

Zero Friction Cycling



Hybrid Ceramic vs Steel Bearings.

This article to try to assist with this fun little area. On the one hand much of the cycling public associates bearing upgrades with going “ceramic”, and on the other hand there is a healthy chunk of cyclists from all demographics who believe ceramic bearings are just marketing hype and a waste of money.

It doesn't help that there is not really any independent information out there. Manufacturers and retailers of Hybrid Ceramic Bearings will put up lots of claims re the lower friction and longevity advantages of ceramic bearings, and manufacturers and retailers of steel bearings put out claims and information which shoots down the claims made by ceramic manufacturers / retailers.

So the question is - is there a genuine friction saving with going to ceramic bearings or is the “ceramic upgrade” just a marketing con? Or even worse – as is claimed by some steel proponents -

is it possible that Ceramic hybrid bearings soon become higher friction than steel bearings due to damage caused to the steel races by the much harder ceramic balls?

This is probably one of the more polarising issues I've come across in my hunt for genuine watts savings and genuine best in class products. It is of particular concern to me due to my goal of providing genuine best in class products. I do not want to be selling hybrid ceramic bearing upgrades if they are a waste of money, or worse – poorer performing than quality full metal bearings within a short number of km's.

This article was prompted after seeing the growth and following of you tube video's produced by Hambini. Hambini has been posting some youtube videos which present the case of steel vs ceramic, and one video in particular is a very powerful presentation – with lots of data, graphs and convincing evidence as to why quality steel is the way to go, and why hybrid ceramic are not worth the money at all.

Seeing all the comments at the bottom of the video one can see that pretty much all viewers are convinced that hybrid ceramic “upgrades” are just a marketing con.

As a retailer who's vision is to find and supply genuine best in class products, and having very carefully selected my current bearing suppliers after over 2 years of assessment and consideration, the video and the information presented by Hambini in his steel vs ceramic speed needed investigation. If what his video presents is factual, then I would either a) stop stocking hybrid ceramic and start stocking steel, or b) I may hedge my bets and stock both quality steel and hybrid ceramic and present main points from both sides to customers to choose what they believe is correct based on information at hand and budget.

But first things first – the thorough investigation.

Step 1 was go to through the claims and data presented by Hambini, and attempt to obtain from Hambini more information re what sits behind the claims and data. Hambini is clearly a very intelligent guy, and in the video he quite seamlessly presents data that is factual data from major bearing industry bodies in amongst what are his own “calculations” and data. He also appears to use a technique you can see a lot of these days in many topics being presented by charismatic personalities on the web – something I can only best describe as “fact baiting” – whether he does this consciously or not I'm not sure.

Fact baiting as I call it is where a presenter will start with some basics about the topic which are not in dispute. By doing this early in a presentation it sets a tone of “fact” for the entire presentation. This enables the presenter to move from the initial basics into “data” which proves one point or another, and one tends not to question how that data was arrived at or calculated. It is simply

accepted as another “fact” just like the points preceding it were clearly factual. This technique is used a lot to promote various diets and natural medical products and remedies etc - it is amazing how easily conditioned our thought routines can be sometimes until we stop, think, analyse what is being presented and have a complete understanding of how the information being presented has been derived. It is also worth remembering most everybody has an agenda behind the presentation, and it is good to know / remember what agenda is – is it handily altruistic or is it to convince you of something beneficial to the presenter?

If the data and key points throughout a presentation are indeed factual – upon questioning this is easily established as the presenter is able to provide detail re where the information was obtained, how it was obtained, how calculations / testing was done etc. Questioning should lead to greater clarity. If questioning leads to waters being quite muddy – it is possible there is an issue with how the data and information being presented was obtained or calculated.

Step 2 was to discuss Hambini claims with Ceramic Speed, as well as the claims made by Ceramic Speed re their bearing performance.

Step 3 was to discuss both side’s claims and data with an independent person from a major bearing retailer that sells all types of bearing and so has no bias – it was the technical sales persons job to match the right bearing to the purchasers application. Step 3 was invaluable as it really helped confirm / not confirm some key points claimed by both sides. At the end of the day we have guy (Hambini) selling steel bearings presenting why steel is the way to go and hybrid ceramic are a waste of money and a marketing con, and on the other side we have Ceramic Speed and quite a large number of other bearing companies selling ceramic bearing “upgrades” who put up some pretty impressive claims on their products vs steel.

Ok so here we go; apologies for article length - this was no small undertaking – the Hambini video is 20 minutes long, I had an hour long skype call with Ceramic Speed, and many pages of correspondence with technical sales person at a large major independent bearing retailer, and so have had to tie a lot of information together here.

However I hope this document helps clarify this battleground somewhat to assist you with purchasing the bearing type you believe is the best choice for you, your cycling goals and your budget. The time and effort was well worth it for me to know what decisions I should make or not make re what I stock / recommend.

I am beholden to no brand or company – if I find something better than what I am currently stocking, I drop what I am currently stocking and replace with the product that is better. Sometimes my “best in class” approach may be tempered slightly by cost. I.e – I have not been stocking Ceramic Speed bearings due to cost of bearings – even though they have some rather convincing data behind their products performance – I have believed there to be other bearing options that have also tested

extremely well and offer a genuine watts savings over many “stock” bearings that come with bikes and at a price that is not so hard a pill to swallow. I.e I have felt it a great option for many to spend 150 to 280 to upgrade a bb and save an easy approx. 1 watt with a silky fast high quality bb, but struggled to get to recommend 400 to 600 dollar options to save about 0.05w more than the 150 to 280 option. I will order in whatever the customer requests no problems, I have a dealer account with Ceramic Speed, my margins on selling Ceramic Speed would be slightly larger than the margins I have with bearings I currently do stock, however I take my recommendations and what products I stock and recommend extremely seriously. I believe that no retailer matches ZFC with regards to time and effort and testing put into product selection and recommendations, full open information and data to back up recommendations, as well as learning information during testing / investigations that is of genuine value to cyclists of all demographics.

That is the pillar of my boutique little hobby business model. So that little ramble is to confirm that if my investigations showed hybrid ceramic not to be what it is cracked up to be or worse to have a performance issue vs steel, I would simply stop stocking, go steel, and explain what sits behind the decision – simple as that. I am not a manufacturer, I am a very selective retailer and am not interested in selling products based on brand name or marketing hype, only proof of performance that is worth your hard earned \$.

With that pre amble to set the scene, let’s get to it.

In the steel corner we have Hambini.

Ok so I may have mentioned this may be a little tough to cover concisely – it was a 20 minute video, and there are a number of key points I need to cover with information from other sides of the coin. But here we go and remember my earlier point mentioned regarding what I term “Fact baiting”. Once a tone of trust has been established early in a presentation, all key data and points are often accepted without question. In my younger days, I have been caught out by this many times, until I figured out it was prudent to fact check and question everything.

