

CVDREVISITED

| story **PETER BRADY**

I developed and introduced the ride control feature CVD (Controlled Vapour Dampening) as a full package to the power cat world in 2006 on the Brava 42. After 12 years I thought it was about time I reviewed how it had performed and whether it has had any influence or impact on power cat design in general.

To bring readers up to date with what CVD is and why I created it, I have included the original article published in 2005 in this magazine and then concluded with my thoughts as to how we have progressed to date.

Original article

CONTROLLED VAPOUR DAMPENING FOR EXCEPTIONAL ROUGH-WATER PERFORMANCE

Every type of vessel has its strengths and weaknesses with power catamarans no exception. Slamming under the wingdeck when driving into head seas has always been considered their archilles heel. Sometimes inadequate clearance or volume of the tunnel in the initial design causes the slamming, but more often than not it is heavier building weight or greater loading than originally intended that make the clearance less than ideal. Unfortunately this can be a vicious circle, as the slamming loads experienced by an overweight boat require more strength to prevent damage which then adds more weight.

In some cases it is a lack of reserve buoyancy or overloading in the bows that will cause the vessel to pitch more than it should and therefore drive the wingdeck down into the waves creating slamming. On some very fine bowed power catamarans I have heard of people being thrown up so violently by wingdeck slamming, that they hit their head on the ceiling. This is obviously an extreme case of lack of reserve buoyancy in combination with low bridge deck clearance; however it does illustrate the forces that can be generated.

Tunnel volume is also critical in allowing the water to dissipate either before or after it strikes the

wingdeck, therefore narrower catamarans require a higher wingdeck clearance than wider ones. Planing power catamarans will create aerodynamic lift at higher speeds, which softens the ride, however when conditions cause them to come off the plane they are vulnerable to heavy slamming, particularly as many of them have very little or no wingdeck clearance at rest.

Displaning or high-speed displacement power catamarans do create some lift from the wingdeck starting around 15kts. When designing this type of power cat it is usually considered more important to reduce slamming by raising the wingdeck rather than lower it to create lift, as they are looking for sea keeping across a range of speeds. Whilst the noise and dramatically increased structural loads are the obvious effects of wingdeck clearance and tunnel volume, there are also less obvious effects that slow the vessel and decrease fuel efficiency.

The first of these comes from a wave created off the inside of the hulls, which meets in the middle of the wingdeck and hits the underside near the transom. This causes drag by increasing the wetted surface and sometimes a kick in the stern from a small slam. This drag slows the vessel or loads the engines further,

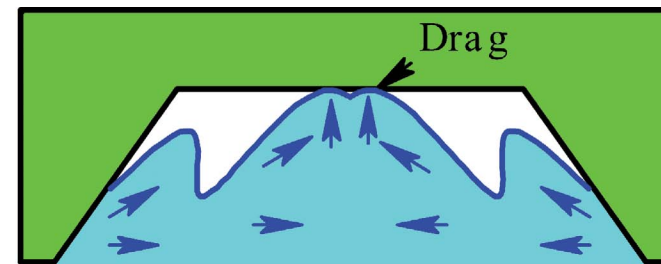


Figure 1: Narrow tunnel bow waves meet and drag on wingdeck.

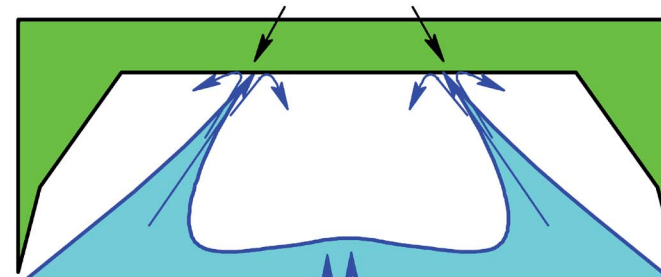


Figure 2: Counter intuitive. Some wingdeck slamming is caused by water jets.

