often seen this evolution very sensibly accelerated in a ship of war, by the crew running suddenly, as the helm is put down, to the lee-bow. And we heave heard it asserted by very expert seamen, that after all attempts to wear ship (af­ter lying-to in a storm) have failed, they have succeeded by the crew collecting themselves near the weather fore­shrouds the moment the helm was put down. It must be agreeable to the reflecting seaman to see this practice sup­ported by undoubted mechanical principles.

It will appear paradoxical to say that the evolution may be accelerated even by an addition of matter to the ship ; and though it is only a piece of curiosity, our readers may wish to be made sensible of it. Let *m* be the addition, placed in some point *m* lying beyond G from *q.* Let S be the spontaneous centre of conversion before the addition. Let *v* be the velocity of rotation round *g,* that is, the velo­city of a p ∣int whose distance from *g* is 1, and let *e* be the radius vector, or distance of a particle from *g.* We have

(ROTATION, No. 22.)«= -—., --if s. But we know

*fPc+m'm9*

(Rotation, No. 23.) that *fpe=J'pr2-}-'M ∙Gg,.* There­fore *v— -—5—~~.. J?~~* 5. Let us determine *Gg*

*∣pr1 + U∙Gg2+m∙mg2* and *tng* and *qg.*

Let *mG* be called *z.* Then, by the nature of the centre of gravity, M -f-m: M=Gwι : *gm∙=zz : gm,* and *grn= -¾,*

and *m ∙ gmi∙= - ■ zt.* In , like manner, M ∙ *Ggi =*

M -∣- *m)*

AIz∕i^

- —.r1. Now mM,+m,M= Mm × M-f-n∙. Therefore M+m)

,r r, 2 . 2 Mm×(M + m) .. Mm , τ ι

M ∙ *Ggt+rn ■ gnr=— -* —⅛-ri. = vi *z2.* Let *u*

M + >m), M + m

be = jj— , then *⅛i ∙ Gg2+m ∙ gmt=Mnz2.* Also Gy

=nr, being = LetçG becalledc.∙ then*qg=c+nz.*

Also let SG be called *e.*

We have now for the expression of the velocity t>=

F(c-∣-rtι) F c+nz „ zll

Τ~~Ί ■ >r~~^i∙ orι, = π × Z- 2 ∙ But (ROTATION,

*Ppri+lAnz2* M *fpr- κ*

ΙiΓ+nι2

Νο.30.)“(Τ *—ce.* Therefore, finally, c= × —.

Μ M *cc-f-nz2*

Had there been no addition of matter made, we should have F *c*

had *v= — × —.* It remains to shew, that *z* may be so M *cc*

*C C A-7lZ*

taken that — may be less than ». Now, if c be to

*ce ce+nz\**

*z* as *ce* to *z2,* that is, if *z* be taken equal to *e*, the two frac­tions will be equal. But if *z* be less than *e,* that is, if the additional matter is placed anywhere between S and G, the

complex fraction will be greater than the fraction —, and *ce*

the velocity of rotation will be increased. There is a par­ticular distance which will make it the greatest possible, namely, when *z* is made = ~ (s∕c2+ncc—c), as will easily

be found by treating the fraction c^^^wg⅛, with *z*, consi- *ce-j-nz*

dered as the variable quantity, for a maximum. In what we have been saying on this subject, we have considered the rotation only in as much as it is performed round the centre of gravity, although in every moment it is really per­formed round a spontaneous axis lying beyond that centre. This was done because it afforded an easy investigation, and any angular motion round the centre of gravity is equal to the angular motion round any other point. Therefore the extent and the time of the evolution are accurately defin­ed. From observing that the energy of the force F is pro­portional to *qG,* an inattentive reader will be apt to conceive the centre of gravity as the centre of motion, and the rota­tion as taking place, because the momenta of the suits and rudder, on the opposite sides of the centre of gravity, do not balance each other. But we must always keep in mind that this is not the cause of the rotation. The cause is the want of equilibrium round the point C, (fig. 10), where the ac­tions of the water balance each other. During the evolu­tion, which consists of a rotation combined with a progres­sive motion, this point C is continually shifting, and the un­balanced momenta which continue the rotation always re­spect the momentary situation of the point C. It is never­theless always true, that the energy of a force F is propor­tional, *cæteris paribus,* to *qG,* and the rotation is always made in the same direction as if the point G were really the centre of conversion. Therefore the mainsail acts always (when oblique) by pushing the stern away from the wind, although it should sometimes act on a point of the vertical lever through C, which is a-head of C.

These observations on the effects of the sails and rudder in producing a conversion, are sufficient for enabling us to explain any case of their action which may occur. We have not considered the effects which they tend to produce by inclining the ship round a horizontal axis, viz. the mo­tions of rolling and pitching. (See Rolling and Pitchino.) To treat this subject properly would lead us into the whole doctrine of the equilibrium of floating bodies, and it would rather lead to maxims of construction than to maxims of manœuvre. M. Bouguer's *Traité du Navire* and Euler’s *Scientia Navalis* are excellent performances on this sub­ject, and we are not here obliged to have recourse to any erroneous theory.

It is easy to see that the lateral pressure both of the wind on the sails and of the water on the rudder tends to incline the ship to one side. The sails also tend to press the ship’s bows into the water, and, if she were kept from advancing, would press them down considerably. But by the ship’s motion, and the prominent form of her bows, the resistance of the water to the fore part of the ship produces a force which is directed upwards. The sails also have a small tendency to raise the ship, for they constitute a surface which in general separates from the plumb-line below. This is remarkably the case in the staysails, particularly the jib and fore-topmast staysail. And this helps greatly to soften the ship’s bows into the head seas. The upward pressure also of the water on her lκ>ws, which we just now mention­ed, has a great effect in opposing the immersion of the bows which the sails produce by acting on the long levers fur­nished by the masts. M. Bouguer gives the name of *point velique* to the point V (fig 12.)

of the mast, where it is cut by the line CV, which marks the mean place and direction of the whole impulse of the water on the bows. And he ob­serves, that if the mean di­rection of all the actions of the wind on the sails be made to pass also through this