Volume 2 No.1 **Rowing Biomechanics Newsletter** January 2002

Facts. Did You Know That…

✓ …rowing power has a very strong correlation with stroke rate (r = 0.72-0.89). The following tables will help you to assess power at different stroke rates in rowers' categories. The statistics were taken from the rowing biomechanics database and based on 250-500m samples. Usually, power over 2000m is 80-90% of the data below.

Men's Sculling Power (W):

Rate (1/min)	20	24	28	32	36	40
Very Low	210	278	340	397	449	495
Low	249	317	380	437	489	535
Average	289	357	420	477	528	574
High	329	397	459	516	568	614
Very High	369	437	499	556	608	654

Men's Lightweight Sculling Power (W):

Rate (1/min)	20	24	28	32	36	40
Very Low	146	223	289	342	384	414
Low	185	263	329	382	424	453
Average	225	303	368	422	464	493
High	265	343	408	462	503	533
Very High	305	382	448	502	543	573

Men's Sweep Power (W):

Rate (1/min)	20	24	28	32	36	40
Very Low	153	211	269	326	383	440
Low	192	251	309	366	423	480
Average	232	290	348	406	463	520
High	272	330	388	446	503	560
Very High	312	370	428	485	543	599

Men's Lightweight Sweep Power (W):

Rate (1/min)	20	24	28	32	36	40
Very Low	110	163	212	259	303	345
Low	150	202	252	299	343	385
Average	190	242	292	339	383	425
High	229	282	332	379	423	464
Very High	269	322	371	418	463	504

Women's Sculling Power (W):

Rate (1/min)	20	24	28	32	36	40
Very Low	117	163	200	229	250	262
Low	157	202	240	269	290	302
Average	197	242	280	309	329	342
High	236	282	319	348	369	382
Very High	276	322	359	388	409	421

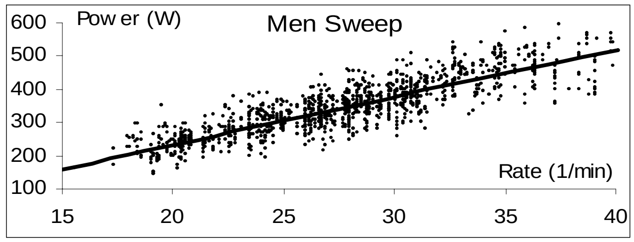
Women's Lightweight Sculling Power (W):

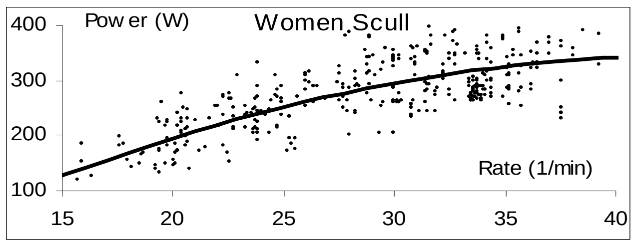
Rate (1/min)	20	24	28	32	36	40
Very Low	83	126	161	187	206	215
Low	123	166	201	227	245	255
Average	163	206	241	267	285	295
High	203	246	280	307	325	335
Very High	242	285	320	347	365	375

Women's Sweep Power (W):

Rate (1/min)	20	24	28	32	36	40
Very Low	94	119	145	172	200	229
Low	134	159	185	212	240	268
Average	174	199	225	252	280	308
High	213	239	265	292	319	348
Very High	253	279	305	332	359	388

✓ …regression lines of power/rating dependencies are different in sculling and sweep rowing. They are curvilinear in all four sculling categories and practically linear in all three sweep groups (see examples below).





This corresponds with our previous findings about stroke rate emphasis in sweep gold medallists and stroke distance preference in sculling winners (1). From practical point, this means that high stroke rate in sweep rowing can increase performance, while ratings above 35 str/min in sculling bring less and less power and boat speed.

News

☺ Biomechanical services are now available for rowing clubs on a commercial basis. Contact the AIS Biomechanics department for further details.

References

1. Kleshnev V. 2001. Stroke Rate vs. Distance in Rowing during the Sydney Olympics. Australian Rowing. 25(2), 18-21.

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Facts. Did You Know That…

✓ …statistical analysis of body segments work can be done using our rowing biomechanics database. Currently, we measure trunk displacement only in small boats (singles, doubles and pairs), therefore number of samples included in analysis is less than total size of database (1430 out of 6000):

Number of samples in each rowers' group (n).

Men Scull	M.Light Scull	Men Sweep	M.Light Sweep	Women Scull	W.Light Scull	Women Sweep
180	136	335	105	121	100	453

✓ …on average, each of three body segments contributes approximately one third of total length of the stroke arch (legs a bit more, trunk a bit less). Both male sculling groups have significantly lower percentage of the trunk displacement and correspondingly longer arms drive:

Displacement Shares (%)	Legs (%)	±SD	Trunk (%)	±SD	Arms (%)	±SD
Men Scull	35.1%	2.1%	28.0%	4.3%	36.9%	3.0%
M.Light Scull	34.1%	2.3%	28.6%	3.1%	37.3%	3.0%
Men Sweep	35.4%	1.9%	31.5%	4.4%	33.1%	4.5%
M.Light Sweep	36.7%	3.4%	31.5%	6.0%	31.7%	4.6%
Women Scull	34.6%	2.2%	32.9%	4.6%	32.5%	4.0%
W.Light Scull	34.1%	2.8%	33.5%	3.2%	32.4%	2.8%
Women Sweep	35.4%	2.8%	31.8%	4.5%	32.7%	4.4%
All rowers:	**35.2%**	**2.6%**	**31.2%**	**4.6%**	**33.6%**	**4.4%**

✓ …legs execute their work during the first half of the drive, when the force exertion is maximal (1). Therefore, legs produce nearly half of rowing power; trunk produces nearly one third and arms a bit more than one fifth. Male scullers have nearly equal power produced by trunk and arms:

Power Shares (%)	Legs (%)	±SD	Trunk (%)	±SD	Arms (%)	±SD
Men Scull	45.7%	5.2%	28.2%	4.9%	26.1%	3.8%
M.Light Scull	46.9%	3.2%	27.7%	3.0%	25.4%	2.2%
Men Sweep	46.7%	4.5%	31.6%	5.0%	21.7%	5.9%
M.Light Sweep	49.7%	5.9%	31.3%	6.5%	19.0%	3.2%
Women Scull	45.2%	3.8%	32.3%	4.1%	22.6%	5.0%
W.Light Scull	44.6%	4.3%	33.1%	3.8%	22.3%	3.2%
Women Sweep	46.6%	4.2%	31.3%	4.8%	22.1%	4.6%
All rowers:	**46.4%**	**4.5%**	**30.9%**	**5.2%**	**22.7%**	**5.2%**

✓ …the following table can be used for assessment of the percentage of the trunk power:

	Very Low	Low	Average	High	Very High
Trunk Power (%)	20.5%	25.7%	30.9%	36.1%	41.3%

✓ …legs increase their percentage of power together with growths of the stroke rate. The following table can be used for assessment of the legs power share at various stroke rate:

Legs Power (%)	20	24	28	32	36	40
Very Low	35.7%	37.0%	38.1%	39.1%	39.9%	40.6%
Low	40.0%	41.3%	42.4%	43.4%	44.2%	44.9%
Average	44.3%	45.6%	46.7%	47.7%	48.5%	49.2%
High	48.6%	49.8%	51.0%	51.9%	52.8%	53.5%
Very High	52.9%	54.1%	55.2%	56.2%	57.1%	57.7%

✓ …percentage of the arm power has opposite trend: it decreases when the stroke rate increases. You can use the following table for assessment of the arms power share at different stroke rate:

Arms Power (%)	20	24	28	32	36	40
Very Low	15.7%	15.0%	14.0%	12.9%	11.7%	10.2%
Low	20.0%	19.3%	18.3%	17.2%	16.0%	14.5%
Average	24.3%	23.5%	22.6%	21.5%	20.2%	18.8%
High	28.6%	27.8%	26.9%	25.8%	24.5%	23.1%
Very High	32.9%	32.1%	31.2%	30.1%	28.8%	27.4%

Ideas. What if…

? …you increase percentage of the trunk power? It should bring you more rowing power and help you to achieve higher boat speed. We found that trunk muscles utilize only about 55% of their work capacity during the rowing. The same time the arms utilization is about 75% and the legs uses up to 95% of their power. These values were obtained during 7 minute tests on a rowing ergometer. Four tests were performed for each of 14 rowers: three for each body segment and one with full length rowing. Better rowers showed higher percentage of the trunk work capacity utilization.