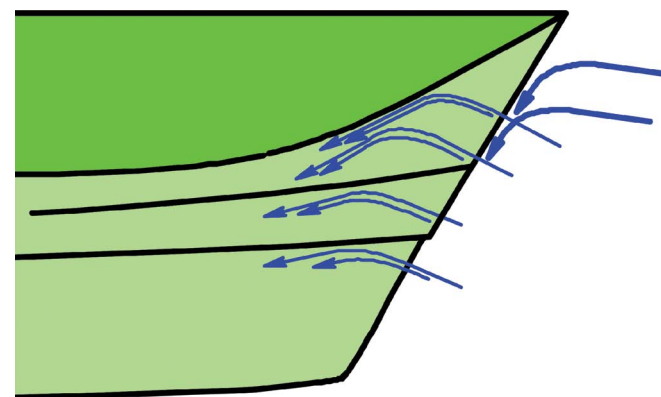


Figure 3: Raked bows. Reserve buoyancy, better lift.

increasing fuel consumption. This can be caused by either the hulls shape or by too narrow a beam which makes the pressure waves created by the bow sections to meet early and under the wingdeck rather than aft of the boat.

The second effect is felt in a following sea when the wingdeck is pressed down by the buoyancy of the stern and the forward momentum of the vessel. The vessel will literally surf or run on the wingdeck, which has a benefit in that it decreases the chance of broaching or burying the bows by the lift it creates. Unfortunately it has the disadvantage of increasing the wetted surface dramatically and therefore slowing the vessel, making it more vulnerable to a second wave pooping it. It also increases fuel consumption as more power is needed to overcome the wetted surface.

The third and probably least recognised effect is jets or squirts of water driving up at an angle from the inside of

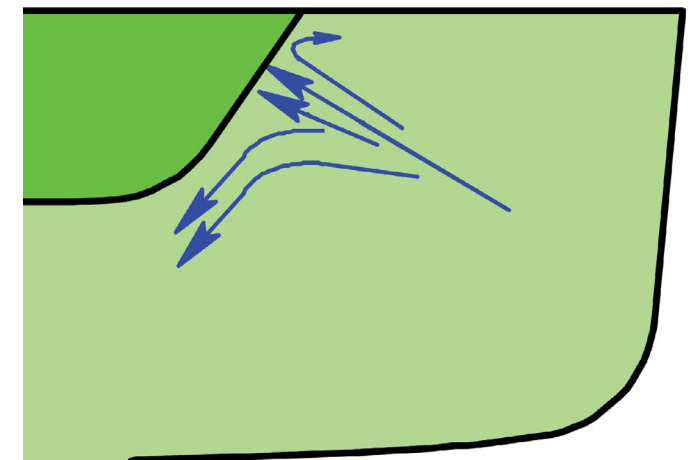


Figure 4: Wingdeck starting further aft. Common to sailing cats. Increased entry angle.

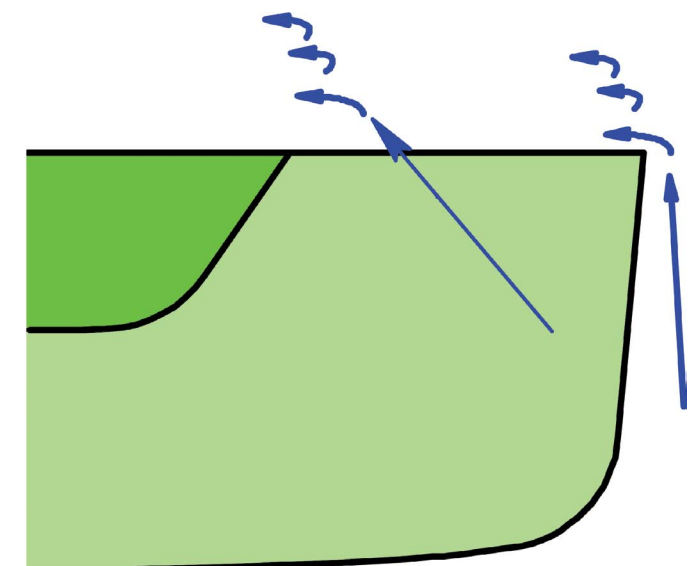


Figure 5: Plumb bows. Also common to sailing cats. Wetter foredeck.

the hulls and hitting the fwd wingdeck panels about a third out from the centre line.

