HUMAN POWER

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Nice shot of VECTOR tandem at Stockton, sandwiched between Caltrans truck and CT Gremlin. Rich Turner, Stockton Record.

HUMAN POWER ON THE FREEWAY

On Friday morning, May 30, 1980, Fred Markham and Chris Springer peddled the Vector Tandem on California Interstate 5 from Stockton to Sacramento, a distance of 41.8 miles. The trip took just under 50 minutes, giving an average speed of 50.5 miles per hour. This is the story of how it happened.

By F. Dan Fernandes, Vector Design Team

It was to be California's first Energy and Transportation Fair in Sacramento, and the Caltrans sponsors were searching for ideas to draw public attention to their event. Why not demonstrate a human powered vehicle on the freeway, suggested Will White, Caltrans employee and IHPVA member. Doug Unkrey and I were requested to supply the Vector Tandem vehicle and to support the demonstration, which was to be 42 miles from Stockton to Sacramento on Interstate 5.

Why not indeed; well, here are some reasons: there are fast cars and big trucks out there, and nasty little lane markers to fracture high speed bicycle tires. There could be a headwind or a crosswind, and it could be very hot in Sacramento in May. And what if we got stuck going uphill very slowly, or going downhill very fast?

Still, the Vector Tandem holds the current endurance record of 46+ miles in one hour and could maintain the legal minimum freeway speed (45) for that distance if the riders were of top quality. We could have a CHP escort, which would make it as safe as possible, and we could make the run early on Saturday morning, so it wouldn't be so hot or windy, and the traffic wouldn't be very heavy.

It all sounds almost conceivable, and what a great chance to show the world what human power can do! We'll do it! Now to find two brave, strong riders. Will White volunteered to ride with me, but he and I being bicycle commuters, the world was not going to be impressed. With some recruiting effort by Will White we obtained Fred Markham and Norman Gall to be our champion riders. Now things were getting exciting!.

It soon developed that some concessions had to be made in the planning. The ride was to be made mid-Friday morning instead of early Saturday morning, to improve media coverage for the energy fair. The CHP refused to escort us, saying a Caltrans escort would be sufficient. Then the CHP, having second thoughts, tried to move the ride off the freeway onto a county road. But they backed down when Frank Lonza, Caltrans coordinator, informed them it was going to be the freeway or nothing.

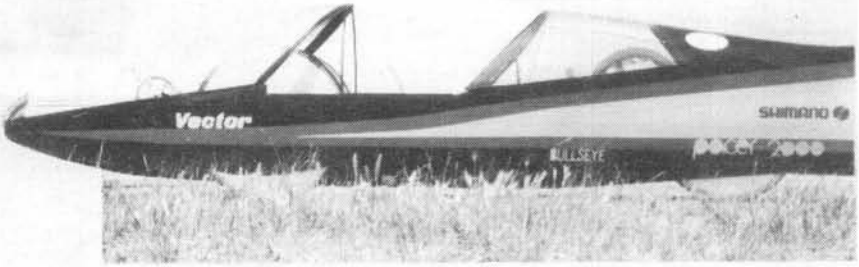
Norman Gall suffered a minor injury in training just a few days before the ride and would be unable to participate. Fortunately,

Photos by Gene John, Stockton, CA.

Markham getting briefed.

Fred Markham (L) & Chris Springer (R) get ready to run.

Vector on the Freeway, Fred in front.



Vector looks good without mid-canopy.

Fred Markham was able to obtain Chris Springer to take Norman's place as his co-rider.

Friday May 30 was a sunny, breezy morning, with temperatures in the high 70's. Riders were fit checked in the vehicle and received their pre-ride briefing in the Caltrans-Stockton parking lot before a crowd of curious onlookers. It was the first time either rider had been in the machine.

My calculations said that tracks would not be able to blow us over. A call to the airport verified no net altitude change between Stockton and Sacramento, but a look at the freeway revealed 1 to 2 percent rolling grades. A constant power output by the riders would leave us sitting at 35 mph on these uphill grades, so I instructed the riders to push uphill to maintain 45 if possible.

Support vehicles caravaned to Hammer Lane, the last onramp out of Stockton. Then sealing Fred and Chris into the Vector vehicle at the edge of the freeway, we were off! Caltrans vehicles were at front and rear to assure safe vehicle spacing. I rode along in the front car and had CB contact with the riders. The rear vehicle was a large freeway repair truck with a flashing arrow warning sign facing rearward.