It is also always worth bearing in mind that almost everyone / every company / every presenter will have an agenda, and will want to present data and information that suits their agenda. It is also worth remembering that the most convincing information is often a mix of clear absolute fact along with information that may be somewhere in the vicinity of fact seamlessly merged in amongst it. It is also worth remembering the saying “there are lies, damn lies, and statistics”.

This isn’t to say it is good to adopt a level of paranoia or conspiracy theory mindset re every piece of marketing thrown your way – just to simply be aware that many presentations on many topics contain a mix of information that is absolutely true, information that may possibly be true but perhaps somewhat “enhanced” or tweaked to suit the pitch – and it is often backed by “data” that

proves this key point. Often the key to separate fact from possible fact is to understand what sits behind the data, where did it come? How was it derived? How was it calculated?

So with that in mind;

Hambini starts with some basics that are not in dispute – in this case it is information such as ceramic bearings are not truly ceramic they are hybrid ceramic where only the balls are ceramic, the races are still steel, and that the ceramic balls are much harder than the steel races they are running on etc.

It continues with other correct known facts such as the much lauded “extra roundness” able to be achieved with ceramic bearings vs steel being almost inconsequential in cycling applications due to the low rpm in cycling – we are not doing 10,000rpm such as in many industrial applications but instead are often around 100rpm. So bearings being 200 times rounder than already really really round doesn’t matter much for cycling speeds. Correct – mostly. It does make small difference, but admittedly it is very small.

Also of critical importance is the manufacturing tolerances. Cheap bearings will often be made to a poor tolerance, and with low quality materials leading to high friction and wear. There is also some great information re race to ball clearance, and that as cycling bearings will be installed in a way where they are pressed into a shell or onto an axle which causes pre load – that the clearance tolerance is important.

All good information that is absolutely true and not in dispute.

Then the presentation moves into what makes it very powerful indeed, and that is the use of data provided by the biggest and most reputable bearing manufacturers in the industry such as NSK and Schaeffler. Information such as breakdown of bearing friction;

- Bearing friction breakdown by schaeffler;
 - Seals – 60%
 - Grease – 28%
 - Cage friction – 7%
 - Ball deformation – 3%
 - Race deformation – 2%

In the above data we can see that the balls themselves contribute a very low amount indeed in the friction equation of the bearing. However we do not know what bearing this industry data pertains too.

Imagine if you will a bearing designed for heavy duty long life use. Double lip, heavy contact seals and packed full of heavy duty grease. The % of friction contribution by the balls will be very small, and it would probably take the resources of CERN to detect an efficiency change using rounder ceramic balls vs already very round steel balls.

Now imagine a bearing designed to be as ultra low friction as possible for racing use, that has non contact or single lip very light contact seals and a low fill level of a very fast grease. The percentages of what components contribute what amount of friction would be markedly different from the heavy duty bearing.

So without knowing what bearing the above information pertains too, you cannot take those values as an absolute across all bearings – the % breakdown will likely change markedly depending on the bearing you have – seal type, grease type and fill level, cage type etc will all heavily influence the above breakdown.

It doesn't take too much online research with Tier 1 bearing manufacturers or major bearing retailers that sell every type of bearing – type hybrid ceramic into their search bar to look up their information on hybrid ceramic bearings and read the main highlights pertaining to them. Always covered in the main highlights will be lower friction as well as longer lasting. So on an initial look into independent manufacturers who sell everything – the claims seem to match the same that we see with hybrid ceramic retailers for cycling bearings.

This leads to the first bit of data that is seamlessly presented by Hambini in amongst industry data;

The graph depicting friction losses that he presents is not industry data – it is data **“he has calculated”**. There is no information on how these figures were calculated, what measurements were done to obtain the data he used to calculate etc. If it is purely a calculation based on assumptive data, it is worth noting there is a distinct difference between a “calculated” number and a “measured” number. It is not an issue not to include this information in the presentation – there is enough to cover already – however this information should be able to be obtained from his website – or at the very least obtained upon writing to him.

Friction Facts data is **physically measured** friction loss. Remember at the time Friction Facts testing was done they were the worlds first independent body doing efficiency testing of drive train components. Yes of course there are calculations involved in arriving at a number from the information the friction test machine derives during its testing / measuring. First comes measured data, then comes calculations from that data. It is just worth noting that the equipment used by FF has torque sensors that are around \$6000usd each and accurate to 0.01w, and the testing equipment all up is circa 25k USD. Torque (turning force) x RPM = power. Precisely MEASURING what goes in at one end and comes out at the other to 0.01w is a testing result you can in my

personal opinion bank on somewhat more than a “calculated” loss where we have no idea how the results are calculated.

Also of importance here - On the Friction Facts reports there is full detail on the equipment used and testing protocols. We do not know what Hambini used to measure input / output changes and the calculations. If one literally had to bet their house on which data report is going to be most accurate, would you bet your house on the data from 25k usd equipment which at the time was completely independent for years and with full disclosure on testing equipment and protocol, or the report that simply says “I calculated the friction losses” and there is no way to obtain further information (I tried).

**It is worth noting that at the time of all the Friction Facts testing – the data and reports of which are still available and have not changed at all – were and are completely independent – Ceramic Speed purchased FF much later – and Ceramic Speed bearings didn’t win the testing – in fact one Hawk racing – an all steel bearing – finished ahead of Ceramic Speed by a tiny bit. In short – I have absolute confidence in the independence of the FF testing and data*

Next is where things became a bit of fun indeed.....

Next there is a graph presenting friction losses over 10,000km of cycling. The data presented shows the friction increases suffered by hybrid ceramic bearings over 10,000km vs the top steel bearings remaining almost exactly constant after a very slight initial increase.

What test was this?! How was 10,000km of cycling simulated and on what equipment? It most certainly was not a test or data supplied by the major bearing companies – bearings for cycling applications from Tier one manufacturers such as NTN, SKF etc make up an insignificantly tiny amount of their product sales. **There is no way that NTN or Schaeffler have conducted a 10,000km simulated test for cycling.**

So this data is obviously Hambini’s own data, test or “calculation”. How he has derived / arrived at this data is simply critical. **It is probably THE KEY piece of information presented in the video** to back up his entire main sales point that hybrid ceramics quickly become higher friction than quality steel bearings due to the harder ceramic balls damaging the comparatively softer steel races. **This is at 10:25 in the video.**

When questioned on this Hambini initially advised he does not discuss testing protocols. I obviously found this extremely concerning. How / where he has obtained the most crucial data of the presentation is secret?!

Again, if you look at Friction Facts testing all tests go into full detail on the equipment and testing protocols used so readers are aware of how the results are derived, giving much disclosure and information for clever engineers of all types to try to pick apart if they wish. Similarly with ZFC lubricant and chain testing – full test brief and protocol for lubricant and chain testing is on website and I even provide full test running sheets for every interval of tests on request for anyone who is interested in that level of detail

So not discussing how this testing was done raises a very large red flag with me, of which I advised Hambini (to which he seemed a bit put out advising he didn't care what colour my flag was). When I fully explained (as above) why I found this so concerning – he did reply back further stating that the tests were conducted as per JIS and DIN protocols which I could find on pages “X” on a very big engineering document, but the maths is pretty heavy etc...and recommended two other engineering books I should read.....

