

RESEARCH PAPER

How does innovation arise in the bicycle sector? The users' role and their betrayal in the case of the 'gravel bike'

Paolo Magaudda

Pastis Research Unit, Department FISPPA, University of Padova, Italy

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ABSTRACT

This paper examines the emergence of the 'gravel bike', a new and successful category of sports bicycles that gained prominence in the global cycling industry in the late 2010s, to advance the understanding of the role of users in the processes of sociotechnical innovation. The study traces the development of gravel cycling and the gravel bike within the framework of science and technology studies (STS), introducing the concept of 'user betrayal' to highlight how innovations initially driven by users can later diverge from their original values and needs. The development of the gravel bike represents a case where users' input played a crucial role in creating an alternative cycling culture that directly supported the introduction of a new, successful bicycle model. However, the commercialization and institutionalization of gravel cycling, driven by industries, institutions and sporting bodies, has led to a significant shift away from the values that motivated early enthusiasts. This case reveals the tensions between user-driven innovation and the forces of commodification, emphasizing how marketing and institutional pressures can undermine the original needs and ideals of user collectives.

KEYWORDS

user-driven innovation, user betrayal, commodification, gravel bike, cycling

Introduction

The gravel bike represents one of the most significant market innovations in the cycling industry since the introduction of the mountain bike in the late 1970s (Rosen, 1993). This new category of bicycle emerged through a heterogeneous process involving both material and symbolic shifts in cycling cultures. What began as a grassroots cycling practice among small groups of enthusiasts in rural areas of the US Midwest was eventually appropriated by large global bicycle firms and integrated into international sports markets and institutions.

The analysis of the development of the gravel bike presented in this paper is theoretically grounded in science and technology studies (STS), with a particular focus on the role of end users and consumers in driving innovation. While the rise of gravel cycling can be seen as a case of user-driven

CONTACT: paolo.magaudda@unipd.it

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innovation, this paper argues that the subsequent commercialization and institutionalization of the practice – led by global firms, commercial sports agencies and international organizations – resulted in a significant departure from the original values and needs of early gravel cycling enthusiasts. This tension highlights the contradictory role of users in innovation processes, where initial user input is overshadowed by marketing and industrial dynamics which, in this case, transformed and subverted the original views and needs that drove enthusiasts to develop this new cycling practice.

To explore these dynamics, the concept of ‘user betrayal’ is adopted. This reveals how the outcomes of user-driven innovation can deviate from the values and needs originally promoted by user collectives. Methodologically, the paper is based on a case study of the gravel bike, developed between 2021 and 2023. The empirical foundation includes semi-structured interviews with key informants, texts from blogs and online magazines, industry data, firms’ catalogues and press releases, and interactions with forums and social media involving gravel enthusiasts and industry actors.

The paper is structured as follows. It first reviews the literature on user involvement in innovation processes, emphasizing the contributions of STS and addressing the need to reconsider the pro-innovation bias. The paper then contextualizes user roles in the history of cycling, with a focus on the invention of the ‘safety’ bicycle in the nineteenth century and the development of the mountain bike in the 1970s. An outline of the sociotechnical development of the gravel bike is followed by an exploration of its cultural origins and the ethos known as the Spirit of Gravel. The paper then delves into the pre-commercial phase of the gravel bicycle, discussing initial unsuccessful attempts to introduce a bicycle that met the needs of gravel enthusiasts, before covering the launch of the first commercial gravel bike, and addressing its technical standardization and consolidation as a successful marketing category, including its integration into industry strategies and international sports institutions. The conclusion reflects on how the case of the gravel bike sheds light on the ambivalent relationship between user input and the commercial and institutional forces that shape innovation, identifying the gravel bike’s development as a case of ‘user betrayal’.

