Rx - Water resistance horizontal projection value 槳面水阻力的水平方向分力；
Ry - Water resistance vertical projection value 槳面水阻力的垂直方向分力
F - foot pushing force 脚蹬船底的反作用力；
P - pulling force （划槳）拉力；
W - Body weight 身體重力

1）The pulling force **P** should be bigger or equal to the water resistance horizontal component **Rx**.

P >= Rx

2）The press down force (foot pushing force) **F** should be bigger or equal to the water resistance vertical component **Ry** **F.>= Ry**

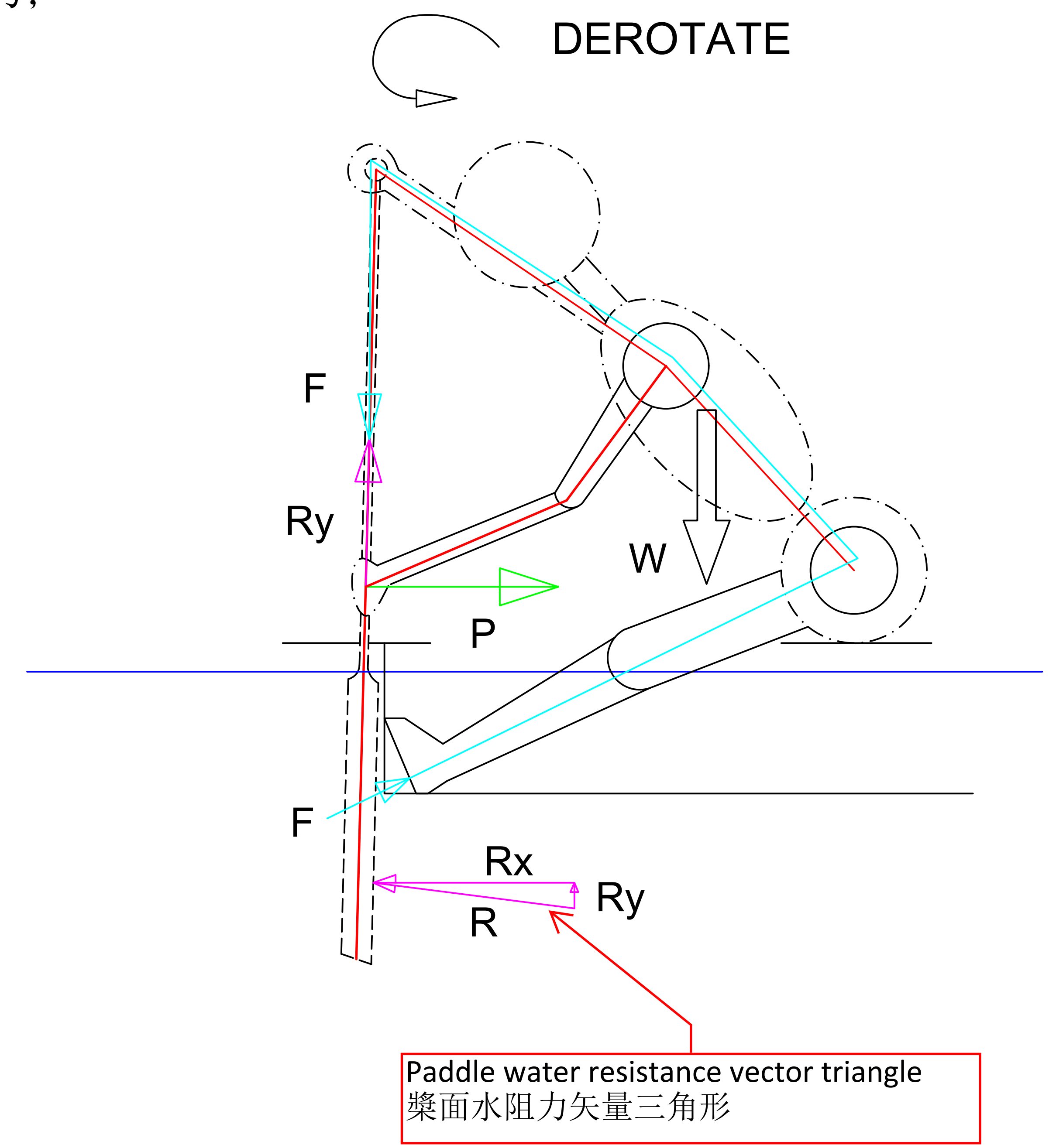
3）When the combination force of the press down force **F** the pulling force **P** is much more than the required value to overcome the water resistance **R**,