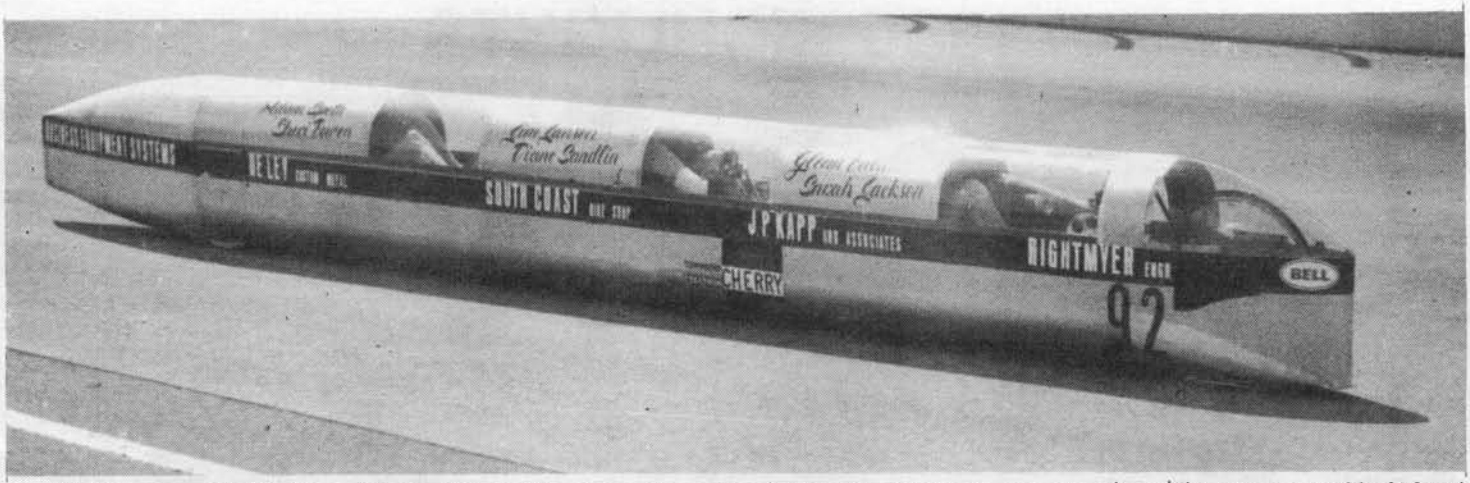
The initial pace seemed too fast to mainain, and I warned Fred and Chris over the CB about pacing themselves. I was hoping for an average speed above 45, and expecting something under 50. The Pacer 2000 speedometer in the Vector told Fred and Chris they were staying above 45 on upslopes, and hitting 59 on downslopes. But could they keep it up for 42 miles?

Meanwhile, on the fast lane of the two-lane freeway, a steady stream of vehicles passed slowly by. The people in these vehicles were a constant source of entertainment, as they stared in puzzlement at the small vehicle moving so fast, then broke into astonished grins when they saw that it was being peddled. One trucker was heard over the CB radio saying to his friend, "Do you see what that is?" His trucker buddy replied, "Yah, and do you know how fast that's goin'?"

A brisk breeze presented itself as a direct crosswind from the left, requiring a steering correction. Vehicles passing in the fast lane caused the crosswind to pulsate, which required Fred Markham to quickly adjust his steering correction to stay on course. At no time did the vehicle tip or wander out of its lane.

Outside Sacramento it became more tricky as our lane turned into a center lane, with merging traffic. We were able to shield our vehicle from the lane changers as we looked for our offramp. Then with a smooth lane change and a gradual deceleration, we caravaned off the freeway onto an uphill off ramp. Fred and Chris popped the center hood off of the Vector car to get more air as they came to a screeching stop, dripping wet, 49 minutes and 40 seconds from go, for an average speed of 50.5 miles per hour.

Minutes later the Vector Tandem rolled into the opening ceremonies of the Energy and Transportation Fair at Old Sacramento, and Caltrans Director Adriana Gianturco asked Fred and Chris to say a few words to the people about how it was out there. Fellas, what do you need to say after you've done it all? Congratulations for a fantastic demonstration of human power.



Paul VanValkenburgh

Tom Rightmyer's all-aluminum Monocoque triple. Men's team placed 5th in 1980: 51.54mph. Women riders did a very respectable 48.85mph.

SECRET STUFF

Dear Members,

I have attended three IHPVA speed trials: once as a spectator, and twice as a participant. As either one, the thing that kept catching my attention was the workmanship on the vehicles. Except for a very few it ran from shaky to oh-my-god-he's-not-going-to-ride-that-thing-is-he? I am in business cutting and welding metal so may be I can pass along a few tips. I know you aren't all experienced metal fabricators but it really isn't that hard.

Most of you build some sort of a tube frame to hold your ultimate body shape. This means you need tubing. Water pipe is too heavy, conduit is cheap, hard to weld (the fumes are poisonous) and not too strong. Cut-up bikes seem to be popular but old Varsitys are heavy and Colnagos are a little pricey.