News

☺ We can help you to assess body segments work of your rowers. Contact us for further details.

References

1. Kleshnev V., 1991, Improvement of dynamical structure of the drive in rowing. Ph.D theses. Saint-Petersburg Institute of Sport, pp. 49.

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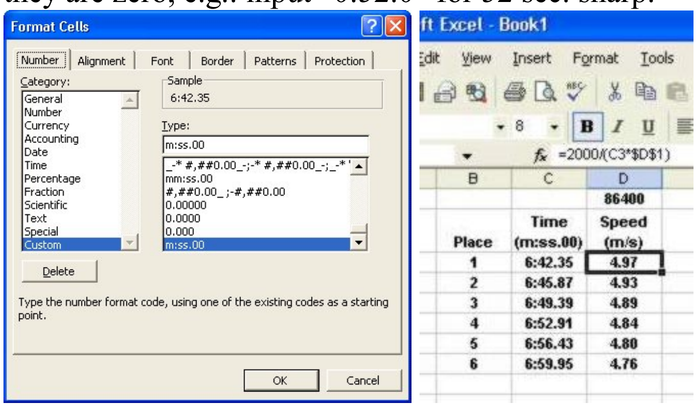
Tip of the Day

MS Excel® spreadsheets are widely used for performance analysis in rowing. Many coaches experience problems when they work with time values in Excel. Here is a simple method of data input in normal time format (minutes:seconds.decimals) and converting the values to the numerical format for boat speed calculation:

Select a range of cells where you want to input a time. Then right click mouse on them and select "Format Cell" from a local menu. In the dialog go to "Number"->"Category:"->"Custom" and input "m:ss.00" in the "Type" input box. Click "OK". Now you can input time data in the cells. You have to input at least one digit for minutes and decimals, even if they are zero, e.g.: input "0:52.0" for 52 sec. sharp.



To convert the time value into seconds, multiply it by 86400 (number of seconds in 24 hours) and format a result cell as a normal number with desired decimals precision ("Category:"->"Number"). You can go directly to boat speed (**V**) if you input this simple formula in the cell:

V = Dist. / (Time * 86400)

,where "**Dist**". is the distance length and "**Time**" is the reference to the time formatted cell.

Facts. Did You Know That…

✓ …maximal speed of body segments is highly correlated with performance in rowing. Many elite rowers have "High" and "Very High" (1.5-1.6 m/s) values of max. legs and trunk speed.

Here are the tables for segments speed evaluation:

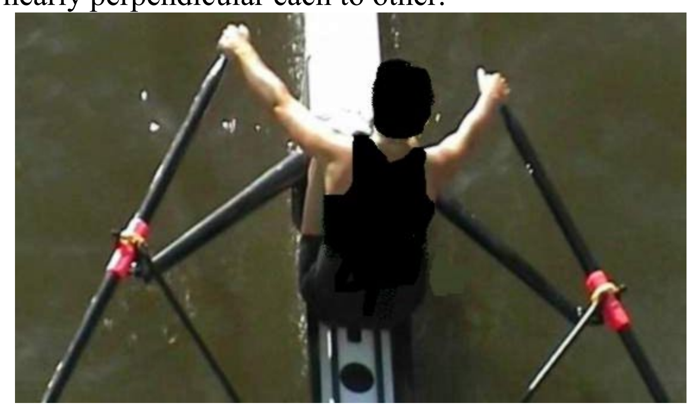
Legs Max. Speed (m/s)	20	24	28	32	36	40
Very Low	0.59	0.70	0.80	0.88	0.95	1.01
Low	0.76	0.86	0.96	1.04	1.11	1.18
Average	0.92	1.02	1.12	1.20	1.28	1.34
High	1.08	1.18	1.28	1.36	1.44	1.50
Very High	1.24	1.35	1.44	1.53	1.60	1.66

Trunk Max. Speed (m/s)	20	24	28	32	36	40
Very Low	0.59	0.67	0.75	0.82	0.87	0.92
Low	0.78	0.87	0.95	1.01	1.07	1.11
Average	0.98	1.06	1.14	1.21	1.26	1.31
High	1.17	1.26	1.34	1.40	1.46	1.50
Very High	1.37	1.45	1.53	1.60	1.65	1.70

Arms Max. Speed (m/s)	20	24	28	32	36	40
Very Low	0.97	1.08	1.17	1.24	1.28	1.31
Low	1.14	1.25	1.34	1.41	1.46	1.48
Average	1.31	1.42	1.51	1.58	1.63	1.65
High	1.48	1.59	1.68	1.75	1.80	1.83
Very High	1.66	1.77	1.85	1.92	1.97	2.00

Ideas. What if…

? …you are considering arms position at catch in sculling. In the figure below you can see that the hands are more than one meter apart and the arms are nearly perpendicular each to other.



The idea is the following: may be the use of a wide grip during weight and ergo training can improve arm and shoulder coordination in sculling? Why do scullers always pull with parallel arms in a gym and on an ergo, when they have to do it differently on the water? Use the snatch grip and a wide handle on the ergo or weight machine for a trunk pull. For the arms pull, use a shoulder-width grip, which is close to the handles position at the end of the drive

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Volume 2 No.4 *Rowing Biomechanics Newsletter* April 2002

Tip of the Day

I received a very positive response on previous Tip, so here is another one. It'll help you to convert numerical data to time format and to use combination of absolute (with $ symbol) and relative references in MS Excel™ for fast tables creation.

B3 fx =2000/(B2*86400

	A	B	C	D	E
1	Target:				
2	Time	6:32.00			
3	Speed	5.10			
4					

1. Format cell B2 for time input (see RBN 3/2002). Then calculate a target speed in cell B3;

A5 fx 60%

	A	B	C	D
1	Target:			
2	Time	6:32.00		
3	Speed	5.10		
4	Training:			
5	60%			
6	65%			
7				

2. Input percentages of the training speed in two cells with a desired increment, select them and fill down by clicking and drawing the right bottom corner;

B5 fx =B3*A5

	A	B	C	D
1	Target:			
2	Time	6:32.00		
3	Speed	5.10		
4	Training:			
5	60%	3.06		
6	65%	3.32		
7	70%	3.57		
8	75%	3.83		

3. In cell B5 calculate the product of the absolute reference of the target speed (B3) with the relative reference on the percentage (A5). Fill it down.

4. Repeat step 2 to create a row of distances;

5. In cell C5 calculate the time of the piece by dividing distance C$4 (relative column and absolute row) with speed $B5 (absolute column and relative row) and with 86400 to convert it into a time format. You can press the "F4" key for cyclic conversion of the references: C4-C4-C$4-$C4-C4… Format the cell as the time value and fill to the right and down.

