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If you have any comments, problems or suggestions about the magazine in general, or this PDF in particular, please email me at *howard@velovision.com*

I hope you enjoy the read!

Howard Yeomans

Editor and publisher, *Velo Vision* magazine.

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Velo Vision, Freshfields, Main Street, Gayton le Marsh, Lincolnshire, LN13 0NS, United Kingdom.
Tel +44 7948 271 763
(from UK, 07948 271 763)
E-mail *howard@velovision.com*
Skype *howardyeomans*.

EDITOR AND PUBLISHER: Howard Yeomans
CONSULTANT AND PHOTOS: Peter Eland
COPYEDITOR AND PHOTOGRAPHIC ASSISTANT: Heather Luna
GRAPHIC DESIGN: Howard Yeomans
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COVER: Alison, enjoying a bridleway ride on the Stanforth Kibo. Read the review on page 34.

OPPOSITE: Originally a prop for our village scarecrow competition, the roadster has become a permanent exhibit on Main Street. *Photos: Howard Yeomans.*

Freezy trees

Well, winter has perhaps finally started to bite, so it is with some relief that I have put out the winter issue before spring! Whatever the weather, Issue 50 should, I hope, give many a reason to cosy up and indulge in a bit of armchair cycling.

I ruminated long and hard on making minor changes to the format this issue, instead deciding that it aint' broke and concentrating on packing in a great deal of content. Hopefully, there's more than something for everyone—we aim to please—and if you want to share your views on any of the content, we value the feedback highly.

As always, inventions and designs feature heavily in our pages, so if you have ideas or projects to share, big or small, please write in.

Many events stand before us this year. In particular, I'm looking forward to more recumbent racing – where I hope to trial some new machinery, the SPEZI in Germany, plus the York Cycle Rally, again in June. Do come along and say 'hello'!

Howard Yeomans

SWITCHBLADE: SHARP TOOL FOR WHOLE-BODY WORKOUT

Mark Chillery writes about the five-year long development of the bike he believes can help anyone in the transition to recumbent riding. With row-power and a unique seat height adjustment, it could benefit experienced and novice riders alike.

BACKGROUND

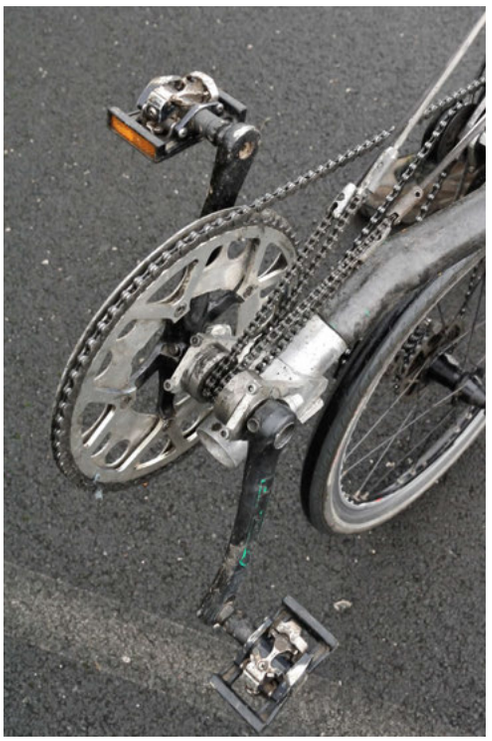
I have spent a good deal of the last few years developing the Switchblade: a conventionally-pedalled recumbent bike but with a supplementary rowing system plus two ride positions, selectable on the move. Throughout the design, I have been wary of adding complexity and weight, but the question has always been whether the complexity is justified by the benefits delivered.

Using the arms for arm propulsion is not new. In fact, doing a patent search gives the impression that it's a garden shed inventor's favourite. A number of patents show devices attached to uprights, trikes, and recumbent bikes. However, the Switchblade row-power system is unique.

Switchblade's row-power system is as simple as possible, while being highly flexible in use; the rowing action is optional, while providing no real detriment to steering. The propulsion has been designed so rowing input is not of fixed amplitude, while the independence of the rider's arms and legs lends favour to the idea of row-power being used in short bursts, particularly when climbing.

ABOVE: Low-ride position is deployed by a 'winching' mechanism when back-pedalling.

RIGHT: A fine-pitch chain pulls on twin clutches in the custom-built bottom bracket.



