

New Airbag Technology

“You cannot negotiate with gravity”

Sonny Crockett in “Miami Vice”

...and due to this, paraglider pilots need effective back protection. Unfortunately, this area of equipment development in paragliding has not been basking in glory. Over the last few years, back protectors have been continuously reduced. Before the times of competing Test Centers, no manufacturer would have dared presenting one of today's “mini-protectors” to the DHV for testing. Now we see certified products on the market where the protector is only present at the point of impact of the test-dummy, the rest of a pilot's back is left unprotected. Of course this satisfies the paperwork and is legal to fly with, as the LTF airworthiness requirements only state that a protector should be present from the middle of the pilot's thighs to the shoulders, but do not specify any particular energy absorption values for it.

Airbags which take an age to fill after launching are a particular step back in pilot protection and safety. The DHV test of reversible harnesses in 2011 indicated some serious deficits in this area. In a lot of cases, these airbag harnesses offered practically no protection during launching. Swing was the only manufacturer to improve their product after these tests. The harness Swing Connect Reverse was modified with a flexible plastic plate to help pre-inflate the airbag. With this pre-inflation this airbag has then sufficient volume to pass the LTF protector test (this was the first harness to ever manage this) with no additional ventilation required.

Skywalk have also used the idea of pre-inflating their Cult C harness. Before launching, the pilot needs to assemble two small fibreglass rods with velcro attachments in the rear of the harness above the main airbag compartment (time required, approximately 20 seconds). With a few good shakes this pre-inflates the airbag completely and extends its protection right to the top of the pilot's shoulders. The stowage space in the harness is connected to the airbag via a valve, and is also ventilated through the main airbag air intake during flight. The system works so well, that the harness passed all the LTF protector tests with very good energy absorption values without additional ventilation. In accordance with LTF airworthiness requirements for certification, airbags should be fully inflated prior to testing. This was not required for this harness. This means that the airbag offers good protection during launching or for a vertical descent (on a reserve parachute) where front ventilation is reduced. Particularly noteworthy for this harness is the protected area, which extends right up to the pilot's shoulders.

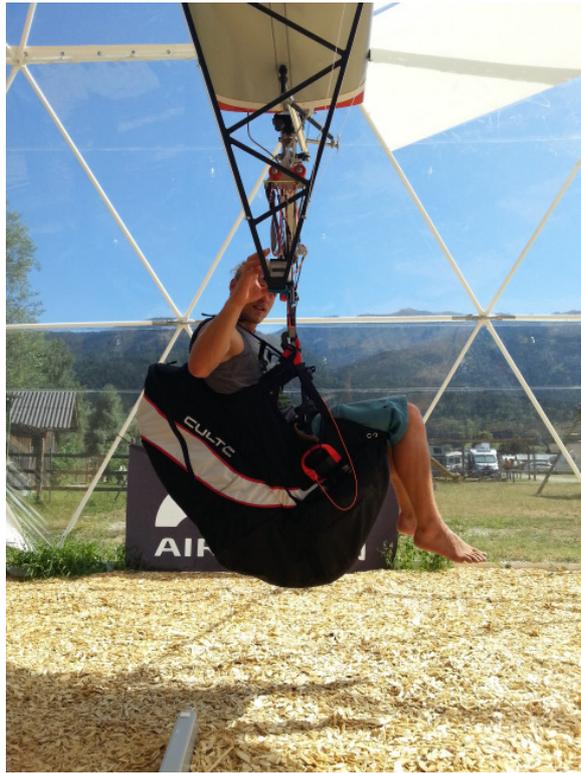
Simone Caldana, designer of Woody Valley harnesses had similar thoughts. He too wanted to develop an airbag harness which functions without the need for additional external ventilation. In his airbag he did away with ventilation slots and built in a large weak spring to push out the bottom of the airbag and effectively pre-inflate the airbag once it is taken out of the bag. No further pilot action is required to activate airbag protection. Tests on the LTF protector test machine were passed with very good energy absorption values. Woody Valley have designed their protector to address some of the main crash scenarios evaluated by the DHV. Impacts with the pilot inclined to the back are the second most common type of accidents after vertical impacts. To help offer protection for this type of crash, the Haska's protector has its widest point positioned somewhat to the rear. However, compared with the Skywalk Cult C, the total protected area is smaller, extending from mid-thigh to the lower

lumbar area. The upper lumbar and thoracic spine areas are left unprotected. The Haska can be fitted with additional side protectors.

Advance have modified their Axess 2 Air harness with its self inflating protector and now market it as the Axess 3 Air. The main criticism point of insufficient back support has been addressed with a new back construction which is more stable and immediately noticeable during flight. According to Advance, the protector has also been improved with additional internal ribs, which aid stability and the protector can now also be replaced if needed. The Axess 3 Air protector lies between the classical foam or mousse constructions and airbags: sidewalls and ribs are made of foam components, the space between is filled with air. The entire protector packs up very compactly, and self-inflates once out of the bag to provide immediate full protection. The protective area is only designed for vertical impacts, no protection is present for impacts to the upper back.



Picture 1: An indication of spinal components for a seated pilot. LWS = lumbar, BWS = thoracic, Steißbein = coccyx. Most protectors offer maximum protection for vertical impacts directly to the coccyx.



Picture 2: Skywalk Cult C. The protective area is optimised from mid-thigh to the lumbar spinal area. The airbag reduces in thickness towards the shoulders but is still present at the thoracic spine area. The harness offers protection for both vertical and supine impacts.