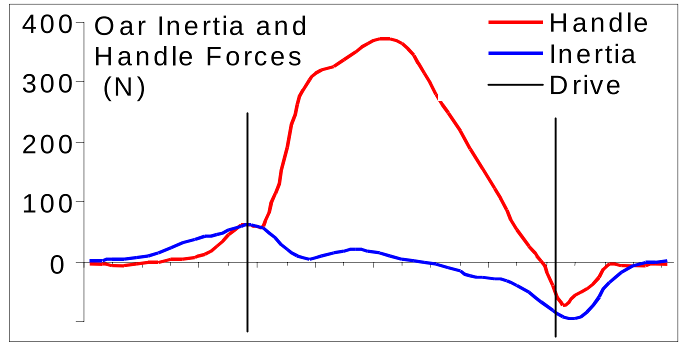
C5 fx =C$4/$B5/86400

	A	B	C	D	E	F	G	H	I	J
1	Target:									
2	Time	6:32.00								
3	Speed	5.10								
4	Training:		250	500	750	1000	1250	1500	1750	2000
5	60%	3.06	1:21.67	2:43.33	4:05.00	5:26.67	6:48.33	8:10.00	9:31.67	10:53.33
6	65%	3.32	1:15.38	2:30.77	3:46.15	5:01.54	6:16.92	7:32.31	8:47.69	10:03.08
7	70%	3.57	1:10.00	2:20.00	3:30.00	4:40.00	5:50.00	7:00.00	8:10.00	9:20.00
8	75%	3.83	1:05.33	2:10.67	3:16.00	4:21.33	5:26.67	6:32.00	7:37.33	8:42.67
9	80%	4.08	1:01.25	2:02.50	3:03.75	4:05.00	5:06.25	6:07.50	7:08.75	8:10.00
10	85%	4.34	0:57.65	1:55.29	2:52.94	3:50.59	4:48.24	5:45.88	6:43.53	7:41.18
11	90%	4.59	0:54.44	1:48.89	2:43.33	3:37.78	4:32.22	5:26.67	6:21.11	7:15.56
12	95%	4.85	0:51.58	1:43.16	2:34.74	3:26.32	4:17.89	5:09.47	6:01.05	6:52.63
13	100%	5.10	0:49.00	1:38.00	2:27.00	3:16.00	4:05.00	4:54.00	5:43.00	6:32.00
14	105%	5.36	0:46.67	1:33.33	2:20.00	3:06.67	3:53.33	4:40.00	5:26.67	6:13.33
15										

In less than 1 minute you can create a table with times for different distances at different speeds. Enjoy!

Facts. Did You Know That…

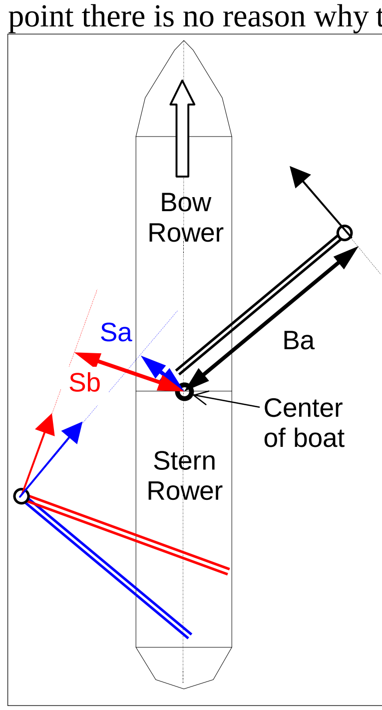
…oar inertia forces are not as low as they appear. Rowing oars are really light (1.4 kg scull and 2.6 sweep oar), but they are long and the heaviest parts are placed at the ends. We defined moments of inertia as 6.6 kgm for sweep oar 4.4 kgm for scull.



Here is a graph showing the contribution of oar inertia to the handle force in 1x at 36 str/min. It is nearly 100% at catch and release, which are 70-80 N forces.

Ideas. What if…

? …you use different catch and release angles in stroke and bow seats of a pair. From a biomechanical point there is no reason why they should be the same



We've measured 4-5^{o} difference in very good crews. At the catch a shorter angle in stroke rower will reduce the difference in rotating moments. On the drawing **Sa** and **Ba** are rotating levers of the stroke and bow rowers at the same catch angles. **Sb** is the rotating moment of the stroke rower at a shorter angle. The length of **Sb** lever has less difference relative to **Ba**.

A longer release angle in stroke seat also reduces rotating moment at the finish of the drive. So, just move foot-stretcher 3-5 cm to the bow in the stroke seat and see how it goes. Tell me if I'm wrong.

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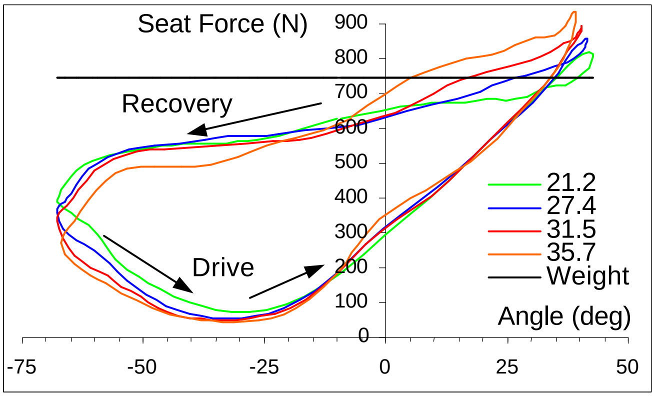
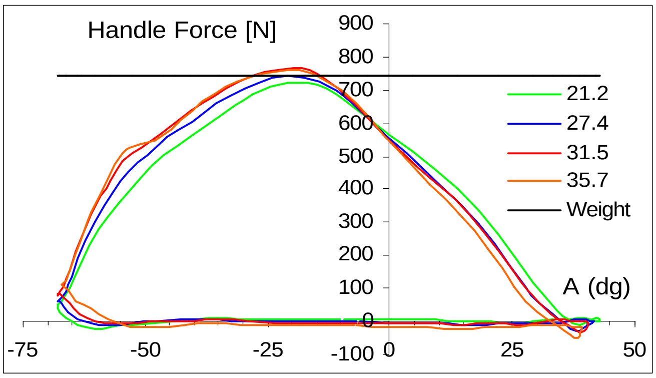
Volume 2 No.5 **Rowing Biomechanics Newsletter** May 2002

News

☺ In May we obtained reliable data about vertical seat force for the first time. We found that it can be as low as 50N at the first half of the drive and as much as 125% of the athlete body weight at the end of the drive. Here are graphs of the seat force relative to oar angle at the stroke rates 21 – 35.



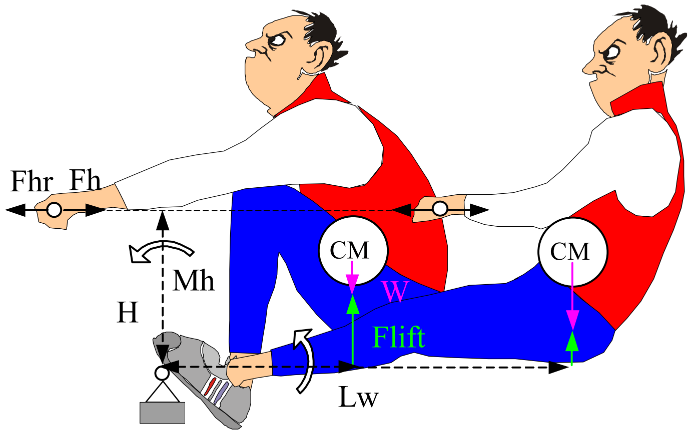
At higher stroke rate the rower lifts his/her weight quicker at catch and heavier push the seat down at the end of the drive. The last can be explained by rotating action of abdominal muscles. Below are the force curves of the same rower.