I do not understand this type of reply. Watchers of his video should be able to simply find out what equipment and protocol was used to simulate 10,000km of cycling and how was the friction losses measured / calculated. To me his answers on this point were purely deflection and nothing more. He is clearly not going to disclose how the data that sits behind his most key graph was obtained – and I really have to wonder why.

Remember this data is seamlessly integrated in amongst factual data obtained from industry – again leading one to simply accept the next part of the presentation often without question – but when one does question – well it was an interesting discussion to say the least.

On top of this there are also two other key points re the data presented that without further information do not appear to add up.

The first one is intuitive – the very linear friction increase of the hybrid ceramic bearing. Hambini claims the harder ceramic balls damage the comparatively softer steel races in a manner called “brinelling” which is where the harder ceramic balls will cause micro indentations in the races.

This is a cascading type of damage. I.e it would start as minor increase in friction, but increase more dramatically as time went on as the initial small damage causes more damage to occur, and once more damage has occurred this leads to even greater damage occurring at an exponentially cascading rate. Bearing failures in industry are quite hard to detect due to the cascading nature of almost all types of bearing failure - leading to costly unpredicted downtime. With bearings, once a small amount of damage starts things often go from slightly off perfect to really not good quite quickly. It is less dramatic in cycling due to the lower rpm's, however it will still be cascading to some degree and unlikely to be this nicely linear line of increased friction as presented in Hambini's graph.

The second anomaly is less intuitive but has a good basis of factual data behind it. New bearings do have a small “break in” period. After a little use under load, the lubricant that is factory applied to bearing after assembly and prior to seals going on will be properly distributed across all surfaces, inside bearing cage etc, and bearing seals will break in on their contact point with inner races. So bearings should show an initial slight decrease in friction from new after a short run in period. In Hambini’s graph, all bearings – including steel bearings, show an initial slight increase in friction. Again it is just an anomaly in data presented by Hambini vs what may be expected, and some internet research backs up that it is expected bearings will hit their lowest friction state after a short break in period - and we simply do not know how hambini is calculating or arriving at the figures used in his graphs.

It is worth me stating at this point I am not saying outright that I dispute Hambini’s data, however the complete shut down re how tests conducted and data obtained is concerning indeed, as are what appear on the surface to be anomalies in the data vs real world expectations. Hambini could clear up the questions on these anomalies, but in the absence of this happening – I have to list them as such.

Why do we use hybrid ceramic bearings then?

Whilst not widespread in industry due to cost as hybrid ceramic bearings often cost significantly more – the purported benefits in industry are billed as being quite high in many applications. Here are the benefits listed from SKF website as just a simple snapshot, and this type of information you can find fairly easily at most of the major bearing manufacturers of the world.

Main recommended uses for Hybrid Ceramic bearings on SKF website

With a bore diameter $d \leq 45$ mm, are most suitable for electric motors in the power range 0,15 to 15 kW as well as for power tools and high-speed drives.

- **Long service life**

The lower frictional heat generated in hybrid bearings, especially at high speeds, contributes to extended bearing service life and extended re-lubrication intervals.

- **High wear-resistance**

Silicon nitride rolling elements have a higher degree of hardness making hybrid bearings suitable under difficult conditions and contaminated environments.

- **High bearing stiffness**

With a high modulus of elasticity, hybrid bearings offer increased bearing stiffness.

- **Reduced risk of smearing**

Even under inadequate lubrication conditions, such as high speeds and rapid accelerations, or where there is an insufficient hydrodynamic film, the risk of smearing is reduced between silicon nitride and steel surfaces. For conditions where $\kappa < 1$, it is common to apply $\kappa = 1$ for hybrid bearing life calculations.

- **Reduced risk of false brinelling**

When subjected to vibration, hybrid bearings are significantly less susceptible to false brinelling (formation of shallow depressions in the raceways) between the silicon nitride and steel surface

<http://www.skf.com/au/products/bearings-units-housings/engineered-products/hybrid-bearings/index.html>

Checking of other independent industry sites one generally finds quotations of bearing lifespan increases of 4-6 times or 4 to 8 times vs steel bearing's, and that it is the steel balls in a bearing that are the first part of a bearing to show wear.

So why the difference for cycling?

Hambini claims the reason for the shorter lifespan of hybrid ceramic for cycling is due to vibration. In industry the applications tend to be high speed and may be high load – however they do not suffer from the vibration and impact type stresses the bearings are subjected too when rolling down the road. He advised me to check for myself with an independent bearing retailer and see if they advise hybrid ceramic for applications that involve vibration. I did this of course and the result of which is.....

Hambini is correct – generally hybrid ceramic is not recommended for applications that involve vibration – however there is a bit more to it than that. RPM, load vs bearing load rating and frequency of vibration all play major factors with regards to the level of impact this may have on a hybrid ceramic bearing's lifespan change and if it may cause damage to the “relatively” softer races. Obviously the quality and hardness of the races used is critical here as well, there is hardened steel and then there is HARDENED steel.

Rolling down the road is low rpm and low frequency vibration. It is believed the largest determining factors re bearing life for cycling will be quality of the materials overall and load rating vs load subjected, running in highly contaminated environments (wet riding etc) especially if have a light or non contact seal and low fill level of light viscosity grease which will form a poor hydrodynamic protection barrier behind seal lip etc.

So – if you have a bearing where the load rating is many times greater than the load it will be subjected to, and the races are made of high quality hardened steel, then the proof of whether or not vibration and shock in cycling is causing damage will be easily detected by feel. If a bearing feels like pure silk when new, and 10,000km later it feels like pure silk, there is no problem. Trust me you can detect easily by feel the slightest non perfect running of a bearing for cycling. When turn inner race of bb bearing with fingers after x thousands of km's you will instantly feel the slightest "non silky smooth" feeling. Same with holding wheels by axle out of bike and spinning etc.

And whilst the steel races may be relatively softer than the very hard ceramic balls, this does not mean they are "soft" per se. Top quality steel races can be hardened to Rockwell hardness ratings of between 60 to 64. That is practically case hardened armour plate level hardness. So sure, the balls are still harder, but this level of hardness with steel races is not "soft", and is not easily damaged by comparatively harder ball.

I see bearings of all types – steel and hybrid ceramic have either great or short lifespans depending on factors pretty much due to everything else but ball material. Correct size for load? Seal type, grease type and fill level vs general riding conditions? Hub / BB design? Correctly installed? Maintenance? I see both hybrid ceramic and steel bearings feeling like pure silk after tens of thousands of km's and I see both hybrid ceramic and steel bearings feel pretty darn average in a short number of km's as well.