You've probably combed the local alleys and garage sales and no one has Reynolds 531 or Columbus tubing on sale. You've called the Tube Sales Co. and they want to sell you 23 feet and you need two. . .

Here it comes guys - a place that will sell you one foot of real onest to goodness 4130 chrome moly tubing! No minimum, no cutting charge!

Aircraft Spruce and Specialty
201 W. Truslow
Fullerton, California 92632

These neat people cater to aircraft home builders. Send for a catalogue. They also have aluminum, fiberglas, resin, hardware, and a thousand other trick little goodies that you can use on your racer. Yes, they do mail order business. (As far away as New Zealand and Switzerland, by the way.)

Okay. Now you have a bunch of light weight steel tubing on your garage floor. What do you do with it? The design is up to you but triangles are always good and .035" wall tubes are usually adequate for what we are doing. Your next problem is fitting the tubes to each other. They're called fish mouths for obvious reasons. Some people use files but the "hot tip" is a hole saw. Drill a pilot hole at the desired angle and follow it with a hole saw and you will have a nearly airtight fit that will be easy to weld or braze. If you take some parts fitted this way to your local welder his eyes will light up and if you include a cold six pack he may waive his usual minimum charge. (In all my years I have never, ever, met a tea-totling weldor.) Heli-arc is great, gas is O.K., braze is so-so and if he wants to arc-weld, leave. If you weld or braze it your self be cool, (pun intended) - 035" is thin!

Other accumulated Speed Secrets:

"Schwinn Twinns" have a cheap, toothed, ball bearing chain idler.

Sturmey-Archer hubs have an over dirve (33% in a 3 speed, 50% in a 5 speed). So you can get those big gears without special oversize chain rings. Also your hired gorilla won't keep dumping the chain into the belly pan when he shifts gears.

Get the best pedals and toe straps you can find. Those big mean racers want to be strapped in tight!

If you didn't say five or six dollars for that hole saw it won't cut chrome-moly.

Sponsors aren't too hard to get but you need to have something to show them. Enthusiasm and a sketch on a matchbook cover won't do it. And if you are lucky enough to get money, parts or any kind of support give your sponsor recognition. Put his name on your racer. Give him an 8 X 10 color glossy photo for his wall. Take him to the races. Best of all: Go Fast! Give him his money's worth and he'll be there for you next year.

Use more than one rider or a team of riders. A team of ladies are great: they go as fast, pound-for-pound, as men and are a lot more competitve than you might think. Also they are just nice to have around.

A few other places I have discovered (in no particular order) that can provide useful parts and services for your racer are:

H&L Metals
(tube bending)
2757 St. Louis Ave.
Long Beach, California

Earl's Supply
14611 Hawthorne Blvd.
Lawndale, California 90266

Aircraft Windshield
3842 Catalina St.
Los Alimitos, California 90720

We really need to clean up our act. It may hurt the duct tape, cardboard and mylar crowd, but wouldn't it be nice to have a field of really nice, sanitary, safe racers? We're going pretty fast (even my racer exceeded 50) and some kind of roll-over bar and a safe environment* for the rider should be a minimum requirement. End of lecture.

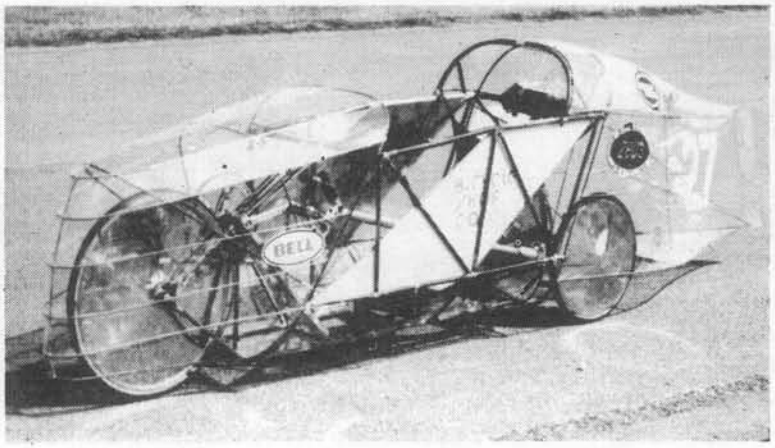
If you need help in building your racer give me a call. (If you want to go fast you'll have to call someone else 'cause I'm still working on that.)

If you need welding etc., and you're in the neighborhood, come by and we'll swap lies, drink beer, and stick your parts together.