HYBRID POWER

When I first started riding recumbents, I really enjoyed the riding position: it felt faster and considerably more fun than an upright. But leg-fatigue and poor hill-climbing seemed to offset the thrill of the aerodynamic efficiency and the comfort advantages. This experience is, perhaps, not uncommon, and it is generally agreed that recumbent riders endure greater leg fatigue than those on an upright, especially in the early days of changing from upright cycling. Training helps, of course, and some would say there isn't a problem as such, one just needs to train. But, for most, the time and effort to adapt to a recumbent—the acquisition of so-called 'recumbent legs'—is too great.

I identified this as a significant problem – an immediate disadvantage for those trying recumbents for the first time and one that might benefit or be solved with supplementary arm power. This might be a way to make up the performance deficit and reduce the lactic acid burn in the quadriceps, too.

My first prototype arm propulsion system was fitted to a Challenge Mistral. Row-power seemed to help most when sprinting and on inclines. The improvement, has, however, always been difficult to quantify. In fact, flat-out performance should not necessarily be the main focus. Much of the benefit is about comfort, reduced overall fatigue, and decreasing the training period needed for a given performance.

In the early days, however, a series of tests found a measurable improvement on a turbo-trainer at full power. In fact, though, with my recent levels of fitness, I am not so sure the tests would be conclusive, if I repeated them. This validates the idea that any measured performance improvement in a machine is strongly affected by biomechanics – both absolute fitness and the amount of recumbent conditioning in the test rider.

A limited amount of more formal research suggests that using additional muscles on an upright bike may benefit performance. One example of such is by Kyle et al. (*Bicycling Science*, MIT press), which describes a test comparing combined hand-cranking and pedalling to pedalling alone. This experiment and others show power advantages, but say nothing about performance and fatigue over a long road ride.

A common objection to the use of arm and leg propulsion on a bike, notwithstanding any operational issues, is that the cardio-vascular system is the limit to absolute performance, not muscle strength. However, I think the alleviation of leg fatigue is more important on a recumbent; the leg muscles tire more quickly due to limited variation in pedalling style, as a result of the constrained riding position.

SWITCHING

Along with row-power, the Switchblade's other feature is the adjustable seat height. The seat height and angle adjustment are also intended to benefit new recumbent riders, as well as offering substantial benefit when climbing. Whilst some debate about whether recumbents can climb as well as uprights, the low seat angles of faster machines all pitch the rider into a near-horizontal position on steeper gradients and this can feel odd. This is accompanied by an increased difficulty in balancing, due to the lower speed; the high and upright position of the Switchblade in high-ride mode aids balance and gives a greater sense of security.

A long-stroke gas piston smoothly controls the transition between riding positions, compressing fully when deploying the low-ride position, a hands-free process assisted by back-pedalling (more of which later). About one pedal stroke is enough to complete the transition to a position ideal for higher-speed riding. To reverse the transition, the rider simply un-weights the seat by leaning forward and pulling up on the bars. The low-high transition will not accidentally occur under hard braking because the pivot point is close to a line between the riders CofM and the front tyre contact patch. The change between the two states is possible while riding or stationary.

NUTS AND BOLTS

All Switchblade prototypes to date have been made by bonding and bolting aluminium tubes and box-section together. I made most of the remaining parts myself, including some one-off items milled and turned from solid. Occasionally, I have wrapped some areas of the frame in carbon fibre to add strength, as on this version. The frames have been successful as rolling demonstrators, but are very heavy at around 50 lbs (23 kg) and, while a welded aluminium frame would help a great deal, the frame is only viable when the design is less subject to change.

All the main frames have been built in two parts, front and rear wheels together on one spar (call it the lower frame) and what could be called the seat to bottom bracket spar (or upper frame), which pivots near the head tube, creating the adjustable seat. I found that simply rotating the upper frame around a pivot placed insufficient weight on the front wheel in low-ride position, while the bottom bracket became too high, so the pivot also moves forward and down to optimise ride dynamics. The upper frame is supported on a gas strut designed for the bike, elevating the seat while placing the bottom bracket in its lowest position.

The riding position adjustment does not affect the transmission, which is a conventional front-wheel drive arrangement with its single chain running over an idler near the fork crown, then down the fork leg to the cassette on the front hub. The steering tiller is, itself, only a heavy duty version of a normal one, pivoting on sturdy bearings, around which a guide for the steel wire ropes transmits the reciprocal rowing force to the bottom bracket.

A key element of the design is in the bottom bracket area. Some details are still to be refined, but the system essentially relies on two sprag clutches (which are essentially freewheels without the clicking) to convert both forward and backward rowing action at the handlebars to forward rotation of bottom bracket. The ratio between rowing input speed and the crank speed was something that I had to decide on by trial and error. With the advantages of normal derailleur gears downstream in the transmission, I believe a variable ratio between the cranks and the rowing tiller to be unnecessary.

