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GRAVEL CYCLING

UNDERSTANDING TERRAIN TYPES AND CHOOSING THE RIGHT TIRES

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WITH THE GROWTH OF GRAVEL CYCLING IN RECENT YEARS, WE ARE IN WHAT MANY REFER TO AS THE "GOLDEN AGE" OF THE SPORT. IT'S AN ERA WHERE EQUIPMENT IS EVOLVING, LIMITS ARE STILL BEING EXPLORED, AND RIDERS ARE ENJOYING A FRESH PERSPECTIVE. HANDLEBARS COME IN VARIOUS SHAPES AND WIDTHS, MULTIPLE WHEEL SIZES ARE COMMON, AND TIRE CROSS-SECTIONS NO LONGER NEATLY SIT BETWEEN ROAD AND MOUNTAIN CATEGORIES, ALL TO BENEFIT USERS OF THIS EXPANDING CATEGORY.

HOWEVER, THIS MOMENTUM OF INNOVATION HAS OCCURRED QUICKLY, IN MANY CASES HAS CAUSED CONFUSION FOR WHAT SHOULD BE A RATHER SIMPLE INTENDED USE, PARTICULARLY IN THE WORLD OF TIRES.

IN THE FOLLOWING WHITE PAPER, WE DERIVE A CLEAR AND SIMPLE NOMENCLATURE FOR COMMUNICATING THE USER BENEFITS FOR THE FULL SPECTRUM OF GRAVEL TIRES, AND HOW THEY RELATE TO THEIR INTENDED TERRAIN. TO ACHIEVE THIS, WE BEGIN WITH A BRIEF HISTORY OF THE SPORT, ALONG WITH A LINEAGE OF ALIGNED DISCIPLINES, AND CONNECT HOW EACH HAVE CONTRIBUTED TO THE FORMATION OF MODERN GRAVEL CYCLING.

INTRODUCTION

By definition, gravel cycling (often referred to simply as "gravel") merges many road and mountain bike sensibilities, while also pulling heavily from both cyclocross and touring categories. In doing so, it provides the consumer with a broad useful range, positioning gravel bikes to be perhaps the most versatile form of bicycle in modern times. As a result, gravel bikes have become quite popular, opening a vast array of commercial opportunities for the bicycle industry to address.

In doing so, the industry differentiates these bikes into many sub-categories, filling the gravel spectrum with terms such as "race", "bikepacking", and "ATB", among others. Then, within each sub-category exist various needs to maximize performance specifically for the terrain which the bike will be ridden on. The compounded effect results in a wide range of tire demands, as well as specifications.

The issue is, how do you make sense of it as a consumer in this fast-paced market segment? Even before that, how can brands neatly construct a product line which is intuitive and logical for any consumer who may walk through a shop door?

In the following sections we will detail the background of where these sub-categories developed and give context for where they play into modern gravel cycling. Once this context is established, we will provide a concise solution for this complex communication challenge, addressing the full spectrum of terrain.

CONTENTS

SECTION 1.
THE HISTORICAL LEAD UP TO GRAVEL

To offer a fresh perspective on the categorization of gravel, we must first understand the use case which spurred the initial gravel movement. From there we can best define each sub-category as the movement evolved.

Looking back, it could be argued that the very first bicycles which featured pneumatic tires were in fact a form of "gravel bicycle". Afterall, most were ridden on gravel roads or other rough surfaces and employed a generous tire cross-section width to smooth out rough roads. While it's true that those bikes bear very little resemblance to modern gravel bikes, the pure utility and simple means to conquer the given terrain remain relevant today.

Soon thereafter, various forms of racing came into being. Track cycling had a notable boom towards the late 1800s, and in many ways paved the way to what we came to know as traditional road racing. In fact, early road races were originally contested over what many would consider gravel terrain, as paved public road infrastructure was also still in development. Shortly thereafter, as racers sought to expand their off-season training regiment, and introduce a cross-training variant, the form of racing known as cyclocross was born. This alternative form of racing utilizes mostly off-road surfaces, and features barriers which racers traditionally hurdle while carrying their bicycle, after a quick dismount.

