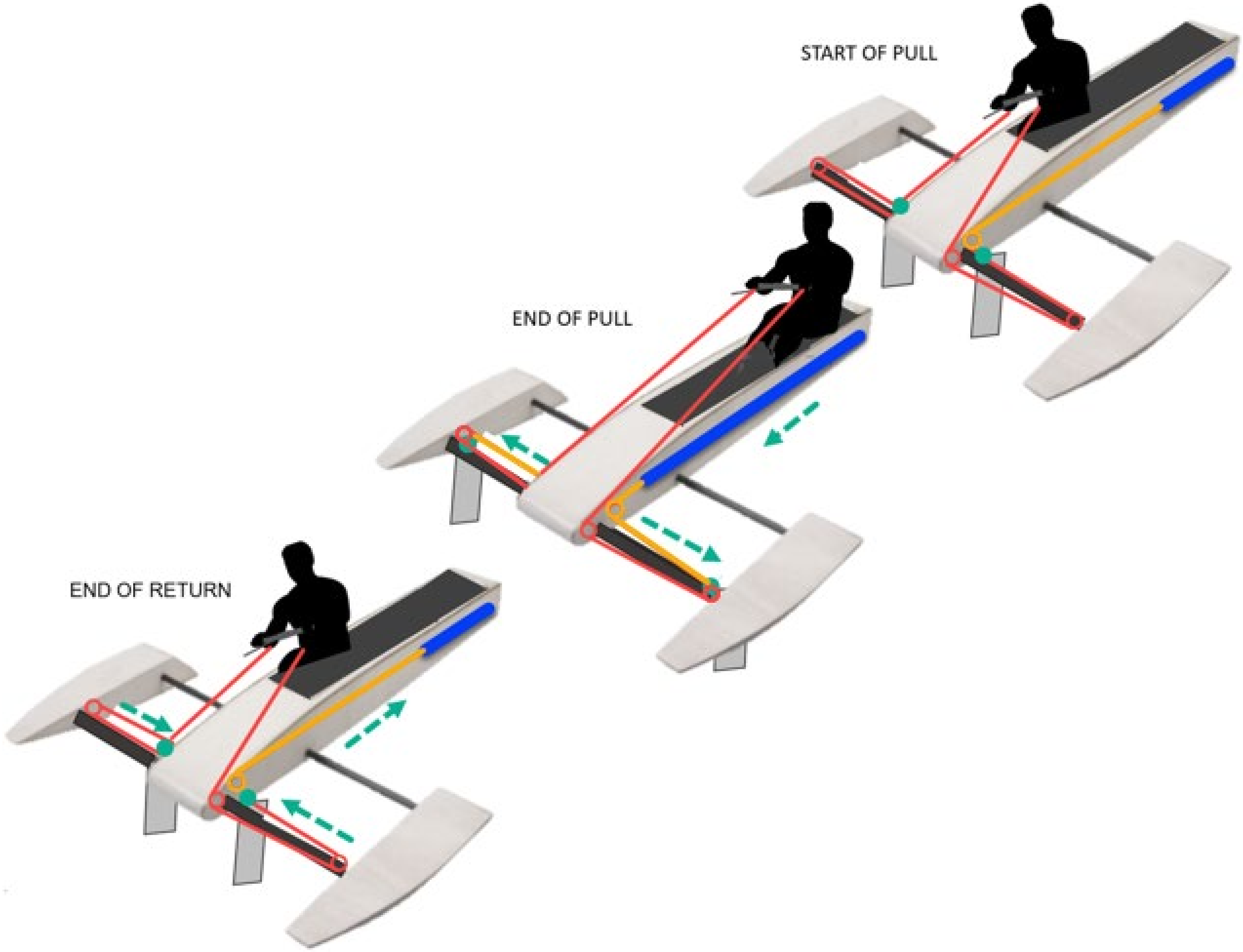
DaggerRo: Description

7 April 2021



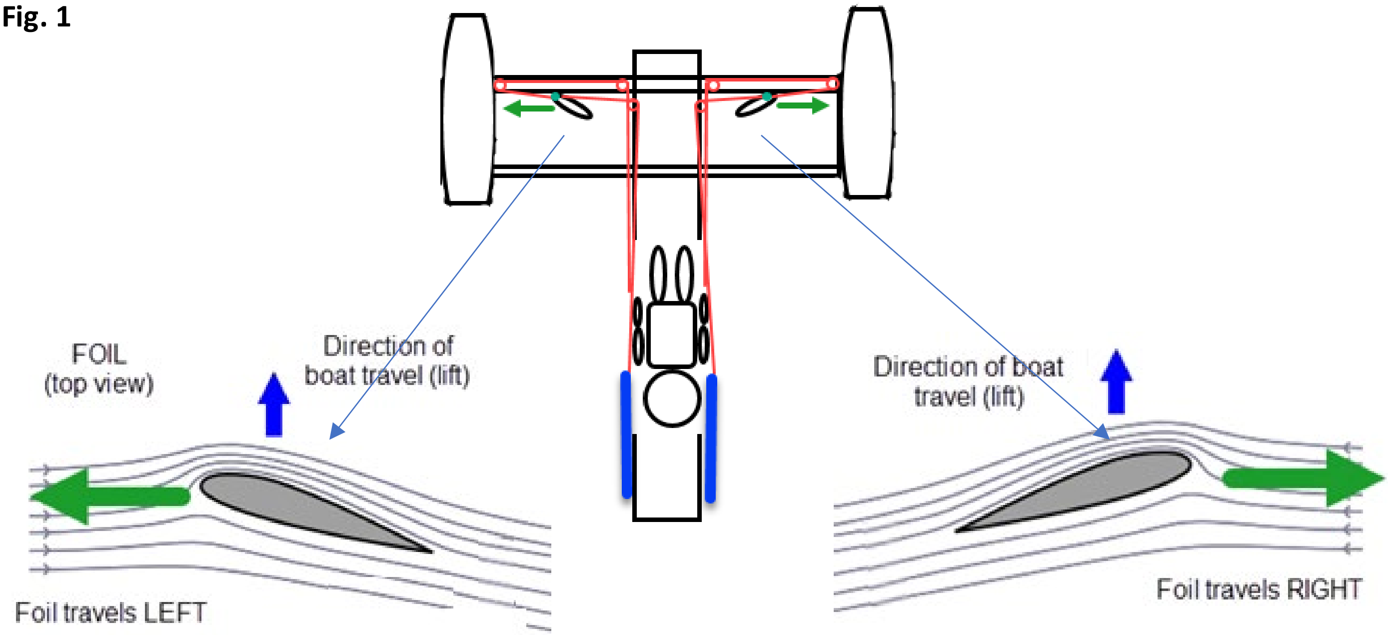
CONFIGURATION:
DaggerRo comprises a long, open hull with a flat, straight bottom angling shallowly toward a square stern, as shown above. Two flat-bottomed pontoons ("sponsons") are positioned forward. Booms hold the sponsons out from the hull. The two forward booms have tracks on their sternward faces; along these tracks run rolling sleds. Mounted on each sled is a flexible, pivoting blade or scull (here called a “foil”), pointed vertically down into the water. “Pull cables” (red) pass through pulleys on the hull, out the length of the boom, through additional pulleys on the sponsons, and back down the boom towards the hull, where they are anchored at the foils’ leading edges (green dots). “Return cables” (orange) are similarly attached to the leading edges of the foils, and run around their own pulleys (orange) on the hull, where they are attached to springs (blue) that are anchored to the stern of the hull on either side.

On the rower’s pull stroke, the foils are pulled outwards along the booms, ending their travel at the inner faces of the sponsons. At the same time, the return cables (orange) extend the springs (blue) anchored at the stern, storing potential energy. Once the pull stroke is complete, the rower relaxes and the springs contract to their rest position. This tows the foils back to their former position alongside the hull, and at the same time assists the rower to return to his/her starting position.

PROPULSION:

DaggerRo's design can be characterized as a "rowing scull." As in a traditional stern-mounted scull, propulsion is achieved by moving a wing-shaped blade (scull) back and forth, transverse to the direction of forward travel at an angle of attack. Forward force is delivered through the lift vector that results from this motion; see Figure 1 below.

