vertical section of the body. Consequently, when a ship is floating on the water in a state of rest, and only acted upon by the upward pressure of the water, the centres of gravity of the ship and of the displacement are in the ver­tical middle line of the same transverse vertical section. But when the ship is inclined by the action of some second force, as that of the wind, a part of the body which was previously immersed is emerged, and a part which was above the surface of the water is immersed ; consequently the form of the portion of the body under the water is al­tered, and the centre of gravity of the displacement is car­ried over towards that side on which the increased immer­sion has taken place, while the position of the centre of gra­vity of the ship, with reference to its position in the ship, has remained unaltered, that being the point about which the revolution has taken place. But though the form of that part of the ship’s body which is beneath the surface of the water after the inclination, will differ from the form of that which was beneath the surface before the inclination, the total displacement will continue the same, since the weight of the ship has not been either increased or dimi­nished by the inclination ; consequently the solid con­tent, or the displacement of that portion of the body which is immersed by the inclination, will be exactly equal to the solid content, or the displacement of that portion which is emerged by the same cause. But the forms of these two solids, which we shall call the solids of immersion and emersion, are not necessarily similar, and therefore their centres of gravity are not necessarily situated in the same transverse vertical section of the vessel. If the centres of gravity of these two solids should be situated in the same transverse vertical section, the inclination of the ship will be round her longitudinal axis ; but if the centre of gra­vity of the solid of immersion be situated either before or abaft the transverse vertical section in which the centre of gravity of the solid of emersion is situated, in either case the motion of the ship in performing the inclination cannot be round an axis coincident with its longitudinal axis; and the position of the centre of gravity of the displacement, in passing to leeward of the position which it occupied before the inclination took place, will be influenced by the rela­tive situations of the centres of gravity of these solids of immersion and emersion. As this irregularity of motion is injurious to the ship, it is desirable to obviate it by regu­lating the form of the body, both above and below the load water-section, in such a manner that the centres of gravity of the solids of immersion and emersion may be in the same transverse vertical section of the ship. The form of that part of the body situated above and below the load water-line is also dependent upon the following considera­tions. Although the total displacement after the inclina­tion must necessarily be the same as that before the incli­nation, the shape of the ship’s body may be such that there will be a tendency to immerse a greater or a less solid on the one side than is emerged on the other ; which tendency will have the effect of causing the axis of rotation, and con­sequently the centre of gravity of the ship, to rise or fall in space during the inclination, and fall or rise in space dur­ing the return to the upright position ; for since the total displacement of the ship continues constant, the solid which is actually immersed cannot exceed that which has emerged.

It is therefore evident that the existence and extent of this motion must depend upon the position of the centre of gravity of the ship, and also on the form of those parts sub­ject to alternate immersion and emersion. For the better illustration of this point, we will suppose a ship of such a form, that when she is floating upright on the water, her sides between wind and water, that is, those parts of her sides subject to the alternate immersion and emersion, are vertical. We will first assume that the centre of gravity of this ship is coincident with the centre of gravity of the

load water-section. In this case there will evidently be no tendency in the ship either to rise or fall during the inclina­tion, because the two prismatic solids intercepted between the load water-sections before and after the inclination are equal, and the axis of revolution of the ship is coincident with the line of intersection of the two load water-sections. Now, if we assume the centre of gravity of the ship to be situated beneath the load water-section, and the inclination to take place, this centre being the axis of inclination, there would be a much larger solid immersed than was emerged, be­cause the line of intersection of the two load water-sections would be to windward of the longitudinal vertical section of the ship ; but in order to restore the equilibrium be­tween the upward pressure of the water and the weight of the ship, the axis of rotation or centre of gravity of the ship must rise until these two solids become equal. Again, in the case when the centre of gravity of the ship is situ­ated above the load water-section, it will be evident that the tendency of the inclination of the ship round it would be to raise a larger solid out of the water than would be immersed on the other side, unless the weight of the ship, in its effort to restore the equilibrium between the upward pressure of the water and itself, were to cause the centre of gravity of the ship to be lowered until the two solids became equal. Now, if we suppose the sides of this same ship were formed in such a manner as to fall outwards from the load water-section upwards, we shall easily perceive, that in the case where the centre of gravity was supposed to be beneath the load water-section, the injurious quality would be increased ; while in the case in which it was sup­posed that the centre of gravity was above the load water- section, it would be diminished. The foregoing examples are sufficient to illustrate the principle on which this cause of uneasiness of motion in a ship depends, and also to point out the means which must be taken to obviate it. We see, then, that it is essential, not only that the centres of gravity of the solids of immersion and emersion should be in the same transverse vertical section, but also that these solids should be as nearly equal to each other at all incli­nations as possible, and that the greater the deviation from equality between the solids of immersion and emersion, the greater the strain the ship will be subjected to, and the greater will be the uneasiness of her motions.

In order to obviate this fault, it would be necessary to compute the exact position of the centre of gravity of the ship when completely ready for sea, that the correct pris­matic solids of immersion and emersion might be ascertain­ed and adjusted to equality, and to have their centres of gravity in the same transverse vertical section. But the computation of the exact position of the centre of gravity of a ship completely fitted is a task of such magnitude, and, in consequence, of such hazard of incorrectness, that it can scarcely be considered practicable. Its position must be de­termined in relation to the three dimensions, length, breadth, and depth ; relatively to two of these, however, it is ascer­tained from the consideration that it is necessarily in the same transverse vertical section as the centre of gravity of the displacement, and that, as it must also evidently be in the longitudinal vertical section of the ship, it must be in the line of intersection of this transverse vertical section with the longitudinal vertical section of the ship. But its position in relation to the load water-section, if not deter­mined by experiment, must be ascertained by a most te­dious and laborious calculation of the moments of the weights estimated from the load water-section, the sum-total of which moments being divided by the displacement of the ship, will give the perpendicular distance of the centre of gravity from the load water-section. This process has been gone through for several two-decked line-of-battle ships at the late School of Naval Architecture, and it was ascertain­ed that the positions of their centres of gravity varied from