How Much Speed Can I Buy?

A Queen City Wheels White Paper

This year will be the 50th season of the QCW time trial series. ***50!*** That's 1000 weeks, 2000 different riders, and over 5000 attempts! In that time the equipment for time trialing has evolved considerably. At the beginning, everyone used their standard road bike. Eventually there were time trial specific bikes, "funny bikes" with smaller front wheels (now banned), and then aero bars revolutionized the whole game. Today we are seeing a huge push towards ever more aerodynamic efficiency, as it's been conclusively demonstrated that aero trumps everything. This has resulted in a bewildering variety of aerodynamic equipment, all of which will make you faster. Unfortunately, none of this stuff is cheap, and for those of us who are not pro or getting our equipment for free, there are limits. So where are our dollars best spent for the greatest gains? Fortunately, there have been a number of technical articles on the internet in recent times that give some pretty good numbers. I've collected the numbers from a variety of sources, and plugged those into a calculator (4) designed to determine time values specific to our Cleves course. I hope you can use this as a guide for any potential equipment choices that you make for the coming season. If you already have a time trial or triathlon specific bike, this article is not really for you. This is for those of us that use our regular road bike, and are looking for upgrades that will make it more suitable for Cleves.

First off, let's dispel one common misconception about aero gains: You do NOT have to be going fast to benefit. These gains not only apply at all speeds, they are more important at slower speeds! Slower riders gain far more time from faster equipment. You'll see this in the numbers below, but a simple way of looking at it is that the more time you spend on the course, the more the savings accrue. Plus, while the net watts gained might be lower, it is a higher *percentage* of your power output. For a professional, all of the possible improvements are needed, because for them mere seconds matter. For us mortals, basic changes produce gains measured in minutes. So let's get into some details…

The values calculated here rely on some assumptions. The baseline time assumes a 150 pound rider on a 20 pound bike, equipped with shallow rim wheels, training tires (Continental Gatorskin), traditional clothing, a standard helmet, and the position of hands on the brake hoods. The temperature was set at 77°, and the air pressure was considered standard (520 ft. density altitude, the same as the actual elevation of the start.) The course is 10.2 miles, and has a small elevation gain, so the gradient is 0.1% up. The watts gained from the changes were taken from several sources (see references). For simplicity sake, I used the same wattage number across all speeds. This is not strictly correct, as the watts gained does increase some at higher speeds, and is a little less at slower speeds. (The actual speed that these numbers were obtained was 22 mph.) Don't take these numbers as absolute values. The point of this analysis is more to point out what the ballpark gains can be.

The changes investigated include:

1. **Skinsuit**: Tightening up the clothing fit gains about 3.7 watts(1), although another source (6) claims up to 15 watts, and a third source (7) says 20 watts at pro speeds. The QCW Team suit that we get from Pactimo is among the very best available. (It's the same as worn in the World Tour by Human Powered Health.) At our cost of $147.60, the cost per watt gained is $39.89.

2. **Aero Socks**: Controversy here! Manufacturers claim up to 8 watts gained (6), and certainly all of the pro teams use them. All of the manufacturers claim wind tunnel data for their numbers, but the only independent test (1) that I could find says the gain is only 0.33 watts. Because the claimed numbers vary so widely, I've left them out of my table below. You can decide if you want to try them. At the very least, almost any sock is faster than a bare leg (7), so don't go barefoot or use a no-show sock length.

3. **Aero Wheels**: Changing to a 50mm rim depth gains 10.2 watts (1). (There are even greater gains possible with deeper rims or disc wheels, but I stuck with 50mm here.) The cheapest wheelsets in this size run about $1200, so our cost per watt is $117.65.

4. **Aero helmet**: This one is complicated. The figure used here is 7.5 watts (1), but this number is highly personal. The fastest helmet for you is probably not the fastest for me. If you can hold the position of your chin up and shoulders hunched, you'll do better with a longer and wider helmet. However, if you tend to drop your head (most of us!) that longer tail will stick up and cost you time. A perfectly fit helmet might gain you even more watts, up to 15 (6, 7). If I assume a cost of $250 for a TT specific helmet (and that's low), the cost per watt is $33.33. A cheap hack you can use is to cover the vents on your standard helmetwith tape or plastic wrap. It will be hotter, but you're not out there all day, and you'll come close to the gains of a special helmet.

