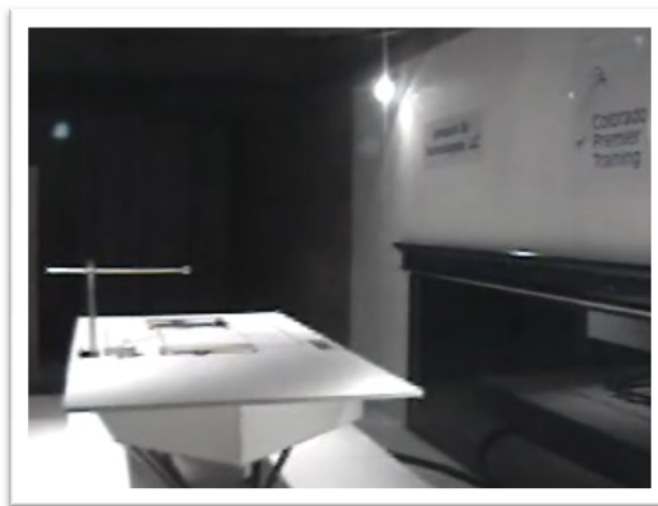


Technology is helping to shape the advancement of many high performance sports such as NASCAR, Downhill Skiing and of course bicycle racing. As a coach of many highly ranked cyclists I have been fortunate enough to have the benefit of significant experience with some of the latest tools and innovations available to cyclist. This article is about the use of two such technologies, Wind Tunnel testing and the Retul 3Dimensional motion capture fitting system. I will discuss the practical application of these tools and will hopefully leave readers with a better understanding of what these tools are and how they are used giving you more information so you can best spend your cycling dollars.

Over the past several years, the proliferation of more affordable wind tunnel facilities has offered both professional athletes as well as amateur racers great opportunities for significantly improving their aerodynamic positioning on their time trial, triathlon and road bike setups. For those unfamiliar, a wind tunnel is a huge continuous wind tube, in which the athlete (and/or equipment) being tested are positioned on (connected to) a measuring platform within the tunnel. As the wind passes through the tube it hits the objects connected to the platform the platform can then measure the drag created by this collision. In sum, a wind tunnel allows the athlete and coach to determine the aerodynamics of equipment and various positions. Each position is measured and documented before moving on to new positions and/or more equipment.

Typically, you are trying to find subtle drag improvements through equipment or positioning changes that might add up to big improvements in speed. For example, on my latest wind tunnel trip, the athletes' baseline position (his original position and equipment) was tested and by the time we finished we found a position that reduced drag significantly. This more aerodynamic position would require 40 less watts to generate the same speed on the bike as the baseline position had previously required. Thus, we found 40 watts of speed. 40 watts is a big number. In this case it represents over 10% of this athletes' Functional Threshold Power (FTP is defined as the power the athlete can hold for 60 min). Such an increase in an athlete's fitness could take months or years to reach, if it was even possible.



This is a picture of the platform used in the Ambient Air Tech Wind Tunnel and Lab used by Colorado Premier Training. The measuring device is inside the platform itself.

The Ambient Air Technologies Wind Tunnel and Laboratory is located in Fort Collins, Colorado and is regarded as one of the most accurate tunnels for cyclist in the country. I have found the predictions of speed gains at certain power outputs from this tunnel to be spot on in the real world. I find this to be extremely important as a coach since results are what the athlete is looking for, and “what did we actually gain?” is the question I usually hear from the athlete at the end of the wind tunnel session. Athletes that use power meters can easily understand, “We just found you 40 watts for your Time Trial.”

When deciding on whether or not a trip to a wind tunnel might be in your future or not, results and cost are obviously concerns. Manufacturers are quick to market and promote the watts that their technologies claim to save over other manufacturer’s technologies. First, if you wanted to test equipment, a wind tunnel can prove out these claims and determine whether they are accurate or possibly liberal marketing strategy. But more importantly, the largest gains made in the tunnel are almost ALWAYS from improved athlete positioning. Your return on your investment could be huge.