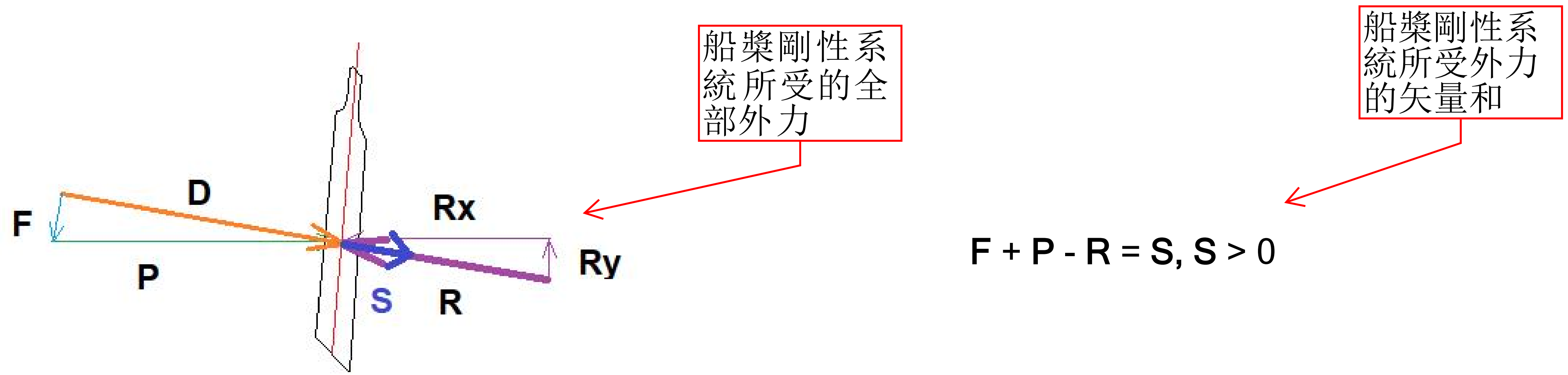
（**F + P >> R**）the paddler's body might be slightly lifting up from the seat.

1）划槳拉力**P** 應該大於或等於槳面水阻力的水平方向分力**Rx**

2）上手臂的壓力（脚蹬力）**F** 應該大於或等於槳面水阻力的垂直方向分力**Ry**

3）當上手臂的壓力（脚蹬力）**F** 與划槳拉力**P** 的矢量和遠大於槳面水阻力 **R** 時，槳手的身體會被從座位上微微提起。





有些隊員讀了我昨天寫的划龍舟力系圖解，似乎還是不太清楚。昨天只是完成了第一步，今天我們做第二步。

開始前，先扯一些不是直接相關的東西。我想告訴大家我爲甚花時間寫這些。通常我們做事有兩種態度。一是你告訴我怎樣做，我按你說的做，至於爲什麼這樣做，背後的原因我就不想了。二是，我做的同時，也要瞭解背後的原因。這樣，在我做的同時，有可能采用新的方法，或者提出改進。我個人欣賞第二種做法。其次，理工科的人都知道，理論學習關鍵是概念要清楚且正確。如果概念錯了，之後的推理即使環環相扣，合乎邏輯。最後的結論也是錯的。

回歸正題，昨天的那個力系圖解，如果我們身體通過手臂作用到船槳上的力與船槳在水中的阻力相等，那麼我們就可以把這個力系理解成一個靜力平衡體系。但是，我們要的不是一個**靜力平衡系統**，而是一個**加速系統**。接下來我就來解釋這個所謂的加速系統。

如圖所示，我們把船槳看成是一個獨立的**剛性系統**，此時作用在槳面的外力有：水阻力 **R** (**Rx** - 水平方向分力；**Ry** - 垂直方向分力），人體通過手臂作用在船槳上的壓力 **P**（下手的拉力）和 **F**（上手臂通過槳杆的向下壓力）。對於船槳的剛性系統來說，水阻力 **R**、壓力 **P**和**F** 都是外力。那麼什麼是我們設定的船槳系統的內力呢？如果我們考慮的船槳因爲外力的作用會產生變形，那麼船槳因爲變形產生的**應力**就是內力。因爲我們假定船槳是一個剛性系統，沒有變形，因此內力可以忽略不計。不在我們計算考慮的範圍。

以上說清楚了什麼是**外力**、**內力**。下面來分析所有外力作用在**船槳剛性系統**的結果。在這個剛性受力體系中，所有的力合成后，最後得到一個合力 **S**。一般來說，合力**S**有兩種情況：

1）S = 0, 此時 船槳做勻速運動（龍舟保持原有的速度運動）
2）S > 0，此時船槳做勻加速運動（龍舟開始加速）

Some team members read the force diagram I wrote yesterday for paddling a dragon boat, but they still seem unclear. Yesterday was only the first step, and today we're taking the second step.