Whilst these do not add to the wetted surface dramatically, they are very noisy and if they strike in a less supported area of the wingdeck can be damaging as the force is very localised.

Most power catamaran designers have been well aware of these problems and there have been a number of different approaches tried to solving them.

1. The first and obvious solution is to make the wingdeck clearance greater.

Most designers are constantly working on this issue, unfortunately like all design features there is a balance in the wingdeck clearance that is practical for each size of vessel. If the wingdeck clearance is higher than is balanced, it will either start to look silly, reduce the accommodation to a ridiculous point or the vessel ends

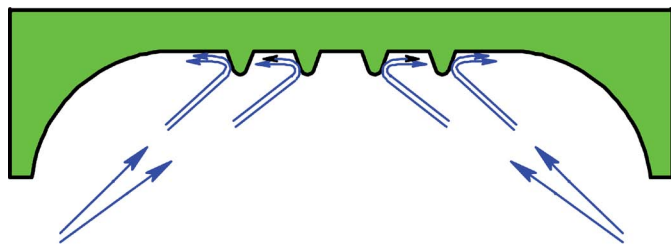


Figure 6: Large stringers. Very little reserve buoyancy. Some breaking up of spray.

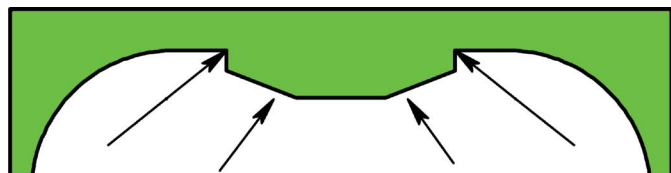


Figure 7: Large shallow third hull. More flat panels to slam.

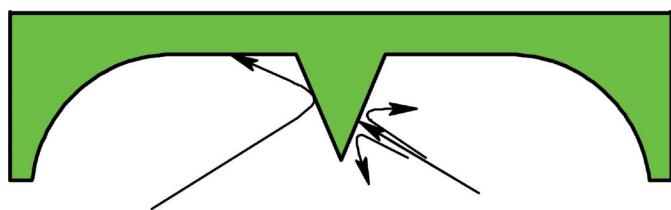


Figure 8: Very deep V-Pod. Increased water velocity. Higher slamming loads.

up with too much windage, and is difficult to manage in a cross wind. Raising the wingdeck will reduce the lift created at over 15kts however I believe that the small trade off in top speed is balanced by the ability to maintain a high cruising speed in rough conditions.

2. The second approach has been to start the wingdeck further aft.

This is a design feature that has been carried over from sailing catamarans that I believe defines the difference in philosophy between a converted sailing cat and a true power catamaran. Most power catamaran designers using the high-speed displacement or displaning type hull form have moved across from designing sailing catamarans. It is understandable that they will use features they are familiar with, like the look of, and understand. I believe however there is point at around 15kts where sailing catamarans and power catamarans separate in their evolution in the same way as did monohull powerboats when they developed distinct paths of displacement and planing types. Whilst the mathematical distinction is much harder to define in power catamarans between displacement and planing, the requirements for seakeeping are not.

Higher bows with their increased windage will have a detrimental effect on the windward ability of a sailing cat as the windage pushes the bows to leeward. This

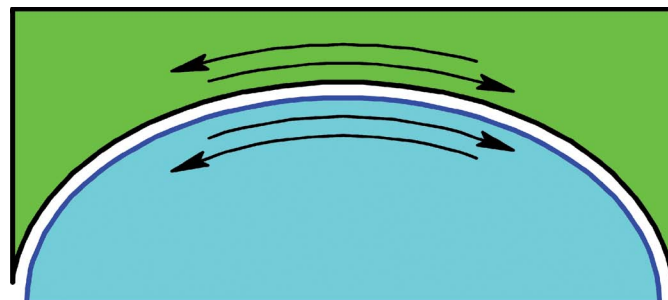


Figure 9: Narrow radiused tunnel. Rolling action similar to a monohull.

