A merchant ship designed by Fredrik Henrik af Chapman, the Baron Anders von Hönken, *is brought to life in a model in the Swedish National Maritime Museum at Stockholm. Built in 1759, this type of vessel had a full fore body and trim after body to provide large deadweight carrying-capacity on trading voyages in the Atlantic and Mediterranean. Chapman defined this design as "cat-built, ship-rigging".*

Chapman, F. H. af.

The First Naval Architect?

200 years ago, a Swedish shipwright published a definitive work that gives him a strong claim to the title.

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Except for the drawings on pages 16 and 17 and one photo on page 18, all illustrations were supplied through the Swedish National Maritime Museum at Stockholm.

"For ships, we have to fear an infinity of bad qualities of the greatest consequence, which we are never sure of being able to remove, without understanding the theory.

To possess this theory in all its extent seems to exceed the power of the human understanding. We are obliged therefore to content ourselves with a part of this vast science; that is, with knowing sufficient of it to give to ships the principal good qualities, which I conceive to be:

1. That a ship with a certain draught of water, should be able to contain and carry a determinate lading.

2. That it should have a sufficient and also determinate stability.

3. That it should be easy to the sea, or its rolling and pitching not too quick.

4. That it should sail well before the wind, and close to the wind; and work well in windward.

5. That it should not be too ardent (a ship's tendency to turn to windward) and yet come easily about.

Of these qualities one part is at variance with another; it is necessary therefore to try to unite theory and practice, that no more is lost in one object than is necessary in order to secure another, so that the sume of both may be a maxium."

—*From* A Treatise on Ship-Building, *1775*

FOR THE NAVAL ARCHITECT, the precepts quoted above are classic—not because they are almost two hundred years old, but because they embody the essence of designing ships. Such timeless words might have been enough to draw history's spotlight to their Swedish originator—Fredrik Henrik af Chapman, a master shipwright who became an admiral—if his achievements were not in so esoteric a discipline. However, once initiated into the mysteries of designing ships, men tend to build their knowledge on traditions established in the current generation and perhaps one generation back. The uninitiated who have never caught a whiff of the heady scent exuded by a sea-going success are even less likely to be interested in an 18th-century naval architect, whose achievements, though seldom heralded, were vital to shipbuilding progress on through the 19th century.

Today, 200 years later, Chapman's most significant concepts are still in vogue. Whether they qualify as "original thought" is doubtful, but Chapman deserves much of the credit nonetheless. His many accomplishments include being one of the first men to successfully translate the mathematical theory of ship design into practical application in a shipyard. Certainly, he was the first to popularize the idea

that a ship designer should be well-versed in theory as well as possess substantial sea-time and on-the-job ship construction expertise. For many naval architects, this goal is as elusive today as it was two hundred years ago to Chapman's peers.

It almost seems that Chapman was fated to be the progenitor of the modern naval architect. His parentage and up-bringing left no doubt as to the career he would follow; only the degree of achievement could not be forecast. His English-born parents settled in Scandinavia after his father, an experienced seafarer and skilled shipbuilder, provided Sweden's King Carolus XII with details of Russian ships being built in England. As a result, Thomas Chapman was invited to join the Swedish Navy. He rose in rank quickly, finally becoming commander of the Naval Yard at Gothenburg. Here his wife, the daughter of a London shipbuilder, gave birth to Fredrik Henrik in 1721.

Throughout his boyhood, Fredrik Chapman was trained as a shipwright in his father's yard. As a result of his maternal grandfather's influence, he was also able to apprentice in English yards despite the wide-spread refusal in 18th-century shipbuilding circles to exchange information with "foreigners". Even though Archimedes discovered the principle of displacement two centuries before Christ, the mathematical procedures for determining a ship's draft were considered a state secret in England into the early 1700s.

An intense, intelligent spirit is evident in this portrait of Chapman painted by Lorenz Pasch. Made a rear admiral in 1783, Chapman retired from active shipbuilding in 1793 to devote more time to practical experiments on ship's resistance using a towing tank. The ship models were propelled by counter-balanced weights. The same type of tank was used for experiments by the U.S. Navy in the 1930s. Chapman died in 1808 at the age of 87.