Most cheap / poor quality hybrid ceramic bearings will be terrible as Hambini states. The steel used for races will be cheap crap, and the ceramic balls will also be crap. Just because ceramic balls CAN be made rounder than steel doesn't mean they are. Cheap ceramic balls can easily have a roundness grade far worse than quality steel balls. However, quality hybrid ceramics where the steel races are made of high quality, highly hardened steel, manufactured to great tolerances and with correct clearance there is no evidence I am aware of re shorter lifespan and friction increases other than Hambini's own secret 10,000km testing and calculations.

It is difficult (basically impossible) to get hardness ratings and composition / quality of the steel used for races from cycling bearing retailers / manufacturers – for both steel and hybrid ceramic – the proof really comes down to brand performance (an exception here is enduro who list the Rockwell hardness rating of their bearing races on some sites – and it is very very hard).

I did a facebook post recently regarding it can be wise to check what bearing size is in the hubs you are buying, as I see a lot of wheels these days where a 6802 bearing is used as main bearings in rear wheel, and that is a tiny bearing to take rider weight over bumps and impacts down the road. It is in my view an engineering fail to use such a bearing size for main bearings in a rear wheel, this bearing size is just barely sufficient for use in free hubs. I have seen many rear wheels with this bearing size for main bearings have continual short lifespan issues regardless of what bearing the customer tries – best steel or best hybrid ceramic. I have even seen wheels with a 688 bearing in them. I just replaced a bearing in one of my jockey wheels that got some grit in it after a cx race – it was a 688

bearing. Should a bearing size suitable for a jockey wheel also be deemed suitable for use in wheel hubs taking your body weight as you ride down the road hitting bumps and pot holes? No, it is not. If you were an engineering student and handed up a hub design as part of your thesis with a 6802 bearing as main bearing for rear wheel or 688 bearing even in a front wheel- you should in my view get an F. Unsurprisingly, the customer whose wheels had 688 bearings in them was experienced bearing lifespan issues.

As mentioned before there is of course more to the story – hub design, alignment, correctly installed bearings etc... but overall, putting very small bearings with tiny balls and very thin width, thin depth races in for wheel bearings taking full body weight, experiencing vibration and the hard shock impacts that come with riding down the road is simply flirting with load tolerances. Hence I believe it is something you should check and consider before spending hard earned \$ on a set of wheels / hubs – most especially so if you are a heavier rider.

But in summary – what Hambini is claiming in essence is that hybrid ceramic bearings need move from a state of having a 4 to 8 times greater lifespan in industry applications all the way over to having a shorter lifespan in cycling application – falling behind steel bearing performance within just few hundred km's due to damage to races from the harder ceramic balls.

Assuming correctly sized bearings for load rating, quality bearings with quality steel races, with correct clearance, correct seal type and grease for the type of riding (ie non contact seals and light grease would not be the top choice for an all weather commuter / training bike), correct installation etc - **this is a rather enormous swing in longevity due to the vibration of riding down the road and seems improbable at best.** And the only evidence that exists to support this claim is Hambini's own test and data – and what sits behind this evidence he will not release.

During my pressing Hambini for more information he advised that he is not trying to convince anybody of anything, he is simply putting out there his knowledge from 26 years of experience in the aerospace industry, and that his current bearing and BB business is hobby that got out of control. However, the time and effort put into producing his youtube video's to advise why steel and why not hybrid ceramic, the time and effort into designing and manufacturing his Bottom Brackets etc – it is hard to believe this information could be classed as independent advice. Currently the market is flooded with hybrid ceramic bearing retailers vying for a piece of the aftermarket bearing “upgrade” pie. It could be viewed as a very clever move to stand out from the crowd by going steel and educating customer why steel and vs hybrid ceramic if you have the back ground credentials and the ability to present a powerful case for people to swing your way. I do not think the success of Hambini's business selling steel bearing upgrades in a market conditioned to ceramic being the default re bearing upgrades is an accident – it is a testament to the fact that this is one clever guy indeed.

From Ceramic Speed re this section

As a pre amble it is probably worth noting that Ceramic Speed has probably been the driving force behind “ceramic” being a friction and longevity “upgrade” – and the now huge number of players vying for a piece of the ceramic bearing upgrade market.

During the skype call they agree that whilst the roundness of the balls may only be a smaller part of the equation overall re the “friction” upgrade side of things – it is important to note that in roller bearings the balls are usually the first component to wear and therefore cause friction increase. Again this is backed up by independent research across bearing manufacturer websites, and hence the quoted vastly greater longevity quoted for hybrid ceramic bearings where the only differential is the ball material.

And so Ceramic Speed argue that whilst the ball material may be on the smaller side of the equation re delivering lower friction, it still does in fact deliver lower friction which is important when you are pitched as the fastest bearing upgrade in the industry, and that the low friction performance will remain for a very long time as the balls will not wear.

It may be worth having a flick through the testimonials on their industrial section – they have quite a number of real world business and with good data on just how much money they have saved switching to ceramic speed due to the lower friction and vastly longer lifespan. A lot of the money saved can be due to the much lower unexpected downtime on machines from bearing failure. Where once they were replacing the highest quality steel bearings they could buy every 2 or 3 months and still experiencing unexpected failures, with ceramic speed bearings they have been able to move to an annual bearing replacement with no failures etc.

So again we have to pause and consider – to what degree does this proven longevity increase change by moving from industrial high load, high rpm machines to cycling? Does it swing all the way from many times greater longevity and performance to poorer performance vs steel within a few hundred km’s?

The other major factors in why their bearings are so fast of course come down to seal design, cage design, their grease, ball and race material quality and manufacturing tolerances – it is everything as a whole designed to be the fastest and highest performing bearing for ultra low friction performance for racing cyclists and to perform as such for a very long time. A part of that is regardless of the fact that the actual balls themselves at cycling rpm’s are a small % of the friction equation, the fact remains that high grade ceramic balls simply are lower friction, and will remain so vs steel for a lot longer – it is not a short term friction benefit. With high quality hardened steel races the balls being harder is simply not an issue or concern the races are so hard they will not be damaged.

At this point it is worth noting here that Ceramic Speed offer a 4 year warranty on non coated bearings and a 6 year warranty on coated bearings. Hambini offers a 1 year warranty – and this is on his machined bottom bracket bearing body – not on the bearings themselves. On Q&A section of this website he advises he replaces his bearings after about 8000km.

Q. How long will the bearings last?

A. I cannot place a life on the bearings as life is largely dictated by the conditions they are subjected to. Having high loadings will increase their rate of wear as will riding in wet conditions. The bearings in all Hambini Bottom brackets are branded and meet minimum ISO standards so they are the best that are commercially available. Typical usage will be somewhere in the region of 2000km to 10,000km. As an example, those who watch my youtube channel will know my fastidious maintenance schedule which consists of weekly jet washing - I change the bearings twice a year, ie 8000km between changes. Due to the low speeds involved keeping them clean is more important than keeping them greased.