Theoretical framework: the user role in innovation and the need to rebalance pro-innovation bias

Over the last two decades, different streams of literature have addressed the active role assumed by users in the unfolding of innovation processes. While a conventional linear view of innovation predominantly identified such figures as scientists, engineers, firms and the production side as unique innovation drivers, new perspectives have started to outline the crucial role that users play in the process (Bijker *et al.*, 1987; von Hippel, 1988). This interest in user involvement in innovation evolved in different directions and can be segmented into three main waves (Hyysalo, 2021: pp.3–8). Users were first identified for their active role in early-stage innovation in the 1980s, often through the involvement of civil society activism and local communities, although their contribution was seen mainly as an exception to standard innovation patterns rather than a structural phenomenon (von Hippel, 1976; Rosenberg, 1982; Schwartz-Cowan, 1983). The second wave of user studies emerged in the 1990s when it became clear that user input modifies and adapts technologies more often than was previously assumed, thus addressing the user role as a structural dimension in the shaping of new artefacts and technologies, especially in the realm of media and communication technologies (Silverstone and Hirsch, 1992; Bakardjieva, 2005). Finally, the most recent trend in user studies has focused on the proliferation of digital platforms and collaborative tools that enhance the ways in which users contribute to innovation, especially through the adoption of new digital media (Tapscott and Williams, 2008; von Hippel, 2016). Notably, this includes the growing efforts by firms and manufacturers to build communities of users and exploit their efforts to develop innovations (Mozaffar, 2016). Two major complementary trends in the re-evaluation of users have marked the debate in the literature. On the one hand, scholars have pointed out the structural nature of the creative power of users in identifying, expressing and articulating their needs; on the other

hand, the focus shifted to efforts by the 'productive side' to turn user involvement into a strategic tool for artefact design and marketing strategies (Jensen and Petersen, 2016: p.138).

As Hyysalo (2021: p.9) outlines, one critical issue in the development of user studies has been the difficulty of keeping together large-scale views about the role of users in the innovation process, as in the case of the sociotechnical change approach (Geels, 2002), with streams of research, prevalently associated with the insistence of science and technology studies on theoretically driven and often ethnography-based studies of innovation. By focusing on the dynamics of the situated uses of technical objects and user inputs to innovation processes, STS literature gave further impetus to user studies, contributing to dissolving the rigid distinctions between production and consumption and between design and use (Oudshoorn and Pinch, 2008: pp.554–5). However, STS approaches to innovation have also been criticized because, while offering a sophisticated set of theoretical tools and empirical cases, they were partially able to allow for comparability and generalizability across cases (Williams and Sørensen, 2002).

While the literature on users' involvement has grown consistently during the last two decades, a current relevant concern relates to the fact that the role of users is in most cases addressed as a positive and effective force in innovation processes, supporting the underlying assumption that the inclusion of user inputs in innovation automatically leads to outcomes that take into more consideration their views and needs. From this perspective, user studies tend to share what Godin and Vinck (2017: p.5) see as a more or less explicit 'pro-innovation bias' that considers technological innovation an ideological and uncontested value. This bias is reflected in all those perspectives that unquestionably understand innovation as something positive and in which user involvement is always beneficial and productive. On the contrary, according to Godin and Vinck (2017), phenomena such as innovation failures, forms of resistance to new technologies and rejections to innovation outcomes represent a useful counterbalancing perspective, especially when problems, troubles and difficulties pertaining to the alignment among users, innovation processes and their outcomes are addressed. This is particularly relevant, for instance, when reflecting on the limits of user involvement in innovation and the methodological weaknesses that often characterize the exploitation of user inputs to develop innovations (Trott *et al.*, 2013).

A stream of research outlining the tensions and contradictions that characterize the user role relates to how users can *resist* technical innovation. While resistance has generally been conceived in negative terms as a hostile psychological predisposition to new technologies (Bauer, 1995), especially in STS, user resistance to innovation has started to be considered a resource, demonstrating that these phenomena are distinctive results of the situated interaction among different actors, cultures and representations within the processes of sociotechnical change (Kline and Pinch, 1996; Kline, 2003; Melby and Toussaint, 2016). Another perspective relates to the *non-use* of technologies. Such studies have shown that even when people decide or are forced not to use a technology, they are nonetheless part of the broader process of innovation. In this regard, Wyatt *et al.* (2002: p.36) propose a taxonomy of non-use, identifying four categories of non-users: (a) those who have never used a technology voluntarily because they were against it for some reason; (b) those who have used a technology but have subsequently and voluntarily abandoned it; (c) those who have never used a technology because they could not access it; and (d) those who have been forced to stop using a technology and have thus become non-users against their will. Another take includes research that pays attention to those cases in which the user role is linked to contestation or controversy and in which, while their role in shaping innovation and supporting sociotechnical change is clearly visible, the definition of the aims, processes and outcomes of innovation are characterized by some kind of problem related to how users become productive in innovation. In this regard, reflecting on a number of cross-sectoral projects sponsored by a Danish innovation programme, Jensen and Petersen (2016) outline how user involvement in innovation and design as a routine R&D activity is increasingly connected with unintended effects and plagued by new forms of user exploitation by firms and industries.