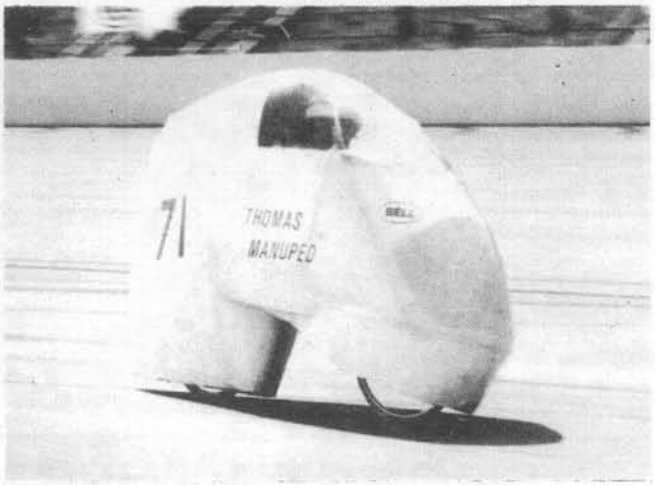
Tom Rightmyer
Rightmyer Eng. 1107 E. Elm Fullerton, California
(714) 635-9443 (after 6:00 p.m.)

1980 HIGHLIGHTS

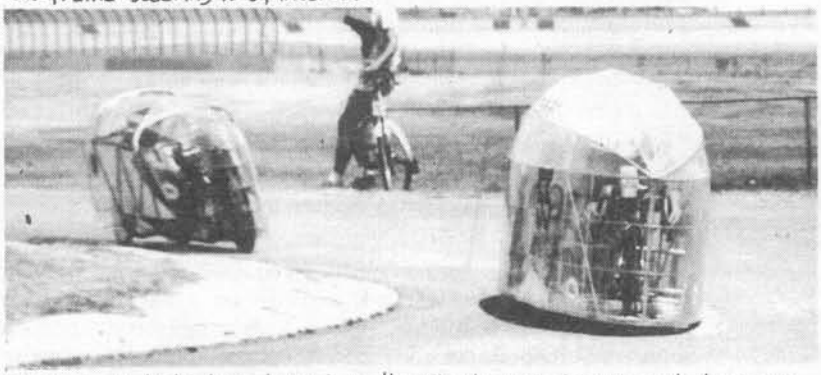
Photos: Paul VanValkenburgh



Roc Fleishman rode his own vehicle to 38.01mph. Not real fast, but tilt-frame steering is of interest.

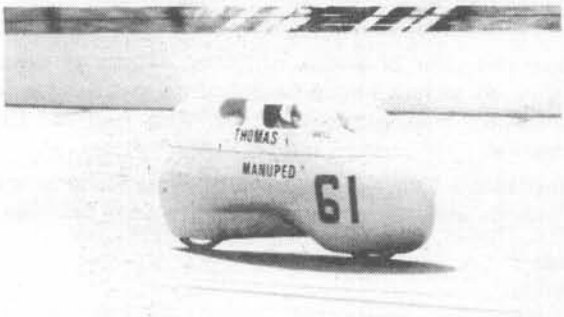


Manuped #71. 37.50 mph.

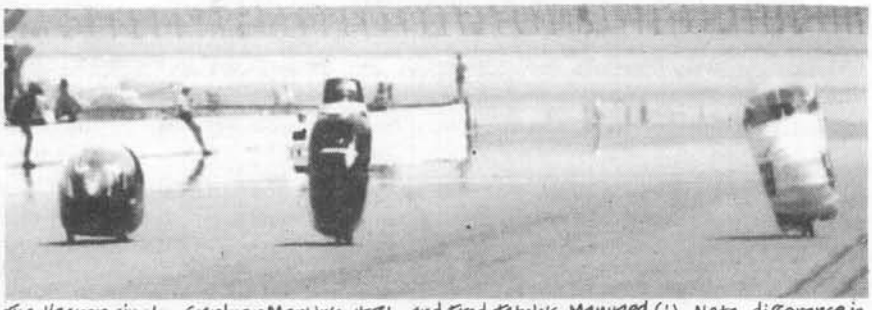


Phil Norton's Lightnin' Rod (#55) leading Fleishman's #27 through the esses.

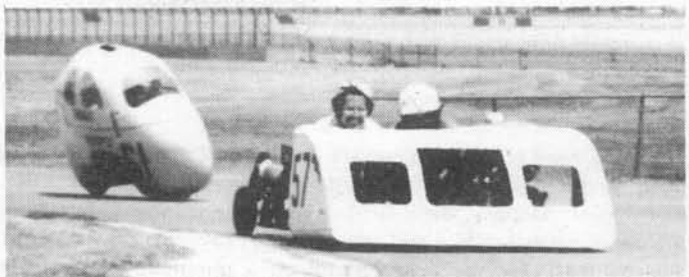
New fairing on Alec Brooks' #13 bagged 10th with 45.05 mph.



