HUFF

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From the editor

Thought I'd put out an early edition of HUFF so the news about the recent Challenge is fresh.

All pictures shown in this HUFF was supplied by Peter Moller **peterm@bold.net.au**

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Announcing the World Recumbent Racing Association

Currently there are a number of records organizations for Bicycle records. The UCI maintains records for all standard upright bikes with no aerodynamic modifications. The IHPVA records absolute records for any type of human powered vehicle.

The World Recumbent Racing Association has been organized to recognize the accomplishments of non-faired recumbent bicycle racers, and to keep a record of those accomplishments. As there was previously no organization that records these feats, the WRRA is in the unique position to begin this task. Separate records categories will be available for Men and Women in 3 different age categories each. In addition,

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The Greenspeed OzHPV Challenge 2004

by Damian Harkin

This year, my daughter Claire was playing her tenor horn in the State Youth Brass Band at the Grand Prix and at the Moomba parade, so wife Joan and Claire stayed in Melbourne while Sarah, Frances and I headed up to Broadford for the Challenge. We were driving Joan's blue van with the Flevobike tandem on the roof rack, the 'Trisled Radar Speed Sign' hitched up behind and our MR Swift trike tied on top of it.

As we arrived at the track we noticed more cars than last year, and they kept arriving – George from Tassie, Peter Moller and the South Australia crew, and a whole posse of Canberra folks with 6 bikes vacuum packed into a trailer in a miracle of packaging efficiency.

Saturday dawned bright and sunny and gusty and we had brekky while preparing for action. The registration desk was ably manned by Frances and Sarah who registered a flood of entries – finally giving out 51 number plates. We only have 59 available so we had better make up some more for next year!

Last year, Jamie Friday had suggested we get a bell to announce when races are about to start. I had hunted around for one during the year, but in the end I used my old cornet and blew the bugle call 'First Call'. It sounds like we are having a horse race but it does the job.

First event was the hill climb.

Glenn Druery conquered the hill on his blue Optima Baron followed by Malcolm Butler and Scott Setford. Malcolm had his trusty Flying Furniture bike and Scott was on a Greenspeed trike this year instead of the road bike he used last year. Only David Cox from Penrith and Steve Barnett

In this issue

Head Up Feet First is the Newsletter of OzHPV Incorporated. The ever developing Web site can be found at http://www.ozhpv.org.au/index.htm.
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fielded conventional upright bicycles in the 2004 Challenge. We started the hill-climb from the start-finish line which may have given Glenn a chance to use the Baron's speed for a bit of a run up. Anyway it shows recumbents CAN climb!

I recalled that Glenn used to have a yellow Baron. He told be the boom had cracked through, and that Optima had very properly given him a new (improved) frame. I think he must be pushing the pedals too hard!

Next we had the time trial – one timed lap of the road circuit. Gareth Hanks got around in 3 minutes and 17 seconds, averaging 42 km/h. That's pretty awesome when you consider the hill. He must have hit some serious speed on the way back down. Glen Druery was a close second with 3'18.03" then Ian Humphries with 3' 20.91"

The D&H Enterprises road race was very interesting. Gareth Hanks was competing in a pedal prix trike, fully streamlined (head out) complete with foot catch-tray, roll bar etc. By all the laws of physics he should have been slow up the hills, fast down the hills and completely overheated by the end of the race. But Gareth passed everyone going up the first hill and he never slowed down. So he well deserved the handsome trophy donated by D&H Enterprises. A very impressive win. Second was Ian Humphries and third was Glenn Druery.

The Broadford scouts (and their mums) provided refreshments throughout the day and lunch. The menu had been expanded from the usual sausage sizzle and I can report that the new healthy salad rolls were yummy.

This year, the 200m sprint was replaced by a straight speed attempt using the 'Trisled Speed Sign', a trailer-mounted radar speed sign that's normally used to 'calm down' traffic. I think the idea of giving riders and spectators immediate feedback

Humphries and Rogan Shopping Race

was good, but this was essentially an experiment. The sign usually worked OK but sometimes the speed was only displayed after the rider had passed by, and sometimes not at all. (Speeds displayed were consistently 'slow' compared to bike computer readings.)