Fig. 1



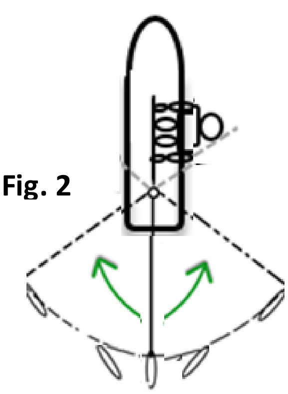
This method of propulsion, inspired by the back-and-forth swishing of a shark's vertical tailfin, is superior in efficiency to that of a paddle or oar. The latter rely on the longitudinal motion of the propelling blade to throw back a volume of water directly alongside and behind the boat, rather than smoothly deflecting a transverse flow. The direct thrust of the paddle or oar creates drag in the form of turbulence and eddies, and, by the nature of the force applied by the paddler or rower, directs substantial portions of the thrust vector downward, upward, and tangential to the direction of travel.

DaggerRo's foil movement minimizes drag and turbulence, and, by moving in a straight line transverse to the direction of travel, orients the majority of the lift vector forward. This is similar to a beam reach on a sailboat, which orients the lift vector along the line of desired travel and is therefore the fastest point of sail. There is no up, down, or radial component to DaggerRo's foil motion.

COMPARISION TO EARLIER SCULLS:

A traditional stern-mounted scull, such as a gondola or yuloh, consists of a long shaft anchored to a pivot point on the boat's transom, sweeping back and forth in an arc as the sculler leans alternately forward and backward on the scull handle (Figure 2).

Fig. 2



While the sculls' use of a submerged, back-and-forth foil is inherently efficient, using body lean as a means of generating power is not. Similarly, the semicircular travel of the scull's foil compromises the orientation of the lift vector, such that it is not aligned consistently in the boat's desired direction of travel. These configurations are thus best suited to slow travel in restricted spaces.

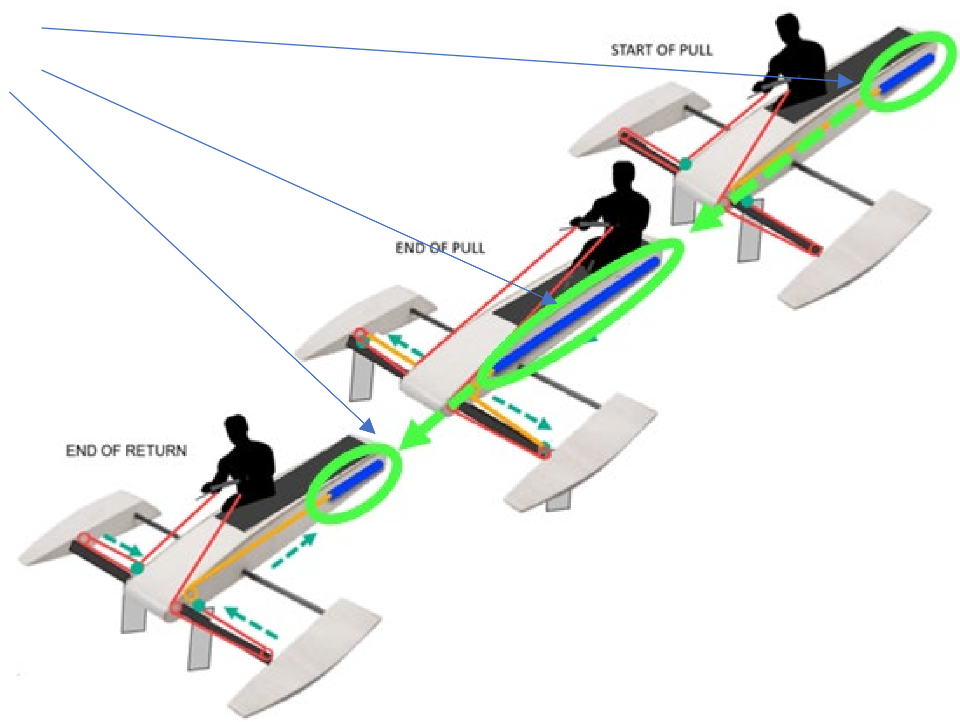
DaggerRo improves on the stern-mounted scull by incorporating the well-known power and efficiency of a sliding-seat "rowing machine" configuration (Figure 3), where nearly all of the rower's muscular potential is utilized. The limitations of a semicircular sweep are avoided, and two foils are driven simultaneously, rather than one.