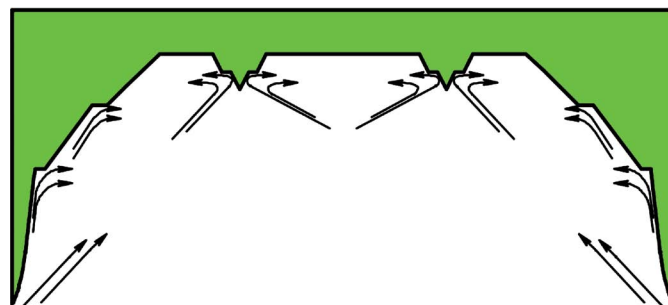


Figure 10: CVD tunnel profile. Breaks up solid water. Dampens vertical motion.

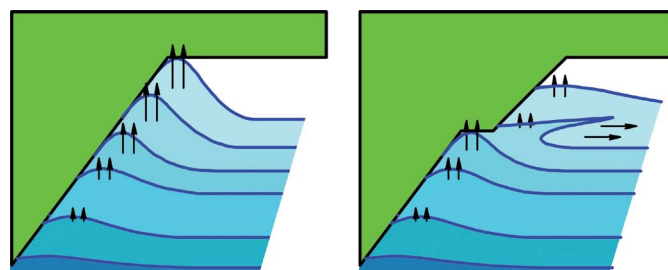


Figure 11: Slows the vertical motion. Increased buoyancy. Create lift by turning down spray.

however is not a problem with power cats as they have no requirement to work to windward and their power to weight ratio is constant. High bows increase reserve buoyancy and create a drier deck.

Raked bows reduce the waterline length of a sailing cat and therefore decrease the hull beam to length ratio for a given overall length. Whilst it is always advantageous to maintain as high a hull beam to length ratio as possible, it is less critical in a power cat where the power is constant and lift can be created, reducing resistance and wetted surface. Raked bows on a power cat provide a better distribution of reserve buoyancy lifting the wingdeck over waves and therefore reducing slamming.

Sailing cats will have their bows depressed by the drive of the sails particularly the leeward bow, therefore keeping the wingdeck entrance further aft makes more sense as the sails often drive the wingdeck down on to the water. Power cats over 15kts have the opposite affect, with lift created by both the hull sections and by air being funnelled through the tunnel. If the wingdeck entry starts further aft on a power catamaran, it will

often make the wingdecks entry angle considerably steeper.

This will lead to a more severe slam when it does occur and a far more dramatic slowing of the vessel as not only is the wetted surface increased, but the vessel will also be required to climb over the wave rather than slide over it.

Other disadvantages to starting the wingdeck further aft on a power cat are reduced torsional rigidity and increased wetness as the spray off the bows is compressed between the hulls and blown up between them on to the deck. This spray can be so strong that it can blow the trampolines out at higher speeds besides making the fore deck a very wet place to be.

3. The third area solution has been to place a V-pod or nacelle in between the hulls to increase the reserve buoyancy and to break up the solid water, therefore reducing slamming.

These V-Pods or nacelles started as either enlarged stringers (*figure 6*) or almost a wide shallow third hull. The smaller stringer types break up the water reasonably well and stiffen the panels, however they do not provide much reserve buoyancy.

The wide shallow type were not much good for anything as they just filled the tunnel volume up and provide more flat panels to slam on.

In the last few years the design of these V-Pods has been influenced by the wave piercer style, with either a deep third hull type under the fwd sections and/or radiused arches further aft. Whilst these go some way to breaking the water up and increasing reserve buoyancy, they often negate the benefits by funneling the water tighter into the now two smaller tunnels and increasing its velocity when it finally hits the wingdeck panels. Because the surface area inside the tunnel has now been increased when water is compressed, the wetted surface will rise even further, slowing the vessel and increasing the power required to maintain speed.

If the wingdeck to inside topside is too radiused without a V-pod, narrow power cats sometimes exhibit rolling characteristics more like a monohull.

