to be in the proportion of the ſquare of the fine of the angle of incidence; and that its action on any ſmall portion, ſuch as a ſquare foot of the ſails or hull, is the ſame as if that portion were detached from the reſt, and were expoſed, single and alone, to the wind or water in the same angle. But we have ſhown, in the article RESISTANCE *of Fluids,* both from theory and experience, that both of theſe principles are erroneous, and this to a very great degree, in caſes which occur moſt fre­quently in practice, that is, in the ſmall angles of in­clination. When the wind falls nearly perpendicular on the ſails, theory is not very erroneous; but in theſe caſes, the circumſtances of the ſhip’s ſituation are gene­rally ſuch that the practice is eaſy, occurring aimoſt without thought; and in this caſe, too, even conſiderable deviations from the very beſt practice are of no great moment. The intereſting caſes, where the in­tended movement requires or depends upon very ob­lique actions of the wind on the ſails, and its practica­bility or impracticability depends on a very ſmall varia­tion of this obliquity; a miſtake of the force, either as to intenſity or direction, produces a mighty effect on the resulting motion. This is the caſe in ſailing to windward; the most important of all the general pro­blems of ſeamanſhip. The trim of the ſails, and the courſe of the ſhip, ſo as to gain moſt on the wind, are very nice things; that is, they are confined within very narrow limits, and a ſmall miſtake produces a very conſiderable effect. The ſame thing obtains in many of the nice problems of tacking, box-hauling, wearing af­ter lying-to in a ſtorm, &c.

The error in the ſecond aſſertion of the theory is ſtill greater, and the action on one part of the ſail or hull is ſo greatly modified by its action on another adjoining part, that a ſtay-ſail is often ſeen hanging like a looſe rag, altho’ there is nothing between it and the wind; and this merely becauſe a great ſail in its neighbourhood ſends off a lateral ſtream of wind, which completely hinders the wind from getting at it. Till the theory of the action of fluids be eſtabliſhed, therefore, we cannot tell what are the forces which are acting on every point of the ſail and hull: Therefore we cannot tell either the mean intenſity or direction of the whole force which acts on any particular ſail, nor the intenſity and mean direction of the reſiſtance to the hull; circumſtances abſolutely neceſſary for enabling us to ſay what will be their energy in producing a rotation round any particu­lar axis. In like manner, we cannot, by ſuch a com­putation, find the ſpontaneous axis of converſion (ſee Rotation), or the velocity of ſuch converſion. In ſhort, we cannot pronounce with tolerable confidence *à priori* what will be the motions in any caſe, or what diſpoſitions of the ſails will produce the movement we wiſh to perform. The experienced ſeaman learns by habit the general effects of every diſpoſition of the ſails; and though his knowledge is far from being accurate, it ſeldom leads him into any very blundering operation. Perhaps he ſeldom makes the beſt adjuſtment poſſible, but ſeldomer ſtill does he deviate very far from *it*; and in the moſt general and important problems, ſuch as working to windward, the reſult of much experience and many corrections has ſettled a trim of the ſails, which is certainly not far from the truth, but (it muſt ſee acknowledged) deviates widely and uniformly from

the theories of the mathematician’s clofet. The honest tar, therefore, muſt be indulged in his joke on the uſeleſs labours of the mathematician, who can neither hand, reef, nor ſteer.

After this account of the theoretical performances in the art of ſeamanſhip, and what we have ſaid in an­other place on the ſmall hopes we entertain of ſeeing a perfect theory of the impulſe of fluids, it will not be ex­pected that we enter very minutely on the ſubject in this place; nor is it our intention. But let it be obſerved, that the theory is defective in one point only; and although this is a moſt important point, and the er­rors in it deſtroy the conduirons of the chief propoſitions, the reaſonings remain in full force, and the *modus operandi* is preciſely ſuch as is ſtated in the theory. The *principles* of the art are therefore to be found in theſe treatiſes; but falſe inferences have been drawn, by com­puting from erroneous quantities. The rules and the practice of the computation, however, are ſtill beyond controverſy: Nay, ſince the proceſs of inveſtigation is legitimate, we may make uſe of it in order to diſcover the very circumſtance in which we are at preſent miſtaken; for by converting the propoſition, inſtead of finding the motions by means of the ſuppoſed forces, combined with the known mechaniſm, we may diſcover the forces by means of this mechaniſm and the obſerved motions.

We ſhall therefore in this place give a very general view of the movements of a ſhip under ſail, ſhowing how they are produced and modified by the action of the wind on her ſails, the water on her rudder and on her bows. We ſhall not attempt a preciſe determina­tion of any of theſe movements; but we ſhall ſay enough to enable the curious landſman to underſtand how this mighty machine is managed amidſt the fury of the winds and waves: and, what is more to our wiſh, we hope to enable the uninſtructed but thinking ſeaman to generaliſe that knowledge which poſſeſſes; to claſs his ideas, and give them a ſort of rational ſyſtem; and even to improve his practice, by making him ſensible of the im­mediate operation of every thing he does, and in what manner it contributes to produce the movement which he has in view.

A ſhip may be conſidered at preſent as a maſs of in­ert matter in free ſpace, at liberty to move in every di­rection, according to the forces which impel or refill her: and when ſhe is in actual motion, in the direction of her courſe, we may ſtill conſider her as at reſt in abſolute ſpace, but expoſed to the irnpulſe of a current of water moving equally faſt in the oppoſite direction: for in both caſes the preſſure of the water on her bows is the ſame; and we know that it is poſſible, and fre­quently happens in currents, that the impulſe of the wind on her ſails, and that of the water on her bows, balance each other ſo preciſely, that ſhe not only does not ſtir from the place, but alſo remains ſteadily in the ſame poſition, with her head directed to the ſame point of the compaſs. This ſtate of things is eaſily conceived by any perſon accuſtomed to conſider mechanical ſubjects, and every ſeaman of experience has obſerved it. It is of importance to conſider it in this point of view, becauſe it gives us the moſt familiar notion of the man­ner in which theſe forces of the wind and water are ſet in opposition, and made to balance or not to balance