Using just half of the gains realized by my athlete on this latest trip as your baseline, to gain even 20 watts would be a very good improvement and could translate into the type of time reductions that would be gained by riding a disc wheel versus a spoked wheel and wearing an aero helmet versus a road helmet. As for cost, Colorado Premiere Training charges USAC athletes approximately \$1000 for a full hour (after discount). When you add travel, hotel and rental car to the wind tunnel this trip can be a \$2000 adventure. Other tunnels do in fact charge less and could offer good returns on your cycling dollar. Yet, whatever the cost, when you compare this to the cost of that disc wheel and aero helmet, all of which might yield lesser results, you are probably wise to consider investing in a trip to a wind tunnel. Many people have the wheels and helmets already and yet are searching for additional gains. Nothing herein suggests you should ease off or lessen your training. I am simply discussing additional gains that could be realized. If you are an athlete that has already invested in disc wheels, aero helmets, TT bike and skin suits, then these 20+ watts could be the difference between winning and losing. As noted in my estimate of costs, they do not come cheaply, but relative to the gains from a new frame, or wheels, 40 watts derived from a trip to a tunnel might easily justify the associated cost.

My experience and my athletes’ results have been impressive. What I have seen since our 3 trips to wind tunnels is many personal records, 5 state TT championships in 2 years, including three course records this season. I think my athletes would also tell you it was worth it to them.

Another very important part of this second trip was test data on some of the top aero equipment in the industry. While there, my client wanted to know which equipment provided optimal aerodynamics and which wheels were best for certain conditions. This led to testing of several different forks, various disc wheels versus deep dish wheels, several different helmets and even the testing of the aero Shimano AX front brake versus side pull brake. The data we established in most cases confirmed what we thought but we also learned a few very interesting things that made the additional testing all worthwhile. Some of the newly learned data was revealing and helps us better establish an optimal equipment setup for various conditions, and eliminated any ambiguity or guesswork in which components were more aerodynamic. After all, most

manufacturers claim their technologies to be superior to their competitors. Tunnel testing eliminates any uncertainty.



Here is a shot of the bike being tested with the brand new Zipp Zedtech 1080's. This picture was taken from the observation area directly next to the platform. The 1080's proved to be a very special wheel set.

One of the most important areas in my coaching involves assuring my clients have optimal fit on their various bikes. Proper fitting ensures a pain-free training experience, allowing the athlete to generate more power and recover more quickly. In a worst case scenario, an improper fit can ruin an athlete and make cycling a miserable experience. On this same trip to Colorado, this same client and I had a very positive experience with Todd Carver and the Retul 3D Motion Capture fitting. (see www.retul.com) This turned out to be a huge benefit to my client, as coming out of the fitting with Todd, he was able to rectify a leg length discrepancy which resulted in the athlete having pain-free training something that was not previously experienced. My client called it one of the most worthy investments he had ever made. He sings praises to this day.

Retul is a three dimensional motion capture system that uses light emitting diodes on the rotation points of the athlete, and three synced cameras to dynamically measure joint and body angles and the motion of the entire athlete. This allows you to capture, in real time, every possible measurement, angle and relative position of the athlete, in motion, pedaling at various intensities. As you know, as you increase power, you may adjust your positioning such that your setup when pedaling softly might not be the same as when going all out.

Virtually all of the traditional fitting systems you will encounter measure the athletes' joint angles after watching the athlete pedal and then trying to statically duplicate the positions so the fitter can then measure these aspects. I have tested a master fitter during this static process and checked their measurement versus a motion capture system and found that even after years of experience this static method isn't even close to being as accurate as this dynamic motion capture method. Furthermore, the 3D system gives information that static fitting just cannot.



If you look closely you can see the light emitting diodes flashing on the athlete's wrist, elbow, shoulder, hip, knee, ankle and feet. This is the athlete during the warm up just prior to tempo and threshold efforts.