Wave piercers have been recognised as better boats at punching into a sea than catamarans as their large nacelle provided reserve buoyancy. Unfortunately, because of the lack of reserve buoyancy in their small outer bows, they have always had a strange corkscrew motion in a quarter following sea and therefore an inclination to suffer wave slap on the outer sections of the nacelle, which can be both noisy and damaging.



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The difficult part of trying to improve the design of the inside topsides and wingdeck is that it is very difficult to observe what is happening, particularly at sea. Whilst simulations and tank testing are useful design aids, this is one area of boat design where I believe practical experience and real time observation is far more effective. The greatest advantage of being both a boatbuilder and designer is that I personally carry out sea trials allowing me to experience the boats performance and handling first hand. Once I decided that improving this area of power catamarans was my next challenge, I began to study what was happening under the wingdeck and why. I was able to gain a unique perspective during a trip on *Negril* when I was able to observe through the inside bathroom portholes where the water was being driven and its effects when punching into large seas at speed. It would have been too dangerous to try and see through the tunnel from either the bow or the stern in these conditions or to get close enough to observe from another vessel. I had suspected for some time that the slamming under the wingdeck of power cats was different to sailing cats. I had been able to feel sharp localised 'hits' in the fwd sections of the wingdeck when feeling around inside cupboards and under berths when at sea, however, I could not see where it was coming from. On *Negril* I could see both where it was coming from and where it was hitting. We made small modifications to *Negril* based on what I had observed which had immediate benefits to her ride and performance. To this visual research, we were also able to correlate the increase in fuel used on the fuel flow meters as *Negril* slid over solid water with other clients reports on the slowing effect they had noticed in following seas when surfing on the forward wingdeck sections.

- (A)** Improve their the rough water ride;
- (B)** To minimise the potential for structural damage caused by slamming loads;
- (C)** To increase fuel efficiency by minimising wetted surfaces and therefore drag in all conditions.

I had been working towards the solution for a number of years by using small stepped V-Pods and asymmetric topsides to reduce the panel sizes in the wingdeck plus chines to create lift and turn down the water. This led me to look at further ways to 'break the water up' and to research the lubricating properties of vapour (a mixture of fluid and air) as apposed to the increased drag created by solid water. As displaing vessels are not going fast enough to utilise pure airlift as would a tunnel hull or hydroplane, I had to look at different solutions.

Naval archaeologists and historians now believe one of the reasons the Vikings were so successful in their surprise raids was the speed they achieved in their longboats from the air induced to the hull by the clinker or lapstrake construction. Through tank and full sized hull testing they have now been able to substantiate this theory of air lubrication.

- It was obvious from this research that air and water mixed was far more slippery than the surface tension of pure water – the next part was to work out how to create the vapour and a small amount of lift at the same time.