After a short period as partner in a Gothenburg shipyard, the young Chapman felt a keen lack of ship design theory. He embarked on what was to become an 11-year quest for knowledge that would see him study with many mathematicians, including the British Royal Academy's Thomas Simpson, known for "Simpson's Rule". Still in use today, it concerns mathematical procedures for determining areas under an empirical curve.

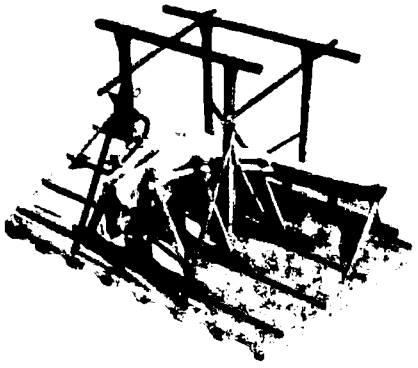
When not studying, Chapman went to sea for short voyages and visited shipyards of the Royal Crown in Britain and merchant and naval yards in Holland and France. Through diplomatic intervention, he was granted permission to observe the 18-month building of a French sixty-gun ship of the line at Brest. Finally, in 1757, at age 36, he ended his self-imposed apprenticeship and began work in earnest as a naval architect for the Swedish Navy.

Chapman's first assignment, which lasted through the 1760s, was to design and build shallow draft combination oar and sail-driven ships in the Finnish archipelago. Misleading information about their operating environment caused these first Chapman-designed ships to be indifferent sailers, though they were part of a Swedish fleet that devastated a Russian naval force at Svensksund in 1790.

While engaged as a master shipwright for the galley fleet, Chapman began compiling a pictorial survey of the mid-18th century's most outstanding merchant ships, pleasure and packet boats, ship's small boats, privateers, warships, and alternate types of rigging.

Rough sketches made during his extensive travels through Europe and later observations in Swedish ports were combined, carefully analyzed, re-drawn and then etched on 62 copper plates[1]. These plates encompassed 146 different vessels and, together with descriptions, dimensions and calculations, formed *Architectura Navalis Mercatoria* published in 1768 in Stockholm.[2] Because of the dearth of ship design information available at the time, Chapman's work immediately elevated him to the front-rank of well-known shipwrights. The minutely detailed drawings, almost sufficient for actual construction in an 18th-century shipyard, seem more like works of art today. (See pages 16-17.)

But perhaps most important for ship de-



Frame molds were used by Chapman in the pre fabrication of complex bow and stern sections, which took longer to build than the mid-body. A model of a bow section is shown above. Chapman was probably the first to use sectional assembly shipbuilding on a large scale.

signers of Chapman's time and historians of today is his categorizing of all merchantmen into five groups, not according to sail rig, which opens a hornet's nest of confusion, but using differences in hull construction: *frigate*, flat-sterned where the planking came to an end at the counter beneath the stern's decoration; *hagboat*, planking continued to a transverse beam below the taffrail; and *pink*, small round-stern that narrowed at the rail. These three groups had a beak-headed bow, such as is shown in plate LI. Without a beak-head, and thus considerably more blunt, were the *cat* and the *bark*. The latter two groups also tended to have a fuller, almost U-shaped mid-section, while the breadth of the first three groups tended to be wider at the waterline than on the main deck and have line lines in the after body.

