Zero Friction Cycling

Lube Test Brief & Protocol.

Why is Zero Friction Cycling doing this testing?

Currently there is extremely little data on how lubricants perform once they are exposed to contamination – which happens to all lubricants actually being ridden!

Friction Facts has done a lot of amazing testing to start to shine the light on drive train friction, however the vast majority of their chain lubricant testing was done on ultrasonically cleaned chains in clean lab conditions.

The small amount of simulated longevity testing they did do – showed that as expected different lubricants handle contamination at different levels. Some lubricants resisted increasing in friction very well during the 1 hour test, some lubricants showed great increases if friction.

And exactly this situation will be happening with the lubricant you are using. Have you selected a lubricant based on Friction Facts test results? Wouldn't you like to know how that lubricant performs outside of clean chain, clean lab conditions?

Wouldn't a lubricants performance in the real world be of even more consequence to you vs its clean chain, clean lab performance?

Seems obvious doesn't it – so why hasn't it been done before?

Mostly because it is very time and resource intensive to do, and if it is an independent 3rd party doing the testing, where is the return to cover costs? If one is a manufacturer, then the testing would be unlikely to be viewed as objective or independent – they are either going to be proving they are number one – which would look suspicious, or if not they are helping their competitors by proving they are better than what the manufacturer doing the testing is making. Not a strong case for making the effort. Accordingly – aside from FF 1 hour long simulated longevity test, really only a couple of other longevity tests have been attempted, which have been done via real world riding to clock up the km's. This takes a long time, and so the tests have been very small in scope (i.e 3 lubes).

As you may imagine there are a number of problems with doing real world testing in the real world.

The friction that will cause wear on a chain is scalable to rider load, so to get an accurate result all chains need to be subjected to same loads for same time. Just riding / training will not deliver this very accurately at all.

Different levels of contamination will be introduced at different points in the chains lifespan. A little bit more contamination introduced early in a chains life can have a large impact on that chains lifespan for a given lubricant.

These two variables alone will deliver highly ballpark results, accurate to around +/- 2000km at best.

Unfortunately the tests I have seen also have a host of other errors / concerns such as chain prep (I.e chain have been cleaned used bleach wipes – so outside is cleaned but factory grease left inside chain to which lube on test is added – greatly tainting the lube on test). Also the tests hinge on chain wear measuring however this has been done very approximately – using an analogue checker, only testing one part of chain etc. I strongly recommend reading velonews article on how to measure chain wear – and you will see just how poorly it has been done in other tests. When the results hinge on chain wear as the determining factor for lubricant performance – this is simply mission critical to be as accurate as possible.

So the reality is – despite the fact that a lubricants performance outside the lab is **THE KEY** performance we need to know, proper testing for this simply has not been done.

And so here we are – As a retailer passionate to find and sell the lowest friction lubricants to cover all racing needs or simply deliver clean efficient running and parts longevity in your riding & training, ZFC is commencing proper longevity testing. (And to be honest….I just need to see the results myself, I couldn't abide this gaping hole in proper use testing vs claims any longer).

Using an industrially motorised Tacx neo smart trainer to control interval load and distance, plus specific intervals that include either no added contamination, dry contamination, and wet contamination - lubricants can be properly assessed over thousands of km's of controlled testing. Not only can we determine a lubricants overall performance – but we can get a break down as to how a lubricant handles different types of conditions, as well as how it stacks up vs the manufacturers claims.

All aspects of the test are controlled and consistent from immaculate chain prep to the most exacting chain wear measuring accuracy.

Each test takes a lot of time and resources to get through, with most tests expected to take around 150 to 200 hours of run time at 250w load, with many many points of intervention for re-lube & adding contamination. So it will take a while still to build a good league table, but it will be a very exciting build!

There are some really exciting new lubes out to test, some misconceptions and wild claims to clarify, some good general facts and knowledge to put out there to save you both watts and $$ - and of course finally some real performance data you can depend on. It is long long overdue, but it is starting now.

Why should I care?

Your chain is your hardest working mechanical component by quite some margin, and it needs to perform this work completely exposed to the elements and contamination. A tough gig indeed for any component and its lubricant.