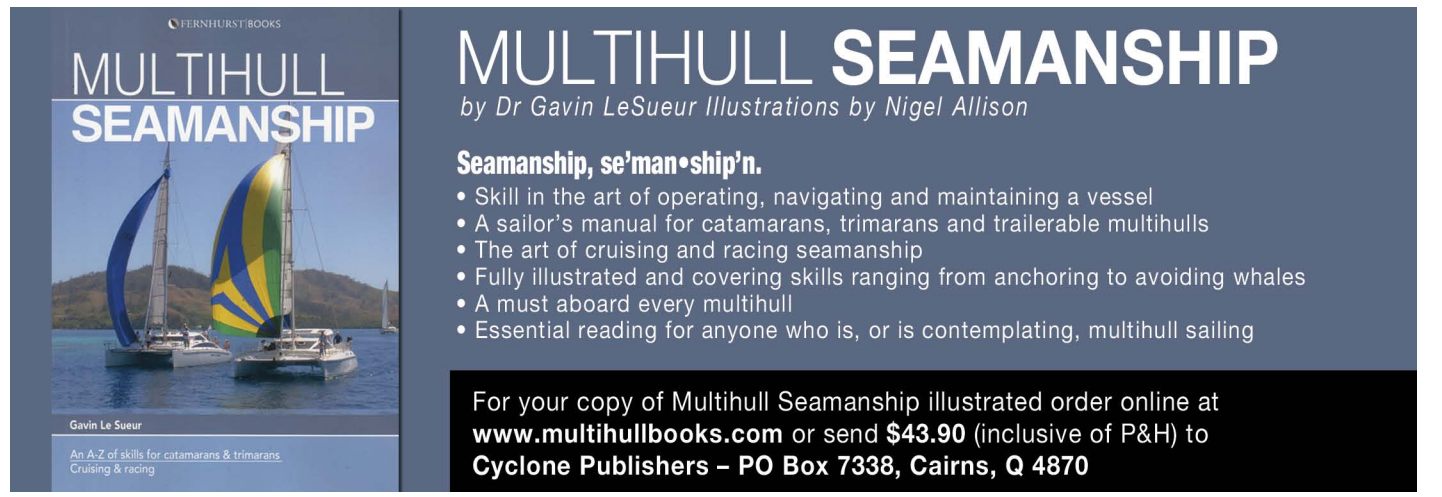
In redesigning these areas I found other benefits including stiffer and smaller panels, plus I was able to increase the vessels interior volume and torsional rigidity. The fore and aft chines created lift by turning the water down and into spray. They also allowed me to increase the buoyancy when and where I wanted it, by varying their width and position. Their entry angle provided additional lift in following seas preventing the bow from burying and the wingdeck driving down onto a wave. The V-Pods or nacelles can now be discontinuous and positioned to best deflect solid water and strengthen the wingdeck. The nacelles themselves have chines to increase reserve buoyancy, provide lift and reduce the wetted surface in solid water. In a following sea, the multiple chines induce air and therefore reduce the wetted surface and drag, increasing fuel efficiency. When all these features are

CVD is not just a pod or chine of indiscriminate shape added to an existing design, it is a carefully researched combination of features and volumes. As it is all above the waterline, it will not have any effect in calm water except increasing the internal volume of the boat and providing better structural engineering. CVD's real benefit will be realised in the vessels ability to maintain high cruising speeds and a quieter smoother ride in rough conditions. CVD will reduce slamming and therefore structural loads and the lubricating effects of the vapour will increase fuel efficiency.

My design office is currently working on programs to computer simulate the effects of CVD on each new design and we are developing a range of its features that could be retro fitted to any of my existing designs. I believe that the ability to control and dampen the ride of power catamarans is going to have a profound effect on their development and marketability. Their lifestyle advantages are well known, enhancing their ability to maintain high cruising speeds in rough conditions on top of their fuel efficiency and range. This may well be just the break through that cements their position in the mainstream powerboating market.

Absolutely if you look at the front on photos of the Brava 42 and Pathfinder 49 running you can clearly see the inside topsides working on both, turning down wash coming from the hulls and creating lift. You can also clearly see the chined V-Pods working to break up the water into vapour, cushioning the ride and reducing either slamming under the wingdeck or jets of water hitting the wingdeck from the hulls. When riding on the boats with CVD you can also feel the features working with a small lift motion as each chine is depressed into waves in rougher conditions and if you sit in the forward bedrooms or lockers you can hear the water being compressed and squirted onto other surfaces rather than slamming into flat panels. In following seas it is less obvious however it still has the same beneficial effects of reducing the pitching momentum when coming out of a wave, softening the ride and lubricating the tunnel.

(a) in the case of punching into short sharp seas when delivering some of the early Bravas to MacKay. Having either crossed the Wide Bay bar and travelled up through the Sandy Straits or having gone around Fraser Island and in through the break in the reef we often found ourselves first thing in the morning with a slightly larger than us Riviera or Maritimo slowly coming from astern. We usually cruised at around 17kts and so in flat waters or a small chop they would track us down doing a bit over 20kts and then gradually disappear over the horizon. Come late afternoon when the wind had kicked in and the seas were larger, we would reverse the situation, gradually coming up astern of





CVD working on Offshore 49 – *Paradigm*.

them still doing our 17kts very comfortably whilst they had slowed to just on-the-plane at around 15kts with lots of spray coming off the bow, or just off-the-plane, still with lots of spray everywhere and now with what looked like a very uncomfortable motion as well. They would gradually fall back during the late afternoon and sometimes if we both anchored up for the night we would do the same thing again the next day but more likely than not we would not see them again on the water as they headed into port to refuel whilst we headed straight through on one tank.

