if we take the experiments of the French academicians as proper measures of the oblique impulses of the wind on the sail, we will brace up the yard to an angle of 48 degrees with the keel. The impulse corresponding to 48 is 615, and the cosine of 48° is 669∙ These give a product of 411 435. If we brace the sail to 54∙44, the angle assigned by the theory, the effective impulse is 405 274. If we make the angle 45°, the impulse is 408 774. It appears then that 48° is preferable to either of the others. But the difference is inconsiderable, as in all cases of maximum a small devia­tion from the best position is not very detrimental. But the difference between the theory and this experimental measure will be very great when the impulses of the wind are of ne­cessity very oblique. Thus, in tacking ship, as soon as the headsails are taken aback, they serve to aid the evolution, as is evident : But if we were now to adopt the maxim in­culcated by the theory, we should immediately round in the weather-braces, so as to increase the impulse on the sail, be­cause it is then very small ; and although we by this means make the yard more square, and therefore diminish the ro­tatory momentum of this impulse, yet the impulse is more increased (by the theory) than its vertical lever is diminish­ed.—Let us examine this a little more particularly, because it is reckoned one of the nicest points of seamanship to aid the ship’s coming round by means of tire headsails ; and ex­perienced seamen differ in their practice in this manœuvre. Suppose the yard braced up to 40°, which is as much as can be usually done, and that the sail shivers, (the bowlines are usually let go when the helm is put down), the sail imme­diately takes aback, and in a moment we may suppose an incidence of 6 degrees. The impulse corresponding to this is 400, (by experiment), and the cosine of 40° is 766. This gives 306 400 for the effective impulse. To proceed ac­cording to the theory, we should brace the yard to 70°, which would give the wind (now 34° on the weather-bow) an inci­dence of nearly 36°, and the sail an inclination of 20° to the intended motion, which is perpendicular to the keel. For the tangent of 20° is about 1/2 of the tangent of 36°. Let us now see what effective impulse the experimental law of ob­lique impulsions will give for this adjustment of the sails. The experimental impulse for 36° is 480 ; the cosine of 70° is 342; the product is 164 160, not much exceeding the half of the former. Nay, the impulse for 36°, calculated by the theory, would have been only 346, and the effective im­pulse only 118 332. And it must be farther observed, that this theoretical adjustment would tend greatly to check the evolution, and in most cases would entirely mar it, by check­ing the ship’s motion a-head, and consequently the action of the rudder, which is the most powerful agent in the evolu­tion ; for here would be a great impulse directed almost astern.

We were justifiable, therefore, in saying, in the beginning of this article, that a seaman would frequently find himself baffled if he were to work a ship according to the rules de­duced from M. Bouguer’s work ; and we see by this instance of what importance it is to have the oblique impulsions of fluids ascertained experimentally. The practice of the most experienced seamen is directly the opposite to this theore­tical maxim, and its success greatly confirms the usefulness of these experiments of the academicians so often praised by us.

We return again to the general consideration of the ro­tatory motion. We found the velocity v= — i It is

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therefore proportional, *cæteris paribus,* to *q*G. We have seen in what manner *qG* depends on the position and situa­tion of the sail or rudder when the point G is fixed. But it also depends on the position of G. With respect to the action of the rudder, it is evident that it is so much the more powerful, as it is more remote from G. The distance

from G may be increased either by moving the rudder farther aft or G farther forward. And as it is of the utmost importance that a ship answer her helm with the greatest promptitude, those circumstances have been attended to which distinguished fine steering ships from such as had not this quality ; and it is in a great measure to be ascribed to this, that, in the gradual improvement of naval architecture, the centre of gravity lias been placed far forward. Perhaps the notion of a centre of gravity did not come into the thoughts of the rude builders in early times ; but they ob­served that those boats and ships steered best which had their extreme breadth before the middle point, and conse­quently the bows not so acute as the stem. This is so con­trary to what one would expect, that it attracted attention more forcibly ; and, being somewhat mysterious, it might prompt to attempts of improvement, by exceeding in this singular maxim. We believe that it has been carried as far as is compatible with other essential requisites in a ship.

We believe that this is the chief circumstance in what is called the trim of a ship ; and it were greatly to be wished that the best place for the centre of gravity could be accu­rately ascertained. A practice prevails, which is the oppo­site of what we are now advancing. It is usual to load a ship so that her keel is not horizontal, but lower abaft. This is found to improve her steerage. The reason of this is ob­vious. It increases the acting surface of the rudder, and allows the water to come at it with much greater freedom and regularity ; and it generally diminishes the griping of the ship forward, by removing a part of the bows out of the water. It lias not always this effect ; for the form of the harping aloft is frequently such, that the tendency to gripe is diminished by immersing more of the bow in the water.

But waving these circumstances, and attending only to the rotatory energy of the rudder, we see that it is of advantage to carry the centre of gravity forward. The same advantage is gained to the action of the after sails. But, on the other hand, the action of the headsails is diminished by it ; and we may call every sail a headsail whose centre of gravity is before the centre of gravity of the ship ; that is, all the sails hoisted on the bowsprit and foremast, and the staysails hoist­ed on the mainmast ; for the centre of gravity is seldom far before the mainmast.

Suppose that when the rudder is put into the position AD, (fig. 11), the centre of gravity could be shifted to *g,* so as to increase *qG,* and that this is done widout increas­ing the sum of the products *pr2.* It is obvious that the ve­locity of conversion will be increased in the proportion of *qG* to *qg.* This is very possible, by bringing to that side of the ship parts of her loading which were situated at a dis­tance from G on the other side. Nay, we can make this change in such a manner that *∫pr2* shall even be less than it was before, by taking care that every thing which we shift shall be nearer to *g* than it was formerly to G. Suppose it all placed in one spot *m,* and that *m* is the quantity of mat­ter so shifted, while M is the quantity of matter in the whole ship. It is only necessary that *m∙ gG2* shall be less dιan the sum of the products *pr2,* corresponding to the matter which has been shifted. Now, although the matter which is easily moveable is generally very small in comparison to the whole matter of the ship, and therefore can make but a small change in the place of the centre of gravity, it may frequently be brought from places so remote that it may oc­casion a very sensible diminution of the quantity *∫pr2,* which expresses the whole momentum of inertia.

This explains a practice of the seamen in small wherries or skiffs, who, in putting about, are accustomed to place themselves to leeward of the mast. They even find that they can aid the quick motions of these light boats by the way in which they rest on their two feet, sometimes leaning all on one foot, and sometimes on the other. And we have