As such your bicycles chain - and by extension drivetrain – is often the largest ongoing running cost, especially if running group set components at the higher end of 11 or 12 speed group set hierarchy.

And importantly for racers of all levels – it is the biggest contributor of mechanical friction. Your chain can easily contribute double the amount of friction than the total from all of your bearings combined. So choosing the fastest lubricant and following correct chain maintenance will deliver some of the easiest and most cost effective watts savings you can get. In fact these watts savings can often mean cost savings when they equate to longer lifespans for your chain, cassette, chain rings etc. There is both free speed to be gained and $ to be saved by choosing the right lubricant for you, as well as understanding some chain maintenance basics.

Unfortunately you cannot rely on the information on your bottle of lubricant. You can pick up pretty much any bottle and it will claim some pretty amazing things. You can go onto manufacturer website and read to an even greater depth about the amazing things it will do. But try and find actual testing for this?! It is open slather to claim that a lubricant cleans as it lubes, forms a protective film / membrane, does X, Y and Z with contamination and remains low friction – but where is any data or testing to back these claims? What friction is it clean? What friction is it contaminated? How was it contaminated and for how long? Who did the testing? How was it tested? How did it perform vs others? Good luck getting anything specific. Write to the manufacturer and ask questions re what data and testing they have to substantiate claims and see how that goes…..

There are a few very good exceptions, but mostly there is absolutely nothing that can be obtained to back up claims aside from “years of testing with riders and developing special formula’s and patented technology” etc. (A hint – just because a technology is patented – does not mean it is actually good). In general I do not believe that manufacturers are making poor lubricants and trying to fleece consumers (although there are couple that I have concerns with), there is simply an accepted culture whereby they can claim whatever they like and provide nothing to substantiate it. So many lubes literally claim they are “Better than all others” – so you would think some testing data and proof to back this world beating claim would be forthcoming, or at least accessible on request – but no, there is a culture where manufacturers can claim whatever they like without needing to provide any data to back it up – because we have been letting them do so. Hopefully we can help clarify these claims and slowly change this culture.

Also for fun, some manufacturers claims on why their lubes work so well completely contradict other manufacturers claims as why their lubes work so well. Here is an example;

“XXX says that nanotubes in lubes are nonsensical, claiming that XXX has tested them and that they make no difference in a lube, being too small to do anything useful, and that they are far too expensive and largely unobtainable to use in a chain lube. He also claims that ceramic in a lubricant is nonsensical, because ceramics are abrasive. Cohen’s further position is that having more than two different lubricant formulations in a bike-lube line is vaporware—that all you need is one for wet and one for dry” (*excerpt from Velonews article on who what why of chain lubes).

In short – overall it is a muddy ol picture for consumers indeed – and with the price of some lubricants that go with claims it is high time there was some performance data to go with it.

Ok – lets get our inner nerd on – the below is quite important re understanding the testing and results.

Friction types & Friction vs Efficiency

Friction and efficiency easily get a bit muddled, and we will do our best to clarify this here, and why higher “friction” or lower “efficiency” may not always equate to higher wear rates in a chain.

We are going to focus on 3 main types of “friction” that come into play as your chain snakes its way around the drive train – and also taking note that there are higher and lower pressure zones of friction.

Let’s focus on what is happening with your chain first. A very key difference between your chain and your bearings is that the links do not constantly turn or spin. A chain link articulates through x range of motion and then stops. Reticulates back and stops. Not only that, within a chain link there are multiple friction interfaces. There is the interface between the pin and the plate shoulders (plate shoulders are what the pin sits in and the roller sits on – sometimes referred to as flanges), between the roller and the plate shoulders, and between the inner and outer plates on both sides of the link. All of these interfaces slide against each other under load every link articulation / reticulation. And there are a lot of those happening! At 95 cadence on a 53t chain ring there are approximately 40,000 pieces of mechanical movement under friction per minute. That is orders of magnitude more mechanical work being performed by your chain vs your bearings turning lazily in a nicely sealed environment.

