sumptions are only true at an infinitely small angle of incli­nation, and at such only, therefore, is the height of the me­tacentre a correct measure of stability. Atwood, who pub­lished two papers on the stability of floating bodies, in the Philosophical Transactions for the years 1796 and 1798, was the first who pointed out the error in the metacentric measure of stability, and who proved that it was neces­sary to involve the actual content immersed or emerged, and the correct distance between the centres of gravity of the solids of immersion and emersion, in the expression, in order to apply it to the measuring the stability of bodies at finite angles of inclination. It is therefore to him that the theory of ships is indebted for the correct solution of the problem on which the stability at finite angles of incli­nation depends.

Atwood agrees with Bouguer in his general reasoning on the metacentre, and even admits that it may be used at very small angles of inclination, as a sufficiently accurate measure of the stability ; but asserts the danger of its ap­plication to practice as a measure at all angles. He shows that two ships may have precisely the same load water-sec­tion, which, supposing the relative distance between the centres of gravity of the ship and of the displacement equal in both ships, will determine the height of the metacentre to be the same, and consequently, according to the meta­centric theory, the stability to be equal ; and yet, from a difference in the forms of the ships’ bodies within the limits of the immersion and emersion, the moments of stability, when correctly measured, may be very different. But while we state this as the result of Atwood’s inquiry, we must ob­serve, that the practical error between the metacentric me­thod of Bouguer, and the certainly correct method investi­gated by Atwood, is not of any importance for small angles of inclination, especially in large ships ; and further, that a constructor who is acquainted with Atwood’s investigations, and who is therefore aware of the correct principles on which the stability of ships depends, may safely apply the meta­centric method in his practice, as his bodies will be formed in accordance with the results of Atwood’s investigations. It will only be in cases of some important alteration from previously existing form, dimensions, or services, that the labour attendant on the calculations involved in Atwood’s expression will be necessary.

The question may probably be stated to resolve itself nearly into this. That ships might be built, in which the stabilities calculated by the two methods would vary very considerably ; also, that at very great angles of inclination the stabilities of ships, such in form as are sometimes built, would be found to differ very greatly when calculated by the two methode, but that a constructor acquainted with both methods would never construct a ship, using only the me­tacentric method in the progress of his work, which would be proved unstable if Atwood’s calculations were applied to the finished design.

In applying the expression ∫*2*t0 dflc\* the height of the metacentre, we may again have recourse to the rules of approximation. The common rule for obtaining the area of a plane surface may be applied, substituting the cubes of the ordinates of the load water-section instead of the ordinates themselves.

The result will be the value of *y3dx,* and two thirds of this value divided by the displacement will give the height of the metacentre above the centre of gravity of the displacement.

The reader who wishes to refer to cases of stability as connected with particular forms, should consult Atwood’s in the Philosophical Transactions, or rather Mr able simplification of them in the Essays and Gleanings on Naval Architecture, and also his Disquisition on the Metacentre, in Papers on Naval Architecture.

*On the Principal Dimensions of* *a* *Ship.*

In a ship of war the efficiency of the armament is neces­sarily the primary object of the design ; this must therefore determine the dimensions: also, whether in a fleet or in a single ship, the greatest effective force must be obtained at the least expense ; or, as when ships are built, masted, rigged, and their armament completed, all of similar mate­rials, their expenses will vary as their displacements, the object to be attained is the greatest effective force with the least displacement.

But there is another point involved in the question of the efficiency of the armament, which very materially influences the displacement. It is the time for which a ship is intend­ed to maintain her armament in an efficient state, without other aid than that which she can carry. This brings us to the consideration of the variable quantities which are to be added to those before enumerated, to complete the load-displacement. The crew is dependent on the armament alone, and therefore is included in the term armament. But the provisions for this crew, and the stores for the wear and tear of the ship and the service of the guns, are dependent on the time that the ship is intended to remain at sea with­out replenishing these resources. It is evident, that the longer this time, the greater must be the displacement, and, consequently, the larger should be the dimensions in pro­portion to the armament.

It results, from the foregoing reasoning, that the nation with the most wide-spread possessions, and therefore the most frequent opportunities for refitting and replenishing her fleets, has the advantage over all others. For she may maintain equal armaments at less expense, or superior ar­maments at an equal expense ; while she may also avail her­self, in the one case, of additional velocity, which may be attained with the diminished displacement.

Many arguments might be deduced from the same con­siderations in favour of the principle of occasionally design­ing specific ships for specific services. These of course would only apply to the fleets of those nations which aspire to wide-spreading and predominant naval power.

We shall now offer some general remarks on the two di­mensions, the length and the breadth. It will be evident, from the foregoing observations, that the minimum length is the space required for the perfectly efficient working of the guns, and that the minimum breadth is the space re­quired for their recoil and effective service, without hind­rance to the manœuvres of the vessel, in the most disad­vantageous state of weather during which they can be used. This consideration necessarily involves a defined and a suf­ficient moment of stability. These minima are the dimen­sions due to the ship when masted and rigged, and with her armament completed : any increase is dependent on the dis­placement necessary for the additional stowage that may be required for a specific time of service, longer than that time for which the ship, as thus determined, would be ade­quate. Then the increased dimensions due to this increas­ed displacement being ascertained, under the same condi­tions of perfect efficiency in the vessel, any increase of one dimension must be followed by a diminution of the other ; or the displacement, and consequently the expense, will be above the limit required for the armament.

We shall now proceed to show the effect on the quali­ties of the vessel, of the separate increase of either dimension ; always premising, that in each case all things else are sup­posed to remain the same, excepting the dimension under consideration. First, then, the length. The displacement, the stability, and the resistance to leeway, vary directly as the length ; therefore we increase all these qualities in pro­portion to the additional length. But we also increase the violence of pitching and scending ; for the momenta of the weights in the fore and after bodies vary as the squares of