These disciplines used a more performance-based approach to bicycle de-

FIGURE 1. Early bicycle with pneumatic tires.

sign, and for the most part featured“ drop” handlebar configurations, 700c wheels, and relatively lightweight components for the day. Where road racing gravitated toward a slightly narrower tires with minimal tread to reduce rolling resistance, cyclocross has evolved over time to benefit from slightly wider tires (compared to road bicycles), often with various patterns of low-profile treads for increased off-road grip and control. Over a century later, these configurations still hold true, with the majority of road tires typically measuring roughly 23-30mm in width, and cyclocross tires targeting the 33mm width per UCI regulations.

In addition to purely performance disciplines, more travel-oriented forms of bicycle transportation began around a similar time, leading the way to the touring bicycle. Touring bicycles offered a more robust frame construction, designed for the added weight of travel and camping gear, as well as more relaxed and stable frame geometry. This enabled users to travel great distances in comfort, moving from camp to camp, or inn to inn depending on the excursion. While many of these bikes shared the drop bar positioning, they added increased frame clearance for wider tires, as well as frame eyelets to serve as added mounting points for racks, bags, bottle cages, and lights. This was a bicycle meant to cover a variety of terrain, while experiencing the outdoors and the spirit of adventure. In doing so, the tires of a touring bike had to be purpose built, with a smaller 27” wheel diameter becoming fashionable, to provide shorter spokes and a sturdier wheel.

FIGURE 2. An example of road tire.

FIGURE 3. An example of cyclocross tire.

While the tires of these bikes were intended to roll quickly, the key performance goal was to provide the rider with a sense of safety and control given the higher loads the bicycles carried. This meant more robust casings than road racing tires, with slightly more tread texture to handle lighter duty dirt road use.

As time passed, and capabilities expanded, the evolution of the bicycle saw riders venturing further off-road. Eventually, riders began adding gearing to older balloon tire cruiser style bicycles, and the mountain bike was born. The benefit to this configuration is the suspension effect which the wider tires provided, in addition to the slacker and more stable frame geometry for varied terrain. The gearing then enabled these early mountain bikes to make use of the wider tires for other purposes, such as climbing ability on loose terrain, as well as increased braking traction compared to road, cyclocross, or touring bicycles. It also allowed for a type of endurance riding over more mountainous terrain, where previous style bicycles would not have fared well. As mountain bikes progressed, optimization increased, adding to the focus and complexity of the discipline. Telescoping suspension forks, disc brakes, and tubeless tires all found their way to mainstream bicycles through this platform. These advancements added to the popularity of the mountain bike, while opening consumer's eyes to new frontiers of exploration and performance.

It's important to remember that the aforementioned cycling disciplines continued to evolve over time, and in many ways pulled from one another along the way. This phenomenon occurred in all areas of bicycle frames and componentry, further boosting performance.

An example of such technology is the introduction and application of carbon fiber within bicycles.

FIGURE 4. Traditional touring bikes.

Where carbon fiber first appeared on road racing frames, it eventually made its way onto handlebars, seat posts, and countless other parts of the greater whole. Simultaneously it crossed disciplines into cyclocross and eventually mountain bikes, where now it remains the performance frame material of choice amongst professionals. This material allowed for tuned dynamics within componentry which had never been achieved previously, which at the same time reduced weight considerably in many cases.

In the end, carbon fiber is just one example, and is used here to illustrate the cross-pollination of materials and technologies which offer performance gains, regardless of discipline.

As we will discuss in the following section, the category of tires is no different, especially in gravel.

FIGURE 5. Repack, an example of first generation MTB.

FIGURE 6. Kestrel, first production Carbon fiber road bicycle.

SECTION 2.
GRAVEL IS BORN

In the 2000s era, cyclists took the familiar desire to improve the simple machine, and began experimenting with a new type of bicycle, known colloquially as a gravel bike. This new style of bike provided users with much of the efficiency and positioning of a road bike, the utility of a touring bike, and a healthy dose of XC mountain bike capability. It allowed users to ride away from roads filled with distracted motorists, vastly increase their usable range of rural exploration, and experience nature without having to negotiate overly technical terrain.