It is also very important to understand what happens when a chains roller comes into contact with chain ring teeth, cassette teeth etc. As soon as there is pressure on the roller, the roller stops, and the internals of the link (plate shoulders and pin) articulate inside it – and it is these parts which articulate under full rider load. This is the main friction interface. As such – it is what is inside the chain that counts for performance, not how the outside of the chain looks. Depending on the lubricant – it may look quite dirty on the outside but be actually pretty good on the inside, or it may look clean on the outside but have very little actual lubrication inside mixed with grit and dust.

The other main friction interfaces are between the outer places and the inner plates which slide against each other during each articulation / reticulation, and also the side of the rollers and the inner plates. These friction interfaces are usually under low load, however this load will increase with greater cross chaining (greater chain line angles), and so chain friction increases at greater cross chain angles. The lower the performance of the lubricant – the bigger the friction penalty for cross chaining, the better the performance of the lubricant – the lower the penalty for cross chaining.

Okay – so back to our 3 types of friction;

1) Abrasive friction which leads to efficiency losses and wear of the parts involved. This part is further divided into high pressure (rider load) and low pressure (moving through derailleur pulleys).

2) Static friction or “stiction” – the amount of force it takes to get a part moving from static. It takes more force to get something moving than the subsequent force required to keep it moving. This is very important in a part that has 4 interfaces to get moving from a static position every articulation / reticulation. The amount of “stiction” plays an important role a lubricants outright efficiency, but plays a negligible part with regards to chain wear.

3) Viscous friction. It takes more effort to perform movements through highly viscous (thick) liquids vs low viscosity liquids. If you had to get somewhere in hurry and you had to walk waist high in either water or molasses to get there, I think most would choose water! Again with so much mechanical movement in a chain this aspect is also important regarding a

lubricants outright efficiency, but has negligible impact regarding wear. Solid lubricants have no viscous friction.

And just quickly touching back on high and low pressure friction area's - the above will be performed under high pressure where links articulate / reticulate under full rider load, or under low pressure as the links articulate / reticulate through bottom cycle of the drive train.

Key for us here is the understanding of the role these aspects above play in a lubricants efficiency as well as friction which causes wear on the chains parts. As Friction Facts testing was done on perfectly clean chains in extremely precise conditions, the outright efficiency of a chain lubricant was able to be measured to great accuracy. And a key learning from this was that lubricants with big claims regarding their high pressure friction performance - and they may have performed very well in this area – may still have not perform well overall if they are average or below average in the area's of static friction and viscous friction. All 3 area's contribute to how many watts a lubricant will sap as your chain works its way around the drivetrain.

But note that static friction and viscous friction will contribute either a zero or negligible amount with regards to a chains wear, despite playing an important role with regards to a lubricants overall friction losses and transmission efficiency. The high pressure abrasive friction performance between pin and plate shoulders + roller and plate shoulders is important from both an efficiency perspective **AND chain wear / component longevity.**

Let us take theoretical look at the top performing drip lubricant on test and the lowest performing on test – Number one had an overall friction loss result (we will call this efficiency) of 4.7w loss at 250w load, whereas the 55th ranked lubricant tested had a loss of 8w. That is an enormous efficiency difference between two drip lubes on a perfectly clean chain.

And yet we could not draw a conclusion or correlation that a chain running on the 55th ranked lubricant is going to wear at around twice the rate as the chain running on the highest ranked drip lubricant. The differences in efficiency performance between the two could well have come as much from stark differences in static and viscous friction performance as it could have in high pressure friction performance. And if it is the case that the extra efficiency losses came from higher static and viscous friction, this will not contribute to a higher wear rate in a chain running this lubricant vs the more efficient lubricant.

In fact it is entirely possible that the chain running the much lower efficiency lubricant will actually wear at a slower rate than the lubricant with a very high efficiency. An example would be to take two identical bearings, and put time trial grease in one, and heavy duty grease in another. The bearing with heavy duty grease will eat up more watts to spin, but will likely achieve an excellent lifespan. The heavy duty grease may exhibit excellent high pressure friction performance, but vastly poorer viscous friction performance.