The case of the gravel bike aims to advance this reflection on the tensions and contradictions characterizing user role by outlining how, even in cases in which the alternative visions and activities

of users are crucial to shaping innovations in their earlier stages, subsequent phases driven by commercial and institutional actors, focusing on the exploitation of their market sectors, can lead to a subversion and betrayal of the original user inputs. To do this, the paper adopts the notion of ‘user betrayal’ in order to identify how the alternative inputs and values shared by early gravel enthusiasts were overturned when these innovations became embedded in the logic of corporate, commercial and institutional actors.

Historical background: user involvement in bicycle innovation from the safety bike to the mountain bike

The technical evolution of bicycles represents a historically relevant area for disentangling the relationship among users, technologies and innovation processes (Bijker *et al.*, 1987; Rosen, 1993). Ever since the invention of the modern bicycle – the Rover or safety, created in 1886 – innovations involving this means of mobility have been recognized as being closely intertwined with broader social, economic and societal transformation for their users. All this makes the case of the cycling sector particularly relevant to enquiry on the evolving dynamics involving users in innovation processes, as well as on the tensions between users’ views and corporate exploitation.

Several historical reconstructions of the early phase of the modern bicycle, between the 1820s and the 1880s (Alderson, 1972; Smith, 1972; Herlihy, 2004; Berto, 2005; Smethurst, 2015), agree that the concatenation of innovations that led to the safety model represented what science and technology studies generally define as a heterogeneous process (Law, 1987). This is a process in which users contribute from a technical, social, cultural and economic perspective to shape a new artefact. The seminal study by Pinch and Bijker (1987; see also Bijker, 1995) analyses the sociotechnical evolution of the modern bicycle at the end of the nineteenth century to exemplify the social construction of technology (SCOT) approach. Here, the initial phase of the invention of the modern bicycle was marked by a strong connection between the technical aspects of the first models and the social needs and wider sociocultural frameworks emerging in that epoque. Specific emphasis was placed on the transformations of the social profiles of potential early users, which started to include women, in parallel with the opening up of public life and salaried work to women. Thus, the user role in shaping the emergence of the safety bicycle was identified in the emergence of new ‘relevant social groups’ (Pinch and Bijker, 1987: p.30) whose need for mobility and safety played a pivotal role in the technical shaping of the bicycle. Thus, the social understanding of the role of the new two-wheel artefact evolved radically from a pastime designed for the upper-middle class accustomed to riding horses (embodied by the drasine, created in 1824), and later a sporty means of mobility designed for athletic men eager to show off their skills and courage (the velocipede, introduced in 1869, and the penny farthing in 1870), to a safe and easy-to-ride means of transport based on the needs of emerging social groups, such as women and non-athletic people (the 1886 safety bike). The SCOT approach was also adopted to discuss the failure of the adoption of the recumbent bicycle in the 1930s, which was discouraged by the International Cycling Union (Ahmed *et al.*, 2015), but a more comprehensive SCOT analysis was linked to a misalignment with user demand during this epoque (Wieser, 2017).

While in the case of the safety bike, the role of users materialized mostly with the emergence of new relevant social groups, the innovation related to the mountain bike in the mid-1970s was instead marked by the much more direct involvement of end users (Rosen, 1993). As has been reconstructed from multiple historical perspectives (Savre *et al.*, 2010; Berto, 2014), the mountain bike took shape in California, driven by the efforts of a small group of young amateur cyclists dissatisfied with the commercially available sport bicycle models (based on the typical European-style road racing bicycle). These groups of amateurs began to handcraft a new bicycle model better suited to downhill competitions on the hilly terrain of San Francisco’s Marin County (Berto, 2014: p.50). In the absence of a commercial offer that was able to meet the emerging entertainment and pastime needs of these young cyclists (among them Gary Fisher, Joe Breeze and Tom Ritchey), these amateur cyclists started repurposing the old frames typical of teenagers’ bikes in the 1950s and began to build original models of the first mountain bikes available on the market (Lüthje *et al.*, 2005).