On Saturday, riders faced a strong headwind. (On Sunday, the wind had turned towards the sign and many riders were seen trying to improve their reading.) Glenn Druery made an initial hot run of 60 kmh. Gareth Hanks complained of a wind gust

Wake me up when it is my turn, Bob Braunstal

during his run and asked for a second go. He then hit 65, forcing Glenn to run again to defend his lead. Alas, the sign didn't register anything - which was very very regrettable. I think we need to do some research into alternative radar speed displays, but I definitely like the idea. If radar can detect a tennis ball it must be possible for it to see a HPV. Anyway we need to get some feedback about this.

The Bike Chameleon Twin slalom saw some thrilling racing and some spills. Rob Wartenhorst was amazingly smooth and precise on his 'High Racer'. Ian Humphries was also very impressive, the Velokraft carbon low racer weaving through the cones with uncanny precision. Ewen Nurse was very competitive on roller blades as usual. He usually only gets pipped in the straight drag race of the return leg.

We had some complaints that the cones were too offset and too closely spaced, making the course very difficult for trikes. Tosh! It's supposed to be an extreme test of manoeuvrability and many of the trikes managed it very well.

The last man out is always a bit of a bunfight. After the first few laps, the slower riders have all been lapped and then it gets more serious. Malcolm Butler won this one.

At dinner time some scary winds blew up, but the threatening rain held off. Broadford continues its reputation for extreme weather.

After dinner, we sat in the classroom for Steve Nurse's Trivia and Karaoke competition. This is already a hit and I think a new tradition has begun. The questions were quite silly and very diverse, with topics ranging from HPV stuff to Kylie and

pop culture. A few people sang songs. Table 4 told a very weak joke and were harshly judged. The Canberra mob won but they got to do the marking for my table so I'm sure they must have cheated! Anyway it was good fun.

Concourse

Breakfast at Stuty's was very well attended, but the resulting queue for croissants and coffee was too long. It took quite a while to get fed, but the pastries and the chocolate cake are highly recommended!

Jamie Friday judged the professional machines. He waxed lyrical about William's Windcheetah, David and Heloise's Trisled Gizmos, the M5's with their curvy swingarms, and David and Fay's Tartaruga and Halfway folders. Finally, he awarded the innovation gong to Michael Rogan's rig comprising a full suspension quad with huge rack and child seat, coupled to his wife Tomako's full suspension adventure trike. As Jamie said, you can start at the front and count the innovations as you work your way back along the vehicle(s).

Best presented homebuilt went to Chris Curtis' lowracer (it was the only one with paint). The innovation award went to Ken Houghton's bike with it's unique ventilated seat.

Trike only criterium

During the whole concourse Kerry Hanson and John sat in the gutter with a tub of hot soapy water preparing Kerry's immaculate red Greenspeed trike. The tyres were blacked (and still had the moulding flash on the centerline). The red bottle cage, red spd pedals and red hooter were just too cute. Kerry's machine won 'best presented HPV ever seen'.

We actually forgot to run a tee shirt competition or award a prize for longest distance travelled to the Challenge. We must create some running sheets in future so we remember everything. Anyway Kerry Hansen had an entry for the tee shirt comp. Instead of coming up with some logo or graphic on a standard shirt, Kerry actually created a novel recumbent jersey, bright orange with a big front pocket and a drawstring hem. It looked very practical and really deserved the award.

After brekky we headed back to the track. Oh the hill! The hill! David and Fay had the right idea. They drove their ute over the hill with bikes in the back and then cycled into town from the front gate of the track. They gave a few HPV riders a tow up the hill on the way back.