Another Manuped! 35.34 mph.



The Vector single, Gardner Martin's #31, and Fred Tatch's Manuped (!). Note difference in size (and stability).



Dick Lewis again! His triple leads a Manuped through esses.

Gomez Bros. and Alec Brooks in his #13.

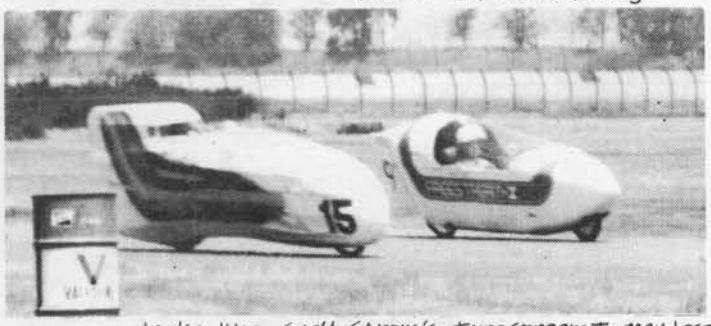
Vector tandem #25 (Where's that number, guys?) 1st place, multiples, 62.97 mph! (Grylls/Barczewski)

3rd place. 56.70 mph. Owner/builder Phil Norton (in front) with Mark Orr.

1980 HIGHLIGHTS

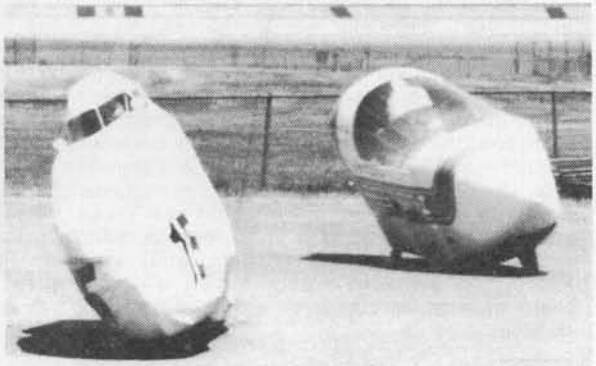
photos: Paul VanValkenburgh

One of White Lightning's last runs: 2nd place, 61.04 mph. Sadly, in a collision with Manuped #71, #8 was damaged beyond repair.

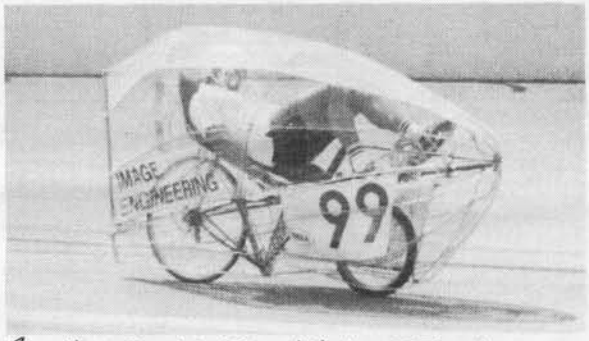


Looks like Scott Strom's Freestream I may lose the inside to Bryan Allen in Bill Watson's single...

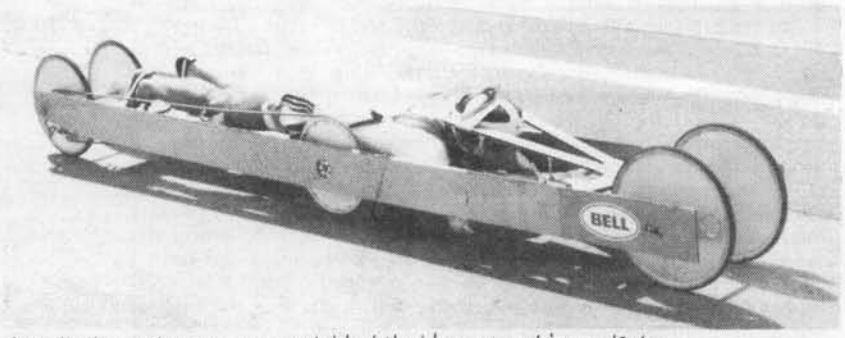
Outstanding craftsmanship on Darold Cummings' single. 12th place 42.53 mph.



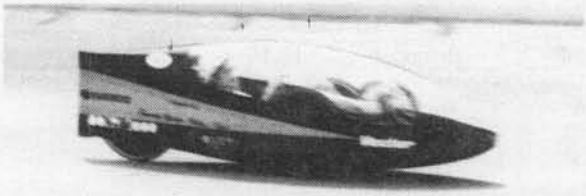
... yep.



