The loss of stability which results from the diminution of draught of water cannot be compensated by a propor­tionate arrangement of sail, without incurring other evil con­sequences. If the quantity of sail, which at all times is comparatively small in a merchant-ship, be lessened, the wind on the increased hull might so counterbalance its effect, that she would be utterly unable to beat off a lee shore, or make any way on a wind.

A shin is not only subject to a loss in stability when lightened, but becomes laboursome, on account of top-ham­per: her rolling motion is more violent as her diminished depth in the water decreases the resistance which is op­posed to the inclination, and she also generally becomes more leewardly, owing to the difference made in the re­sultant of the resistance, the diminution of the lateral re­sistance, and of her power of carrying sail.

That these effects are to be dreaded, is proved by the enormous loss of lives and property in light merchantmen, and especially light colliers.

Thus, for a ship which is intended for the various pur­poses of commerce, to be at all equal to a ship destined only to sail with a constant lading, more art is required in the design. But though this is a difficulty which opposes itself, it is no bar to progressive improvement, which is evident, as we are now suffering under the effects of such improve­ment, made, under all the same obstacles, by foreign powers.

That the forms of merchant-ships may at all be benefited by the application of that knowledge which is possessed of the principles of naval architecture to their construction, a sacrifice in part must be made of those qualities which have hitherto been considered too exclusively at the expense of others. These are great capacity under small dimensions, and few men to navigate them.

To enable them to sail and work well, their resistance must be diminished and their stability improved by an in­crease of dimensions in comparison with the displacement, by which they would gain in velocity, easiness of motion, power to carry sail, and consequently safety. But this would require a proportionally greater quantity of sail, and of course a larger crew to manage it ; yet as other na­tions possess better ships than ourselves, and have there­fore subjected themselves to this inconvenience of larger crews, that must not be considered as an insurmountable obstacle.

As the body of a ship is not generally any regular figure, the rules which determine the contents of regular solids will give only approximations when applied to finding its con­tent ; but the error arising from the application of the best methods now used for calculating displacements is so small as to be utterly insignificant in practice.

The rules most applicable, and at present most generally applied, to the measuring of curvilinear spaces, by naval architects, are those published by Atwood in the Philoso­phical Transactions of the Royal Society for 1798. “ They are founded on Sir Isaac Newton’s discovery of a theorem, by which, from having given any number of points situated in the same plane, he could ascertain the equation to the curve which would pass through them all ; and by means of this equation was enabled to express the ordinate in the curve corresponding to an abscissa of any given length, as well as the area intercepted between any two of the ordi­nates.”

In order to determine the area of any curvilinear space by these rules, parabolic curves are supposcd to pass through the extremities of a certain number of equidistant ordinates, dependent on the order of the parabola ; for a conic para­bola three ordinates, for a parabola of the third order four ordinates, and so on. It is evident that the correctness of the approximation of the parabolic area to the area of the required curvilinear space, is dependent on the distance be­tween the ordinates ; as on that depends the nearer or the

more remote coincidence of the parabolic curve with the curve bounding the area required. An almost mathema­tical accuracy is attained in naval architectural calculations by assuming the ordinates to be one foot apart, even in those portions of the curvilinear areas in which the alterations of the ordinates are the most rapid, as in the fore, after, and lower parts of the body. But spaces considerably longer than this will be found to give results of great correctness.

Atwood gives eight theorems for measuring curvilinear spaces, two only of which are necessary for the purposes of the naval architect. The first of these is applicable when the number of equidistant ordinates is odd. It is founded on the assumption, that each portion of the curve which passes through the extremities of three successive ordinates is a part of a conic parabola, and that the first of the three ordinates of each succeeding portion is the last of the three ordinates of the preceding portion. It is not necessary in this article to prove the correctness of these rules ; it is suffi­cient to describe their application to the subject of the article.

The first rule is as follows : Measure the lengths of all the equidistant ordinates. Take the sum of the extreme ordi­nates, then take the sum of the second, fourth, sixth, or even ordinates, and multiply it by four ; and then take the sum of the remaining odd ordinates, or the third, fifth, &c., and multiply it by two. To the sum of these two products add the sum of the extreme ordinates, and multiply this sum by one third of the common interval between the ordinates ; the result will be the approximate area required.

The second rule, which is frequently useful, is applicable when the number of ordinates is one greater than a mul­tiple of three. It is founded on the assumption that each portion of the curve which passes through the extremities of four successive ordinates is a part of a cubic parabola, and that the first of the four ordinates of each succeeding portion of the curve is the last of the four ordinates of the preceding portion.

This rule is as follows : Measure the lengths of all the equidistant ordinates. Take the sum of the extreme ordi­nates, then take the sum of those remaining ordinates which are one greater than a multiple of three, as the fourth, se­venth, tenth, &c., and multiply it by two ; and then take the sum of all the remaining ordinates, and multiply it by three. To the sum of these two products add the sum of the extreme ordinates, and multiply this sum by three eighths of the common interval between the ordinates ; the result will be the approximate area required.

Now, if we suppose that we have a solid formed by the revolution of a curve, and that the cubical content of that solid is required, we may first, by the application of either of the before-mentioned rules for obtaining the areas of curvilinear spaces, find the areas of a series of parallel and equidistant sections of the solid. Then, if we consider these areas as expressing ordinates to the abscissa of a curve, we shall have a curvilinear plane surface, the area of which will express the cubical contents of the solid. For it is evident that every increment of the assumed curvilinear area has correctly represented the contemporary increment of the solid.

We have here, then, rules of easy application, by which the areas either of the transverse vertical or the horizontal sections of a ship’s body may be calculated, and by which also, from a series of the areas of either these vertical or these horizontal sections, the cubical content of a homoge­neous solid, of the same shape and bulk as the immersed portion of the ship’s body, may be determined ; which cubi­cal content, multiplied by the specific gravity of water, will give the displacement of the ship.

It will be seen, as we proceed with our subject, that it is necessary to ascertain the position of the centre of gravity of the homogeneous solid of the immersed part of the ship, and also, that in proceeding with the work of designing the