To cope with the lack of bicycles suitable for a practice that appeared quite bizarre (descending at high speed down a mountain trail), a collective of early users began turning old bikes from the 1950s (the ‘balloon tires’ produced mainly by Schwinn) originally intended for children and teenagers, into bikes suitable for competitive amateur events. These events consisted of high-speed races from the hills of Marin County, the best known of which was the Repack race, first organized in October 1976 (Savre *et al.*, 2010). In the wake of the significant local success of these new bikes, some of the first enthusiastic youngsters began to handcraft brand-new frames suitable for downhill off-road biking. In 1981, Tom Ritchey, Charlie Kelly and Gary Fisher founded a small company called Mountainbikes, which was not particularly successful, but directly influenced the name that this new model of bicycle assumed in following years after a period in which the term ‘all terrain bike’ (ATB) was predominant. Then, in 1981, another small company in the Santa Clara province of California, Specialized (set up in 1976 to import racing bike components from Europe), began production of the first industrial mountain bike, the Stumpjumper, outsourcing production to Japanese factories with an initial output of just 250 units.

This process of innovation based on early user involvement intersected with an emerging globalized model of cyclical production which was instrumental in turning the mountain bike into a commercial success, stimulating a cultural change in the social understanding of the bicycle and restructuring at the industrial level (Rosen, 1993). Just five years later, in 1986, mountain bikes accounted for 60% of the US bicycle market, and Specialized became one of the most important global brands in the bicycle industry with a turnover in 2020 of around €500 million. The mountain bike was the most successful bicycle model for at least the next three decades, turning into a highly significant cultural icon of the contemporary world, increasingly connected with imaginaries related to hiking, leisure and a new relationship with nature.

Both cases suggest that understanding bicycle innovation requires disentangling the interaction of users, innovation processes and wider cultural and social changes. The gravel bike provides a contemporary case of how users have played a role in the process of innovation in the bike sector and how the outcomes of innovation have evolved in different directions, based on firms’ commercialization strategies and their appropriation within wider institutional processes.

The case study: what is a gravel bike?

The gravel bike is a new category of sports bike which can be described as a crossover between a mountain bike (from which it has the ability to tackle dirt and off-road terrain) and a road racing bike (from which it retains curved handlebars and the ability to develop higher speeds). The gravel bike category emerged in the global sports bike market in 2015 and soon became one of the most popular categories in the cycling sector. In 2020, research by marketing firm NPD Group identified the gravel bike category as the one with the largest percentage increase in terms of sales (+144% from 2019 to 2020), alongside electric bikes (+190%). By 2021, gravel bikes accounted for 35% of the total road bike category in the US. In 2022, a gravel bike world championship was organized for the first time by the Union Cycliste Internationale (UCI), officially integrating this new bike into the sanctioned disciplines of cycling. In less than a decade, users assisted in the emergence of a new successful model of bicycle capable of producing a rapid convergence of firms, enthusiasts and specialized media, at a pace that resembled the success achieved by mountain biking in the 1980s. Early gravel bike users were also influential in creating the context for the emergence of the gravel bike by triggering a cultural reframing of the practice of sport cycling and by materially engaging with experimentations to develop and test the new bike models that evolved into the gravel bike.

The term ‘gravel bike’ derives from the type of roads that saw the development, at the end of the 1990s and early 2000s, of a new cycling practice which soon took the form of amateur events organized on the gravel roads common in rural areas of the Midwest of the United States, primarily Kansas, Iowa and Minnesota. In these agricultural states, the transport infrastructure is based on a network of roads that are not paved but are covered with different types of gravel. The state of Iowa

alone, one of the homelands of the gravel bike, has about 100,000 kilometres of gravel-covered roads, which is about 70% of all country roads in the state.

What technically distinguishes a gravel bike from other kinds of sports bikes? The gravel bike is essentially a crossover between two popular sports bike models: the road bike and the mountain bike (see Figure 1). The gravel bike has adopted most of the characteristics of the frame of the road bike, but slightly modifies its geometry to make it more suitable for routes that are not asphalted, while preserving the curved or 'drop' handlebar (albeit as a slightly flared version towards the outside), allowing a better aerodynamic position of the rider to maintain high speeds. However, unlike the road bike, the gravel bike can accommodate tyres of a larger width so that uneven terrains can be tackled more easily. Whereas the standard width for road bike tyres is between 23 and 28 mm, gravel bikes mount tyres between 35 and 50 mm, thus approaching the size of mountain bike tyres (which range from 50 mm to 70 mm, 2.8 inches and larger).

