.



NO INSIDES—Without superstructure, a model ship is hollow and fashioned from layers of Western pine glued together.

The headquarters for nautical experimentation is named in honor of Rear Admiral David Watson Taylor, responsible for model testing of ships in this country. It was he who planned the original experimental basin at the Washington Navy Yard and for years guided its research.

Super Model Basin

But with the advent of a two-ocean Navy, the Washington Tank proved inadequate for its many tasks and also its equipment was fast becoming obsolete. Thus plans were drawn up for a super model basin, the best in the world.

Construction of the Taylor Model Basin was authorized by Congress in 1936. The basin was completed and put into full commission just prior to Pearl Harbor. Capt. H. S. Saunders is its new director.

Carderock, Md., some 12 miles from Washington, in the valley of the Potomac, was made the site of the new establishment for several reasons. Here solid rock, needed for accurate alignment of the rails of the towing carriages, was near the surface. An ample supply of clean, fresh water was available. There was little traffic to disturb the alignment of the towing carriage rails or their foundation.

Fresh water is used instead of salt water because of its unvarying weight and performance. The values secured are reinterpreted to apply to salt water.

Plant life must be kept to a minimum in the basin water, so no sunlight enters the windowless building. The water surface is skimmed each morning so that no film will interfere with the performance of the models.

Each class of ship built or even considered during the war was tested in the model basin. LSTs, LCIs, new destroyers and carriers were all tried out here. Models of older *(See page 332)*

Do You Know?

World *butter* production has declined with the expansion and consumption of other, more profitable, dairy products.

Most *headaches* are due to migraine or to muscular tension associated with anxiety and emotional tension.

A *housefly,* beginning its reproductive activities in early spring, might have over 5,000,000,000 descendants by fall if all lived and reproduced.

Carbon, from wood soot and other sources, has a beneficial effect in most soils; it causes bacteria to work faster and accumulate humus and fix more nitrogen from the air.

Parchment diplomas awarded by many colleges are a sheepskin product coming to the United States largely from England; one British parchment factory is said to have been in operation for a thousand years.

Shrimp develop from tiny size to five-inch crustaceans in coastal waters in a few summer months, and, when grown, go out from the shore to spawn; then they go farther to sea to shoals where they remain, never spawning again.

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battleships and cruisers to which blisters had to be added to improve under water protection underwent experiments here first.

With the return of peace, test runs are now being made of luxury liners and pleasure craft. The laboratory is authorized not only to conduct research for the Navy and other branches of the government, but for private shipbuilders and designers who pay the cost of the work.

The structural performance of metals is also studied at this marine laboratory. Both full-size and model-scale beams, columns, riveted and welded joints are tested on an alternating stress machine.

Strain Tested

The amount of stress and strain a wide variety of structural specimens will withstand before breaking is estimated on another apparatus. A new testing frame has been devised so that forces can be applied from all three sides in testing the structural strength of metals.

The nature of an explosion and its effect upon the structure of a ship is studied in a pentagonal pond built nearby. Sections of steel plate with bulkhead doors are lowered into the pond and pictures are taken from a bathysphere to show what actually happens when the TNT goes off.

The path of a model bomb or torpedo after it strikes the water is watched through the transparent walls of an enormous tank. Glass windows three-quarters of an inch thick and four times as as strong as ordinary plate glass of the same thickness form one side and one end of the tank. Continuously filtered, crystal-clear water is used to insure clear photographs, complete to the minutest detail.

Air Flow Checked

Extensive tests check the flow of air over the decks of carriers, or around the bridges and upper structures of ships. In these tests a model of a carrier deck, cut off at the water line, is set up in a wind tunnel, also used in testing planes. Threads pasted to the model show the path taken by the wind and the eddies created.

Lilliputian launchings were made of big ships built on rivers with only a short run to the other side. Proper models of ships were mounted on miniature launching ways to show precautions needed to keep ships built at such Navy Yards as those at Norfolk and Philadelphia form running aground. Scale models of snubbing chains or anchors were used to stop the ship's run. From these models, the necessary precautions were devised and full-scale ships performed almost exactly as predicted from the models.

Small-Scale Replica

A small-scale replica was built to test the effectiveness of the anti-submarine net outside San Francisco harbor. The model, carried up and down by the carriage over the big model basin, showed that to be effective the whole scheme of mooring had to be changed.

Two separate shops, one woodworking and the other metal-working, form an integral part of the basin. Models of ships, aircraft and other forms to be tested are fashioned by experts skilled in building in wood something that will eventually be constructed in steel. All special equipment, instruments and other gear as well as models in metal are made in the other shop.

Problems ranging from how best to load a ship to how to identify our fleet, from the effectiveness of enemy designs to the best kind of seasick pills, are all handled at the basin. For questions concerning anything that is propelled, towed or projected on or through the water, or driven through the air, they either have the answer or can get the answer for you.

Science News Letter, November 23, 1946

Only about 1% of the *carbon* atoms found in nature occurs as carbon 13; 99% of the carbon atoms weigh 12 mass units.