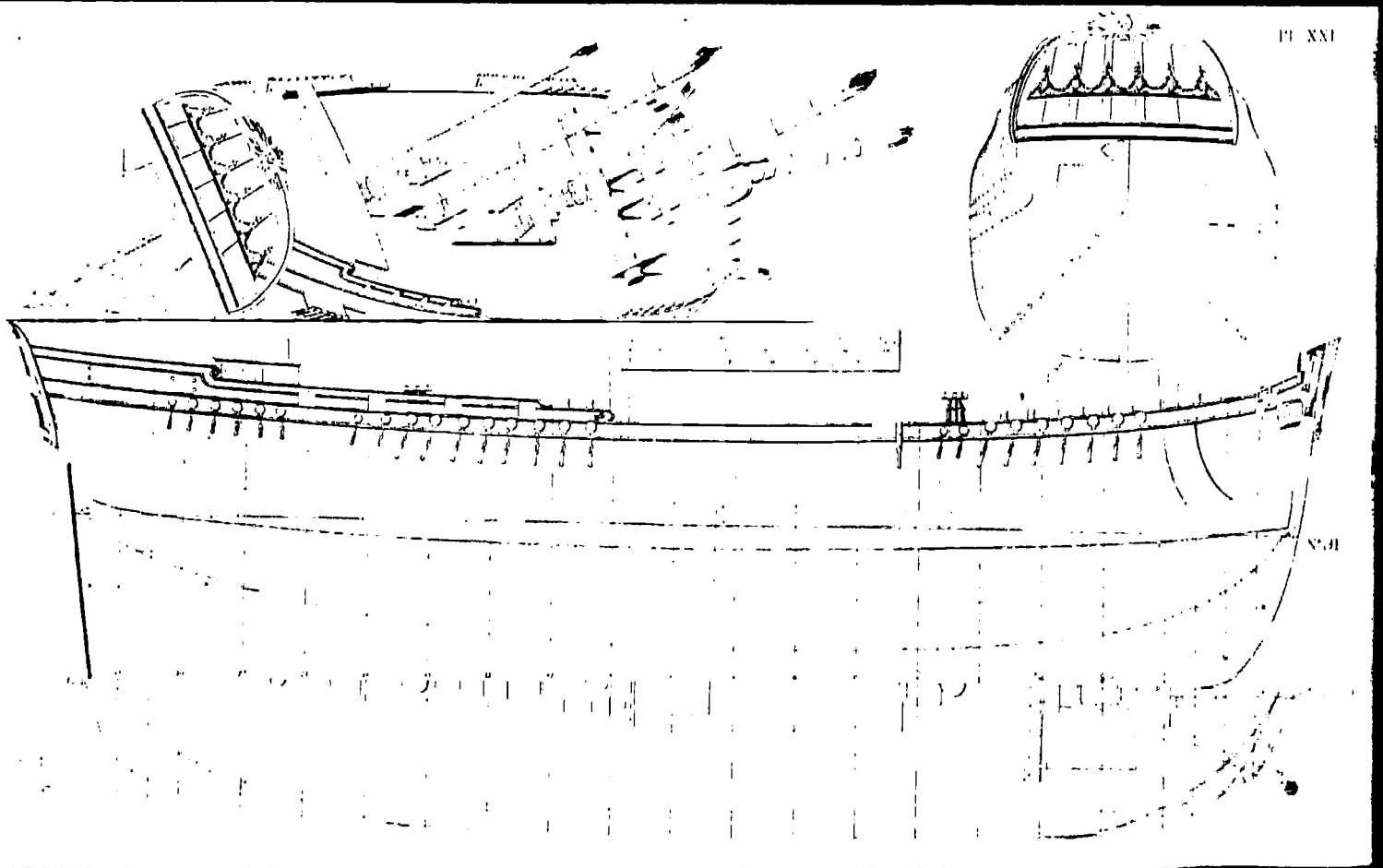
These five major merchant ship categories, carefully defined through construction drawings and dimensions, became well-accepted benchmarks, known quantities on which to compare, criticize and finally progress to an improved design. In addition to known calculations and lines, the book also established a semblance of a uniformity among the confusion of labels for sailing rigs and ship types.