Fig. 3

RECOVERY STROKE:

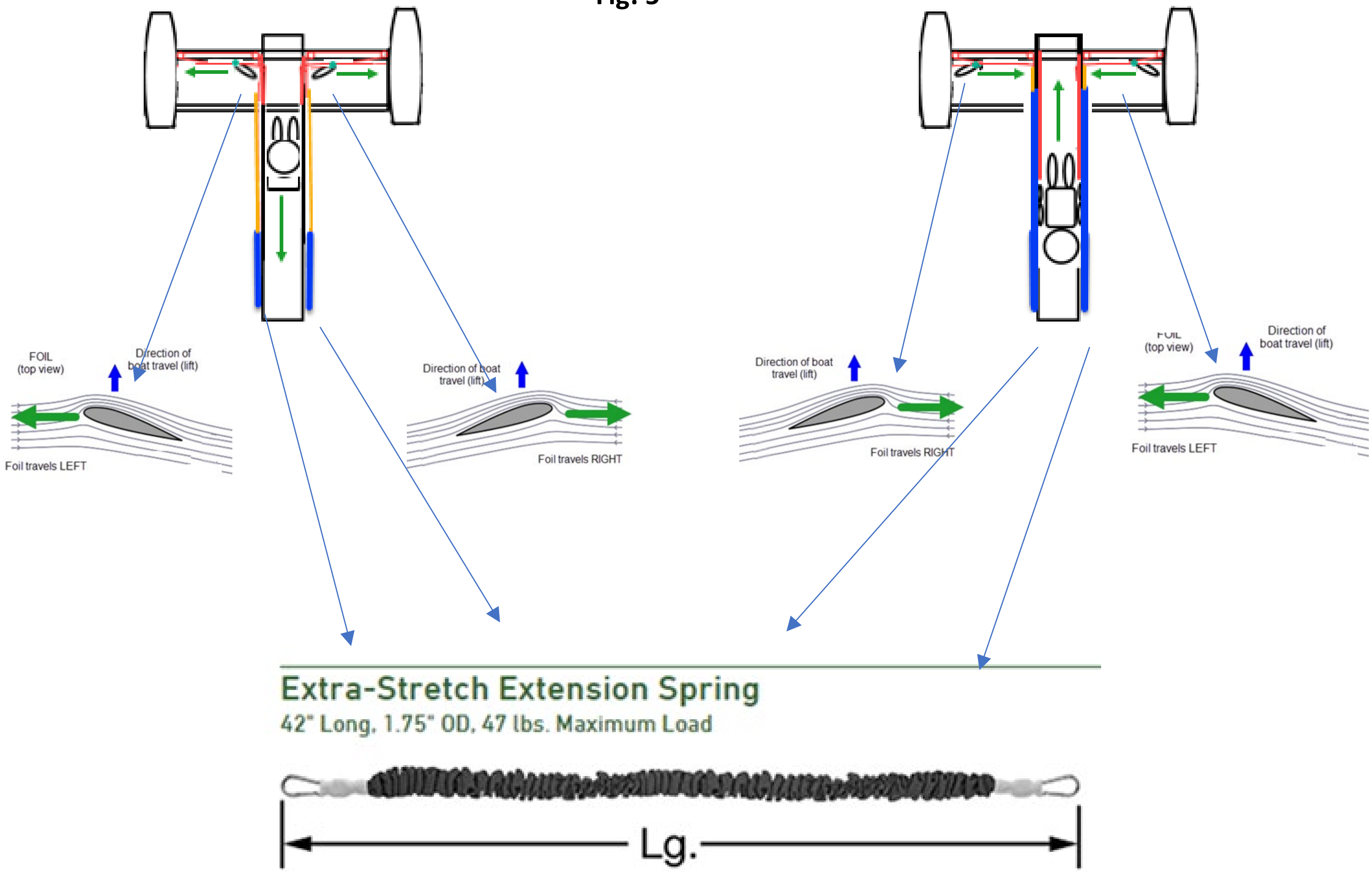
Because of DaggerRo's configuration utilizing pulleys and cables, the rower cannot push on an oar shaft to return the oar to its start position at the end of the pull stroke. Instead, some external force is required to return the foils from the sponsons to the hull, as well as to return the row handles to their initial forward position. This explains the "springs" that appear in blue (Figure 4):