Many early gravel bikes leaned heavily on cyclocross framesets and added the rack mounts and slightly more upright positioning of a touring bike. Some used 700c wheels (or narrow 29er mountain bike wheels), while many experimented with 650b set ups to maximize tire volume for the given circumference. As in the early days of mountain bikes, there were no rules, and the spirit of experimentation fueled the passion to progress this new genre forward.

Now riders could have a single bike which accepted road wheels, or with a simple wheel swap could accept tires up to nearly the width of mountain bikes from decades past. These early gravel bikes sparked a revolution, and removed some of limitations of each of the categories it was influenced by, while quickly becoming a "must have" addition for any cycling enthusiast's quiver.

This renaissance era of gravel moved quickly. Within just a few short years, gravel bikes went from boutique custom builds, which used repurposed mishmash componentry from various categories, and grew to popular models of the mainstream bicycle brands, complete with dedicated group-sets and accessories. Participation numbers soared, and very quickly the trend was validated as a category which was here to stay.

However, with the broad use range of the gravel bike, the challenge of appropriate tires quickly emerged. While gravel tires offered a wider cross-section than road tires, optimizing performance on what still was considered a relatively small contact patch became the next obstacle. Similar to cyclocross, these tires needed to be supple yet durable, roll quickly on pavement yet provide off-road traction. While there was vast experience in the categories which influenced gravel, labeling a tire as "gravel specific" became a new frontier for many brands.

FIGURE 7. Early gravel bike.

FIGURE 8. Vittoria Terreno Dry gravel tire.

To address this, tire brands offered tires which appeared to be based heavily on cyclocross style file treads, or in many cases inverse tread patterns which resembled urban commuter tires. These treads worked in many instances, but as with the other categories, specific treads based on terrains were demanded by the market.

The top tire brands which had expertise in both road and off-road cycling disciplines had a distinct advantage in this regard, as a deep understanding of road and off-road traits was needed to make sense of the quickly evolving category. This effect was compounded with broad terrain spectrum gravel bikes were used on, and before long the gravel tire market was flooded with technical choices for almost any adventure.

Uses such as bikepacking, ATB (all terrain bike) style adventure riding, and ultra-endurance gravel riding all came into vogue. Events began popping up, capitalizing on the new gravel trend, with many events quickly selling out. The "spirit of gravel" continued to grow, as these fun events became contagious, and a form of personal challenge, while maintaining a causal and friendly atmosphere. Eventually, when formalized racing entered the equation, the performance nuances became much more prevalent. The 2022 season marked the first year where the UCI sanctioned an official World Championship race, which for many was a pivotal moment in the trajectory of the sport.

Suddenly, the bicycle industry had the need for a broad array of tread patterns, which were all expected to offer nuanced advantages at the high-performance level within their given intended terrain use. At one end of the spectrum, there were tires which resembled large volume road treads, while at the other

FIGURE 9. An example of tubular casing.

FIGURE 10. An example of tubeless ready reinforced casing.

end there were scaled-up cyclocross mud treads, with a generous amount of mixed conditions treads filling the largest market segment in the middle. As consumers flocked to bicycle shops to inquire about these new gravel tires, salespeople were met with the challenge of describing the benefits of these new gravel tires, without much context.

There was an obvious parallel with cyclocross treads, but the differences in how the product was used was often an oversight in how the products were positioned. For example, cyclocross riders often change bikes over the course of the race, while their mechanic washes the spare bike between laps. Combine this with the fact that cyclocross take place on a closed course, where the entire track may be filled with muddy ruts, and very little which may resemble a proper road. In contrast, even the muddiest gravel races take place on something which resembles a road or pathway designed for some sort of transportation to pass over, and are more often than not structured for long distance adventure (as opposed to the short, closed course). Additionally, cyclocross casings are subject to less abrasion compared to gravel tires, so they often don't feature the same level of sidewall protection which gravel riders demand. This necessitates more robust tire constructions for gravel tires, which were intended to reduce failures while riding in remote locations.