The twin drag race went to Jamie Friday on his new commuter bike, narrowly beating Rob Wartenhorst's 'high racer'. Jamie built this machine over the last few months and it's a very professional, neat and fast machine. We're thinking of awarding a new prize in future for best homebuilt in the Challenge, because this kind of effort really deserves recognition.

Cross country in the off road race

Michael Rogan laid out the MR Components Off-Road Adventure – three laps of an evil circuit using the downhill gravel SuperMotard track with its huge bumps, ruts and gutters, and returning straight back up the hill across the bumpy grass. The last vicious little gravel bank up onto the road circuit was sure to stop almost anything short of a four-wheel drive. I think Michael was as amazed as the rest of us when Ian Humphries ran away with this race, easily holding his own on the slippery gravel and humiliating the field on the uphill sections. Picture Ian on this dainty carbon low-racer with its wheels like pizza-cutters, clawing his way up the grassy hill and the gravel bank for all the world as if lowracers were the ideal off-road bike! He is a champion and I reckon the

Neck and Neck for 3rd trike only criterium

Velokraft carbon frame is tough!

After lunch we had the Flying Furniture Criterium. It was my misunderstanding that left Flying Furniture out of the program, but Ian Humphries had always meant to sponsor the race and kicked in his $100 on the day. Sorry Ian!

This year the criterium track was faster and more technical than last year. It included four 180 degree turns per lap - or was it 5? A very steep hill, narrow bends and some gravel all added to the challenge. Really exciting close racing ensued and after three heats, Ian Humphries took the final, followed by Rob Wartenhorst and Malcolm Butler.

Tony Romanos during criterium

The last event was the shopping race. Paul Sims sent up the same Milo tins full of sand that we had used last year. Little did anyone realise the tins were all rusted through and barely holding together. We had to stop racing several times after the tins burst open on being dropped. Ian Sims came to the rescue with yards of gaffer tape and we were able to complete the event. Jamie Friday won it with speed and precision. Ian Humphries came next using a neat folding trailer behind his lowracer. Malcolm Butler came in third. The shopping race produced the usual loony entries. Some people towed assistants along in their trailers to help with the unloading (and the hill climbing). Others tried to fit everything in a big bag, pretty much jamming the steering and making their bikes uncontrollable. We hope they don't really do their shopping like this!

We had an award ceremony at about 4pm but many people had already left, and the rest had to interrupt their packing to attend. Ian Humphries gets to put his name on the trophy once again. He remains a fierce competitor, a very skilful rider and lets' face it – he rides a pretty fast bike! I'm not really convinced that the Velokraft carbon lowracer is the best all-round HPV, but it sure is when Ian is on board! Helen Curtis took the womens' trophy with her Optima Baron lowracer. Alright maybe we should just admit that lowracers are the best! Ewen Nurse won the junior on his roller blades. Maybe next year Steve will finally build the kid a bike!

Logo tandem trike in pits

Notably, Kerry Hansen came second in the women's class. Nobody would say Kerry is fast, but she entered every event and she didn't give up. At the end of the road race she started out on a new lap just before Gareth crossed the line. She could have easily called it a day, but that extra lap put her into second place. So that's a lesson for everyone – attempt every race and you too can get a good result!

I was very happy with this Challenge. There's always a few things that go wrong, but the vibe was good, there were lots of competitors, great sponsors and I think most people had a great weekend. We made a profit, which helps the club. I've got some ideas about how to make the event better, but I think we should all have a think about this and put our ideas up on the yahoo discussion group. Anyway its definitely on again next year, probably the first weekend in March so stay tuned for details!

Damian Harkin - **damianharkin@fastmail.fm**

Bob Braunstal

Affect of the Posture and Rolling Resistance on the Required Effort to Ride a Recumbent

Initiator and author: Bert Hoge
Translation: Rob Wartenhorst & Danielle Cantono

This research was done in cooperation with the NVHPV and has been published before in the magazine "Ligfiets&" nr.3-2003 titled "De Meetligfiets".

