Case study on technique efficiency

Did you know these five key principles of effective rowing technique?

1. **During recovery, the trunk angle should be constant after the "transition position" (90° knee angle), avoiding any further "diving" into the catch.**
2. **The later the rowers begin to push on the stretcher and slow down the seat before the catch, the better.**
3. **An appropriate Catch Factor and a sharp legs "bounce" at the catch enable effective acceleration of the rower's mass and a powerful, well-connected drive.**
4. **A fast leg drive, with an emphasis on stretcher force application, produces a front-loaded, high, and full force curve.**
5. **Quick blade insertion after the catch is crucial for harnessing the hydro-lift effect and improving blade propulsion efficiency.**

During our recent ***BioRow*** testing, we obtained some interesting data that required further in-depth analysis. Two M2- crews were tested consecutively using the standard ***BioRow*** test protocol (a step-rate over a total distance of 2000m), with a 10-minute interval between them, under the same favourable weather conditions (light tailwind). The boats, oars, and rigging were identical (Empacher, Concept2 Skinny Smoothie2, 116/376/85 cm), and both crews had similar average physical parameters and ergometer scores. Crew 1 consistently outperformed Crew 2 and, at the racing stroke rate of 36–37 spm, was 2.1% faster (7.9 seconds over 2 km). Naturally, the rowers and coaches sought an explanation for this performance difference, so we decided to publish this as a case study on rowing efficiency.

The most obvious difference between the two crews was in the timing of boat acceleration at the catch: in Crew 1, the negative acceleration peak occurred after the catch, while in Crew 2, it occurred before the catch. When plotted relative to oar angles, the acceleration curve of Crew 1 formed a small loop at the catch, which was absent in Crew 2. During the drive phase, Crew 1 had a higher first positive acceleration peak and a shallower dip following it.

The force curves were similar after the catch and before the finish, but differed in the middle of the drive: Crew 1 produced more force, with a higher and earlier peak. Stroke lengths were also quite similar between the two crews.

Seat velocity revealed the most pronounced differences. During the recovery, Crew 1 had a later negative peak than Crew 2, indicating **a later transition from pulling to pushing on the stretcher**. At the catch, Crew 2 reversed seat movement earlier, resulting in a more negative Catch Factor (–30 ms), compared to Crew 1 (–16 ms). This was mainly due to the bow rower in Crew 2 having an excessively negative Catch Factor of –40 ms combined with upper body movement to the stern before the catch, often referred to as "diving with the trunk into the catch." In the first half of the drive, Crew 1 achieved a significantly higher peak seat velocity, which helped them produce considerably more force, and completed the leg drive earlier developing greater trunk velocity.

Crew 1 also showed more efficient blade work. They inserted the blade quicker at the catch, resulting in a shorter catch slip (7.9°) compared to Crew 2 (12.2°). Crew 2's issue likely stemmed from "skying" the blade before the catch, caused by lowering the handle too much. During the second half of the drive, Crew 1 maintained a shallower but sufficient blade depth, which ensured good water connection and resulted in a longer effective drive length (62.5%) compared to Crew 2 (59.1%) and higher blade propulsive efficiency.