<https://www.hambini.com/bike-parts/bb30a-to-shimano-racing-edition-black-bottom-bracket.html>

Again I find this somewhat interesting considering Hambini's purported benefits re friction and longevity of steel over hybrid ceramic. How many of you pre emptively replace your BB / wheel bearings every 8000km's ?

For Australian customers – a Hambini racing BB costs 165 pounds + 26 pounds shipping = \$347 at time of writing. Replacement NTN 6806 low friction bearings from his website which we cannot buy in Australia are 25.5 pounds each, x 2 = 51 pounds, + 26pounds shipping = 77 pounds or \$140 aud. Recommended replacement approximately every 8000km. The financial argument of hybrid ceramic being an overpriced option vs low friction steel is looking a little shaky on these numbers. Of course you could just source and purchase the low friction steel bearings for your existing BB shell and hubs and you should come out ahead of the majority of hybrid ceramic options - but you need to decide which side of the fence you believe is advising the correct information re friction and longevity.

Ceramic speed also advised re the number of warranty returns for North America as those figures were available – I cannot divulge as that is commercially sensitive, but I can advise the number was EXTREMELY low – especially factoring in sales volumes, and that with the price point and expectations of bearing performance / longevity for that price point any dissatisfaction (ie bearing not remaining silky smooth perfect) is likely to result in a warranty return. If you shell out \$400 to \$600 for a BB – you are going to complain if it doesn't live up to what you were expecting for that level of coin.

I did ask Ceramic Speed for data on bearings that have been re tested after x thousands of km's in the field with pro athletes etc – a bunch of pre / post bearing data across both ceramic speed and some high quality steel bearings could simply shed a lot of light on validity or not of Hambini's claims, and this request has been taken under advisement.

I was advised however that whilst this kind of data / testing was not available at time of call – overall the feeling was that it is simply a non issue for them. They do have a machine that pedals cranks like mad with the whole thing shaking around simulating sinusoidal forces similar to real world riding and their products have obviously been extensively lab and field tested, as well as some pretty powerful testimonials and data proven cases in industry. Now we know the claims of cycling being different from industrial applications – but again I refer consideration of the likelihood that cycling

application is such that it reduces such a proven longevity benefit in high speed, high load industry applications to one of lesser longevity in cycling application.

Proving that their hybrid ceramic bearings have a longer lifespan vs steel is simply not something that I think they expected to appear on their radar, for quality hybrid ceramic bearings it is assumed that this just an accepted and proven situation – however in light of the Hambini video's growing in profile and the rather powerful and convincing presentation style – providing this data is a request they have taken on for review. I will update this document as soon as I receive.

Bearing Cage material

This point is crucial - Hambini makes much of the advantage of steel riveted cage vs polyamide cages used in most hybrid ceramic bearings, and claims the steel cages to be superior, that cages cause the majority of friction inside bearing, and that it is expensive to manufacture riveted steel cages to exacting tolerances which is likely why bearing makers such as enduro do not use them for their hybrid ceramic bearings. He also claims steel cages act as lubrication reservoir.

However during my discussion with a technical sales person at one of Australia's largest bearing retailers, my discussion with ceramic speed, as well as much internet research on major bearing manufacturer sites, I personally believe Hambini is way off base here.

The independent retailer advised that steel cages are **not** recommended for applications where vibration is a factor, ironically the very same argument Hambini uses to advise against hybrid ceramic bearings.

But crucially, polyamide cages are also most definitely lower friction, it is pretty much like the balls are turning in teflon, and also of great importance for cycling is the polyamide cages are self lubricating and so perform much better in situations of low lubrication levels.

This is a condition that presents itself quite frequently in cycling – almost all high performance low friction bearings will have a low fill level of a light viscosity faster grease. This does not last anywhere near like a bearing packed with a heavier duty grease for bearings where outright longevity or long service intervals is the key priority for the bearing vs low friction.

So for many of the more expensive and lower friction / faster bearings – they will come with a low amount of a faster grease, and unless user maintains with grease top up by around 10,000km – things will be running dry indeed. The supposed “oil reservoir” of a steel cage will only be of use if there is any lubrication to fill the reservoir. Once the reservoir runs dry, you have a poorly lubricated

metal cage running on a poorly lubricated metal bearing, and this is not good situation at all – the bearing will be quickly damaged. For bearings in a polyamide cage, they can run in a very low lubrication condition for a long time and be far less likely to suffer damage. This is even more so for ceramic balls vs steel balls. So ultra low friction steel bearings with steel cages – such as the ones recommended by Hambini – require attention indeed re lubrication levels. If you pack them with a standard grease, you undo a lot of their low friction performance. If you run them as they come, you will need to keep a close eye on adding a bit more of a fast grease at regular intervals. It is perhaps a bit of a match why Hambini advises he replaces his bearings approximately every 8000km, and also his rather low warranty cover.

So in summary for low friction bearings for cycling use, one most definitely wants a polyamide cage as it is;

- Lower friction
- Self Lubricating
- Recommended for use in applications where vibration is a factor
- Recommended for use where bearing may experience low lubrication levels.

The ultra low friction steel bearings that Hambini recommends all have steel cages. But again cycling was not necessarily the intended purpose of the bearing from these manufacturers.

What is also interesting is that Tier 1 manufacturers such as NTN do not bring the bearings Hambini recommends into Australia. Only the heavier sealed, heavier greased bearing models are imported. Long lasting they may be, but low friction and suitable for your riding not so much. Going back some years I decked out my commuter with the top NTN bearings I could get from CBC bearings – which are the heavy sealed bearing – thinking how clever I was paying \$10 a bearing and saving a fortune vs buying cycling specific brand bearings.

However was literally like riding with your brakes on. Even on my commuter I couldn't stand it, it was simply not pleasurable to ride, and I still liked to zip to and from work. So I replaced with quality steel bearings made for cycling which have a good balance of seal drag, grease viscosity, and come with a polyamide cage. Of course this meant my clever plan to save money didn't really pan out. Many others probably wouldn't mind those bearings at all on their commuter and so it may be a good option for others – just not me – I just have a friction limiter I cannot switch off ☺

Companies such as Enduro that offer 2 grades of steel and two grades of hybrid ceramic – simply make a steel bearing option that is suitable for cycling – it has a decent level of a sensible viscosity grease, the abec 5 level has a polyamide cage, and the seals are proprietary and a good balance of contact level so as not to be too much drag, but also offer good protection against the elements.

It is also worth noting that by the time you get the recommended ultra low friction steel bearings Hambini recommends from Europe over to Australia, you are basically back at the same price point as other great low friction hybrid ceramic options such as HSC, and notably more than the Abec 5 level steel bearings from Enduro – which now armed with my new knowledge of polyamide vs steel cages – I personally would choose over the recommended NTN / SKF as proposed by Hambini. How often have you had your wheel or BB bearings re greased? Never? Want more than 8000km of recommended service life? Polyamide cages are for you if the answer is yes to those questions.