While measuring the change in joint angles is extremely accurate and impressive this next step is something static fit techniques cannot replicate. The principal change we made related to a wobble in the athlete's right knee. The lateral wobble I had noticed in the athlete's knee (one of the motivators of this fitting) was actually measured as well. The system, measuring in three dimensions could show in real time, the athlete's leg length, but then easily showed how his knee wobbled outward at the top of each pedal stroke.

His knee was traveling laterally 6cm on each pedal stroke. Retul showed that the athlete was compensating for a short leg by shifting his hip forward on the saddle and wobbling his knee through the top of the stroke. This added stress to his adductors and was causing a repetition injury. To correct this discrepancy, Todd Carver, our Retul fitter, added a very small shim (length) and some cant (angle) in between the athlete's shoe and cleat and upon retesting it instantly reduced the lateral motion in his knee - by over 30%. In the passing weeks, the athlete has adapted further and the improvement has been significant. He is reporting far less discomfort in his groin and feels much more comfortable on both his road and time trial bicycles. Retul allowed us to see the athlete as a whole unit while simultaneously seeing how each part worked in the whole. This allowed us to diagnose issues in his fit while he was exerting himself. This dynamic fit is by far the best way to see how the athlete is actually moving. We also now have a computerized 3D image of the athlete stored for further reference.

The Retul System is being sold to shops, coaches and fitters around the country. Prices to athletes for a Retul fitting range from \$250 - \$350. While this is expensive compared to other fittings I must say that it is hard to compare a Retul fitting to other systems. While any tool is only as good as the tech using it, my guess is you will see more and more top fitters with this system. When a good fitter gets this type of instantaneous information and feedback it will be the perfect combination of science and art. I can say I highly recommend Retul.

This trip was obviously expensive. Not everyone will have the budget to plan such an excursion but results are waiting for you if you do. A few weeks after this trip, this athlete won his 3rd consecutive Master Men's State Time Trial Championship in a record time. His leg feels better than ever and with Nationals just weeks away he feels very confident that he can turn his 6th place of a year ago into better. Another top athlete, the client I first visited this tunnel with in January, has since won the Overall NJ State Time Trial Championship, while setting a course record and has only been defeated once (an uphill TT where he placed 2nd) since his trip to the tunnel. He has also set 2 other time trial course records in the Northeast. These athletes work hard and are talented but both are much faster now than they were before their wind tunnel testing. Their confidence grows with each race.

As you can see, there is much to be offered from the world of technology to cyclists. While some of you might think this is a bit extreme, the general population thinks we are all a bit crazy for enjoying a 60 mile ride in the hills on a beautiful sunny day. This sport rewards the extreme.

There is no easy answer. Each athlete must determine the best use of their cycling dollar. My goal was to show you the material gains that could be realized. Whether the cost associated with those gains is worthwhile is for each rider to determine. If you train hard for hours each week (sometimes on a trainer indoors), spend time away from friends and family each weekend as a weekend warrior and spend thousands of dollars on bikes, wheels, skin suits and aero helmets I am sure you don't want to feel you left anything on the table. I am absolutely convinced athletes must be dialed in aerodynamically to get the best out of their total investment and efforts.

More tunnels are popping up offering their services to cyclists and the prices are very competitive. The gains could be significant.



Peter Cummings specializes with training with Power meters and is one of the earliest adopters of the Trainingpeaks platform and WKO+. He was certified by the American College of Sports Medicine in 1993. He is a Certified and Licensed USA Cycling Level II (Expert) Coach, and Certified USA Cycling Skills Instructor. As a health club owner and coach he has directed and overseen the programming of over 10,000 individual and has been racing bicycles since 1991. His many athletes stand on podiums at Nationals, State and Local championships and have worn the Stars and Stripes National Championship Jersey. He is available for consultations, presentations, testing, programming or coaching. Those interested can contact him at Peter@Plan2Peak.com. For more articles on training and racing with power and other cycling specific topics by Coach Cummings visit

www.Plan2Peak.com. For those interested in a Time Trial Specific Training Camp including wind tunnel testing check back with www.Plan2Peak.com this fall.