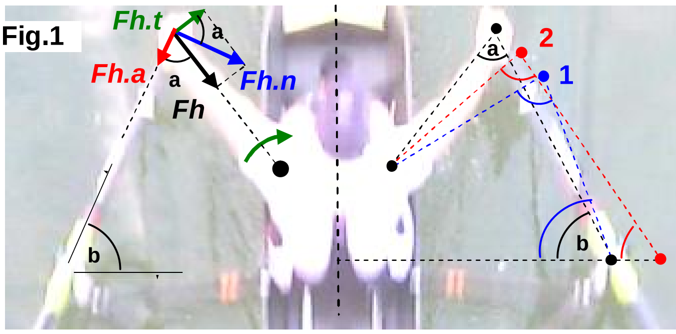
Dynamic analysis in horizontal plane. Part II.

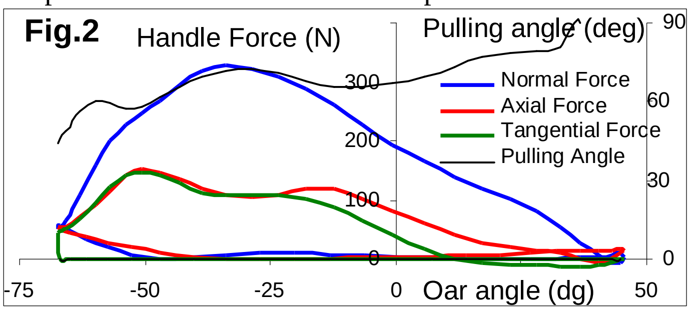
We received very positive feedback on our previous Newsletter and continue discussing forces in the horizontal plain. Stephen Aitken, a coach at TSS club, asked: **could scullers use their pectorals at the catch** to increase the normal component of the handle force?

Yes, in sculling, bringing the arm together at the beginning of the drive, i.e. applying some inwards torque at the shoulder using pectorals muscles could be useful. This torque creates a tangential force at the handle ***Fh.t*** in the perpendicular direction to the arm (Fig.1). To make the resultant force perpendicular to oar, ***Fh.t*** must have the following proportion to the pulling force ***Fh*** and angle ***a***:

Fh.p = Fh / tan(a) **(1)**



The Fig.2 shows that amount of the tangential force ***Fh.t***, which is required to make the pulling angle straight and completely eliminate the axial force ***Fh.a***. The data from the previous Newsletter was used of the same LM1x at 33 str/min. It can be seen, that hypothetical ***Fh.t*** is very close to measured axial force ***Fh.a*** and must be very significant, up to 150N. It is unlikely that pectorals of this lightweight sculler are able to produce enough torque to create this force at very long lever of the straight arm. However, it is possible to achieve a partial effect and make the resultant vector of the handle force closer to the perpendicular. At the pulling angles a=60-90^o the tangential force ***Fh.t*** is nearly reversely proportional to the axial force ***Fh.a***, because cos(a)≈1/tan(a), so, the more tangential force is produced with pectorals, the less axial force is applied to the oar. The negative tangential force towards the finish shows the press out with the thumbs to keep collars at swivel.

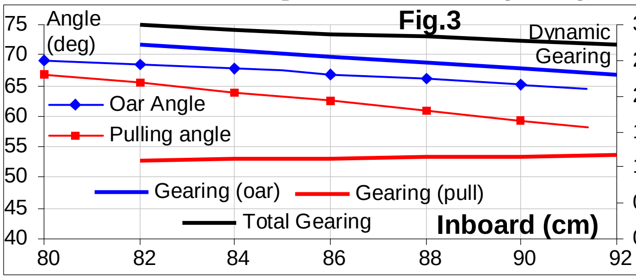


<u>**Strength developments of the pectorals, say bench press exercise, could be useful for scullers**</u>, but not for rowers, where pectorals can not be utilised there in this way and core muscles should be used instead. It is still not clear if using pectorals would increase a general efficiency and effectiveness in sculling, so more experimenting needed with measurements of energy consumption (VO_2) and muscles coordination (EMG).

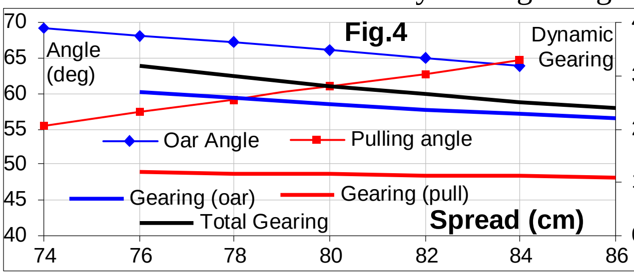
How can we adjust rigging to make the pulling angle straighter and reduce the axial handle force?

Longer arms and wider shoulders of a sculler make pulling angle ***a*** more acute and increase the oar angle ***b***, which both make "dynamic gearing" heavier. Therefore, the arms span (sum of the shoulder width and arms length) should be taken into account for rigging adjustment. In rowing, arms span has no such effect.

With shorter inboard (Fig.1, 1), the position of the handle moves outwards, which makes the pulling angle ***a*** straighter and dynamic gearing lighter. However, it increases the oar angle ***b*** and dynamic gearing of the oar becomes "heavier" (2007/03), which overcomes the effect of "lighter gearing" of the pulling angle. Fig.3 shows dependence of the pulling and oar angles and corresponding dynamic gearing on the inboard length (assuming constant position of the shoulder, spread and real oar gearing).



Wider span/spread (Fig.1, 2) makes the pulling angle ***a*** straighter and also decreases the oar angle ***b***, which we already mentioned in RBN 2007/02. This means that both trends have the same direction and enhance each other effect on the dynamic gearing:



This makes the effect of the spread very noticeable: <u>**wider spread makes dynamic gearing significantly lighter in both rowing and sculling**</u>. This could be a reason why, historically, the ratio of the outboard to the spread was used as a measure of gearing ratio. However, it works only at the catch and beginning of the drive. At the middle of the drive and at finish, the spread do not really affect the oar and pulling angles, so and the gearing ratio. Therefore, <u>**the only direct and valid measure of the oar gearing *G* is the ratio of actual outboard *Out* to inboard *In***</u>:

G = Out / In **(2)**

All other rigging variables, such as spread and position of the stretcher (affects oar angles) could be considered as indirect factors, which have effect at various parts of the drive, so we call them "dynamic gearing".