In another of hambini's video's he states that polyamide cages do not last as long as metal cages, and this is true in a number industrial applications – however that is usually because the type of lubricant or exposure to chemicals may over time degrade a polyamide cage, or operating temperature, high rpm and load can be an issue. I do not believe anyone has been able to discern polyamide cage wear as factor in bearing performance drop / failure for cycling application – all indications point to Polyamide being superior re friction, low lubrication levels and vibration – all very important points for cycling application.

So - noting the difficulty in obtaining low friction steel bearings from Tier one manufacturers such as NTN and SKF – ie they cannot be obtained in Australia, you have to buy them from Europe or elsewhere overseas, and even then Hambini admits they are difficult to obtain. The bearings with low friction seals made by NTN and SKF have simply have riveted metal cages – is this a factor behind Hambini's endorsement of this type of cage vs polyamide?

I have doubts that the biggest players in the cycling industry such as Enduro, Ceramic Speed etc, at the price points they are charging for their bearings – (Enduro XD15 are similar price to Ceramic Speed) – that the cost difference in going with a riveted steel cage vs a polyamide cage would be of concern if a riveted steel cage was indeed superior.

Ceramic Speed advised they believed polyamide to be genuinely clearly superior to metal cage for the reasons outline above by the independent bearing retailer, and all online research re cage materials concurs.

Images for riveted steel vs Polyamide cages below.



Bearing clearance tolerance

So far in this document I have simply referred to bearings requiring the correct race tolerance. This tolerance is referring to how tight the races are to the balls. CN is classed as normal tolerance. C2 is one grade less than normal tolerance – meaning that the races will be slightly tighter to the balls. C3 is one grade higher than normal tolerance meaning the races will have slightly more gap to the balls than CN.

In another of Hambini's videos re which bearings should one buy – he refers to the C3 clearance of Enduro bearings in a negative way, and recommends CN. I didn't get to cover this particular point off with any parties during all the other information I needed to cover, so this one is purely based on my own experience.

It is the amount of preload – ie how tight bearing is pressed into bb shell, or hub shell, and then how tight is the axle going into the inner race – that will determine whether CN is ok or is C3 a safer bet. From my experience CN clearance runs a high risk for many bb's and hubs / axles that a bearing which feels silky smooth out of the box will run too tight and notchy once installed. C3 clearance allows for the generally fairly high pre load on races experienced in most BB's and hubs.

Enduro, who focus on making bearings for cycling and are I believe the largest cycling bearing manufacturer - make their bearings specifically with c3 clearance for a reason, and I wholeheartedly agree with c3 clearance. As a general rule I would steer clear of CN clearance unless you know that the bearing is going to be installed into a shell with very low preload, and that inserting the axle will also exert very low pre load.

Bearings that are installed in cups are generally under a low amount of preload and CN will be fine – quite possibly preferred as Hambini states. Bearings that are pressed into a shell – ie. BB30 or similar, and most hub shells – I would most definitely be going with c3.

The clearance is not stated on most other brands but I would bet my bottom dollar that pretty much every cycling specific bearing manufacturer / retailer will be selling bearings with c3 clearance for a good reason. Hambini eludes in his video that c3 clearance will soon lead to issues, however my experience is the opposite and that CN clearance will be more likely to lead to very premature wear. You can feel straight away a bearing that was smooth as silk out of the box, carefully pressed in dead straight to correct point in BB / Hub, is now notchy and rough from compression on outer race from hub / bb shell etc. So in short – CN will be ok sometimes, but other times it will not be, and why take the risk? C3 clearance I have never seen have this issue on install, and never seen an issue re c3 clearance impacting on bearing longevity.

Hambini advises in his video that whilst the Enduro bearing he was holding felt fine, it probably wouldn't in short while due to having c3 clearance. Yet Enduro manufacture bearings for cycling application, and deliberately manufacture them with c3 clearance, and put c3 clearance as feature listed in bearing performance. They obviously believe c3 clearance is the suitable clearance tolerance for cycling applications, and with most bb's and hub shells requiring a level of race compression fit – I most definitely agree. Here's a snapshot of one of Enduro's Abec 5 level Steel bearings;



ENDURO 61803 17X26X5 ABEC 5

Stock Code:

ENBG-BB-61803-LBB-C3

DESCRIPTION

- Grade 5 Chromium Steel Balls
- High precision balls are within 5/1,000,000? round. These are military level specification, used for precision equipment. R-64 hardness, of the highest grade.
- 52100 High Carbon Chromium Alloy Races
- Vacuum de-gassing process for the purest chromium alloy steel, hardened to R-62, extremely tough and very durable. Polished to a mirror finish for ABEC-5 precision and noiseless movement.
- Graphite/Nylon Ball Retainers
- Nylon with graphite retainers are virtually frictionless while providing constant lubrication.

The ABEC 5 Standard

To meet the ABEC-5 standard, bearing design must pass all tests, which include noise testing at high RPM, extremely close tolerances for I.D. and O.D., roundness of ball, trueness of the races and micro surface finishes of balls and races.

C-3 Clearance

This specification describes the internal clearance between the bearing and its race. For example, in a 10-18 I.D. bearing, our standard is 11-21 micrometers where as others use 11-25 micrometers.

Enduro LLB Type Seals

Our most popular seal type, this is a Nitrile material rubber with a steel insert. Rather than the standard 2RS type seal, we go a step further by machining a groove into the inner race where the seal can rotate with better efficiency and less rolling resistance. Rather than one thick seal lip rubbing on a blunt surface, LLB type utilizes two razor thin sealing lips riding in the groove with light contact. The outside lip keeps the water and contaminants out, while the inner seal retains the grease for smooth function and long intervals between servicing

Just at this point – it is the LLB type seal that NTN do not bring into Australia, only the heavy contact LLU – which also comes with a heavier grease. It is the NTN LLB that Hambini lists as Ultra Low friction on his website, and is the only low friction type bearing of that type without going to a ZZ seal which is not actually a seal but a complete non contact metal shield for very low friction. The NTN LLB and equivalent SKF only come with metal cages and CN. Other variations can be obtained for the sizes we need to a point – it takes a very large bulk order to make possible. Very large.

I do not have Hambini's 26 years aerospace engineering experience, but I have some years experience in the actual topic at hand – cycling application. I have upgraded bearings in new hubs where the stock bearings installed were just that – stock steel. They felt rough on turning axle with fingers and had high turning resistance. Upon pressing bearings out, bearings turn light and perfectly smooth. Installing upgraded bearings from a variety of manufacturers depending on customer's choice – often it is just enduro abec 5 steel – bearings have been perfectly smooth and axles easily and smoothly turned by fingers. I would bet large sums the bearings from cycling specific retailers / manufacturers all have c3 clearance, the stock steel in some of the hubs I have seen would be CN or normal clearance, and as such bearing has suffered from compression of the race onto balls when installed into a press fit hub shell or BB.