As these differentiations between cyclocross and gravel treads were established, brands experimented further with gravel specific tire formulations, compounds, and casing constructions. These were both influenced by the lessons learned in touring bikes, as well as in cross-country mountain bikes. External sidewall protection, complex compounds, and an emphasis on extended life durability all became key features of the

new gravel tire offerings.

However, this didn't reduce the number of tire models being offered, and certainly did nothing to streamline the categorization of the products being offered to consumers. While this gravel classification helped in terms of offerings and intended use, it did very little to help guide consumers to the correct product for their own specific version of gravel cycling.

For example, imagine a consumer enters a bike shop, and is greeted by a salesperson. They state that they are interested in gravel riding, and in need of tires. At this point, the salesperson likely thinks that their job is halfway done, as the initial categorization is identified, much as it would be if the consumer had stated road or mountain bike as their main interest. However, at this point the battle now begins, as they must pour through seemingly endless tread designs, widths, casings, and worst of all model names which are devoid of any clear contextual application. While simply stating that the consumer is a gravel rider helps guide the discussion, finding the correct product is inherently more nuanced in today's modern gravel landscape.

FIGURE 11. Shimano Nordic's shop wall with Vittoria tires.

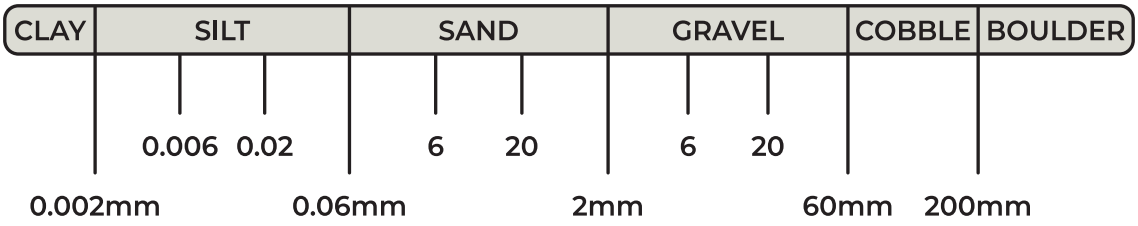
SECTION 3.
THE TERRAIN SCORE

In the world of gravel cycling, it's well established that the best tire for a given rider depends on the terrain the rider intends to conquer. As we've established above, this range of terrain is vast, and in many instances can be confusing for both consumers and dealers, as previously existing naming conventions simply used a generalized word to link the intended use to the product.

What if there was a better way to communicate all this, and quickly narrow down what a rider truly needs to suit their goals?

To make sense of this all, consider that all terrains exist on a spectrum. In simple terms, this spectrum covers pavement surfaces at one end, to mud surfaces at the other, with a range of terrain types in between. These terrains include various types of road surfaces, and transition through a range of packed dirt, fine loose granular, mixed surfaces such as rocks and roots, and even mud.

Each terrain is as different as the tread which is designed to conquer it. For example, in academic circles, soils are often expressed by their grain size, in a spectrum ranging from clay at the smallest end, to silt, sand, gravel, cobble, and finally boulder.



Relating to the practical terrains upon which a person may ride a gravel bicycle, the range of clay through gravel is most applicable. However, each type within this range requires a different set of parameters for effective tread design and performance, based heavily on the grain size of the soil in which the tire is rolling. Also, it's worth remembering that each type of terrain can be wet or dry, which can have an impact on how the tire reacts with the soil type.

Consider that a road made mostly of clay type soil will pack down in a dense manner, providing a smooth, almost paved-like surface, for a tire to roll upon. This can produce a situation where the tire must perform on the surface of the terrain, much like a road tire. Often, this type of terrain is known as "hardpack" in cycling vernacular. As rubber tires cannot penetrate this hard type of terrain, hardpack treads typically have a more even profile, to maximize the contact area of the tread to the ground, which in turn gives the tires a greater ability to provide control.

Inevitably, as the various types of soil break down, there can often be a thin layer of "fine loose" debris, which sits on top of the hardpack substrate. This provides an additional challenge for tire designers, as the tread must roll well on hardpack, but still cut through the debris, and evacuate it in order to provide traction.