Is this the case with the two drip lubes used as an example here? (We will find out! ☺). But it is very important to get this base understanding of the abrasive vs static vs viscous friction, high and low pressure friction area's, and what they mean for efficiency and wear. Without this you will not correctly understand the longevity testing performance we are undertaking and the results we can glean from it.

The last point to grasp is that chain friction is scalable to rider load. It is not perfectly linear, however it is fairly close. So friction will be nearly double at 250w vs what it is at 125w. Friction at 500w will be nearly double than what it was at 250w etc. However – it will be the high pressure abrasive friction performance that will be what scales with the load – static and viscous friction will be greatly less effected if at all (which likely explains why friction increase is not directly scalable to load).

So the percentage of the overall efficiency equation that static and viscous friction play will be much higher at 50w load than they will be at 250w load, and by 500w load they will be a fairly small part of the equation.

As a lubricant becomes contaminated from riding in the real world, its high pressure abrasive friction will increase by quite a bit, as mechanical movement / articulations are taking place under full rider load are not taking place with abrasive contaminant particles impacting how slippery smooth the lubricated surfaces are. Contamination always ruins a low friction party – and to what degree a lubricant becomes contaminated and how it deals with it is the key part behind real world performance results and chain wear..

It is this abrasion that causes chain wear (chain stretch) as the pins and plate shoulders are worn thinner and roller bore is worn larger. The amount and rate of this wear is easily measurable (albeit rarely accurately done!)

So it is possible for a lubricant to have a low wear rate but still be a low efficiency lubricant due to poor viscous and static friction performance, but it is not possible to have a poor wear rate and a high efficiency lubricant. As high pressure abrasive friction will be the largest contributor to the overall friction equation – more and more so the higher the rider load and higher contamination levels – if a lubricant is abrading though hardened steel parts at a prodigious rate it flat out **<u>cannot</u>** be a low friction lubricant.

Key summary points to understand;

- A lubricant may achieve a good longevity result but still be a low overall efficiency lubricant due to high static and viscous friction

- Abrasive friction in the high pressure area's of the chain – which is responsible for chain wear & stretch – will quickly become by far the biggest part of the friction equation as lubricants become contaminated and abrasive. Also the higher the rider load, the larger and larger part of the friction equation this aspect will play.

- As such, a lubricant will not be able to be a high efficiency lubricant in the real world outside the lab if it records a poor longevity test result. If a lubricant is eating through hardened steel at good rate – that just flat out takes friction.

- Different lubricants absorb or resist contamination at vastly different rates, and have completely different mechanisms for dealing with contamination. Different lubricants will prevent or allow metal to metal contact or contamination to metal contact at different levels depending on strength of any film / membrane or if it is a solid lubrant. This showed up starkly in the Velo Lab / Friction Facts simulated longevity test. One lubricant that started with an efficiency 1 watt higher vs another finished 2.5watts lower vs same lubricant at the end of the 1 hour test. The lowest performer on test increased its friction by 3.8watts in the one hour test whereas others barely moved.

- Manufacturers often make big claims re their lubricants contamination resistance / mechanisms to deal with contamination, but without testing and data you simply do not know what your lubricant is or is not doing vs claims.

- Our testing will reveal very clearly a lubricants performance vs claims, its strengths and limitations.

To further assist the longevity test results, if a lubricant we are testing has been efficiency tested by FF and the data is freely available we will provide this information.

So where a lubricant achieves a high longevity, but is matched with a low efficiency result – this may be a good choice for your commuter but not your race bike or avid weekend warrior steed. If a lubricant achieves a great longevity result and has a great efficiency result, it may well be a good race performance lubricant to consider. If a lubricant has an average or poor lab efficiency result and a poor longevity result – it would be hard to see it as a good choice for anything. Even if the lubricant itself is very cheap, it is going to hit your hip pocket in component wear.

Link to Velolab / Friction Facts Longevity test excerpt here - https://moltenspeedwax.com/pages/velo-lube-test-1

The Test Protocol

Later in this document I reference another longevity test that has been done that is an example of why I felt the testing needed to be done properly.