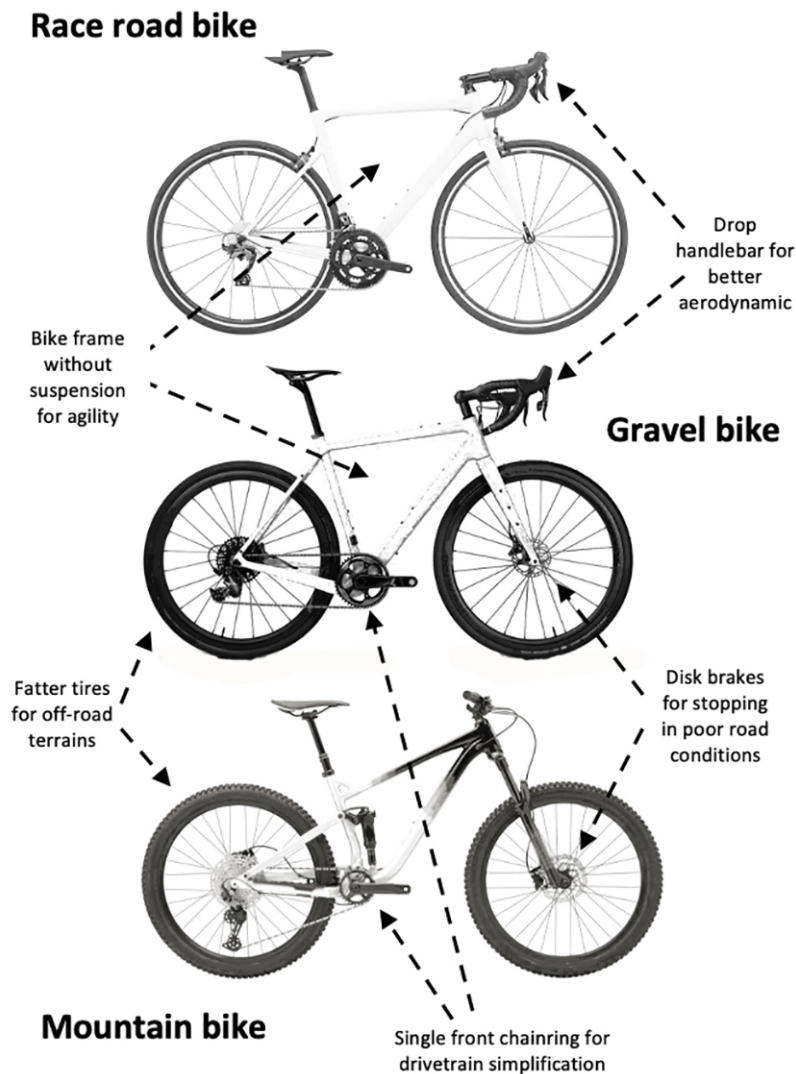


Figure 1. Technical features of the gravel bike

In addition to the larger tyres, the gravel bike borrows other technical details from the mountain bike, such as disc brakes (although this brake system has also been more recently adopted by racing bikes) and often a single chainring in place of the double or triple chainring front drive to simplify the work of the chain on poor terrains, a common standard among mountain bikes. At a

cultural level, the gravel bike shares with the mountain bike the possibility of using the bikes not just for racing or training, but for having fun in nature, far from the asphalt roads typical of urban areas.