On one particular rough delivery trip around the outside of Fraser Island we arrived with nothing more than a loose exhaust connection that had coated one engineroom with a fine mist of black soot whereas a larger planing monohull also on its delivery trip had suffered quite serious water and structural damage in the same conditions.

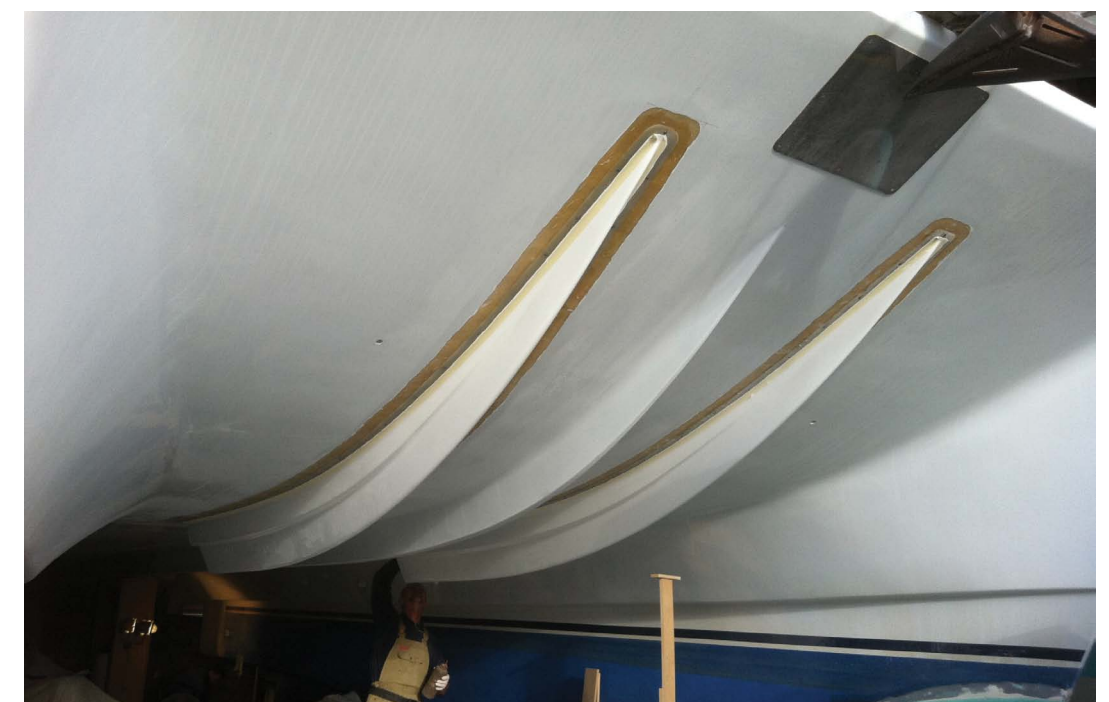
(b) In the case of following seas it was on *Rehab*'s delivery trip during the leg from Magnetic Island to Cairns. There was a good sized following sea, the boat was on auto pilot and we had set the engine RPM's for just over 15kts as this is the theoretical wave train speed. Rehab settled into the most amazing demonstration of running and surfing steaming along and staying with the wave trains. Every few minutes we would catch a surf taking the speed up to 22kts and just when you expected it to fall out of the wave into what were quite deep troughs, when I looked over the bows I could see the CVD softening the drop and the boat would charge on again. I sat out on the front seats with the owner and Lorma enjoying the ride for hours, waiting for a hard landing or to wear a wave over the bow, but the multiple chines and increases in volume effortlessly did their thing and each time the bows would rise again. We gradually got more and more

confident as the afternoon wore on, until we were sitting right on the bows as the ride was almost mesmerizing. The boat also tracked so well that the auto-pilot was hardly working and when got into Cairns, we had averaged 17kts for the trip, so the constant surfs had picked up 2kts over the speed we would normally achieve on the engine RPM's. I had taken a string of short video footage on my phone of this performance but had filed and forgotten about them until recently, when we started to put together the new Pacific Power Cats' website. So when I was going through the hundreds of photos I had taken over time, I found them again and realised it would be worth getting the short videos professionally spliced into one and putting it up on the website.