The years following publication of *Archi-*

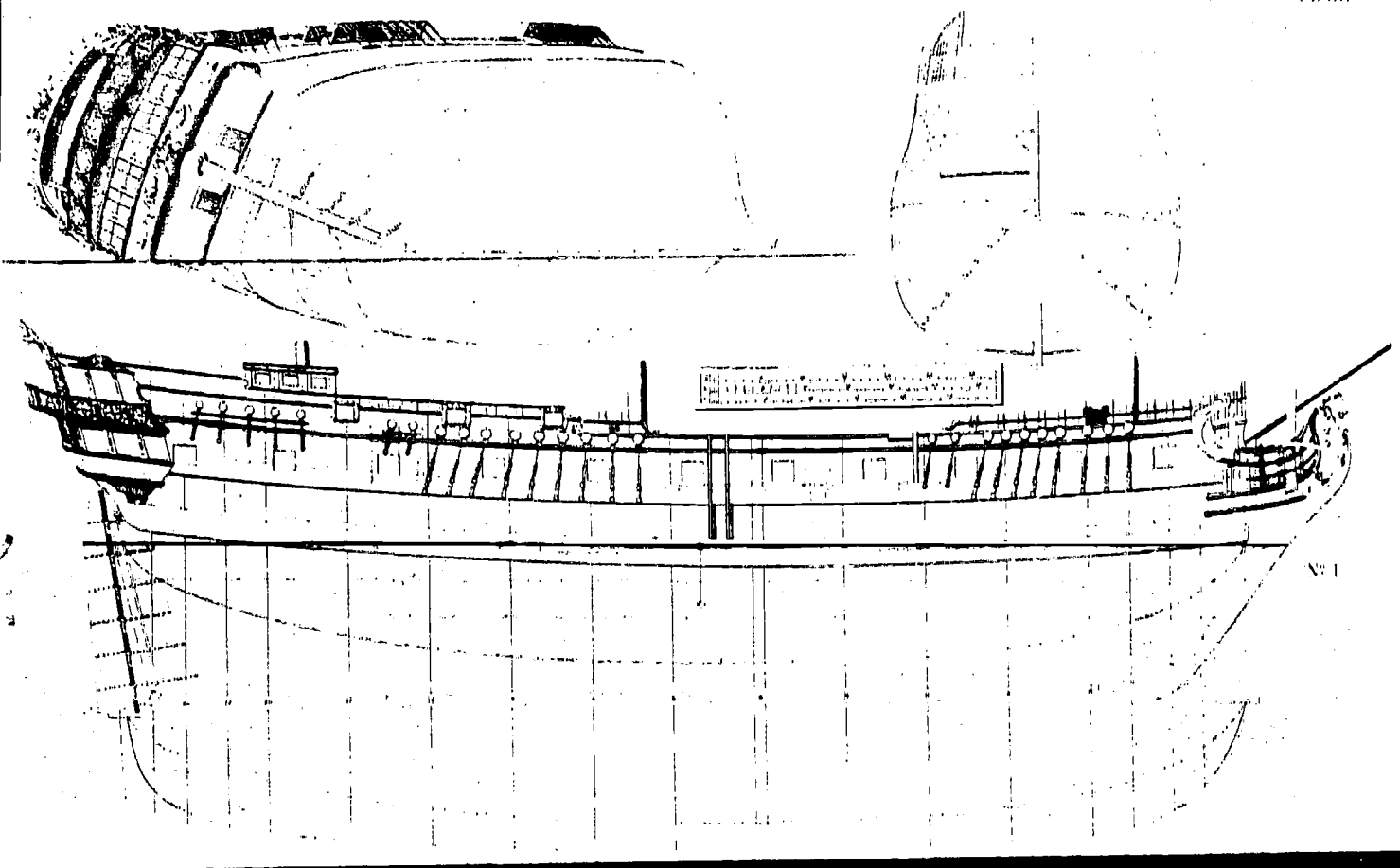
1. It is known that while studying in London between 1750 and 1756 Chapman became skilled in the art of copper engraving. Thus, it would seem that he had planned the publication of *Architectura Navalis Mercatoria* (The Structure of the Merchant Ship) for more than 12 years.

2. One of the few existing first editions of *Architectura Navalis Mercatoria* was purchased some 25 years ago for the American Bureau of Shipping's library. Measuring 34½ x 23¼ in. with original boards and a leather back, all the original copper plate engravings are stitched into the binding, intact after 200 years. In addition, 18th-century leaves explaining the plates in English are pasted in at two places. One is dated 1769. The paper, off-white in color with occasional brown splotches, is still quite strong and flexible.

Ship drawings from Chapman's Architectura Navalis Mercatoria *published 200 years ago.*
Below, Projection of a 1,257-dwt bark in hove down position. Dimensions: 150¾ ft lbp. x 38 ft x 20⅝ ft.
Right, English East Indiaman, hove down projection. Dimensions: 129¾ ft lbp. x 38⅓ ft x 19½ ft.
Bottom Right, An 840-dwt bark measuring 127½ ft lbp. x 32¼ ft x 18⅛ ft.
In the upper right corner of Plate XXIII are the displacement curves for the vessels described on Plates XXI through XXVI. The scales are French, English and Swedish.



PL. LI.