The funny thing about trying to do real world testing out in the real world - You cannot replicate the same time / power / conditions etc for every chain and lubricant leading to very ball park results at best. I have kept track of chain longevity for years and using same chains and same lubes achieved longevity results of +/- 2000km. Not very accurate.

No test is going to be an accurate representation of the longevity a consumer can themselves expect from a chain / lube. Differing power levels, contamination exposure and maintenance will greatly affect lifespan – however as our testing will subject lubricants to the same loads for same times and same levels of contamination – a rider should expect the same longevity correlation to occur for them in their own riding – i.e lubricants that deliver excellent longevity on our test vs others should deliver the same relative longevity to riders.

Measuring chain wear - When measuring chain wear as the determining factor for longevity it is quite critical to be as accurate as possible. I will also include a link which explains very well the various methods and shortcomings of each method of determining chain wear (and you can see how poorly this was executed in the other test example referenced here). A very short summary is that whilst measuring chain wear across total length of chain against a ruler is most accurate re overall wear, unfortunately chains do not wear in a uniform manner across their length. In fact, on occasions they can wear at vastly different rates in different sections of the chain, which one single measure of total wear will not pick up.

So we will be measuring wear across 7 different sections of the chain at each wear check mark with an extremely accurate digital chain checker. We will allow a maximum variance of 0.15mm between highest and lowest measure, above that we will class the test invalid due to uneven wear performance of the chain, and restart test with a new chain. The total wear recorded for a given measure checkpoint will be the average of the 7 measures, so variances within this range will have little overall impact to the average giving us a very accurate start, finish and checkpoint measures for each chain during the test.

Our chain wear measure tool is accurate to 0.01mm – hugely more accurate than an analogue checker which is accurate usually to only 0.25mm, and also usually highly variant based on amount of pressure applied by user.

(Chain wear checker used by ZFC – by far the best in the world – can check and re check sections of chain to same 0.01mm accuracy every single time)

Link to worlds best article on measuring chain wear;

http://www.velonews.com/2015/12/bikes-and-tech/technical-faq/technical-faq-chain-wear-measurement_390085

Contamination – Sandy Loam will be used as this is a good mix of sand, silt and clay. Contamination will be also be introduced both dry and wet at determined intervals vs just wet as different lubricants handle dry or wet contamination with varying ability.

Lubricant application intervals – Lubricants will be applied strictly as per manufacturer instructions. Re lube intervals will be every 400km on Flat simulation intervals, and 200km on hill simulation intervals UNLESS this rate of re-lubrication would be detrimental according to manufacturer instructions with regards to if re lubing too frequently risks gathering too high a level of contamination. If an adjustment to re lube intervals vs base levels is made this will be noted accordingly in test.

During contamination blocks, the rate of re lubrication is doubled – every 200km of flat simulation and 100km hill simulation – as it would be normal behaviour that riders re lubricate more often if riding in harsh conditions, as well as giving lubricants more of chance to “clean as they lube” etc.

Again this will be adjusted if manufacturer instructions are clear that this rate would be detrimental and noted accordingly.

Flat vs Hill Simulations – The chains will be run on a calibrated smart trainer (Tacx Flux) at alternating intervals to simulate flat riding and hill km's. If just run on flat all the time the km's clock up too quickly. Most riders ride up hills to some degree so having intervals where the chain is still subjected to 250w load but km's clocking up slowly delivers an overall average speed for the test of around 29kmh (depending on what block test finishes). It also allows me to rotate through more cogs on cassette and between small and big chain rings for longer wear rates on test components. Flat sim intervals will be on cogs 4, 5 and 6 on large chain ring and be 400km long, Hill sim will be on cogs 1,2 and 3 on small chain ring and be 200km long. The interval lengths are halved during contamination blocks to 200/100km.