Peter Chesney on Lynn Tobias' single. 35.76 mph



Get that number on your vehicle! No idea who this is, but...



#24 Vector single. 1st place Leigh Barczewski 56.66 mph. Dave Grylls, co-rider, reached 55.92 mph.

Dick Lewis' single made respectable 7th place. Eric Bush pumped to 46.95 mph

Larry McNay rode #97 to 11th place – 44.25 mph

G. Martin's #31 and F. Tatch's singles during road race.

BRITISH SPEED CHAMPIONSHIPS

Mr. Peter Boor, President,
IHPVA

8 September 1980

Dear Peter,

I am pleased to be able to tell you that we are still alive and well, and that the first European speed Championships were a great success. That Al and his boys scooped the pool was only to be expected, but considering that it was our first year, and that effectively only five months work went into the machines, our entrants were not in any way disgraced, nor too far outclassed. Speeds were inevitably way below Ontario because of the short run up, and the sudden gusts of wind produced some distinctly thoughtful moments. The Manupeds in particular suffered from the wind, which was the cause of the one really sensational crash of the day. It was a pity, because the machine was going at over 46 mph at the time. Still fortunately nobody was hurt. Most of the English machines had taken heed of our warnings and had three or four wheels. There were the expected mistakes of lack of testing, instability and wild optimism about gear ratios. Proceedings were enlivened by a coxed four from Munich, which had a steersman seated in lofty splendour on high, while his slaves flogged their guts out in a rowing motion which was transmitted to wheels. There were at least a dozen other unorthodox but very interesting ideas.

We were fortunate in having good weather all day, and a crowd estimated at over 20,000. The press from all over the world was there, as well as television, and I believe it has gone out as a satellited news item in almost every territory. Certainly my sister in Saudi Arabia saw a 3 minute report on Sunday night. There were 15 minute reports on Nationwide on Friday and today, and it has been on the Children's programme 'Blue Peter' and all the news programmes on both networks. I am making a half hour documentary from all the material which we have shot and which has been made available to us. It should be available in about a month, and we will be trying to sell it all over the world.

On the Thursday before the event we did a road run with the one man Vector in very crowded conditions. This finished along the sea front at Brighton. We all survived, thank goodness and both I and NBC got some good film. Vector averaged a comfortable 30 mph including urban conditions, traffic lights etc. For the sake of our sanity, longevity and the peace of mind of future generations, please assure Al we do not want to repeat this one!

We were able to start the actual event itself at 8.30, getting under way in fact at 8.45. The timing, by SEIKO was all electronic, and very efficient, with the time being displayed on big boards, and instantly converted into miles an hour. The commentator, David Duffield is an ex-racing tricyclist himself, and as he is the best in the country at this type of event, we were very fortunate there. Unfortunately loud speakers were not extended back to the paddock, and so competitors did not have full information. This was our major mistake to be rectified next year. All the competitors had at least three runs, and we had short intervals with a marching band and with a stunt plane doing tricks, and then we finished with the six fastest solos and multis each having one run. Except for a couple of runs early in the day, the wind was too high for records to be set up.

After the three runs, we had planned a semi final, but as time was getting on, I scrapped this and substituted final runs for the six fastest in the two categories. In fact on one succeeded in beating his precious time. After the last Vector run, all the machines came together at the finish line in a scene of total chaos, which was rather fun, and large cheques were doled out to all your wretched lot....(Actually they did deserve them).

Anyway, I think we are well launched, and a great deal of enjoyment was had by everybody. May I confirm that we would definitely like to have the permission to run an event next year, probably over two days, with a one hour road race on the Sunday at Goodwood or some other suitable race track? Even if Aspro Nicholas back out, which is extremely unlikely from all the coverage they have had all over the world, I have three other major companies ready to jump in.

Also please water. I am coming back to a 200 meter course on still water on the Serpentine in the middle of London, rather than a longer course, and all my advisers say that 25 mph is a realistically impossible goal to aim for. The moment I get your approval, I will dig out an international sponsor, and we will get the whole thing under way.

(And I think you will not be surprised to learn that dispite all the worries we thoroughly enjoyed ourselves)

Greetings to all and don't think it is going to be so easy next time.

Yours,
Peter Selby

P.S. Could we also arrange an event in Australia?

