tecture which, labouring under the difficulties attendant on our imperfect knowledge of fluids, cannot be attained by theory alone. It will now be shown that, by the aid of theory, sufficient deductions may be made from experiment to remedy its practical insufficiency. Throughout the fore­going considerations, the sails have been reasoned on as if they were plane surfaces. If this were the case, their centre of effort would coincide with their common centre of gravi­ty ; but, from the flexibility of the materials of which they are made, the sails become, when acted upon by the force of the wind, curved surfaces. However, from the whole surface of sail with respect to height being composed of several such surfaces, the error arising in practice from as­suming the height of the common centre of gravity of the whole surface to be the height of the centre of effort, will be very inconsiderable; therefore, in practice the centre of effort of the sails may be represented, with respect to height, by their common centre of gravity.

Since we know, from the principles which have been ex­plained, that when the centre of effort of the sails is at the true height of sail, the trim of the ship will not be subject­ed to alteration by any increase or diminution in the force of the wind, the height of sail for any trim may be deter­mined by experiment, by first bringing the ship to that trim when she is at rest, and then adjusting the sails so that her water-line when in motion may be parallel to this trim. This being admitted, it is evident that, by proceeding on the principles already explained in this article, the maxi­mum of advantage arising from the correct position of the centre of effort of the sail may be insured, by first ascer­taining, from experiment and observation made with re­ference to the longitudinal position of the centre of effort with respect to the centre of gravity of the ship, the most advantageous draught of water, and then determining the correct height of sail with respect to that draught, of water.

The observations necessary to effect these objects will require considerable patience and attention ; but it must be considered that they will not only enable a commander to derive the greatest possible advantage from the means at his disposal, but that they will afford correct data for per­fecting those means. The following observations may suffice to explain the principle which should be pursued. The draught of water previous to sailing should be observed ; and an instrument which will correctly measure the angle of inclination should be fixed, in reference to this water­line, so that by means of it every deviation from this trim may be exactly known. This is rendered absolutely neces­sary, because, when a ship is in motion, her correct trim, that is, her horizontal water-line, cannot be observed, in consequence of the accumulation and depression of the wa­ter which is caused by the motion. In fact, any alteration made in the trim of the ship or the sails, founded on obser­vations made with reference to the apparent water-line, might be extremely hazardous, and certainly woιdd not produce the results expected, as the position of this water­line depends wholly on the circumstances which are in im­mediate operation. Having the instrument fixed, when the ship has acquired a uniform velocity observe the alteration which has taken place in her trim, as, until the velocity is uniform, the trim will be influenced by the force which ac­celerates the velocity. Then, if her longitudinal oscillations or her pitching motions appear to be only influenced by the state of the sea, the centre of effort is correctly placed at the height of sail. Therefore the height of the centre of gravity of the surface of sail set, will give the height of sail. But if at every change in the force of the wind the vessel experi­ences a sudden increase of longitudinal oscillation, observe by the instrument its nature and degree, and make such a change in the adjustment of the sails as the foregoing prin­ciples have shown to be necessary ; and when the tendency to increased longitudinal oscillation ceases, find the height of sail by calculating the height of the centre of gravity of the surface of sail then set. In this manner the correct height of sail for any trim may be found ; while, by observing at the same time the comparative qualities of the ship when at each of these trims (after the height of sail is determined for it), that trim of the ship and sails may be determined at which a maximum of advantage may be derived from the inherent good qualities of the ship, as far as the perfection of the *matériel* will admit, that is, as far as the position and pro­portion of the masts, yards, and sails, are adapted to the ele­ments of the construction of the ship’s body ; while from knowing the best trim of the ship, and the true position of the centre of effort under the several circumstances of wind and sea, the naval architect will be in possession of sufficient data to make such alterations in the *matériel* as shall then insure a maximum of advantage with a maximum of the means. In fact, correct observations of this nature would go very far to remove much of the difficulty which theory, in its application to some points in the practice of naval archi­tecture, at present labours under.

The laws which govern the mutual action of the wind and water on a ship when she is in motion have now been ex­plained, principally as they affect her equilibrium round a vertical or a horizontal axis of rotation ; because by point­ing out the various states of equilibrium which result be­tween the action of the wind on the sails and the water on the hull, we are enabled to show the effects which may be produced on the qualities of the ship by modifications in these equilibrio ; either by the use of the helm, by altera­tions in the trim of the ship, in the quantity of the sail set, or in the disposition of that quantity, so that in the various changes which may take place in the state of the wind or of the sea, the qualities of the vessel may either experience the least possible injurious effect, or the greatest possible degree of benefit, according as the tendency of the change may be injurious or beneficial. In pursuing this train of reasoning, we have also endeavoured to explain in what manner the principles that govern the mutual action of these forces may be made available in directing such ob­servations on the performances of ships as may lead to the formation of correct conclusions on tl>eir powers and quali­ties, and guide us to the best means of rendering these qua­lities most easily available. It has also been shown, that by experiments and observations made according to the prin­ciples which have been advanced, a maximum of advantage may be obtained from a ship, as far as the form, the fitness of the proportions and positions of the masts and yards, the proportions of the sails, and the trim of the vessel, will admit; and, what is yet more important, that sufficient data may be obtained to enable the naval architect to judge correctly of the comparative perfection of those means, and so to form correct conclusions as to such deviations from them, as would either tend to their improvement or to obviate similar de­fects in a future design.

It is evident, that whatever may be the service required from a vessel, there must always be some maximum of ef­ficiency with reference to those services, which is to be arrived at by a judicious combination of the powers of the vessel with the means which call them into action. The distinguishing division of the characteristics of the qualities required in vessels are mainly those peculiar to burden and those peculiar to velocity. In England, for the last century, we may say that burthen, to the sacrifice of every other quality, nay, even to an extent compromising the safety of the vessel and the lives of the crew, has been the solitary requirement in the design of a merchant-ship.

In ships of war, under almost all circumstances, it is a combination of the two which is the desideratum ; and it is not sufficient that a vessel should be only capable of great velocity in direct courses, or when the propelling force acts in the direction of the keel ; for it is in most cases of more