Among recumbent riders, there are often discussions about the effects of factors such as rolling resistance of tires, lying down more, or sitting upright more, having the steering wheel low or high on speed. Sometimes opinions are formed by riders' own subjective observation, but more often, they are formed by what other people say. The most commonly made error is comparing apples with pears.

Reasoning like: "After changing the path my chain follows on my bike, changing my tires or posture I went faster or slower on my recumbent" is often heard in discussions. But then factors like fitness, type of road surface, direction and strength of wind, temperature etc. are then not taken into account.

Or a fitter cyclist A is compared to a less fit cyclist B. Of course not everybody is in the situation to make objective measurements or have enough knowledge about the effects that are a factor in the efficiency of movement.

Many recumbent rides still want to express their opinions because it is fun to talk about it.

The reality is often very complicated and is described by the quote "It depends on and is caused by".

Of course, we all want to ride on a comfortable recumbent, which at the same time efficiently converts the limited pedalling power into speed. We all know that by lying down more, for example, you catch less wind and thus have to deliver less pedalling power for the same speed. But the relation between those two factors is not known, or at least has not been published. If we want to be able to say objectively something about these effects, we have to measure them in a controlled environment. To test this, I had the idea of measuring resistance using a basic measuring recumbent. This recumbent should be adjustable so that we can measure the factors of posture (air resistance) and tires (rolling resistance).

In cooperation with the NVHPV, this bike (see picture 1) was created. In December 2002, a series of measurements were executed using this measuring recumbent and a power measurement system entitled SRM. This systematically set up test environment is unique for as far as I know. The results, of course, only say something about what could be measured within the available budget and time. The effects of the biomechanics (how efficiently a body converts body energy in pedal energy), for example, are not measured. And energy-efficient recumbent riding is also related to comfort. But as many experienced recumbent riders know, comfort and speed don't exclude each other on a recumbent. Before reading any further, I want to warn you that the reading can be tedious, but it was hard to make it more readable. However, you will be rewarded with many interesting conclusions and more insight into these two resistance factors from which you can benefit.

The test environment:

* Measuring system: SRM
* Measuring speeds: 35km/h.
* Measuring location: The Velodrome at Sloten, Amsterdam, The Netherlands (covered velodrome with a 200 meter wooden track).
* Type of recumbent: Adjustable measuring recumbent.
* Design and production of measuring recumbent: Bram Moens of M5-recumbents.
* Adjustable or replaceable are:
  - Brackets (both horizontal and vertical).
  - Angle of reclination.
  - Steering wheel, narrow under seat or above seat.
  - Type of wheel 406, 451 and 559.
  - Type of tire: IRC 20(451) x 1 1/8 at 8bar
  - The other types of tires tested were also at 8bar
* Test rider: Bram Moens of M5-recumbents
* Air temperature: About 10°C.
* Pedal revolutions: About 80 revolutions per minute if not indicated otherwise.
* Speed and power were measured on average every 10 laps or 2km. If there were small deviations of the measuring speed of 35km/h, then the measured power was corrected with commonly accepted formulas.
* During the measurements, the average speed could be kept within a 0.2 km/h margin.
* Clothing: long cycling pants + thin thermo jacket.
* Weight of recumbent plus rider about 92 kg.
* Inaccuracy of SRM-meter < 2%.
* The results were easy to reproduce because the SRM meter only had to be mounted and calibrated once.

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GREENSPEED OZHPV CHALLENGE 2004