As the grain size increases through silt and sand types, the tire tread has a tendency to increasingly sink down within the soil, activating the tread as intended, using the edges of the tread blocks to create grip and traction to ultimately provide control. This "mixed" type of terrain is quite common and requires a broad ability for the tire to perform. The tread must return a low rolling resistance while simultaneously providing enough tread depth to dig into loose or even soft terrain. This produces a well-rounded list of benefits, and for this reason, mixed terrain tires often are a popular choice.

As we go further through the spectrum of soil grain size, we approach what appear as small gravel stones, or what cyclists may call "coarse loose" terrain. The reason is, gravel stones don't typically pack together to create a substrate where tire traction may be gained. Rather, on the type of coarse loose terrain, the tire must be able to clear these stones away from the traction point of the tire as it makes contact with the ground, while doing so in a predictable and controllable manner.

While all of the above soil types relate to grain size, each individual dynamic and characteristic may become exaggerated when conditions turn wet. In fact, the effect of wetness can make a smooth hardpack surface slick, or in extreme examples of each soil type create a type of "mud" terrain for which the tire must be designed to clean upon each rotation.

FIGURE 12. Rider on a bike in muddy gravel terrain.

While historically, brands have attempted to label bicycle tires based on a specific use, in gravel the terrain is never quite as easy to define as in other categories. The simple reason is that gravel riders cover more distance, and in the process will encounter multiple types of terrains within the spectrum, along the way. For example, many gravel rides will begin or end with pavement, despite how far off the beaten path the route may take a rider. This means that if a brand were to simply offer tires for the 3-5 most common terrain types, there would likely be a gap in desired performance between models.

For that reason, Vittoria has introduced the Terrain Score, or "T-score" for short. This score defines the full spectrum of gravel terrain as percentages, assigning a score for each tread from 1-100, based on the intended use. Essentially, the higher the score, the deeper off-road tread capability, all while maintaining the basic identity of a product targeted specifically for gravel.

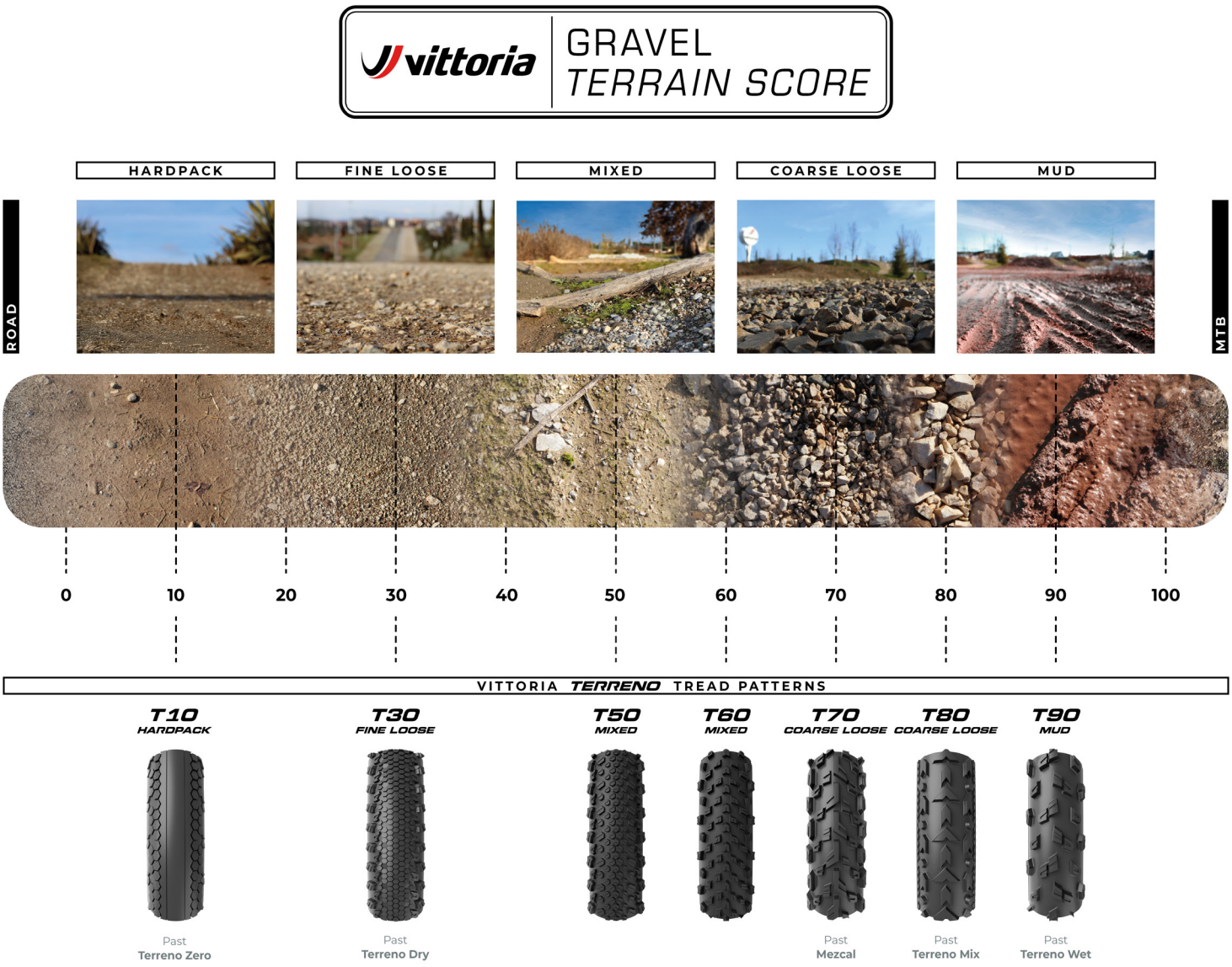
In other words, if you are a rider who enjoys mostly pavement, with the occasional hardpacked dirt road, then the T10 tread option will be right for you. Conversely, if you are the rider who desires a gravel style tread, but with the capability to handle coarse loose and mud conditions, then the T90 will be your choice. Directly in the middle, you will find the T50 option, which is designed to be an all-conditions tread, when you want set it and forget it option. In addition to these extremes, are popular options for each type of terrain, completing the product line in a graduated and logical array of tread choices.