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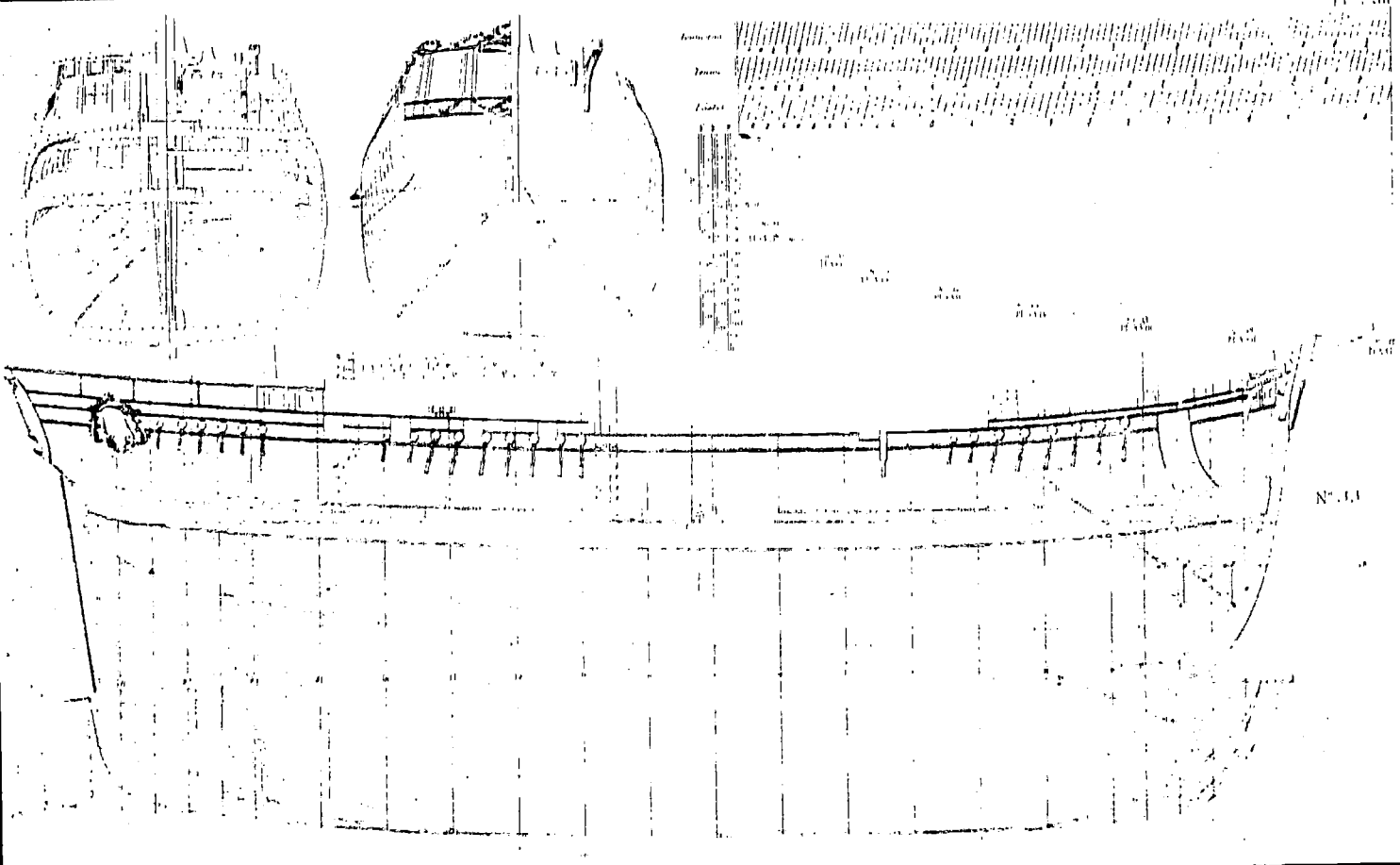

N° 11

tectura Navalis Mercatoria were frenetic but rewarding for Chapman. Withdrawing from his regular navy assignment but still drawing full salary in exchange for supplying ship plans, he joined a Stockholm yard as a partner. While designing and supervising the building of merchant and warships at his yard, Chapman was working on a new book, and developing plans for new lineships and gunsloops. In the midst of these projects in 1772, he was knighted *af* Chapman.