The 250w 1400 rpm industrial motor has a 14:1 reduction gearbox giving us 100 cadence, so we can pretend it is chris froome doing the testing on his light training rides ☺. The smart trainer automatically adjusts resistance so the cadence and power will remain constant regardless of gear ratio. Cassettes will be replaced once teeth pitch has worn by greater than 0.2mm, which is around 25% of the wear mark whereby a cassette may have difficulty accepting a new chain (I have a lot of experience replacing customers chains on existing cassettes and it is usually at around 0.8mm pitch wear that skipping issues appear with a new chain). The same wear tolerance measure will be used regarding replacing chain rings.

Test Blocks

1000 km Blocks containing flat and hill intervals alternate between no added contamination and contamination being added. This not only gives us a way to track how well a lubricant handles contamination, but also how well it is able to "clean" or "clear" contamination when it moves back into a block where no further contamination is added. With both dry, wet and extreme contamination blocks we will also get to see what is within a lubricants ability to handle and what takes it outside its ability to handle.

Block 1 - No added contamination. Flat sim intervals 400km long, hill 200km long.

Block 2 – Dry contamination – Re lube intervals doubled (200km flat and 100km hill), and 5grams of sandy loam introduced midway through interval. Wear rate increase for this block vs wear rate in block 1 will give first indication of how the lubricant behaves with contamination. How much does it absorb? Does it "clean" as it lube? Does it have a protective film / membrane that prevents contamination from abrading against chain metal?

Block 3 – No added contamination. Re lube intervals restored to 400 / 200km. With no contamination added this is a chance for lubricant to slow wear rate down from block 2. It gives a good indication as to how well a lubricant is able to clear contamination gathered from previous block.

Block 4 – Wet contamination – Again re lube intervals doubled, and wet contamination is introduced mid interval. 500ml of water is sprayed onto chain from small pressure sprayer, as well as the 5grams of sandy loam. Wear rate increase and comparison to block 2 gives a good indication as to how well lubricant handles wet conditions.

Block 5 – No added contamination. Re lube intervals restored to 400/200km. Same as block 3, a chance for lubricant to show how it can recover with no further contamination added.

Block 6 - Extreme Contamination. Chain is completely cleaned at end of block 5 to reset contamination levels. Re lube intervals are same as blocks 2 &4 at 200/100 – however contamination is introduced at both 60 and 120km mark on flat sim and 30 and 60km mark on hill sim, and contamination levels are doubled to 1000ml of water and 10grams of sandy loam added. This block is a good simulation for harsh off road riding conditions.

For blocks 1-6 the test will stop once a net wear of 0.5mm total or above is recorded since start of test. If a lubricant does not make it through to the end of block 5 before reaching this net wear mark, then it will not be tested in block 6 – it will not handle that block if it has not been able to handle previous blocks.

Block 7 – Single application longevity test. Again chain is fully cleaned to reset contamination levels to zero. Lubricant is applied and chain is run for 250km flat sim intervals on cog 4 with chain wear checked every 250km. Chains are given a maximum of 0.25mm extra wear on top of what their end of test wear measure was from blocks 1-6 (or 1-5 if not tested in block 6). Single application longevity test may stop prior to reaching 0.25mm if lubricant has obviously reached its limit between one wear check to the next if there is an obvious large jump in wear rate.

Chain wear check measures during test – Chains are measured in 7 separate sections with digital chain checker accurate to 0.01mm. The average of the 7 measures is used to determine the wear measure for that check. Chains are checked initially after fully cleaned of factory grease to get initial tolerance measure, and then wear is measured at end of each block - it may be measured throughout a block if concerns chain may hit net 0.5mm wear limit prior to reaching end of block. 0.5mm is classed as 100% wear, so every 0.01mm is 2% wear. It is possible that a chain may record a negative wear result in block 1 if the thickness of the lubricant and any contamination is greater than any net wear of the chain in that block as the initial tolerance check is done on a perfectly clean chain.

Test Variables and other considerations.