Again – is it possible – that due to the difficulty of obtaining low friction steel by tier 1 manufacturers such as NTN and SKF etc – and the ones that can be obtained only come as CN, that this plays a part behind Hambini's endorsement of CN, and against C3, when the largest cycling specific bearing manufacturer – Enduro – specifically manufactures its bearings to C3 tolerance for a reason.

Hambini's bottom brackets do look to be designed and engineered extremely well, and so no doubt CN is perfectly fine for his BB's. It would be interesting to know if any users have had any longevity

issues with CN NTN or SKF in wheel hubs, or 6806 (bb30) bearings pressed directly into BB30 shell bikes etc – but this information will be rather hard to get objectively. If tolerances are correct compression may hopefully not trouble CN, and the larger and stronger the bearing the more safety margin one has - but again – c3 is a safer bet indeed. I haven't seen evidence this causes a shorter lifespan – enduro Abec 5 with c3 are installed as standard in a lot of high end wheelsets that go for a very long time with no issues.

What is ZFC position after all this?

Across this journey I have learnt some new information indeed, and the aim of this research was for me to see if based on Hambini's presentation do I need to either drop selling hybrid ceramic and stock low friction steel, or add low friction steel to my range to hedge my bets and let customer decide based on if they personally believe ceramic bearing upgrades to be a costly marketing con or not.

I have also looked into stocking the low friction steel bearings by NTN, SKF etc as per Hambini's recommendations however in Australia this is tricky – they are hard to get (even half of options listed on Hambini's site are often out of stock), they are expensive to get here – bringing them almost to same cost as some very good hybrid ceramic options; and at the end of all this my summary information after working my way through;

- The hambini video in detail, badgering hambini to the limit with questions,
- Skyping ceramic speed for their input (note I do not stock ceramic speed bearings)
- Badgering technical sales person at a major independent bearing retailer
- Many many hours of internet research
- Years of detail focus on parts longevity including testing many bearings on my own bikes as well as seeing longevity and performance or not on customer's bikes

And at the end of all that my personal conclusions are that;

- Quality hardened steel races are not troubled by harder ceramic balls in cycling application due to vibration. Longevity is determined by overall bearing quality, load rating vs application, seal type vs application, hub / bb design, correct install & maintenance.
- For Hambini's claims to be true, quality hybrid ceramic needs to move from a state of many times greater longevity vs steel to lesser longevity within just a few hundred km's

- The evidence / test for this data presented as fact cannot be obtained. Despite full design drawings for his Bottom brackets being open source, his 10,000km cycling test, his calculations, what data was used to make calculations and how was it obtained – he will not disclose.
- All evidence shows polyamide (and its variants) to be the superior cage for cycling both from friction and low lubrication levels perspective, not steel cages.
- All evidence shows c3 clearance not CN is the more applicable clearance tolerance for most cycling bearing applications, and there is no evidence c3 leads to a shorter lifespan even in the instances when CN clearance would have been fine.

The only evidence to the contrary I have found comes from Hambini, and how he has obtained that evidence is known only to Hambini, and he isn't sharing.

So ZFC take at this stage is that despite his most excellent youtube video's and graphs I cannot accept at face value the information behind Hambini's claims re hybrid ceramic bearings low friction performance lasting for only a few hundred km's in cycling application before degrading, and the conflicting information re metal cages and CN clearance which just happens to be what comes with the only low friction steel bearings that he can obtain outside of sourcing from cycling specific industry manufacturer. I believe Hambini's aim is to be a retailer with a clear point of difference so as to carve his own piece of the bearing upgrade market. If he was to source quality steel from say Enduro, he would be just another of hundreds of retailers who sell Enduro bearings.

The lack of openness regarding his 10,000km test currently puts Hambini in the same basket as how things went questioning Muc Off and Wend Wax re their products performance and testing claims. I found in lubricant testing there were companies who could not wait to talk about their testing and proof behind claims, one sharing so much I was required to sign a non disclosure agreement. However it demonstrated that if genuine testing that will pass any level of scrutiny is being done, and the results of the testing are a match for the claims – the companies are eager to share and talk about. Why wouldn't a company be? If one has invested a lot of time and hard work into something and been successful in an outcome, the best thing ever is people showing an interest in your work.

Invariably I found in the lubricant testing that companies who were bursting at the seams to talk about the testing and proof to back up marketing claims had great products. Companies who refuse, deflect, run away from questions and scrutiny – it makes no logical sense unless there is something going on they do not want you to see / things will not pass proper scrutiny.

My personal opinion at this stage until further information shows otherwise – and I highlight this is just my personal opinion at this stage until new information proves otherwise, is that Hambini uses his credentials of 26 years as an Aerospace Engineer, and his clearly very high intelligence – to present the case he wants to present which suits his business and commercial aims. It is very clever

to go steel in the manner he has as a point of difference in a crowded bearing upgrade market, and he has the abilities to easily convince almost everyone who see's his video's.

Cost per Watt saved breakdown

Hambini's cost per watt saved breakdown is also interesting – it does show a much greater cost per watt saved for ceramic options – but again this is just looking at bearing cost. A lot of the NTN wheel hub size bearings are granted much cheaper than the hybrid ceramic offerings by enduro or ceramic speed – however, for most bikes when looking at doing the entire bike drivetrain bearing change as a whole as is the point of this graph – it is not taking into account if you were to purchase say a Hambini Racing BB for 165 pounds vs just some 6806 bearings – this changes the cost per watt for his steel options quite significantly, and of course for Australian customers it does not take into account 26 pounds postage to obtain.

For Australian customers, re- running the numbers based on buying a Hambini racing PF30 BB, Australian prices and postage vs Australian prices and postage for Ceramic Speed PF30 the ratio changes quite a lot. On hambini's calculations the ratio of his recommended steel vs ceramic speed = ceramic speed is basically 4 x the cost per watt saved. On the above the ratio changes dramatically to ceramic speed being only 1.7 times the cost per watt saved.

And personally, having now researched this from all angles at great depth, if I was to go with steel I would be going Enduro Abec 5 steel which has;

- Polyamide Cages
- C3 clearance vs CN
- Grade 5 chromium steel balls and R62 to R64 hardness rated bearing races.
- A good balance re the low friction low contact seal and viscosity / speed of the grease.

In short – the higher quality Abec 5 Enduro steel bearings are made specifically for cycling and have the features most applicable for cycling. The low friction steel bearings recommended by Hambini are manufactured by major industry players for industrial / commercial application – not cycling. We cannot easily obtain those bearings in Australia, even Hambini in UK needs to sources from multiple manufacturers to cover just some of the main bearing sizes – and as at the time of writing I very much believe that steel cages and CN clearance are clearly inferior vs Polyamide and C3 for cycling application.