OVERALL RESULTS

			POINTS											Place	Men		Women		Junior	
Vehicle	Name	Class	Hill	Timetrial	Road	Sprint	Slalom	Last Out	Drag	Enduro	Shopping	Criterium	Total	Overall	pts	place	pts	place	pts	place
1	Mick Webster	men	18	20	14	18	29	6	25	17	16	19	182	20	182	18				
2	Rob Wartenhorst	men	4	4	5	6	2	4	2	5	8	2	42	2	42	2				
3	Robert Regester	men	50	31	27	44	29	6	25	26	27	25	290	50	290	37				
4	Ewan Nurse	jun	28	31	27	44	3	6	25	26	25	22	237	30					237	1
5	Stephen Nurse	men	26	28	21	42	28	6	25	26	18	23	243	32	243	27				
6	Kerry Hansen	women	29	30	22	29	22	6	22	26	9	23	218	27			218	2		
7	Laura Houghton	jun	50	31	27	43	29	6	25	26	22	25	284	44					284	3
8	Ken Houghton	men	24	27	27	30	29	6	20	26	27	25	241	31	241	26				
9	David Cox	men	14	12	12	27	29	6	12	13	13	25	163	16	163	14				
10	Heloisa Mariath	women	25	26	20	35	29	6	18	23	24	20	226	28			226	3		
11	Peter Moller	men	50	31	27	31	29	6	17	26	27	25	269	41	269	33				
12	David Cox	men	12	21	18	18	11	6	5	4	27	25	147	12	147	10				
13	Ian Humphries	men	5	3	2	3	9	2	5	1	2	1	33	1	33	1				
14	Bob Braunsthal	men	19	19	16	27	15	6	9	9	17	9	146	10	146	9				
15	Atholl Reid	men	20	23	24	18	24	6	15	21	12	20	183	22	183	20				
16	William Reid	men	27	25	27	31	12	6	16	20	14	21	199	23	199	21				
17	Chris Curtis	men	8	10	19	6	17	6	5	15	27	5	118	6	118	6				
18	Mike Bell	men	17	13	13	9	21	6	3	11	11	6	110	5	110	5				
19	Malcolm Butler	men	2	5	4	5	18	1	13	18	3	3	72	4	72	4				
20	Ray Searle	men	50	31	27	39	29	6	25	26	27	25	285	46	285	36				
21	John Kuljis	men	23	22	17	22	14	6	14	16	6	21	161	15	161	13				
22	Malcolm Butler	men	50	6	27	13	29	6	25	26	27	25	234	29	234	25				
23	Michael Rogan	men	21	31	27	17	20	6	25	26	10	25	208	25	208	23				
24	Alan Murchison	men	22	24	15	35	16	6	24	22	23	19	206	24	206	22				
25	Andrew Fatseas	men	10	17	11	18	1	6	25	26	27	25	166	17	166	15				
26	Scott Setford	men	3	8	6	4	29	6	25	26	27	25	159	14	159	12				
27	Matthew Elliston	men	16	16	23	22	3	6	5	12	4	22	129	7	129	7				
28	David McCook	men	15	18	25	6	27	6	11	24	15	8	155	13	155	11				
29	Liam McCook	jun	50	31	26	37	19	6	21	25	26	22	263	40					263	2
30	Glenn Druery	men	1	2	3	2	29	6	25	26	27	25	146	10						
31	Graham Teakle	men	11	15	27	26	5	6	10	6	5	19	130	8	130	8				
32	Helen Curtis	women	9	14	10	13	26	5	3	19	20	20	139	9			139	1		
33	David Westbrook	men	50	31	27	44	29	6	25	14	27	25	278	43	278	35				
34			50	31	27	44	29	6	25	26	27	25	290	50						
35	Tomoko Yamashitu	women	50	29	27	44	25	6	25	10	21	25	262	37			262	5		