Lift of the athlete weight from the seat correlates very closely with the force application at the handle. Therefore, try to hang longer on the handle during the drive and sit down on the seat as late as possible.

Facts. Did You Know That…

? …amount of force, which lifts the rower from the seat depends on the height of the handle relative to foot-stretcher? The following drawing illustrates this. When rower pulls the handle, reaction force ***Fhr*** creates rotating moment ***Mh***. It is proportional to the force ***Fhr*** and a distance between line of the force and a point of rotation at the foot-stretcher ***H*** (height of the handle relative to foot-stretcher). This moment produce lift force applied to the rower's center of mass, which inversely proportional to a distance **Lw** between foot-stretcher and the center of mass.



Lift force equal to: ***Flift = H / Lw * Fh***

From other side lift force cannot be higher than rower's weight. This follows to the formula for maximal handle force: ***Fh.max = Lw / H *W***

Ideas. What if…

? …take into account above considerations? The following recommendations can be done:

✓ Find an optimal height of the handle relative to foot-stretcher. Higher handle helps to increase stroke length by means of better compression at catch and longer arms travel. However, it limits amounts of force, which can be applied to the handle. This especially important if you want to increase force faster at catch;

✓ Try to decrease rotating moment and weight lift at the first half of the drive. To do this you should:

Push the foot-stretcher with your toes in horizontal direction at catch. Any vertical force on the foot-stretcher increase your weight lift;

Pull the handle horizontally and do not insert the blade too deep at catch;

✓ Try to increase weight lift at the second half of the drive, because rotating moment already does not limit the handle force (distance ***Lw*** became much longer), but you can lift the boat and decrease drag resistance. To do this you should push the foot-stretcher with your heels and pull the handle higher.

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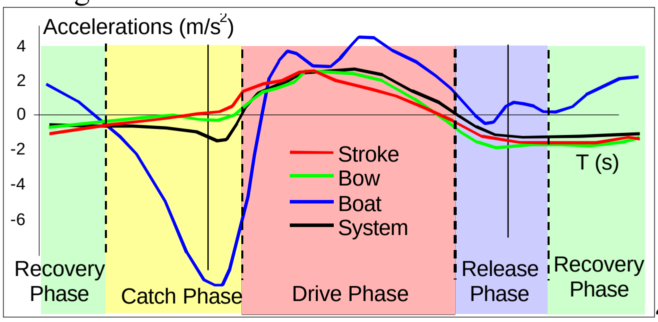
Volume 2 No.6 **Rowing Biomechanics Newsletter** June 2002

News

☺ Our article "Moving the Rowers: biomechanical background" was published in the last Australian Rowing magazine. Mistakenly, Figure 4 was printed twice, and Figure 5 was excluded. Here are original versions of the charts:



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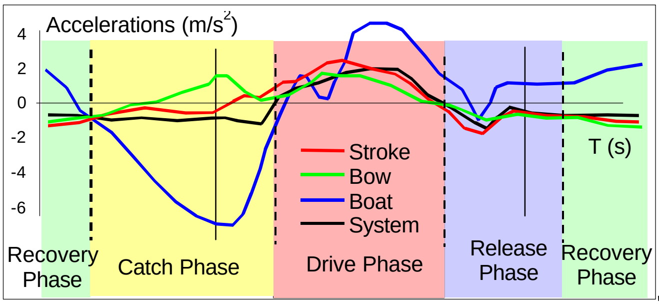


5

Boat, rowers CM and the system CM accelerations of World Champions (4) and national level rowers (5) in M2-, 35 strokes/min.

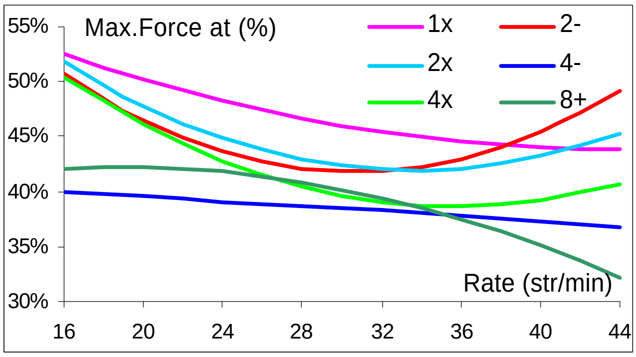
You can see that better rowers have a higher and more synchronous accelerations of their center of mass (CM). This leads to a longer period of positive system acceleration (drive phase) and shorter periods of negative system acceleration, when rowers' masses exchange kinetic energy with boat mass.

See the Australian Rowing magazine for more details.

Facts. Did You Know That…

? …the peak of the force application depends on stroke rate? It is common opinion that in the bigger, faster boats rowers should apply force quicker and earlier during the drive phase (1). But how much earlier? We studied position of peak force (as a percentage of the length of the rowing arc) in different boat types and found that this parameter has mild negative correlation (r = -0.25 - -0.45) with stroke rate. This means that at higher stroke rates position of peak force is closer to the catch. The trend of relationship of peak force position and stroke rate is different in different for each boat types (Fig.1). Notice:

✓ at low ratings two groups of boats can be defined: 1x, 2-, 2x, 4x with peak force at 50-55% and 4-, 8+ with the peak force at 40-43% of the arc.



1

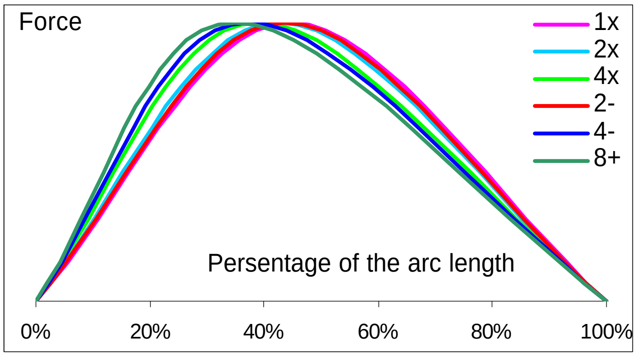
✓ at higher ratings position of the peak force agrees with common opinion: the faster the boat the earlier peak force is applied;

✓ the shapes of the trends also form two groups: one with continuous decreasing (1x, 4-, 8+); and another with non-linear dependence and the earliest peak forces at around 32 str/min (2-, 2x, 4x).

Here are the average positions of peak force for the different boat types at their racing stroke rates:

Boat Type	1x	2x	4x	2-	4-	8+
Prognostic Rate	36	38	39	37	39	40
Max.Force at (%)	44.6%	42.5%	39.0%	43.5%	37.4%	35.1%

Visual images of the average force curves with above positions of peak force are presented here:



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References

📖 1. Schwanitz P., 1991, Applying Biomechanics to Improve Rowing Performance. FISA Coach 2(3), pp.2-7.

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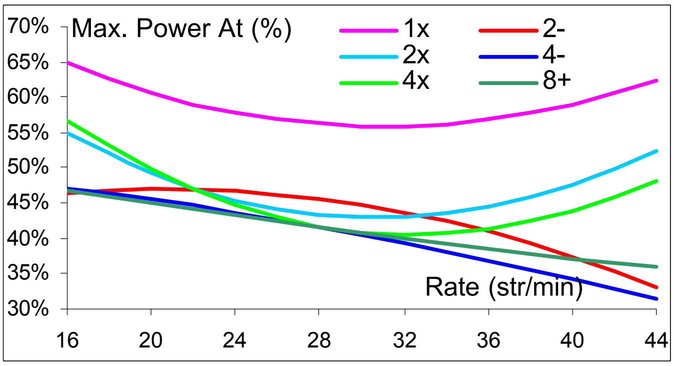
Volume 2 No.7 **Rowing Biomechanics Newsletter** July 2002

News

☺ Intensive testing of the AIS rowers and National Team members was undertaken in May-July. A total number of 42 athletes were tested in 12 boat types over 44 testing sessions.