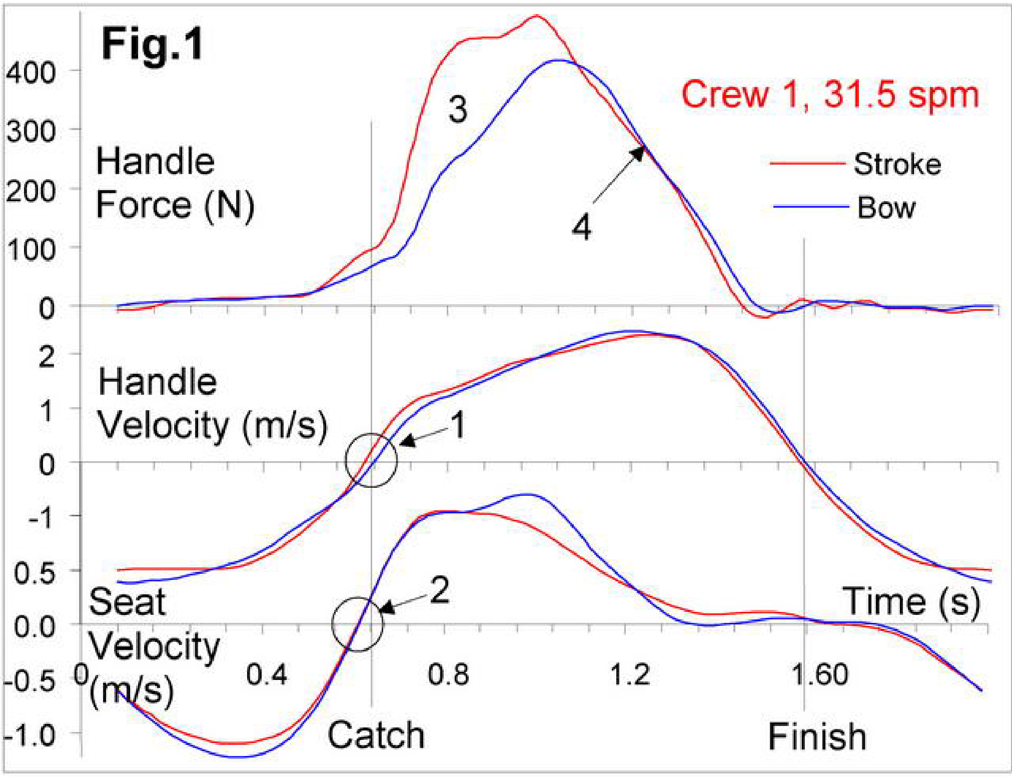
Ultimately, despite a slightly lower stroke rate , with similar stroke length and physiology, Crew 1 generated 5.9% higher force and 5.7% higher power. Combined with 1.9% greater blade efficiency, this translated into a 2.1% higher boat speed.

Case study on rowing efficiency

Interesting data was obtained recently: two LW2x performed the standard BioRow® test protocol (RBN 2013/03) side-by-side, so the weather conditions should be the same. Both crews had the same boat build (Filippi with bow-mounted carbon wing-riggers), oars (Croker Super light), very similar boat age (made in 2012 and 2013) and average rowers height and weight (1.72m / 59kg for crew 1, and 1.75m / 58kg for crew 2). Both boats were equipped with BioRowTel system calibrated in the same way.