36	Steven Barnett	men	7	9	8	9	29	6	25	26	27	25	171	18	171	16				
37	James Friday	men	6	7	7	13	5	3	1	3	1	4	50	3	50	3				
38	Peter Mathews	men	13	11	9	11	29	6	25	26	27	25	182	20	182	18				
39	Gareth Hanks	men	50	1	1	1	10	6	25	26	27	25	172	19	172	17				
40	Lloyd Charter	men	50	31	27	22	23	6	25	26	27	25	262	37	262	31				
41	Lisa Kitson	women	50	31	27	22	5	6	25	26	27	25	244	33			244	4		
42	Cale Dobrosak	jun	50	31	27	39	29	6	25	26	27	25	285	46					285	5
43	Aaron Dobrosak	jun	50	31	27	38	29	6	25	26	27	25	284	44					284	3
44	Daniel Dobrosak	men	50	31	27	16	29	6	25	26	27	25	262	37	262	31				
45	Steven Healy	men	50	31	27	11	29	6	25	26	27	25	257	35	257	29				
46	Dorian Friday	jun	50	31	27	39	29	6	25	26	27	25	285	46					285	5
47	Thorin Quinn	men	50	31	27	34	13	6	19	2	7	25	214	26	214	24				
48	Harry Gordon	men	50	31	27	33	5	6	25	26	27	25	255	34	255	28				
49	scout		50	31	27	44	29	6	23	26	27	25	288	49						
50	Tony Romanai	men	50	31	27	44	29	6	25	7	19	21	259	36	259	30				
51	Samuel Quadflieg	men	50	31	27	44	29	6	25	8	27	25	272	42	272	34				
52	Grover Lancaster-Cole	jun	50	31	27	44	29	6	25	26	52	25	315	52					315	7

Steve Nurse

Ian Humphries

Continued from page 5 - Affect Posture & Rolling Resistance has on Effort to Ride a Recumbent

The measuring variables:

The resistance a rider experiences during cycling is determined by the factors air resistance, rolling resistance, chain- and bearing energy losses.

In this test, we have limited ourselves to the most important factors. The air resistance and the rolling resistance. Chain- and bearing energy losses are interesting as well, but they have to be measured another time. The air resistance is determined by the frontal surface of the body and bike. Equally important is the streamlining. I.e. how well the flowing air is guided alongside the body and bike. With a recline angle of 40°, the frontal surface of the body will be larger than with a recline angle of 20°. For the tests, we have chosen for 3 reclining angles. From a fairly upright position (38°), to a commonly used middle position (29°), to an almost reclined position (21°).

Reclineation °	Difference in height in cm. Between bracket and seat (hvs) (If not indicated otherwise, the tests are executed with the above seat steering wheel).		
	+ 5 cm	+14 cm	+ 22 cm
	Power and type of tire	Power	Power
21°	-184 Watt—— Specialized Fatboy 26x1,25inch -199 Watt** -201 Watt—— Schwalbe Stelvio Kevlar 25x559 -218 Watt—IRC 20 (451)x1 1/8 inch (6bar) -222 Watt—— Schwalbe Stelvio Kevlar 28x406 -234 Watt—— Vredestein Monte Carlo Double Density 37x406	189** Watt	-188**Watt -190**Watt (under seat steer + wintercoat) -194** Watt (under seat steer) -197** Watt (under seat steer + 105 rev/min)
29°		210** Watt	201** Watt
38°		235** Watt	234** Watt
	** Measured with 2xIRC Road Lite (451x1 1/8inch)-tires (8bar)		

The more the legs and feet protrude, seen from the front, the more the air resistance will increase. One of the factors in this protrusion is the difference in height between the bracket and the seat. In practice, this varies between 0 and 30 cm. We have chosen 3 positions: +5cm, +14 cm and +22cm.

Furthermore, we thought it would be interesting to measure the difference between under seat- and above seat steering wheel. We have chosen to test a narrow under seat steering wheel and a narrow above seat steering wheel. The rolling resistance is determined by the material, the build and the width of the tire, and in addition, by the wheel diameter and the tire pressure. You can imagine that a stiff tire (e.g. a lot of rubber) gives more resistance than a supple tire (e.g. a little rubber and many threads per cm^2). Also, we know that the same tire gives less resistance on a larger wheel than on a smaller one.

The results table below indicates the tires chosen for the test. What we wan to know is which of the indicated parameters have more or less of an influence on the required effort.

For example, it would be less interesting to recline very much if this would have only limited effect on the air resistance.

A good measure for the required effort is the required power in Watts. This is measured using the NVHPV's SRM-meter. During the measurements, only one parameter was changed at each test run so that the influence of each parameter could be measured separately.