Before we begin, let me digress a bit and explain why I spent time writing these. Typically, there are two attitudes we can have towards tasks. First, you tell me how to do it, and I'll do it as you say without questioning the reasons behind it. Second, while I do it, I also seek to understand the reasons behind it. This way, while I'm doing it, I can potentially come up with new methods or suggest improvements. Personally, I appreciate the second approach. Furthermore, those in the field of science and technology know that clear and accurate conceptual understanding is crucial for theoretical learning. If the concepts are wrong, even if the reasoning is logically consistent, the final conclusion will also be wrong.

Returning to the main topic, in yesterday's force diagram, if the force exerted by our bodies through the arms on the paddle is equal to the resistance of the paddle in the water, we can interpret this force system as a **static equilibrium system**. However, what we want is not a static equilibrium system but an **accelerating system**. Next, I will explain this so-called accelerating system .

As shown in the diagram, we consider the paddle as an **independent rigid system**. The external forces acting on the paddle surface are: water resistance **R** (**Rx** - horizontal component; **Ry** - vertical component), the pressure **P** (pulling force from the lower hand), and **F** (downward pressure from the upper arm through the paddle handle). For the rigid system of the paddle, **R**, **P** , and **F** are all **external forces**. So, what are the **internal forces** within our defined paddle system? If we consider that the paddle may deform due to external forces, then the **stress** generated by this deformation is the internal force. However, since we assume the paddle to be a rigid system with no deformation, we can ignore the internal forces in our calculations. They are not within the scope of our consideration.

The above explanation clarifies the concepts of external and internal forces. Now let's analyze the result of all external forces acting on the rigid paddle system. In this rigid force system, when all the forces are combined, we obtain a resultant force **S**. Generally, the resultant force **S** can be in two situations:

S = 0, in which case the paddle undergoes uniform motion (the dragon boat maintains its original speed).
S > 0, in which case the paddle undergoes uniform acceleration (the dragon boat starts accelerating).

計算:

情況1：根據牛頓第二定律：F = ma, F - 系統所受外力之和；m - 系統質量；a - 系統的加速度
對於船槳系統，∵ m > 0, 如果 F = 0， 那麼加速度 a = 0。a = $\frac{dV}{dt}$= 0 如果速度 V 對於時間t 的導數等於零，那麼：$V = \int_0^t \frac{dV}{dt} = C$（常數）船槳做勻速運動。

[或者，情況1也可以直接用牛頓第一定律解釋：「慣性定律」。 物體若不受外力作用或所受外力的合力為零時，則物體的運動狀態保持不變，即靜者恆靜，動者恆作等速度運動。 若物體運動的速度大小改變或方向改變時，則物體必受外力（或合力不為零）的作用。]

情況2：根據牛頓第二定律：對於船槳系統， ∵ m > 0, 如果 F = C （常數， 那麼 $F = C = m\frac{dV}{dt}$
加速度 a = $\frac{dV}{dt}$= C 。如果速度 V 對於時間t 的導數等於一個常數，那麼：

$V = \int_0^t \frac{dV}{dt} = Ct + E$（$E -$ 常數）（速度V 是時間 t 的一次綫性方程）所以，船槳做勻加速運動。

結論：當合力S 不變，質量m越小，則加速度a 越大。所以，有條件的槳手應該買碳素結構的船槳。

Calculation:

Scenario 1: According to Newton's second law: F = ma, where F is the sum of external forces acting on the system, m is the mass of the system, and a is the acceleration of the system.

For the paddle system, since m > 0, if F = 0, then the acceleration a = 0.

a = $\frac{dV}{dt}$= 0 means that the derivative of velocity V with respect to time t is zero. Therefore, $V = \int_0^t \frac{dV}{dt} = C$ (constant), indicating that the paddle undergoes uniform motion.

[Alternatively, scenario 1 can also be explained using Newton's first law: the law of inertia. An object remains at rest or continues to move at a constant velocity when the net external force acting on it is zero. If the speed or direction of motion of an object changes, it must be acted upon by an external force (or a nonzero net force).]

Scenario 2: According to Newton's second law: For the paddle system, since m > 0, if F = C (constant), then $F = C = m\frac{dV}{dt}$ and the acceleration a = $\frac{dV}{dt}$= C 。 If the derivative of velocity V with respect to time t is a constant, then $V = \int_0^t \frac{dV}{dt} = Ct + E$ (E - constant), which represents a linear equation of velocity V with respect to time t. Therefore, the paddle undergoes uniform acceleration.

Conclusion: When the resultant force S remains constant, the smaller the mass m, the greater the acceleration a. Therefore, conditioned paddlers should choose carbon fiber paddles.