Facts. Did You Know That…

? the peak of the power application depends on stroke rate? Power is a product of the force and velocity, so its trends are similar to peak force (RBN 6/2002), but correlation factors are lower (r = -0.26-0.35). The trends of peak power position are different for sweep and sculling boats. Notice:



✓ Trend lines of all sculling boats have a minimum at a stroke rate of around 32. This means that the rowers apply power later at very high rates;

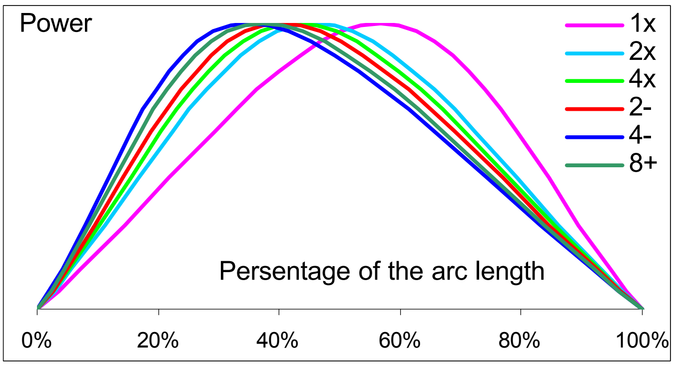
✓ The trend of 2- is opposite to that of the other boats with peak power occurring progressively earlier at stroke rates above 28;

✓ Singles have a significantly later position of peak power at any rate and fours have a much earlier power application at high rates.

Here are the average positions of peak power for the different boat types at their racing stroke rates:

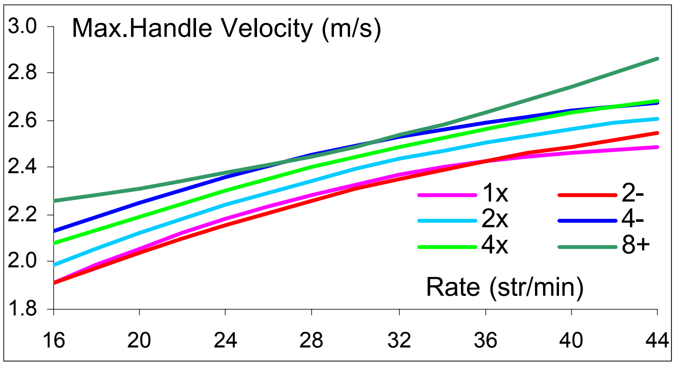
Boat Type	1x	2x	4x	2-	4-	8+
Prognostic Rate	36	38	39	37	39	40
Max. Power At (%)	56.8%	45.8%	43.0%	40.2%	34.9%	37.2%

Visual images of the average force curves with above positions of peak force are presented here:



? …the position of the peak force and power have a mild negative correlation with maximal legs speed (r=-0.28-0.42 in different boat types). This means that a faster leg drive helps to apply force and power quicker;

? … obviously, maximal handle velocity, correlates with stroke rate (r=0.52-0.69). Here are the trends in different boat types;



? … practically, peak handle velocity does not depend on stroke rate and boat size. On average, it happens at 64±4.8% of the total arc length in sweep boats and at 65±5.2% in sculling. This means that the oar handle moves with acceleration during the first two thirds of the drive length and with deceleration during the last third;

Ideas. What if…

? …we take into account the above facts for training in small boats and for selection of the rowers? The following can be recommended:

✓ Fours and eights have similar positions of the peak power (at 35-37%) and can be used for cross-training without limitations;

✓ 2-, 2x and 4x have very similar position of peak power at 40-45% of the arc length. Therefore, from this point of view, rowing in pairs is better preparation for a quad than rowing in singles;

✓ Singles have a very distinctive pattern of force and power application in the second half of the arc length. This may require a special selection of the rowers and training with emphasis on a powerful trunk and arm drive.

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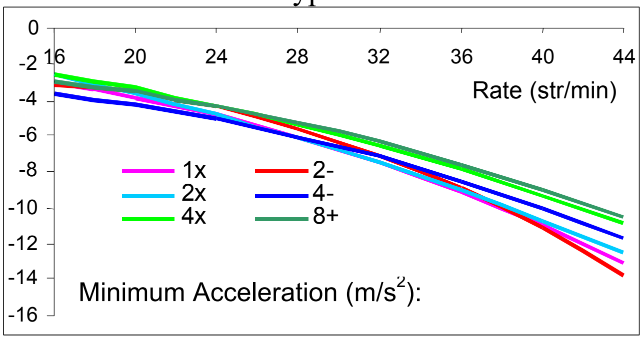
Volume 2 No.8 **Rowing Biomechanics Newsletter** August 2002

News

☺ Very detailed research measurements were conducted in Canberra during the last month. 25 parameters were measured in a single scull. The purpose of this study was optimization of the gearing ratio.

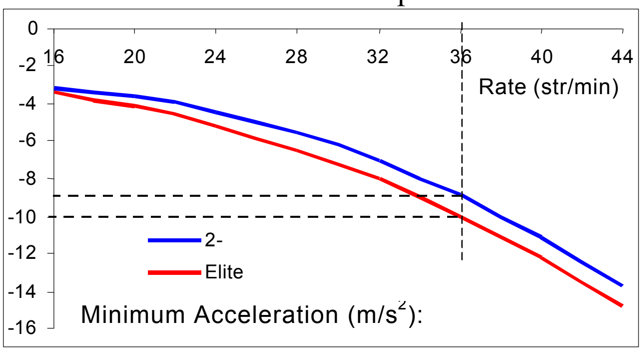
Facts. Did You Know That…

? …the peak of negative boat acceleration at the catch depends on the stroke rate (r = -0.79)? Here are trends in different boat types:



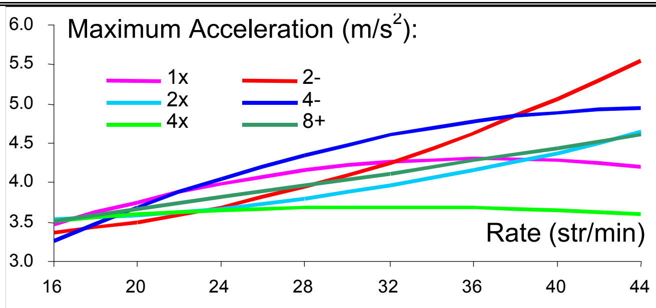
Note that all trends are very close to each other at low rates, but at high rates negative acceleration is more significant in small boats.

? …negative boat acceleration at the catch is more significant in better crews? Here are trends in pairs of national and world champions:



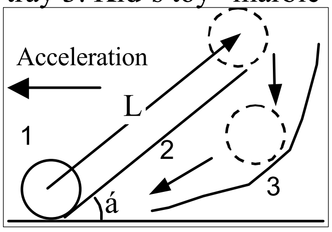
Note that at racing rate the magnitude of the negative acceleration is about 1m/s^2 more significant in elite crews, but its duration was shorter (RBN 6/2002).

? …the peak of positive boat acceleration also increases with the stroke rate, but not as significantly as peak negative acceleration (r = 0.33)? Below are trends in different boat types. They are also very close in different boats at low rating, but their variation is very significant at higher stroke rates. There was no difference found between peak positive acceleration in elite and national level rowers, but the duration of the positive acceleration was longer in elite rowers.