In 1775, he published *A Treatise on Ship-Building*, a remarkable companion piece to *Architectura* filled with a variety of useful formulas and specifications. The two books combined to form what was probably the first complete theory of shipbuilding. He did not originate most of the concepts, but rather he transformed the theoretical research of scientists like Leonard Euler and Pierre Bouguer into a cohesive body of practical information.

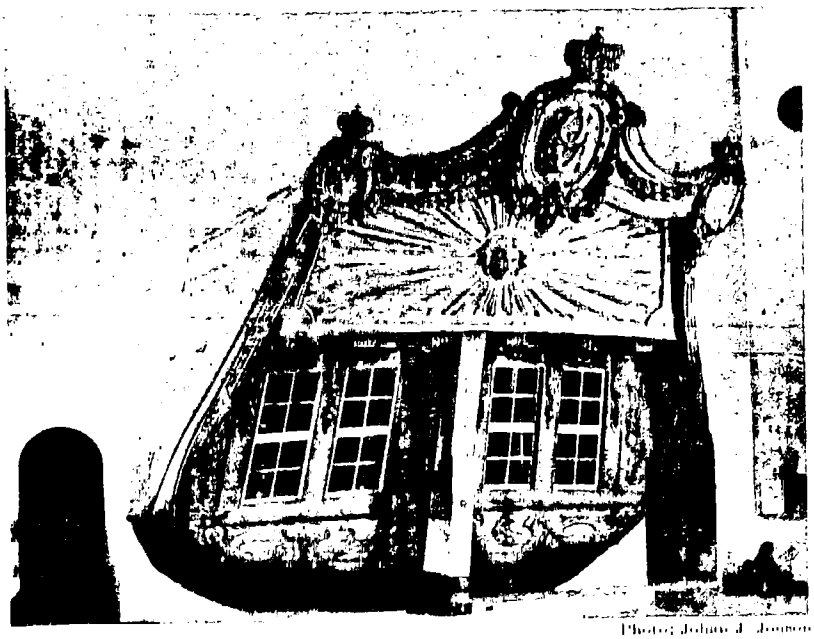

Photo: Johan A. Jonsson

The original transom and stern section of a pleasure-going frigate designed and built by Chapman survives today. Built in 1778 for King Gustaf III, the ship was later turned over to the Swedish Navy and used as a hospital ship. When the vessel was broken up in 1884, the stern and saloon were saved. Now fully restored, it stands in the main entrance hall of the National Maritime Museum in Stockholm. To the left and right are doorways leading to other parts of the museum.

More than 100 years after publication, naval architects still thought enough of his work to attack it as being inconclusive.

Chapman coped with almost every practical problem faced by designers today. His formulas were usually oversimplified but the 18th- and 19th-century shipbuilders were not concerned. Chapman's calculations and techniques produced successful ships.

Using a technique called "parabolic system of construction", Chapman established the first practical method for measuring an irregular curve. Though not quite as accurate as the later Stirling and Simpson methods, Chapman's technique was more than adequate for practical use. Chapman's system was easily applied to determining displacement, sectional areas of the bow and stern sections, center of gravity and carrying capacity.

For 20 years after the *Treatise* was published Chapman continued to build ships and experiment with new techniques. During the construction of 20 ships in a series, Chapman had the bow and stern sections fabricated separately and the mid-body built on adjacent slipways in pairs. This was probably one of the first major applications of sectional assembly, a well-accepted shipbuilding technique today.

Probably Chapman's most outstanding research focused on hull resistance and its crucial relationship to speed. He correctly determined that hull speed is closely related to the way underwater volume or displacement of a vessel is distributed longitudinally.

In one sense, Chapman's work lacked originality. It can be argued that since he did not invent a series of major principles his contributions to naval architecture were minimal. But, on balance, Chapman's main contribution was in serving as a catalyst for precipitating existing but scattered knowledge into an organized, well-structured discipline available to any serious student. When ship design was mostly a matter of chance, Fredrik Henrik af Chapman transformed the field into a predictable art destined in the 20th century to become a precise science. ✦

This large Stockholm shipyard, shown as a model circa 1784, built many ships to Chapman's design.