The table indicates the relationship between the posture on a recumbent and type of tire and the amount of power in Watts (W) measured at 35km/h.

Possible conclusions from this test:

Rolling resistance.

This factor has been measured with a hvs of +5cm and an angle or reclination of 21°.

1. Influence of diameter of wheel

There is a difference in total resistance of 21W (10%) between the Schwalbe Stelvia in 559 (201W) and the 406- type (222W), contrary to the fact that the air resistance of the 559- type must be more. From measurements in the past, we know that the rolling resistance is inversely proportional to the increase in diameter of the wheel. I.e. a 20 inch wheel gives about 40% more rolling resistance than a 26 inch wheel.

The rolling resistance of this recumbent at a speed of about 35km/h is about 25% of the total resistance. This matches very well with the total difference in resistance of 40% of 25%, which equals 10%.

2. Influence of type of tire

The relatively large influence of the tire type is shown by the difference (17W) between the Specialized Fatboy (184W) and the Schwalbe Stelvio Kevlar (210W), both of the 559- type. The difference is 9%. The increased stiffness of the Stelvio profile tire can be felt by hand and thus gives more resistance to the changing of its shape than the supple (e.g. no Kevlar) and wider, slick fatboy. The result of the extreme stiff Vredestein double density tire speaks for itself.

3. Influence of tire pressure

Decreasing the tire pressure from 8 to 6 bar for the IRC-451(199W versus 218W) increased the resistance with 19W(10%). So keep your tires pressurized!!.

The share of rolling resistance in the total resistance only increases at lower speeds.

Air resistance

1. Influence of difference in height between bracket and seat.

This influence is measured at a 21° reclining angle and with the reference tire IRC 451 Road Lite at 8 bar.

An increase in the difference in height (bracket/seat) of +5cm(199W) to +22cm(188W), decreased the resistance with

11W(6%). The relatively small influence on the total resistance by the difference in height between the bracket/seat at a given reclining angle was also demonstrated in earlier tests I had done (1996).

The total resistance hardly changes between +15 and +25 cm hvs.

Under the +15cm and above the +25cm the feet, leg and knees protrude more below or above the upper body. The amount of protrusion of course also depends on the reclining angle.

2. Influence reclining angle

This influence is measured using a hvs of +14cm and with the reference tire. Decreasing the reclining angle from 38° (189W) to 21° (235W) resulted in a decrease of resistance of 46W (20%). Now we are talking!

This means more than 1% reduction in resistance per degree of decrease of reclining angle. The decrease in resistance of 25° to 20°, for example, will probably be bigger than from 40° to 35°. This is caused by the fact that the frontal surface of the upper body decreases more (sinus curve) and by a bigger length/width ratio of the upper body, which is favourable for streamlining. Slim cyclists should, in my opinion, then experience relatively less air resistance then wider cyclists. We'll have to measure that as well someday!!

3. Influence of type of steering wheel

This influence is measured at a reclining angle of 21°, a hvs of +22cm and with the reference tire.

A relatively small increase in resistance of 6W(3%) using the under seat steering wheel(194W) was achieved in place of using the above seat steering wheel (188W). The increase in frontal surface for the under seat steering wheel is probably partly compensated by a better streamlining. The approaching air going through the arms in front of the chest probably gives extra turbulence.

4. Influence of winter jacket (see picture below).

This influence is measured using a reclining angle of 21°, a hvs of +22 cm and with the reference tire. This was actually meant to be a joke, but the thick jacket and hat gave a resistance decrease!!! (194W versus 190W) of 4W (2%),

The thick jacket gives a larger frontal surface, but filling up the belly and rounder shape gives probably a better streamline (lower cw-value).

5. Influence of the amount of pedaling revolutions

Same configuration as in 3.

Only a small increase in resistance of 3W(1.5%) was measured when increasing the revolutions from about 80 (194W) to 105(197W). You would expect a larger difference. Difference in resistance comparing a relatively slower and faster version of the bare recumbent.