To compliment the T-score, the intended use terrain is also listed on each tire. The full array includes T10 Hardpack, T30 Fine Loose, T50 Mixed, T60 Mixed, T70 Coarse Loose, T80 Coarse Loose, and T90 Coarse Loose/Mud options.

This nomenclature is specifically intended to structure the needed product offering in the perspective of the consumer. While this may seem obvious, the truth is that many consumers are intimidated when they enter a shop and can easily become overwhelmed when sorting through the various options from manufacturers. They often don't know the product names, construction, or type. Rather, they just know what they want in terms of ability and where they plan to ride.

The T-score approach allows the consumer and dealer interaction (from the previous example) to be much simpler, as the dealer can quickly and easily explain the product line structure. When that same gravel consumer enters the shop, the dealer can ask, "what percentage of the time do you ride off-road?", and the consumer answer will automatically link their needs to the correct product.

Consumers can more easily understand where each model fits within the line, and how they relate to one another. If the consumer has tried one of the models and wants more off-road capability, then the logical progression is easy to allow them to make an informed choice. Likewise, if they find that they would like a slightly faster tread, stepping down one model in the line is equally intuitive.



The scheme and definitions are proprietary to Vittoria. Use requires prior approval

All terrain images were captured at Vittoria Park

FIGURE 13. T score chart.

CONCLUSION

As the bicycle industry continues to evolve, we see trends which more directly serve the needs of consumers. The popularity of gravel bicycles is a testament to this, due to the versatility and utility this style of bicycle provides. The evolution of the gravel has many parallels with the broader bicycle industry itself, which has simultaneously evolved alongside this new form of cycling, providing increased consumer benefits.

Along this path, the clear and logical communication of consumer benefits has been critical, making it easier than ever before to research and purchase new bicycles and associated accessories. The Vittoria T-score is an example of this evolution, and one which is specifically designed to offer a simple and effective consumer benefit within the commercial sphere, while also helping dealers to place more happy consumers on bikes.