Although capable of being ridden on rough terrain like the mountain bike, the gravel bike differs from the mountain bike in its evolution in functionality and marketing. One of the main characteristics of the gravel bike is that it fills a significant gap in the market between road and mountain bikes. For decades, the road bike sports sector has been increasingly characterized by models calibrated to the needs of professional or competitive racers, making it less suitable for a growing number of weekend cycling enthusiasts lacking competitive ambitions. However, since the early 2000s, the evolution of mountain biking has proceeded in the direction of a clear-cut division into different technical sub-disciplines (from 'cross-country' to 'trail', from 'enduro' to 'downhill', to the more recent 'down-country'), with a prevalent emphasis on the ability to tackle difficult terrains or to race in artificial bike parks. All of this development has turned contemporary mountain bikes into increasingly expensive and complex artefacts from a technical viewpoint. When considering the pattern of specialization of racing bikes and mountain bikes over the years, the social need for a new model of sports bicycles not based on aggressive racing or technical off-road terrains would appear to be important. However, the history of the gravel bike shows that the creation of this new category of bicycles has been neither linear nor simple. The emergence of the gravel bike did not come about because of the recognition by large firms of an uncovered market and the subsequent development of a solution for filling this gap. Before the gravel bike, the bicycle industry had already partially failed to find a new commercial category of bicycle suitable for mixed sport use. Consider the categories of 'trekking' bikes and 'hybrid' bikes, two labels adopted since the early 2000s, especially in Europe, but doomed to quite limited success. To reopen the interpretative flexibility of the sports bicycle, a more solid sociotechnical framework was required (Bijker, 1995: p.123). Let us, therefore, turn our attention to the cultural origins of the practice of gravel cycling and their role in triggering the development of the new standard for the gravel bike.

The Spirit of Gravel and the sociotechnical framework of the gravel bike

To understand the emergence of the gravel bike as a new model of bicycle, it is necessary to shed light on the cultural and social contexts in which a new sociotechnical framework related to sports cycling has emerged. The context for this was the first grassroots bike events, expressly associated with gravel roads, organized in the mid-2000s in several Midwest states. As shown by Elizabeth Shove and colleagues (2012), the emergence of new artefacts is strictly connected with the construction of new social practices, supported by a change occurring at a material and cultural level. Therefore, let us focus more closely on the development of the practice of gravel cycling and the emergence of a distinctive gravel culture, often defined by the early enthusiast as the Spirit of Gravel.

Accounts dating back to the 1990s tell of the use in several US Midwest states of the expression 'gravel grinding' to refer to a particular form of cycling activity which consisted of bike racers training on unpaved rural roads, initially using racing bikes whose narrow tyres inflated to high pressures gave an effect similar to that of industrial machines that 'grind' or 'crush' stones into gravel. Based on this informal practice, in the mid-2000s, amateur gravel cycling events were organized by enthusiasts and amateurs in rural Midwestern states, such as Iowa, Kansas and Minnesota, where these gravel roads were prevalent. These events consisted of fairly long races, between 100 and 300 miles, organized with an inclusive approach and a primary emphasis on participation and community rather than competition and the quest for victory. These events were explicitly in opposition to a mainstream sociotechnical framework supporting amateur cycling competitive events dominant in the US at the time, the 'gran fondos', races for amateurs that reproduced professional European races in terms of the routes (on asphalt), bicycles used (racing bikes) and organizational approach (including high entry fees). In those years, this sociotechnical framework based on competitive races was particularly fashionable in the US, especially after the success of pro-cyclist Lance Armstrong, five times winner of the Tour de France, from 1999 to 2005 (although he was subsequently disqualified for doping).

One of the earliest and best-known amateur gravel events was the Trans Iowa gravel race, organized from 2005 until 2018 with fewer than 100 participants per year. Like most other early gravel events, the race was characterized by an approach openly opposed to the competitive model of the *gran fondos*. Other important early events included the Dirty Kanza race in Kansas (since 2006), which had about 50 participants in its first year (but more recently embraced a more commercial approach with 4,000 participants in 2022); the Almanzo race, organized in Minnesota (since 2007), which was later became the Heywood Ride; and the Heck of the North, also in Minnesota, which started in 2009 (Legan, 2017). These initial sporting events constituted the contexts around which the practice of gravel cycling emerged, embodying what was for early amateurs an authentic Spirit of Gravel. The expression ‘Spirit of Gravel’ encapsulates a distinctive cultural understanding of sports cycling practice, reflected in the organizational format of cycling events, the attitude of the participants and the variety of actual artefacts they use.