ASPRO CLEAR CHALLENGE 1980

6th September 1980

RESULTS

Single Rider Machines

	Vehicle No.	Name	Fastest Run	
			Sec	m.p.h.
1st	39	Vector Single	9.61	46.55 - Grylls
2nd	44	Vector Single	9.87	45.32 - Barczewski
3rd	41	Manuped	10.55	42.40
4th	43	Manuped	10.74	41.65
	2	Poppy Flyer	11.01	40.63
	26	Tony Glaysher	11.10	40.30
	28	Philip Webster	11.10	40.30
	14	Britax	12.15	36.82
	6	Transition	12.27	36.46
	3	The Manta	13.57	32.96
	20	Mike's Solo	13.66	32.88

Multiple Rider Machines

	Vehicle No.	Name	Fastest Run	
			Sec	m.p.h.
1st	38	Vector Tandem	9.43	47.44 -Grylls/ Barczewski
2nd	19	Webb/Hughes	10.60	42.20
3rd	37	Ken Bird Tandem	11.04	40.52
4th	33	B.P. Research Centre	11.18	40.01
	22	Hawker/ Hudspith Tricycle	11.77	38.17
	30	Hexapod 80	14.04	31.86
	31	Highview High School	14.21	31.48

WHO NEEDS A WIND TUNNEL ?

(by Willmot White, CALTRANS Transportation Engineer and IHPVA member)

"Why tamper with something perfected 75 years ago?" My answers to similar questions from press and fellow cyclists has been typically: "The bike will always have its place. But on the open road, I think people want to go faster and/or further instead of wasting over 80% of their precious power churning up the air like an egg beater."

The engineer or technician might prefer to approach the problem with two questions? First, how to design a minimum drag envellope for the reciprocating road-bound homosapiens? Then, how can we best tell when the model (or prototype) has been developed to minimum drag after various modifications? In lieu of (and sometimes better than) expensive wind tunnel time, the following drag testing methods have been used by myself and others on a shoestring budget.

POOR MAN'S WIND TUNNEL (PMWT)

The "PMWTS" (Poor Man's Wind Tunnel Simulator), is my update on an old idea. It consists of a unique overhead support with a test rack suspended from a pendulum/parallelogram ("pendelogram") to maintain alignment of the test object to the air flow. Instrumentation included a Dwyer wind gage, thermometer, and degree displacement plate. The purpose of the PMWTS was to determine the drag of various shapes and display air flow by tuft testing. (See Figure 1)

Figure 1.

The PMWTS support frame was attached to my car by cranking up the windows to clamp it in place. This allowed in or out movement to assure clearance of the test object from parasite and boundary disburbance next to the car. The pendelogram was first placed about a foot out from the driver's side. There I could easily watch it while making runs at various speeds.

On a dead calm morning, I began calibrating the PMWTS using a square plate for a test object. The plate allowed direct comparison with a standard empirical curve of drag vs. speed for square plates. Calculations were simplified by using a plate one square foot in area.

Imagine driving 50 mph, studying the road for the smoothest pavement, reading the Dwyer gage, car speedometer, tuft motion, and--after the undamped pendelogram settles down--observing frame displacement, then jotting down all the readings! (Next time the PMWTS will be hung out the other side for an assistant to read. After a set of several runs both ways at the same speed, the procedure was then repeated, dropping ten mph per set. Similar data runs were then done without the test object (substitute weight was installed) so that the resulting drag of the "naked" frame could later be deducted from that of the plate.

Drag force is resolved by remounting the test object, then using a spring tension scale (in line with the drag) to determine the horizontal force (drag) vs. displacement over the range observed. Results can then be plotted, naked frame drag deducted and drag vs. speed plotted.

It turned out that the plate drag curve was in the textbook ball park in the 10 to 50 mph range tested. I received an "A" for my effort and I still have the PMWTS for drag testing items such as streamlined frame tube elements. As implied in the pictures, the PMWTS is easily constructed--just be sure to use good needle or ball bearings at the four pivot points.

While the PMWTS is fine for drag testing fully air enveloped objects and making comparative drag tests, the system has a limitation when applied to a land vehicle model. As tested with the PMWTS, interference drag at the road/body interface is not simulated.

Two more shortcomings of the PMWTS include lack of pendologram damping and "scale effect" of small models. Even a quarter scale model of an HPV would require that my poor old Datsun reach 200 mph plus to maintain proper scale factors (Model speed X size = vehicle speed X size).

AUTO TOW TESTING (ATT)

A better answer for testing a prototype HPV should have occurred to those who saw the films of the Gossamer Albatross trials. One memorable scene had former IHPVA president Dr. Paul MacCready towing his pedal powered aircraft with tow line attached to a handheld spring scale. He was directly observing overall drag while facing backward on the rear of a minibike! His motorized towline test is elegantly simple yet relevant for measurement of overall drag of the HPV as well!