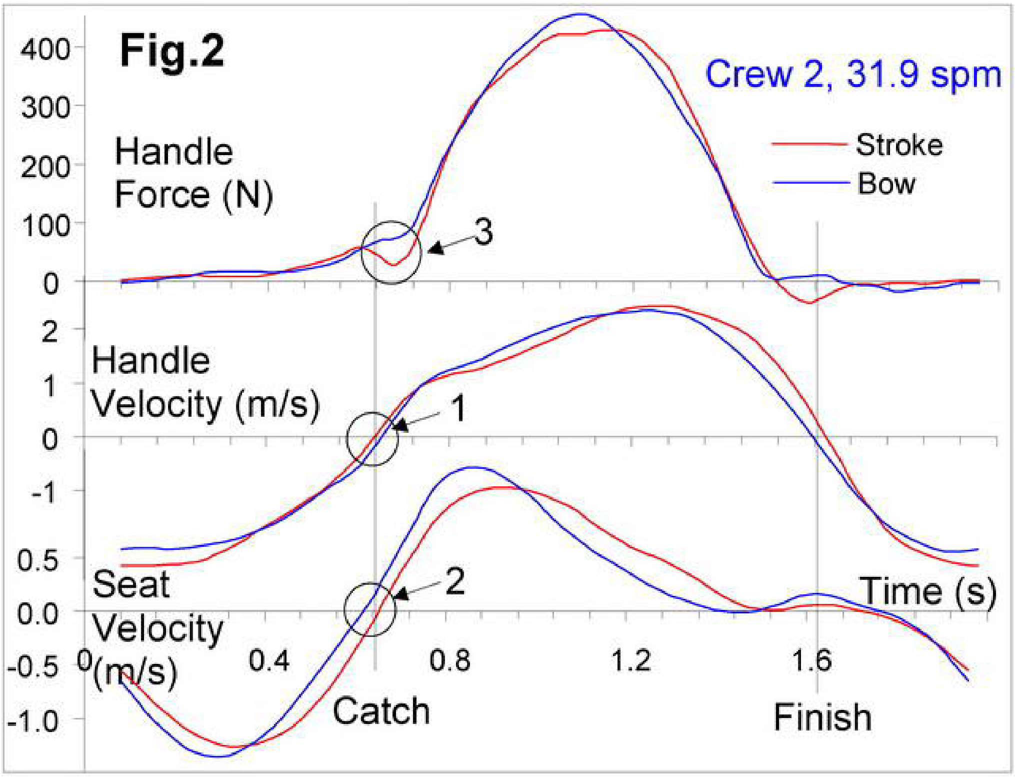
Table 1	N	1	2	3	4	5	6	7	8	Aver
Rate	1	36.6	20.2	24.1	28.6	30.4	31.5	33.5	37.5	27.7
Rate (spm)	2	37.9	20.2	24.4	28.8	29.6	31.9	35.0	38.4	28.0
Speed	1	4.95	4.04	4.39	4.68	4.78	4.86	4.93	5.01	4.58
(m/s)	2	4.94	3.99	4.40	4.63	4.76	4.80	4.90	5.12	4.55
Angle	1	98.3	104.6	104.3	102.9	102.2	101.5	100.8	98.0	102.7
(deg)	2	96.4	106.3	105.7	104.3	104.0	102.2	99.7	96.5	103.7
Force	1	488	454	460	472	472	469	480	493	468
(N)	2	511	438	456	485	474	484	499	514	472
Power	1	505	285	343	405	425	434	464	514	388
(W)	2	563	298	369	450	449	480	524	570	423
Net DF	1	3.42	3.52	3.38	3.36	3.31	3.25	3.31	3.41	3.37
	2	3.69	3.74	3.58	3.70	3.49	3.58	3.64	3.51	3.63
Gross	1	4.17	4.33	4.05	3.94	3.89	3.78	3.87	4.09	4.02
DF	2	4.68	4.67	4.33	4.53	4.18	4.34	4.45	4.23	4.43