The row-power wires are also used to actuate the transition to the low-ride position. They do this when the cranks are turned backwards by the rider, which engages the sprags and pulls the bottom bracket up and towards the bars, simultaneously lowering the other end of the upper frame where the seat is mounted. When lowering, the gas strut has the job of storing the gravitational energy for returning it later when the rider switches back to the high-ride position.

Two aspects of this ingenious system do, however, need some managing: firstly, the inability to back-pedal without lowering the seat (something impossible without a rider onboard); and, secondly, a need to adjust the pressure behind the piston according to the rider and luggage weight. In practice, a fairly large range of weights is acceptable before any change is required.

CYCLING FUTURE

While I am reasonably convinced of the benefits of the systems so far developed, future prototypes will require a great deal of structural refinement to reduce weight and improve

ABOVE: Mark made his own gas strut to assist the transition between ride heights. The cantilever rear axle is, he says, the simplest mounting option for a single-spar frame.

BELOW: The twin cables are alternately pulled around a solid form on the steerer when rowing back and forth. The shock cords add tension to the other end of the chain.

reliability. I persevere with development, despite the risks, because I find it very enjoyable to ride. For example, a few short rows on the bars give a worthwhile burst of acceleration with no apparent energy deficit, feeling like free power. It's great for accelerating up to speed, cresting short hills, overtaking: I love the feeling.

Added to this task, I've now decided to design around larger wheels, a lower seat, and bottom bracket, requiring a more curvaceous framework best achieved with a composite construction. In a move towards carbon fabrication, I'm now making moulds for the new frame, first for glass fibre, then prepreg carbon using vacuum bagging and bladder compression. With good fortune, the next prototype should weigh in at sub-30 lbs (13.5 kg). I'm also hoping a light carbon frame will have much reduced dynamic hysteresis due to carbon's compliance and low inertia, compared with those big bolted aluminium tubes, so the whole frame will absorb less energy.

The Switchblade is a potentially fast recumbent with good hill climbing ability, a rapid learning curve with good touring and commuter potential, too. I would value your comments and feedback at mark@cyclingfuture.com, (or write to *Velo Vision* and we will pass on your letters. Ed). See www.cyclingfuture.com for pictures, project updates, and videos.

Mark Chillery

PHOTO: John Kerr johnkerrpix.com

THE RIDE

Mark writes:

Before moving off, getting the pedals into the right position is achieved by a little selective rowing, standing astride, with the front wheel off the ground. This is not an issue if the rider remembers to set the pedal position before coming to a stop. In terms of adjusting to the format of the bike, it is true that one has to learn how to use the row-power system, but this can be done out on the road and does not have much impact on the initial experience.

Howard writes:

To sit on the bike brings no surprises – the air strut supporting the seat acts as a virtually solid linkage and will only deploy the low-ride position when required to do so. Getting underway with pedals alone felt perfectly normal (once they were set in a position for pushing off) and steering and handling felt relaxed and quite normal. Initially, riding in the high-ride position inspires confidence and, with a compact wheelbase, it can still be turned in a small circle as with any front-wheel drive bike, allowing for chain twist.

Trying some tentative pulling on the handlebar felt strange at first, but rarely unsettled my balance. Feedback into the steering was minimal and is set to improve in the next version; the steering while rowing sensation was one that took only minutes to grasp. During the 'adjustment period', my brain also learnt that the legs can ride normally, but to pump my arms I also needed to pedal – although it's not a problem if you forget momentarily and end up pushing your own legs around.

Once confidence was up, I took the bike up some challenging hills, using what I guess was up to 25% arm power / 75% leg power. As discussed, the benefit of sharing the load is hard to quantify, but I certainly had no problems with the method, putting significant effort into the push stroke, with the seat-back giving resistive support. At times I couldn't decide if I was generating more power with combined-limb effort, but it really did seem to be taking the strain off my legs, which is one of the aims of the system.

In high-ride mode, the Switchblade was as stable and easy to ride as the next recumbent. The version I tried out has been heavily trialled and such is the wear and tear on the components that I only managed the switch to low-ride mode once. The transition was, however, smooth and I can imagine the mode is a very useful tool on a mixed terrain ride; I was sorry not to experiment with the mechanism further. It would be fair to say the bike is thoroughly well-tested and has done a good job of demonstrating the principle.