My next experiment to study drag reduction of my own arm and leg powered HPV will utilize my version of tow testing which I call the ATT method (see Figure 2). The ATT can easily be set up by rigging a streamlined boom extending sideways from your car's front bumper. A simple pulley and cable system will serve to tow the HPV and connect at the other end to a calibrated tension scale that can easily be read from inside the car. A full length manometer series may be installed in the HPV to measure pressure distribution. Boom and tow line lengths will be variable to help locate the HPV outside the car's boundary disturbance, aft of the bow wave and boom wake and forward of the car's wake. For safety, a tow line quick release and an intercom will be set up inside the HPV.

The ATT will measure but one thing--overall drag. The process will consist of tow runs both ways covering the expected performmance range. Cable tension T will be observed and recorded at 5 mph intervals. We will then be able to calculate overall drag by D = T cos 0 and the resulting curve plotted with respect to speed as in Figure 3.

We can break overall drag D into the approximate components D_r (rolling resistance) and D_a (aerodynamic drag) assuming:

$D = D_r + D_a$, lbs (wheel bearing friction negligible)

When the HPV is barely set into motion overall drag D almost equals D_r. However, the real question is the amount of total drag, and how it improves from one configuration to another. For more

detail on the analysis, see article by Prof. Chet Kyle in July, Aug., Nov.'74 Bicycling magazines.

One final caution: All drag readings must be taken at constant speed to eliminate the F = ma effect. Even the smallest variations in tow vehicle speed could create forces greater than air drag.

The ATT is not only cheap, easily rigged and simple, but it can produce more meaningful results than a multi-million dollar wind tunnel. Again, like the PMWTS, even wind tunnels with floor boundary layer drawdown cannot simulate the compounded complexities of wheelspin, ground effect, shear and interference at the body/road interface. Unlike wind tunnel setups, in the real world both air and road sweep past the HPV's lower body at the same speed. Even attempts to simulate these effects in the wind tunnel by moving belt road simulators have failed--so far.

A bicycle was first utilized as a moving test stand for drag measurement before the Wright Bros. built their wind tunnel. We are in good company still with later experimenters who used their family wagon (or minibike!) as a shoestring budget substitue for a wind tunnel!

COASTING INTO THE FINISH

An article about shoestring methods to avoid wind tunneling wouldn't be complete without mention of Dr. Chester Kyle's original classroom/hallway experiments. Such a level and enclosed coasting tests as conducted at the Long Beach campus are ideal for developing empirical curves of overall drag vs. speed. From this, required power vs. speed can easily be derived and plotted. "Coastdown tests" are used to measure deceleration rate. Equidistant intervals are laid out and time recorded as the bike and rider coast through. Professor Kyle's articles describe how to convert the elapsed times to drag in pounds. If you have a stopwatch and a speedometer, all you have to do is record the time to coast from one speed (V1) to another (V2). Drag force is then:

$$\text{lbs} = \frac{\text{weight} \times .045\ (V1 - V2)}{\text{seconds}}$$

This force will be at an average speed of $\frac{V1 + V2}{2}$

Kyle's experiments with early HPVs and bike/riders so inspired those involved that the IHPVA was formed and the historical achievements of the past five years were the end result.

And finally, a plug for an even simpler, if crude, coasting method. This one requires but a basic bike and a stopwatch as used by myself. Glen Brown and others.

The "hill coasting" method is simple (See figure 4). Mark off an interval on a grade steep enough to produce the desired speed range. On a dead calm morning, carefully time and record several runs down the hill. Change but one thing per set and repeat, making sure that the weight is maintained constant. The change in coasting time gives a good comparative measure of improvement (or the reverse) in overall drag by your modification.

In the case of my "Bod Pod", I found a reduction of about 10% in the coasting time. This about matched my improved distance covered during one hour runs in my crude Pod prototype.

In conclusion, I suspect that many HPV developers feel at a disadvantage without access to a wind tunnel. Fact is, with the above "poor man's methods" you might well come out with more meaningful results! Especially if done in dead calm air and repeated until "reproducible" data has been collected. Safety First! For survival of you and your team, the methods I have outlined should be conducted on a reserved airport taxiway or raceway, or an empty road.

For further information of bibliography references, telephone Will White at (415) 489-6296 or write Will at BREAK THRU ENTER ENTERPRISES, 32300 Trevor Avenue, Hayward CA 94544.

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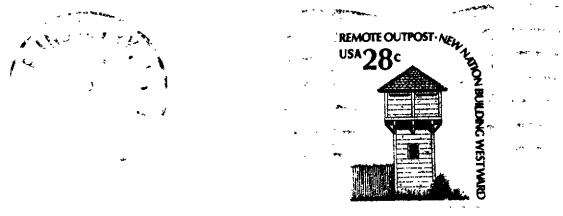

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