- Abrasive friction in the high pressure area's of the chain is scalable to load. This test will not simulate the high power accelerations , power climbs, sprints etc that chains are subjected to in real world riding. But also, everyone doing those things whilst riding also has periods of rolling, soft pedalling, drafting etc. The important thing for accuracy is to subject the chain to the same loads for the same time and subjecting to the same conditions. The Tacx neo smart trainers are well reviewed re their power accuracy and consistency, and tacx quote an accuracy of +/- 2%. So the worst possible outcome of chains being subjected to different loads would be for one chain to have always been subjected to +2%, and one chain always being subjected to -2%. Considering the length of each test which will be run across many different days –the odds on such a variance happening is extremely small. The overall variance in power across one chain to another should be extremely low and far away from the amount of variance that would be required to taint the test. The trainer will also be calibration tested vs my quarq, which has itself been tested multiple times vs 5 other quarqs – all of which achieve a grouping within 3w at 5 different loads tested. This will be handy for when we wear out the first tacx and need to check the new one is the same!

- We cannot attain - nor do we need - measurements to tiny fractions of a watt like FF efficiency testing. For our longevity testing load variances within a few watts, and the same expected variances across all chains, is going to deliver a vastly greater accuracy re longevity testing than any other proper long term testing done to date – which have been done by real world riding. Plus our prep, lubrication, contamination, measuring protocols etc will deliver drastically more accurate longevity test results.

- In time once we have built up a nice initial results table covering some key lubes we wish to benchmark and test, we hope to get to some other exciting testing in the future such as the difference using same lube but performing basic chain cleaning maintenance every 1000km and after every wet ride etc. We will also be able to test different chains using a control lube (probably the worst longevity lube we find so we can really test a chains coatings and hardening).

Where did other testing go wrong?

In terms of longevity testing – there have really only been a smattering I can find. One is the Friction Facts simulated longevity test which was fantastic but only started to give an insight being a 1 hour long simulation across 8 lubes.

The other main one I have found which would present to most readers as a very good test and report was in fact riddled with errors (in my view – no doubt the test author may disagree). Errors I believe made were;

- Chains prepped by wiping outside with Clorox wipes (bleach wipes). This leaves the factory grease inside the chain. The lube inside the chain is what determines performance - so completely tainting the lube on test with factory grease is not good.
- Chains / lubes were tested by riding through normal training. This means a lot of variance in the loads and times to which the chains are subjected, as well as a lot of variance re how much contamination is introduced and when.

- Chain wear has been measured with an analogue checker – accurate only to a very broad measure – measuring chain in only one place I believe, and with no ability to get an accurate start tolerance. To determine net wear one needs an accurate start and finish point.

So if one is conducting a test of a lubricant – hinging the performance on the correlation between chain wear and km's achieved – but one has not properly cleaned chains, subjected them to different loads for different times, different contamination levels at different times, and very inaccurate wear measuring – this is going to give extremely ball park results. Pretty much every key aspect of the test has been either executed poorly or allowing for a lot of variance.

(He also mucks up wax application and comes up with his own incorrect theory to explain results. He obviously hasn't noticed that the vast majority of race chains in the pro peloton are wax and powder chains nor have the understanding as to why).

Really cool tip 1

So it is not great to rock up to an important race using the same chain you use all the time in training and just doing a re lube and wiping the outside. On drip lube chains you can expect to gain around 3w for free just by performing a proper chain clean prior to a race. A clean chain is a fast chain and is some of the easiest and cheapest free watts you can get. If I was to get hold of your bike the day before a race and throw some sand into your bearings and add 3w of friction I bet you would get on that and get it that sorted out before the race asap. Why oh why then are we happy to run an extra 3w+ of grit in your chain without a second thought?

Also – as explained well in the FF white paper on friction mechanisms in a chain and how this increases due to wear, you can expect your chain will gain around 2w extra friction at 250w load per 1% of chain wear.