5. **Aero Bars**: The number here is assuming clip on bars added to a standard drop bar set up. (Integrated TT bars are faster, but are much more expensive.) The gains here are big: 31 watts (1). At a price of about $140 per set, the cost per watt is only $4.47.

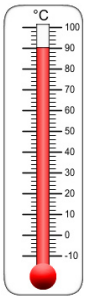
6. **Shaved Legs**: This is a fun one! It seems improbable, but multiple testing organizations have confirmed that shaving your legs saves about 14 watts (2, 3). That's more than a skinsuit, fancy wheels, or fancy helmet! Your cost is probably zero.

7. **Body Position**: Without adding anything to your bike, dropping your position down from raised arms to where your forearms are parallel to the ground (called the "aero hoods" position) saves you 22 watts (1). This is even faster than hands in the drops. It does require greater tricep and core strength to hold this position, but it's free speed.

8. **Tires**: This one is complicated. There are both aero gains and rolling resistance gains. The calculation I made is way too simplified, but for a general idea the difference is about 6 watts (1), although in an extreme situation, bad beginner tires and tubes might be costing you upwards of 44 watts (6).

9. **Maintenance**: This isn't really a strictly aero thing, but not having your bike properly maintained is costing you time. A dirty bike is less aero. How much less aero: well, how dirty is dirty? It's at least a few watts. A dirty chain, however, that's a big deal. The difference is at least 6 watts, and you can double that to 12 watts or more with a waxed chain (6).

10. **Weather**: Our final consideration is weather. I did not calculate for wind. There are just too many possibilities. As a general rule, the Cleves course is fastest when the wind is from the northwest, and slowest with a southeast wind. I did calculate for temperature and air pressure. Raising the temperature to 90° and changing the altitude density of the air to 3100' (about the thinnest value we've had at Cleves in recent years), the gain is the same as shaved legs, 14 watts. These conditions are generally associated with unsettled weather. If thunderstorms are coming, but not yet there, that will be a fast night. That condition is also usually associated with a favorable wind, so it could be a really fast night. (My personal PR for nearly 20 years was set in these conditions.)



The table below is for our hypothetical 150 pound (68 kg) rider. It covers power outputs ranging from 2 watts/kg, probably lower than anybody at Cleves, to 6 w/kg, which is higher than the power of the course record holder. The base time represents a position of hands on the hoods, at 77° and standard air pressure. The calculator used is available on the web at bikecalculator.com (4). The numbers represent seconds saved against the base time.

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Seconds Saved

W/KG	Watts	Time	Skinsuit/ Bottle in pocket	Helmet	Wheels	Clip on Bars	Shaved Legs	Tires	Total	Aero Hoods	Weather 90°
2.0	132	36:53	26	66	50	181	88	40	451	92	88
2.5	170	33:20	17	45	33	134	61	30	320	62	61
3.0	204	31:03	13	34	25	99	45	24	241	43	48
3.5	238	29:16	10	28	20	85	38	20	201	33	46
4.0	272	27:49	8	23	17	70	31	18	167	22	44
4.5	306	26:37	7	19	14	56	27	16	139	16	42
5.0	340	25:36	6	16	12	49	23	14	120	10	40
5.5	374	24:43	5	14	11	43	21	13	107	7	39
6.0	408	23:56	5	13	10	40	18	12	98	5	38

The gains realized range from just a few (as little as 5 seconds saved) to over 3 minutes for individual items. If you add all of the potential savings, hypothetically we're looking at over 7.5 minutes saved for the lowest power rider, and over 1.5 minutes for the fastest riders. The cost if you bought all of this stuff is about $1700, but that's far cheaper than buying a new aero or TT bike. If you spent nothing, and just worked on your position and shaved your legs, you could see a gain as high as three minutes on the slow side, or over 20 seconds for the very fastest. For the riders at the very fast end of the spectrum, they've probably already got a dedicated TT bike, and this analysis is not really aimed at them. For those of us with mortal strength and budget, I hope you've gained some insight, and maybe saved some cash. Good luck for the coming season! The Cleves time trial starts May 3rd. Check in is at 6:30, first rider off at 7 PM. You must be a QCW member to participate, but otherwise the time trials are free.More information about the Cleves time trial can be found on our website HERE.

References

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