Ideas. What if…

? …you provide immediate feedback on boat acceleration? You can use a simple device consisting of a ball 1, a slope 2 (inclined tray) and circular return tray 3. Kid's toy "marble" can be used for this gadget.



The ball climbs the slope and hits the return tray only if the average boat acceleration, over a certain period of time, exceeds the defined value. The table below gives you angles of the slope α corresponding to the average boat acceleration and the length of the slope *L*, which defines the time period.

Boat Acceleration (m/s^2)	Slope Angle (deg)	Time period (s)				
		0.1	0.2	0.3	0.4	0.5
		Length of the slope (cm)				
3.0	17.0	1.4	5.7	12.9	23.0	35.9
4.0	22.2	1.9	7.4	16.7	29.6	46.3
5.0	27.0	2.2	8.9	20.0	35.6	55.7
6.0	31.5	2.6	10.2	23.0	40.9	64.0
7.0	35.5	2.8	11.4	25.6	45.6	71.2
8.0	39.2	3.1	12.4	27.9	49.6	77.5
9.0	42.5	3.3	13.3	29.8	53.1	82.9
10.0	45.5	3.5	14.0	31.5	56.0	87.5
11.0	48.3	3.7	14.6	32.9	58.6	91.5
12.0	50.7	3.8	15.2	34.2	60.8	94.9

E.g.: If the ball climbs the slope of the angle 27^o and the length 20cm, this means that the average boat acceleration was higher than 5.0m/s^2 during 0.3s.

The gadget can be used for two purposes: 1) shortening of the time of negative acceleration at catch (step angle, short slope, the ball must NOT hit the return tray); 2) increasing of the magnitude and duration of the positive acceleration during the drive (flatter angle, longer slope, the ball MUST complete the climb). Try it!

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Volume 2 No.9 Rowing Biomechanics Newsletter September 2002

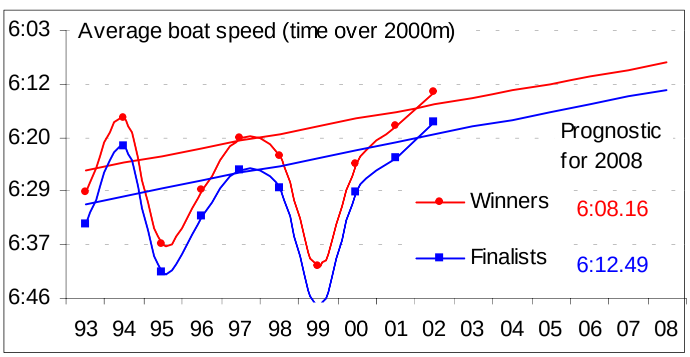
News

☺ Australian women crews were the best at the recent World Championship in Seville. W4-, WL4x and LW2x won gold medals and W8+ won silver. Well done! Congratulations to the athletes and coaches!.

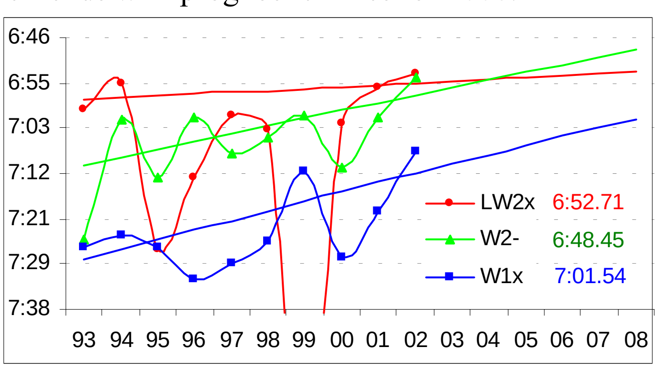
Facts. Did You Know That…

? …the latest Worlds were the fastest ones over the last 10 years? The average boat speed of the finalists in 14 Olympic boat classes was 6:17.7 (in min:sec over 2000m) and the winners average was 6:13.0. The second fastest championship was in Indianapolis in 1994, where the times were 6:21.7 and 6:17.21, respectively.

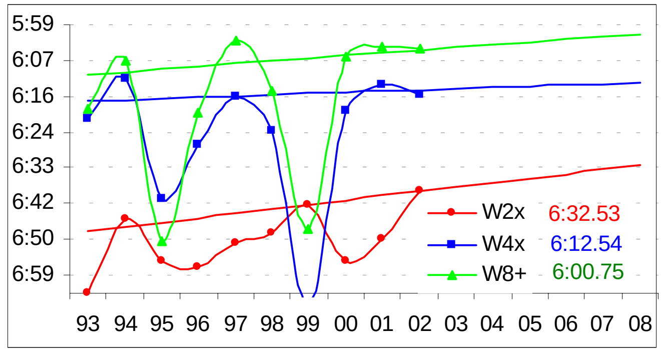
Here are graphs of the average boat speed and their trends until 2008. The expected increase in the boat speed is 0.32% per year in finalists and 0.31% in the winning boats. This means average boat speed in the finals is getting closer to the winners speed and the competition is getting tougher.

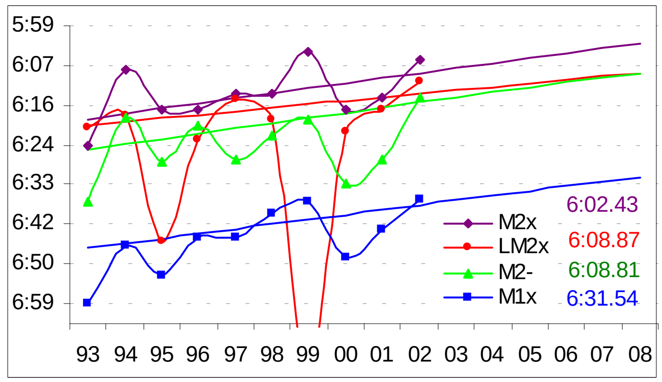


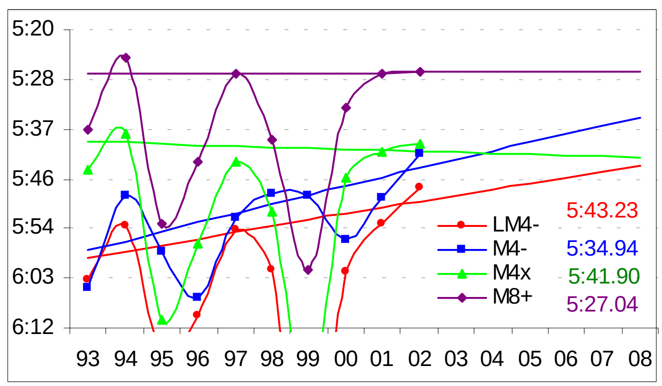
? …the similar trends of the boat speed are quite different in various boat types? Here is the graph of the boat speed of the winners in Olympic boats and the trends with prognostic times for 2008.



It is interesting that in 2008, the W2- is expected to be faster than the LW2x and the M2- will have similar speed to the LM2x. The M4x will be much slower than the M4- and will have nearly the same speed as the LM4-.







? …the expected increase in the boat speed per year is also very different in Olympic boats?

M4-	W1x	W2-	LM4-	M2-	M2x	W2x
0.45%	0.41%	0.35%	0.31%	0.29%	0.29%	0.27%

M1x	LM2x	W8+	LW2x	W4x	M8+	M4x
0.26%	0.20%	0.18%	0.08%	0.08%	0.01%	-0.05%

Higher increase in speed found in small boats and both men's fours, except LW2x. Big boats have less increase. In the fastest boats M8+ has practically no increase and M4x is the only boat with decreasing speed. Above proportions can be changed in future and can be different if we consider longer period of time. However, they reflect current situation in rowing.