So even for those that haven't yet thought that much about their lubes performance, cleaning chains properly prior to races etc, it can be well worth considering a dedicated race chain that you keep properly clean for race days / sportifs etc - vs using the same half clapped out gritty chain you use in training. Remembering also how fast drip lubes will abrade off a chains low friction coatings. All these small things matter in a part doing tens of thousands of pieces of movement a minute. Having a dedicated race chain is a very smart way to go. It doesn't cost any more, you are always going to need a new chain - it is your most consumable mechanical part. So just get two and a park tool cc3.2 chain checker. When you have worn your training chain to 0.5, your race chain moves to becoming your training chain, get a new chain for races. So it doesn't cost more, you are simply pre buying your next chain. And replacing at 0.5 wear mark will ensure you get at least 2, sometimes 3 or more chains to a cassette (it depends on cassette – steel cogs last a lot longer than titanium or alloy). And replacing chains at 0.5 will pretty much ensure your chain rings outlast your bike. Worn cassettes are higher friction, worn chain rings are higher friction – ensuring you replace your chain before the stretch begins to eat out your cassette and chain ring teeth saves a fortune vs having to replace cassettes and sometimes even chain rings when replacing your chain. World tour teams often get seasons out of their cassettes and chain rings because they replace their chains frequently – it is very much the “stretch” or pitch increase that does the damage – replace chains early and save a fortune in $ and save friction.

Link to friction facts white paper;

http://www.friction-facts.com/media/wysiwyg/Friction_Producing_Mechanisms2.pdf

Really cool tip 2

So you may have noticed things such as Oversize Pulley Wheel Systems? They claim some pretty notable watts savings, the vast majority of which are delivered simply by the chain needing to articulate less around a larger pulley wheel vs any savings from superior bearings (although they play a part). Latest iterations have a larger tension wheel (bottom wheel) and normal size or close to normal size guide wheel – the chain articulates under very low load around the guide wheel vs the tension wheel.

In the same vein – one can see certain clever time trialists like Tony Martin often running a 60t chain ring paired with an 11-32 cassette. This gives him the least articulation and generally the straightest chain lines for the ratio’s he wants to run as he is running bigger cogs for the same gear inches vs smaller chain rings. On an 11-32 cassette the 25t cog is 3rd cog down, whereas on an 11-25 it is cog one and requires an extreme chain line angle to use when on the big chain ring.

Friction Facts testing on friction losses from chain line angles was also very insightful re friction losses from running same ratio’s on small chain ring and smaller cogs vs large chain ring and larger cogs. Less articulation = friction savings. Again on a part performing around 20,000 articulations a minute – very small things add up to notable changes in friction losses.

How much? Well it will depend a lot on how much chain friction you have to start with. If you are running a drip lube chain with sporadic or little proper maintenance it will likely be in the 8-12w friction range at 250w load. It usually takes good maintenance to remain around 8w, and can easily be above 12w depending on what you are running and if you never do anything more than wipe the outside of the chain. In which case the friction savings from less articulation / limiting cross chaining will be high – can easily be multiple watts.

If you are running a very clean chain with a highly efficient lube or wax and are in the 4 to 6w friction range, then the penalty for higher articulation or chain line angles is much lower – it may only be around a watt ish for all but the worst possible combination of small chain ring and smallest cogs etc.

So if you race and tend to hang onto the big chain ring and cross chain a lot – a fast chain will save your some watts. Don't run small cogs on the small chain ring – this introduces the greatest amount of articulation at every point on the drive train. Once you start to get to around mid cassette you should definitely be shifting up to big chain ring. For time trials and track – you want to run the largest chain rings and cogs that are feasible for your speed and cadence. For road tt's note that the a large chain ring and large range cassette option will also have a penalty re the cadence jump between gears – a 10+ cadence change from one gear to another may leave you stuck between gears.

I generally recommend OPSW systems can be well worth considering for drip lube customers as the savings can be quite good (around 2w+), however if running a very low friction chain (especially wax that has no viscous friction) then it can work out as very expensive $ per watt savings. In these cases if one is keen to upgrade jockey wheels (many have a jockey wheel upgrade fetish – just look at the market for them!) it can be worth considering just upgrading jockey wheels to lowest friction bearings possible such as full ceramic bearing jockey wheels (ceramic balls and races vs hybrid ceramic bearings that have steel races) these usually have no contact seals and require no oil and so have extremely low bearing friction – and with quality versions the full ceramic bearings are practically indestructible. The best ones I have seen on the market are from Kogel, KCNC and Tiso. (Ceramic Speed lead the way with OPSW however there are numerous other brands on the market now – but I haven't had a chance to check them out much yet).