On average, crew 1 (Table 1, in red) had 1.1% lower stroke rate, 0.9% shorter stroke length, 0.9% lower force and 8.6% lower power, but 0.52% higher boat speed compare to the crew 2 (in blue). Therefore, drag factor of crew 1 was significantly lower in all samples (on average, 7.2% lower Net DF, and 9.7% lower Gross DF, RBN 2015/03). The obvious question is: how it was possible at the same weather, equipment and crews' weight? What could be the reasons of higher rowing efficiency in crew 1 compared to crew 2? To answer these questions, biomechanical analysis was made at the sample 6 (31.5 and 31.9spm), where crew 1 was 1.3% faster.



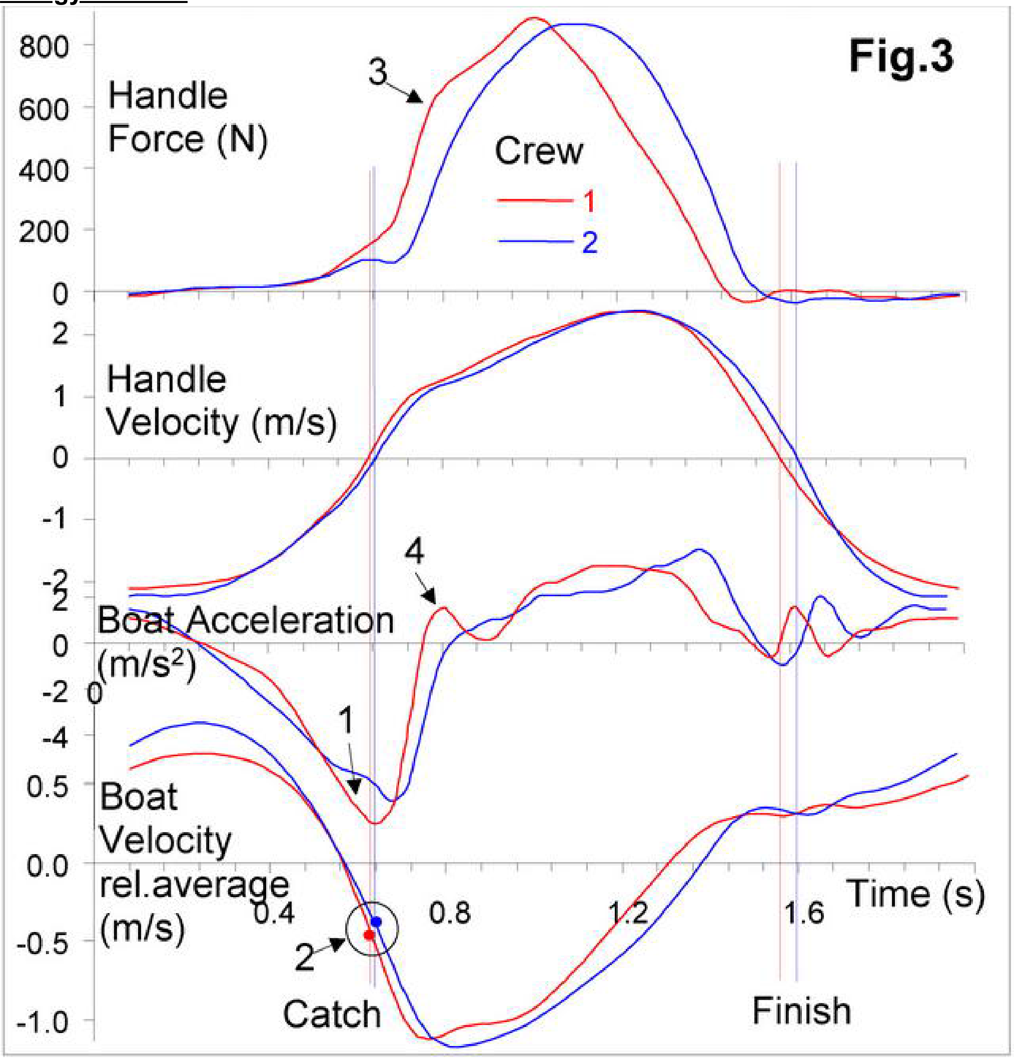
At catch, the crew 1 (Fig.1) had quite different timing at the handle (bow rower was 20ms later at change direction, 1), but very good synchronisation at the seat (less than 2ms difference, 2), which means rowers push the stretcher at the same time. The stroke rower applied a much higher force during the first half of the drive (3); then, the forces were quite similar (4). Catch Factors CF were quite similar in this crew (-10ms in stroke, and -27ms in the bow), as well as Rowing Style Factor RSF (80% and 90%).

Contrarily, the crew 2 (Fig.2) had slightly better synchronisation at the handle (bow rower was 18ms later, 1), but much worse timing at the seat (bow rower overtook the stroke by 35ms), which means their stretcher forces were not synchronised. So, the CF was very different: +16ms in the stroke and -35ms in the bow, as well as RSF (79% and 98%). Force curves were quite similar in general, but the stroke rower had a significant gap after the catch (3), which means (after subtracting oar inertia force) she applied a negative (braking) force at the blade .



Comparison of the whole boat data (Fig.3) shows that the negative peak of the boat acceleration in crew 1 (1) was narrower, but deeper (because of better synchronisation at the seat and stretcher), which allowed lower boat speed at the catch and easier “connection” to the water (2). The force curve (sum of two rowers) was more “front-loaded” in crew 1 (3), so they had a significant “first peak” of the boat acceleration (4), while the crew 2 didn’t have it at all. Also, **“front-loaded” force emphasis at**

lower handle velocity allowed crew 1 to produce nearly the same impulse at 10.1% lower power, so they were more energy efficient.



Concluding: In the more efficient crew 1, better synchronisation at the seat and stretcher allowed:

- **Lower "energy transfer through the boat" (RBN 2012/04), which may decrease inertial energy losses;**
- **Deeper, but narrower negative peak of the boat acceleration, which helps better "connection" at catch;**
- **More "front-loaded" & efficient force curve and better pattern of the boat acceleration during the drive.**

Our Clients!

LM4- DEN World Champions 2013-14

LM2x NOR World Champions 2013

LM2x DEN Olympic Champions 2012

W1x CZE Olympic Champion 2012

M4x UKR World Champions 2014

"The support from BioRow was very useful, especially as a pedagogic tool to show in graphs and numbers what I as a coach mean when we work with some specific aspects of the stroke. The measurements transfers the rowers feeling and make it easier to understand them."
Mads Haubro Petersen, National Coach, Denmark

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