Fig. 4



Energy is added to the springs during the pull stroke, and is then extracted from them over the return stroke, in the manner of a slingshot (Figure 5). This offers another opportunity for efficiency: since foils can generate the same lift in the direction of travel whether outbound to the sponsons or returning to the hull, we opt to utilize the return of the foils for forward propulsion.

OUTBOUND (Pull stroke): **Fig. 5** **INBOUND (Return stroke):**



It is acknowledged that this method subtracts power from the pull stroke itself, as compared with a traditional rowboat or shell. On the other hand, because of DaggerRo's improved efficiency in converting power delivery into forward motion, some measure of surplus power from the pull stroke is available to "charge" the spring. Additionally, the apportionment of power between pull stroke and spring can be controlled by varying the angle of attack, thus resistance, of the foils. Because there is no need for unpowered recovery of oars, the full strength of the rower is optimized, and the power can be applied continuously to the scull, resulting in a more constant boat speed.

HYDROPLANING:

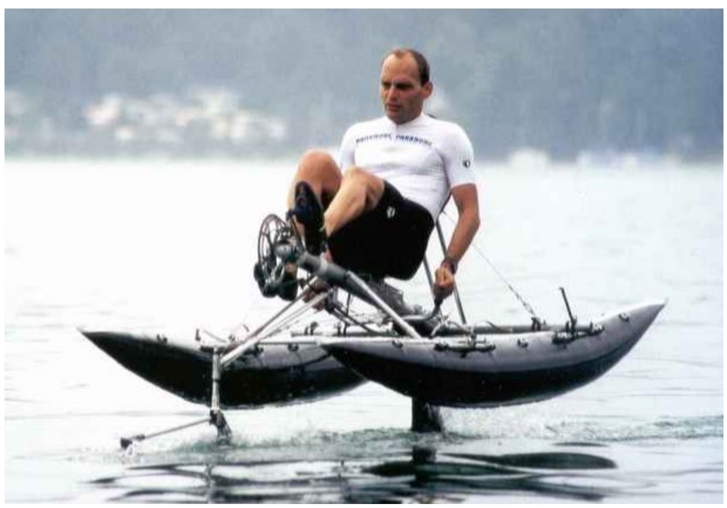
A constant boat speed is desirable for a hydroplaning watercraft, and thus DaggerRo's design is intended to exploit this feature. The central hull and sponsons define a simple three-point hydroplane, and upon an initial application of high power and torque, the boat is designed to lift up and plane on the three points formed by the flat rear portions of sponsons and the hull's flat stern.

Early hydroplaning speedboats of a configuration similar to DaggerRo's were indeed able to rise up on a plane quickly and deliver high speeds on little power due to reduced drag on the hull (Figure 6).

Fig. 6

Similar efforts to reduce drag can be seen with human-powered hydrofoils (Figure 7), which lift the entire weight of hull and rider up out of the water on submerged foils (horizontal wings). For DaggerRo, a hydroplaning configuration is preferred, both to improve stability and to provide improved flotation and performance when the boat is at rest or traveling at low speed.

Fig. 7



COMPARISONS AND CONCULSION:
The advantages of DaggerRo's method of propulsion, powertrain, and hydroplaning behavior make it best suited to speed applications. While recreational use is possible, the above advantages are not directed to leisurely exercise. DaggerRo is not suited for rough waters, nor for navigating rapids or narrow waterways. Its ideal setting is a flat lake, canal, or large river. It is a race boat, designed to achieve speed quickly and maintain that speed over sprints and moderate distances.

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