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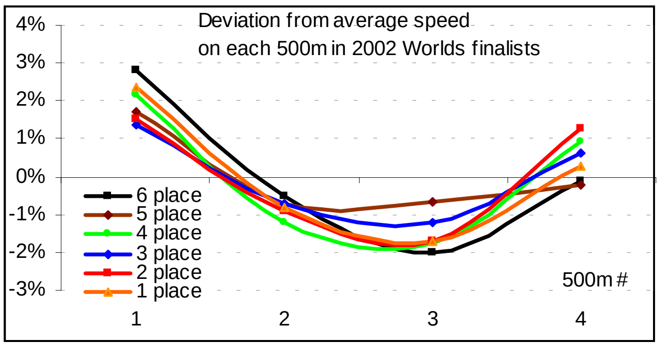
Facts. Did You Know That…

? …the winners of the latest Worlds were relatively faster over the 1st 500m, but silver and bronze medallists were relatively faster over the final piece? This corresponds to the strategy of the Sydney Olympics medallists.

2002 data: Deviation of boat speed from average of the same crew in 14 Olympic classes.

500m piece	Place 1	2	3	4	5	6	All Finalists
1	2.4%	1.5%	1.4%	2.2%	1.7%	2.8%	2.0%
2	-0.8%	-0.9%	-0.7%	-1.2%	-0.7%	-0.5%	-0.8%
3	-1.7%	-1.7%	-1.2%	-1.8%	-0.7%	-2.0%	-1.5%
4	0.3%	1.3%	0.6%	0.9%	-0.2%	-0.1%	0.5%
Variation	1.8%	1.6%	1.2%	1.8%	1.2%	2.0%	1.5%

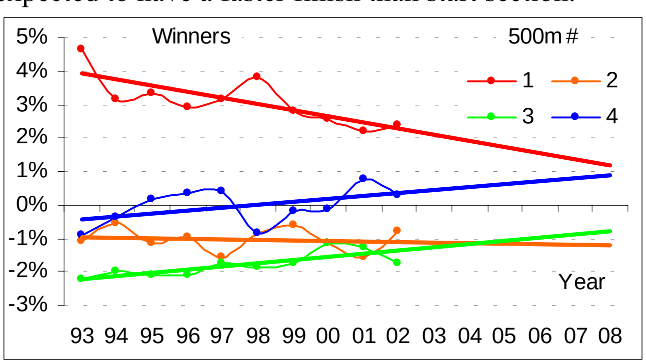


1.

This can be explained by the following reasons:

- Winners have chosen a better race strategy, which gives them advantages in psychological (control over the race) and/or physiological (better work-capacity utilization) aspects.
- Winners were better sprinters, but other medallists had good endurance and cruising speed.

? …analysis of the trends over the last 10 years shows that the boat speed is getting more and more even during the race? Also, these trends confirm the above considerations and show that the winners usually have relatively faster starts and higher variation of the boat speed. It is interesting, that in 2008 silver medallists are expected to have a faster finish than start section.



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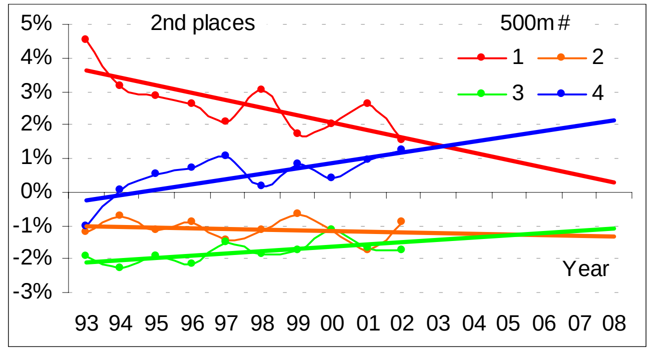

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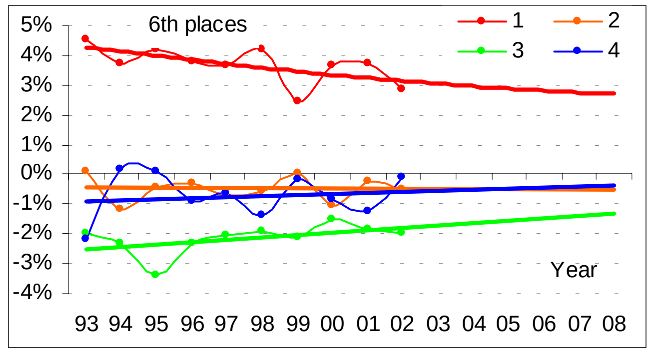

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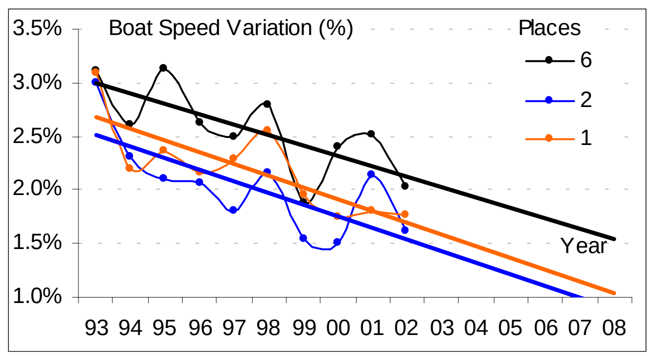

5.

Very likely, the winning strategy in 2008 will be:

- +1, -1, -1, +1%.

Ideas. What if…

? …you put a bit more effort in obtaining the correct race strategy? Start with a low speed (70-80%) and practice the desired distribution of the boat speed over the race sections. Then, increase speed and try to maintain correct race pattern. Good luck!

References

1. Kleshnev V. 2001. Racing strategy in Rowing during Sydney Olympics. Australian Rowing. 24(1), 20-23.

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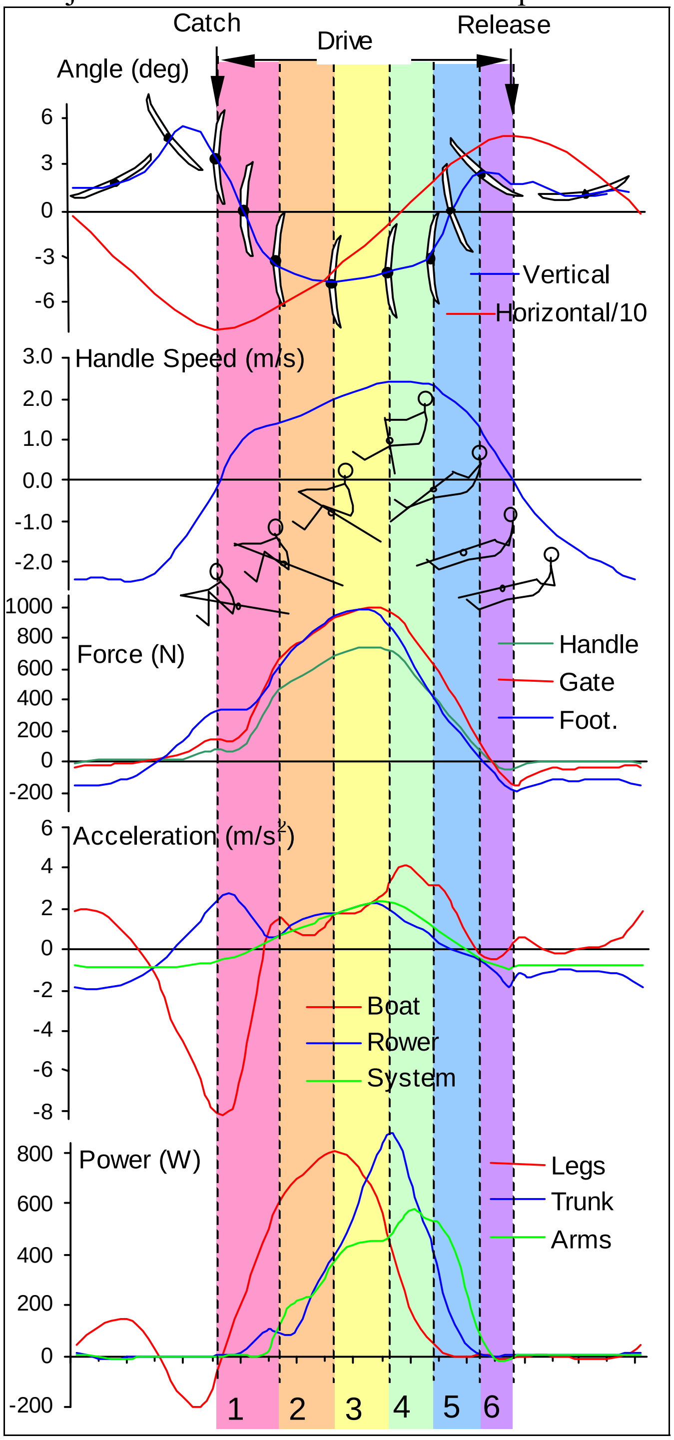
Back to basics