Gravel racing has always had *completers* – participants whose goal is to finish the event – and *competitors* whose goal is to win. Both are there for the challenge and the vibe they experience, and to contribute to the challenge and the vibe, which is often characterized as the *Spirit of Gravel*. It’s a phrase that’s shorthand for a feeling, and also an unwritten code that governs etiquette and competition in a gravel race. (Bike expert and journalist Andrew Vontz, 2022)

There are several distinctive elements that help make sense of how this distinctive vibe contributed to the emergence of gravel cycling and gravel bikes as distinctive entities. A relevant element was the so-called ‘grassroots approach’ of the early events. ‘Grassroots’ emphasizes the self-organization of these events, the freedom for organizers to define their own rules and their independence from any sanctioning bodies. A crucial element shared by all the early events was rejection of the constraints imposed by local and national cycling associations for amateur races, and thus the idea of having to adhere to regulations and standards, as is the case with the *gran fondo* races, which have strict regulations on the type of bicycles that can be used (Berridge, 2014). The lack of rules relating to the types of bicycles that could be used in the early gravel events was crucial for users’ ability to experiment with technical adaptation in their innovative bicycles.

This grassroots approach is also reflected in the economic and organizational features of these events, which typically have very low or no participation fees (compared with the very high fees for *gran fondo* races). In addition, organizers and staff were mainly volunteers who offered their time for free, motivated by friendship and the sense of community shared in these events. These elements underline the importance for early enthusiasts of building a cycling context autonomous from institutional and commercial constraints, foregrounding the building of a sense of community, sometimes referred to by the expression ‘gravel family’.

A crucial cultural dimension characterizing the early stages of gravel cycling was the rejection of the competitive approach typical of the European cycling tradition. For example, there were no prizes for the winners in the Trans Iowa, and the most important distinction was that between non-finishers and finishers, i.e., those who were able to complete the demanding routes within the time limit (notably in parallel with an approach common in other non-competitive European cycling traditions, such as *audax* or *randonnée* events). The non-competitive approach was also embodied through the support of different forms of inclusivity, particularly in relation to female participation, which has always been a marginal area in sanctioned race cycling events. So, while in races sanctioned by sports institutions women competed in separate races from men, in gravel racing there was no separation of genders. Moreover, highly significant was the fact that inclusivity also concerned the type of bicycles used, which allowed the participants to experiment with alternative bike setups and solutions.

Another element at the core of the original Spirit of Gravel was the self-sufficiency of participants during the events. The emphasis on self-sufficiency meant that participants could not receive any outside assistance during races, had to provide their own food and water supplies, and take responsibility for their own conduct, an aspect necessitated by the lack of insurance and the need to ride on roads open to traffic (though generally only light traffic). This aspect directly influenced the

kind of bikes used by early enthusiasts, as well the development of proper gravel bikes, characterized by the presence of multiple attachments for water bottles, bags and other accessories.

One final consideration regards how this quite local Spirit of Gravel and the resulting new sociotechnical framework related to the emergence of the gravel bike that spread and nurtured a new global category of bike. The internet played a significant role, especially in those years when commercial advertising-driven social media had yet to acquire a central role in online communication. In the mid-2000s, information about events, alternative equipment, bikes and the cultural aspects of gravel events spread primarily through the personal blogs of organizers and riders, amateur sites and forums of enthusiasts. The event became popular through the new availability of blogs, social media and chatrooms:

If we go back to 2004–2005, many people were just getting the internet in their home, they were searching for people with similar interests, so they were finding chat rooms and web sites of their interests. And at that point in time blogs, chatrooms, things of that nature were very popular, and people found similar places to feed off each other. When we put the announcement on a section of a website, and we were able to get that kind of reaction because of those people paying attention to these chatrooms, sites and blogs. ... Back in the 80s or 90s, the only information in US was from magazines, and magazine information was slow, one month at least ... It is different now, we can find things in real time. (Mark Stevenson, founder of Trans Iowa, interviewed by the author, 17 March 2023).

These characteristics highlight some of the distinctive features of the new sociotechnical framework that supported the development of the gravel bike, based on the emergence of gravel cycling as a distinctive and unique practice. While the emphasis on cultural and organizational autonomy of early amateur organizers and cyclists paved the way for an alternative cultural interpretation of sports cycling, one opposed to existing competitive-based approaches, it also made it possible for users to experiment with bicycles that were different from the existing offerings of global bike corporations and were better suited to gravel cycling.