And again lastly as a wrap we need to consider;

- How accurate are Hambini's "calculations". How were they calculated? What measures were taken? How were they taken and with what equipment? The raw data that is input for "calculations" is rather important. I understand them not being covered on a video, however

full detail should be on website, or at the least available on a document to send to any who request this detail. **Most especially his 10,000km longevity test.**

- Whom do you believe re harder ceramic balls causing brinelling damage to the relatively soft races. Whilst the ceramic balls will still be harder, is armour plate level hardness for steel races hard enough to avoid being damaged by ceramic balls for cycling loads and cycling level vibration assuming the load rating of bearing is sufficient for the application?
- Whom do you believe re steel vs polyamide cages for cycling application?
- Whom do you believe re CN or C3 clearance for cycling application?
- Are you happy with recommendation of replacing the recommended steel bearings every approx. 8000km? Does this match his claims of the steel bearings he recommends having a low friction longevity advantage over hybrid ceramic? If you have hybrid ceramic bearings in your BB / wheels and have done many more km's than this – how are they feeling? Still perfectly silky smooth? If yes do you believe there is brinelling damage to bearing races?
- Is all the information Hambini is presenting in a rather powerful manner unbiased and independent based on his experience and knowledge from 26 years in aerospace industry, or is it a very clever way of standing out in the bearing upgrade market from a sea of hybrid ceramic offerings?

It is clear that Hambini is a super smart guy, his bottom brackets look beautifully designed and crafted. I can see why he has all positive reviews on his products, why his business looks to be very successful in Europe, and also a pretty much 100% success rate on convincing those who watch his video's on why they should go steel and avoid hybrid ceramic. If his customers are happy, and experiencing no issues with his recommended bearings – then at the end of the day if customers are happy and giving 5 star reviews – there are no real issues to worry about, and I assume if any Australian customers go down the path he recommends – It looks like good odds you will be happy.

However I personally simply cannot agree with his recommendations at this time. There is too much completely contradictory information from genuinely independent sources, and the lack of transparency is a big red flag. Just because someone is very smart – it doesn't always make them right. It may simply make them very shrewd and very convincing.

It is of course entirely possibly Hambini is correct on every front and he is as honest as St Peter himself, and that after my investigations my small amount of underpowered neurons have everything incorrect – but until Hambini provides the full detail of his 10,000km test, measures and calculations behind his friction figures – the above is where my best information and recommendations sit at the time of writing this document. I am always open to being convinced otherwise.

What is ZFC agenda? My goal is to build a small boutique hobby business with a business vision of selecting the genuine best products based on real evidence and testing – not just who has the best marketing department / skills. As part of the journey re finding what products are best fit for ZFC, I aim to provide and share better information about products, friction, maintenance etc in general so that cyclists of all demographics are better armed to make purchasing decisions that best suit them. This way the product they select will save them both friction and money over what they were using previously. A true win win.

I invest a substantial % of my revenue back into testing projects, not to mention the amount of time involved - as this builds the pillars of the business model which will carry forwards for years into the future. I simply NEED to know what products I should stock and why. By using actual facts and test data to sit behind product selection – all of which is completely open to scrutiny – this is already proving a very successful model for a small hobby business- with growth rate exceeding expectations.

Why was there no independent testing pre Friction Facts and then post Friction Facts?

Friction Facts was very very clever – you needed to pay a small amount for the reports which is fair enough considering the costs of obtaining the data, however again the winning lubricant formula was used to start a side business for the worlds fastest chains at the time – Ultra Fast Optimisation. This side business proved successful, so much so that it was soon purchased by Ceramic Speed, and not long after Jason Smith himself was brought on as staff at CS.

But the business models in general to recoup the large \$ and time invested in obtaining data are rather tenuous. My business model is the only other one I could think of. I felt very strongly that the testing needed to be done, as with the absence of independent testing there can often be a gaping hole between manufacturers claims and real world performance. Manufacturers can claim anything they like. Sometimes what they claim is true, sometimes it is complete hogwash and the manufacturer is fully aware the product performs nothing like their claims, sometimes it is in between.

I was in a fortunate position that when my wife and I had our little guy, it was always going to be me to take a career break to stay home and play with the little guy (I don't know why more guys don't take up the opportunity if you can – who doesn't want to stay home and play silly games all day vs going to work?! ☺). So after sending the lovely wife went back to work, I had the time to play with setting up ZFC and the testing project, and without any weekly revenue pressure a normal business faces to pay rent, bills, be able to eat etc – we had the wifey's good steady income to cover everything - and I could take my time to focus on a much longer break even / recoup cost business strategy that is a genuine win win for ZFC and customers. And so here we are, finally the right set of circumstances allowing a business model to be put in place to bring back independent testing. And there is much to be done!

So that is back ground on ZFC (overshare? 😊) & my agenda.

If Hambini is correct (and only he can prove it to me) – I am ready to drop my hybrid ceramic offerings and set about importing the bearings he recommends if that is genuinely what is the best option for my customers. At this time however, I feel very secure in the information and recommendations contained in this document. I will edit and re upload should new information come in that changes any of the above.

I hope to have given you some information to ponder / balance, and if you have been wondering about the entire steel vs hybrid ceramic – if you are unsure after seeing Hambini's rather convincing video's and my document here – then I heartily encourage thee to simply do your own internet research / contact major independent bearing retailer in Aus and do your own digging and see where you end up. Feel free to contact me and let me know of any interesting information.

Thanks for taking the time to read, and I hope this has helped clear up the conflicting information you may have seen over time from the camps sitting on opposite sides of the fence. Any questions on any fronts please email me at info@zerofrictioncycling.com.au

Steel vs ceramic (speed) video prompting this article -

<https://www.youtube.com/watch?v=o7iZVfSDbiA>

Addendum

What do seal codes mean?

This is very tricky as different manufacturers use different codes for the same type of seal. What is LLB for NTN is denoted VV by SKF or DD by another brand etc. So understanding what the seal code means for what bearing means you need to look up that specific brands seal codes.

What is fairly universal is that ZZ means a completely non contact metal shield, and the grease inside the bearing forms a hydrodynamic seal between the inner race and the shield. This type of bearing is what you will find inside computer hard drives etc where contamination levels are low.

A very common code used by many manufacturers is 2RS – this simply means both sides of the bearing are sealed by 2 rubber seals. But whether or not the seal is light contact or heavy contact, dual lip or single lip etc – you have no idea. So a bearing with 2RS code may have a low friction seal, or it may have a very high drag seal.

Generally speaking bearing manufacturers who make bearings for cycling only, shields coded 2RS are likely to be light contact and low friction. If it is just a generic brand – it could be anything.

Some bike specific brands may have no seal code just the bearing size code number, and that is because the seal is proprietary and specific to them – ie I don't believe any of Ceramic Speeds bearing seals have a seal code on them as theirs seals and the inner race have been designed to be as low friction as possible whilst still actual seal, and is an important factor in their bearings low friction performance. They do not have a range of seals need to delineate from one another – they just make one type of seal – their own.