The drive phase can be split into six sections or micro-phases. Here are their graphical definitions in conjunction with the main mechanical parameters:



Below is description of each phase and border points (*in Italic*).

***Catch**, beginning of the drive. Oar changing direction of the movement. Small inertial forces applied to the handle and the gate, but the foot-stretcher force is already significant. These forces produce a negative peak acceleration of the boat and a positive peak of the rower's acceleration.*

1. **Blade immersion.** Fast increase of handle speed and force. The boat acceleration is also increasing and becoming positive, but the rower's acceleration decreasing.

The blade is fully immersed. Little hump in the handle speed. The bend of the force curve and legs power curve. First positive peak of the boat acceleration and cavity of the rower's acceleration.

2. **Rower's acceleration.** Handle speed and forces are increasing at a slower rate. The legs are generating nearly max. power that leads to an increase in the rower's acceleration, but decrease in the boat's acceleration.

The deepest point of the blade. Second bend of the force curve. Maximal speed and power of the legs.

3. **System acceleration.** Handle speed is continuing to grow, but the forces increasing very slowly. Legs power going down and trunk power is becoming the highest. The boat and rower's accelerations are almost equal each to other and to the system's acceleration.

Maximal handle and gate force. Maximal acceleration of the system. Maximal speed and power of the trunk.

4. **Boat acceleration.** The oar is crossing the square off point. Handle speed has a plateau. All forces are decreasing, but the foot-stretcher force is decreasing faster than the gate force that produces the highest boat acceleration. The rower's and systems acceleration are decreasing as well as legs and trunk power. Peak of the arms power.

The upper edge of the blade is at the water level. Handle speed starts decreasing. Legs power is nearly zero.

5. **Blade removal.** Handle speed is decreasing. All forces are decreasing. The foot-stretcher force becomes lower than the handle force, which causes a negative acceleration of the rower and whole system.

The blade is completely out of water. Forces and accelerations are close to zero.

6. **Idle drive.** The handle is continuing to move towards the bow by inertia. Rower's mass is turning to the recovery (negative acceleration) that causes small positive boat acceleration. The system acceleration is negative due to a drag force.

***Release**, end of the drive. Oar changing direction of the movement. Inertial forces applied to the handle, gate and foot-stretcher.*

These definitions will be used for later biomechanical analysis of the rowing styles.

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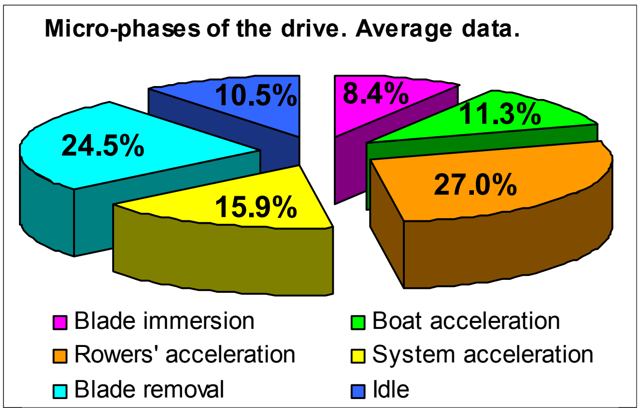
News

☺ ***Dear rowing coaches, rowers and all people supporting rowing!***

The best wishes to you and your families in the New 2003 Year!

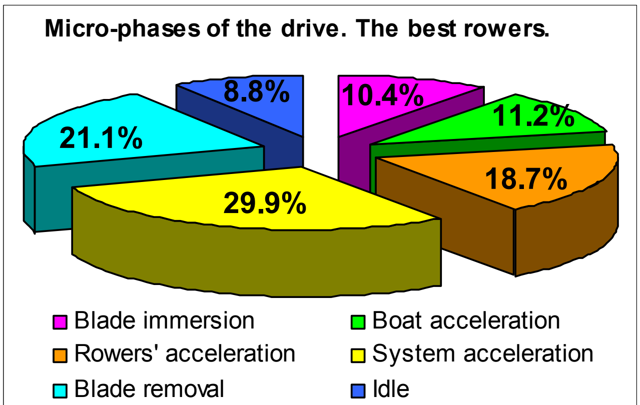
Facts. Did You Know That…

✓ …rowers' CM acceleration micro-phase is the longest one in the drive phase and comprises 27% of its duration. The second longest is the blade removal micro-phase (24.5%) and the third one is the system CM acceleration micro-phase (15.9%).



The definitions of the micro-phases were done in the previous RBN 11/2002. This data was obtained as an average of 1450 biomechanical samples in all boat types.

✓ …the best rowers have nearly two times longer duration of the system acceleration micro-phase (29.9%) than average data:



Rowers' acceleration micro-phase is significantly shorter (18.7%) than average (27.0%). All other micro-phases have similar duration.

Ideas. What if…

? …we want to row like the best rowers in the world? Then we need to increase duration of the system acceleration micro-phase. This means we should accelerate the rowers' center of mass and the boat together as long as possible. To do this, we can take into account the following rules:

✓ As you can see on the graphs of the previous RBN, the system acceleration micro-phase coincides with simultaneous activity of the legs and trunk. Their power curves overlapped and this produce the highest amount of power applied both to the handle and the foot-stretcher and the highest acceleration of both the rowers' mass and the boat.

To increase duration of the system acceleration, all other micro-phases should be shortened:

✓ The blade immersion micro-phase can be shortened by means of quicker vertical movement of the oar at catch, which must be coordinated with the fast force application to both the handle and the foot-stretcher;

✓ Duration of the rowers' acceleration micro-phase correlates positively with the quickness of the legs speed increasing;

✓ Boat acceleration dominates when rowers apply more force to the handle and gate than to the foot-stretcher. This can happen twice during the drive phase: strait after the blade immersion and before the blade removal. Once again, we should emphasize importance of simultaneous force application to the handle and foot-stretcher (do not confuse with the simultaneous rowing style);

✓ The blade removal phase can be shortened if the handle quickly tapped down at the end of the drive phase. Also, a fast arms work concentrated at this moment can help;

✓ Duration of the idle drive micro-phase correlates with the duration of the blade removal micro-phase and depends on quickness of changing of the oar movement direction at the end of the drive.

Other News

All previous issues of RBN can be found on the Rowing Queensland site: www.rowingqld.asn.au/Resources

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