Picture 3: The protector position on Woody Valley's Haska offers protection for both vertical and slight supine impacts. Its protective area extends to the lumbar spine. For impacts to the thoracic spine no direct protection is present.



Picture 4: Advance's Axess 3 Air offers protection only for vertical impacts to the coccyx and lumbar spine areas. No protection is present for supine impacts.



Picture 5: The side view of the three harnesses shows the covering of the back-protection. Advance Axess 3 Air (front), Woody Valley Haska (center), Skywalk Cult C (rear)

Reserve deployment

DHV Testpilot Simon Winkler tested reserve deployment under simulated spiral dive conditions on Thomas Grabners G-Force trainer in Greifenburg. Tom Grabners invention is quite a blessing for the sport, and give us the option to make real-life tests in a controlled simulated environment. Hundreds of reserve deployments on the G-Force trainer lead to the following statement, which deserves to be highlighted in printing.

A reserve deployment from a static harness suspension must be possible with absolutely no signs of obstruction, and not require any special force or strength! Every small resistance to deployment becomes greatly magnified when subject to additional G-forces as in a spiral dive. Even small difficulties to deploy a reserve from a harness should not be tolerated.

Deployment testing was conducted in two configurations: normal pilot position and a simulated twist or sat position where the pilot is thrown to the outer side of the spiral. The deployment side was always chosen to be the “high side” which makes deployment more difficult. Deployments were made with a standard sized (Independence Annular Evo 22) and a large reserve (Independence Seven Up) which were compatible with the harnesses.



Picture 6: This test configuration simulates a twist or sat spiral, where the pilot is thrown to the outer side of the spiral. The reserve must be deployed up and against spiral forces. The downward sloping container on Woody Valley's Haska was much easier to deploy from compared with the straight containers on the Cult C and Axxess 3 Air.

During our first deployment test series on the G-Force trainer in 2011, Woody Valley's constructions were noted for their careful attention to detail and good functionality. This is also the case with their Haska model: the smooth-sided wide opening downward sloping container offers practically zero resistance on deployment. Even under the twisted simulation, deployment was no problem. The maximum sized reserve required somewhat more force to deploy. The strap length between deployment handle and inner container is approx. 16 cm.

Skywalk's Cult C has a relatively large reserve container aligned straight out to the side. Construction is not quite as smooth-sided as the Haska. Standard sized reserves were no problem to deploy in both simulation configurations. The large sized reserve had noticeably more resistance and was difficult to deploy especially in the twisted simulation. The deployment handle is mounted higher on the harness than by other models, which makes it easier to reach for pilots with shorter arms. The disadvantage of this is the relatively long connecting strap (approx. 25 cm) to the inner container.

The Axess 3 Air has a somewhat tighter tube container, which restricts the sizes of compatible reserves. The harness comes with its own reserve inner container which is compatible for reserves of sizes up to 7000cm³. This is smaller than the Independence Seven Up reserve we used for testing. The smaller Annular Evo 22 was mostly unproblematic to deploy, but the tight fit did create more resistance than with the other harnesses. Of the three harnesses tested here, the Axess 3 Air had the shortest connecting strap (approx. 12 cm).

Impressions in flight

All three harnesses were flown with the Get-Up strap configuration. Both Haska and Cult C are also available with a T-Lock strap configuration. Straps with the Get-Up system are attached relatively far to the rear of the seat board, this makes reaching the sitting position easier but means you need to work a bit to get upright again in preparation for landing. Pilots who do a lot of groundhandling will probably be more comfortable with a T-Lock strap configuration as the straps here don't cut into sensitive body parts quite as much. In flight all harnesses gave us no surprises, and are all suitable for school or novice pilots. Skywalk's Cult C has the lowest carabiner strap height at 39 cm, with a chest strap attached at 35 cm over the seatboard. The Haska in comparison is built much higher at 43 cm carabiner and 38 cm chest strap height. Differences are noticeable in flight, the Haska is more damped whereas the Cult C is more agile. The Axess 3 Air lies between the two at 42 cm carabiner and 36 cm chest strap height and has good balanced flight characteristics. With the Haska it must be noted that side strap adjustment in flight is not possible as permanent buckles are used requiring both hands to adjust. The positive side of this is that they cannot slip during flight.

Conclusions

Light weight airbag harnesses which do not require external inflation now exist and are available on the market. This makes airbag harnesses which offer protection only after take-off once filled with air outdated. Manufacturers should pursue this new direction in airbag technology offering far better protection for pilots, and pilots should also request it. There is still room for improvement regarding the back area which is protected by the harness. Skywalk have demonstrated that a full back protection is possible with a lightweight harness, other manufacturers are hopefully also following this lead.

Model	Test center	Weight for size M	Energy absorbtion measurement*
Skywalk Cult C	EAPR	3,6 kg	28,2 G**
Woody Valley Haska	DHV	4,1 kg	24,7 G
Advance Axxess 3 Air	EAPR	3,6 kg	33,5 G**

** LTF test regulations are for a vertical dummy of 50 kg mass falling from a height of 165 cm. The G-forces recorded by an accelerometer mounted in the dummy are measured on impact. The lower this value, the better the enery absorbtion of the protector. DHV testing is performed with no external ventilation.*

***Testing at the DHV was conducted without a reserve fitted and with the reserve container open. Other test centers may test harnesses with reserves fitted and/or with closed reserve containers which may lead to different results to those attained at the DHV.*

Text: Karl Slezak

Pictures: Simon Winkler

Translation: Peter Wild