Slow version

* Recline angle 38°.
* Difference in height bracket/seat +5cm.
* Under seat steer
* Tires Schwalbe Stelvia 406 and 28 mm wide

Fast version

* Recline angle 21°.
* Difference in height bracket/seat +22cm.
* Above seat steer
* Tires Specialized fatboy 26x1,25 inch.

When comparing these two differing versions with each other, the fast version will use about 102W (about 39%) less energy for the same speed of 35km/h when compared with the slow version. This 102W is equivalent to the resistance caused by the installation of about 7 AXA HR-dynamo's on a recumbent. This is a tire driven dynamo that is being used often on regular bikes. I tested the resistance of this dynamo a couple of years ago. Don't take the comparison with the dynamos too literally, but see it more as a metaphor. Expressed differently, it is the difference between relaxed touring and having a hard time.

At a constant effort, the difference of about 39% will give an increase in speed of about 4km/h at a speed of 35km/h. By the way, at lower speeds the percentage difference in speed will be the same. A rule of thumb is that the cube root of the difference in power in % gives you the difference in speed in %.

For example, the cubed root of a 30% difference in power is equivalent to the cubed root of 1.3, or 1.1, which represents a 10% difference in speed.

The resistance increasing effects of chain tubes, (extra) chain rolls, gears, mudguards etc. has not been taken into account with these measurements. We will also measure this sometime in the future.

As we can see from the measurements, the benefit of the reclined position is nullified when we add resistance increasing parameters to our bikes such as sitting more upright, positioning our feet lower, and mounting stiff tires. The translated inverse of the M5 motto does then apply more and more: Less miles with more effort.

Since most (recumbent) cyclists only can output a power of 100-200W for a couple of hours, it is important to make use of this energy efficiency.

Speed is not important for all recumbent riders. But you can also ride slowly on a more efficient recumbent with less effort.

Cyclists riding traditional cycles will in addition to having this sort of bike, also have a road bike and/or an mountain bike. They will, for example, choose the more efficient road bike for longer tours than their traditional bike. If you would equip your road bike with 20 inch wheels, stiff tires with a lot of profile, chain tubes, a hub and touring handle bars, then it would be a lot tougher to keep up with your mates on their road bikes.

Recumbent riders usually buy only one recumbent due to the high price. This bike should then be suitable for all situations where riders would want to use a bike (commuting, going to town, cycle vacationing, touring, in nice weather, in bad weather, in the hills etc.). For those who buy an all around recumbent and find the difference in speed between it and a road bike (for the same effort) disappointing, a solution could be to buy a second or third (used) recumbent and use each for a different situation.

Conclusion:

Many little bits add up (to huge resistance). It is an art to be able to distinguish the large factors from the small ones. I hope that this article can contribute to being able to make such distinctions. But everyone makes his or her own considerations when choosing a new recumbent or bike.

Many thanks to Bram Moens(M5-recumbents), Harry Haenen(NVHPV) and Jan Limburg(NVHPV) for their assistance during the tests.

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Continued from page 1 - Announcing the World Recumbent Racing Association

records for unfaired, tail cone, and nose cone recumbent vehicles will be recorded.

Note that the WRRA does not organize, sanction, insure or oversee events or record attempts. The WRRA exists only to record outstanding achievements on recumbent bicycles and insure that these achievements were accomplished in a consistent and fair manner.

See: **http://www.recumbents.com/wrra/** for more information.

Warren Beauchamp - **wbeaucha@yahoo.com**

For Sale

M5 Shockproof 406. Beautiful dual suspension recumbent in as new hardly ridden condition. 105/Deore groupset with road triple (61/53/39) and 12-32 cassette. Velocity Aeroheat wheelset with Vredstein slicks. Dura-ace bar end shifters, rear rack, comfy cloth seat cover and mudguards. Ready to tour with M5 sidebags included $3800 or near offer. Call Andrew on 0410 480 586 or **shockproof@fatseas.com**

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