How many boats are fitted with CVD?

All the Bravas and the boats that we have built since have the full package and we have also designed or designed and built a number of CVD packages as retrofits to either my earlier boats up to 64ft in length or to other designers power cats including a large aluminium cat and in every case the owners have reported an improvement in their ride quality. Some of these packages have just been the chined V-Pods and some have included false chines on the inside topsides to get as close as possible to the chined inside topsides. There is no downside to retro fitting the CVD features except the cost of making and fitting the parts as being above the waterline they do not have any effect on performance or ride until they are needed. The upsides however are many including strengthening

and stiffening the forward wingdeck panels without any intrusion into the boats interior plus quieting and softening the ride. Even when building from new the CVD features do add to the boats cost as they make the construction more complex however they improve the boats ride and add so much strength and stiffness in this high load area that I strongly believe they are worthwhile and have not designed or built a power cat without the CVD features since I first designed them.



Scimitar modified with chined V-Pods.

A Leopard having chined V-Pods fitted to compliment its original V-Pod.



CVD features working as designed on Brava 42.

Have I modified the CVD features over the last 12 years?

Yes but not dramatically. I have adjusted the proportions and volumes of the inside topside chines and the V-Pods slightly on each new boat but in essence the design has stayed the same because it works. I have also tested different numbers and sizes of the chined V-Pods to see the effect that this has on the CVD performance and an example of this is *Rehab* and the Pathfinder Pilothouse 52 we are currently have under construction. They both have close to the same overall beam at 7.7 to 8m but *Rehab* has two larger volume V-Pods with wider chines and the Pilothouse 52 has three smaller volume V-Pods to keep the same volumes and are combined with chine width similar and to provide more strength as there is no centreline fore and aft partition in the full width bedroom of the 52.

Have the CVD features had any overall effects on power catamaran design besides on my boats?

Not really at this stage, but this is partly due to the fact that the GFC and other factors effectively stopped offshore power catamaran design dead in its tracks to a point where I cannot find any other designer trying anything different except following the latest fashion in looks for the last 10 years. A couple of years ago I did see a New Zealand boatbuilder using a very close copy of the V-pods, however I think that now virtually all new production power cats are aimed at what I call the inshore market of bareboat charter: the Mediterranean and the US inland waterways, and I assume that the builders have decided that it is not worth the extra cost and complexity during the building stage. We did start the process to patent CVD in the United States, but

the economic realities of the GFC made this unviable, but what the process did show was that nothing like it had been documented in the past. I also think that the fact that it has not been understood or promoted by anyone other than myself has meant that many owners have missed out on its advantages. I've spent a lot of time at sea in both my pre CVD boats and boats that are fitted with the full package and I would describe the difference as being like the before and after ride qualities of motor vehicles and motor bikes before the invention of the telescopic shock absorber or the pneumatic tyre.

Is Controlled Vapour Dampening suitable for planing power cats?

Absolutely, because the faster you go, the harder you fall. So although planing power cats generally have a narrower tunnel than my displacing type due to their wider hulls, it is just a matter of adjusting the volumes to suit. When they are planing in smooth water, they get greater cushioning from the ram effect of air through the tunnel, however they will lose this occasionally when they come down on waves and this is when CVD would come into its own softening the blow and maintaining speed.

Is there more for improvement in CVD?

There is always room for improvement in every design feature and whilst they may not be large changes, I will still keep testing small alterations, and have another couple of ideas that I believe would work particularly for faster boats.