Innovation through user experimentation

Midwest gravel events provided the context in which the gravel bike began to take shape from a technical and material perspective. However, before focusing on the first gravel bike on the market, it is important to note that user experimentation with bikes suitable for gravel riding predated the emergence of widely available commercial products. As soon as mountain bikes began to be successful (in the mid-1980s) a series of attempts to develop a bike suitable for gravel riding were made, though not resulting in a new market category of sports bicycle. The phase predating the commercialization of the first proper gravel bike highlights failed efforts to reopen the interpretative flexibility of the sports bicycle and shows how the emergence of the new sociotechnical framework was crucial for the evolution of the gravel bike as a viable new market category for bike industries.

One of the earliest attempts to develop a mix of mountain bike and racing bike for the market was made by Bridgestone (the US branch of the Japanese parent company, but with full creative autonomy). In 1987, it introduced the MB-1 mountain bike model, equipped with drop handlebars typical of racing bikes instead of flat bars. This model was also used in some American competitions, but it did not achieve a commercial following, although it soon became a cult model among enthusiasts. Another example, this time more connected with user efforts to develop a bike alternative to the two dominant standards, was the ‘monstercross’. Around 2001–2002, this cyclocross bike in a monster size gained visibility in the web forums of enthusiasts as a result of bike mechanic and internet user Matt Chester posting his hybrid prototypes on his personal blog (Sevo, 2017). This alternative was based on converting existing frames designed for flat handlebars into bikes with drop bars suitable for off-road riding and able to be fitted with 40–50 mm tyres. Thanks to internet forums, the monstercross label began to circulate widely and was even used commercially in 2007

by a small company based in the San Francisco Bay area. Black Mountain Cycles introduced a model very close to what would later become a proper gravel bike – the only difference was that it had traditional rim brakes instead of disc brakes.

In short, prior to the diffusion of early gravel events, a niche interest in bikes between mountain bikes and racing bikes was already emerging among amateur sport cyclists, triggering several attempts by amateurs and small firms to meet this need with niche models similar to contemporary gravel bikes. Despite these attempts, at the start of the new grassroots gravel scene in the mid-2000s, enthusiasts and amateurs still did not have a dedicated bike for gravel riding, with the exception of a few models with limited circulation or produced on an artisanal scale (Brewer, 2017).

In the early years, enthusiasts used different kinds of bikes in racing, experimenting with existing cyclocross and mountain bikes to find what was best for a gravel race:

There weren't any gravel bikes in 2005 when we started Trans Iowa. The big 'cyclocross vs MTB' debate for T.I.v1 eventually was won by the cyclocross crowd. We never saw the sheer numbers of mountain bikes at Trans Iowa after v2, but mountain bikes continued to be used quite a bit over the years. It probably wasn't until about Trans Iowa v8 that seeing a mountain bike line up for Trans Iowa was considered weird. (Guitar Ted, 2021)

Cyclocross bikes were similar to racing bikes (with drop handlebars) but were characterized by a slightly larger space for wider tyres (usually up to 33 mm wide) compared with traditional racing bikes (23–5 mm). The most popular bike model in the early gravel events was the Cross Check, whose design was a direct evolution from a traditional cyclocross bike, but originally based on the needs of bike tourists or city commuters. The Cross Check was introduced in 1999 by Surly, a Minneapolis-based company focused on offering single-speed, urban and travel bike models. The possibility of fitting wider tyres, combined with a sturdy steel frame and a relatively low price (in 2000 frame and fork cost US\$389, and the complete bike cost US\$825), made the Cross Check the perfect bike for early users participating in early gravel events. They adapted and tinkered. The Cross Check lacked a crucial feature that would later become typical of gravel bikes, namely disc brakes. At the time these were used only on high-end mountain bikes, but would later become a common feature on cyclocross and road bikes.

In summary, during the 2000s and for the first full decade of gravel cycling development, there was no bike on the market that fully fitted the needs of the pioneering gravel cyclists. Users embarked on a voyage of experimentation, centred on adapting and modifying existing bikes designed for other purposes to meet the new needs of gravel cycling. Such end-user adaptations were crucially facilitated by the grassroots approach of gravel events, in which – according to the grassroots philosophy – there were no established rules about which kinds of bikes could be used.

Design and commercialization of the first gravel bike

The early gravel races were fertile terrain for enthusiasts to experiment with existing bike models. Soon, small and niche bike firms started to test new prototypes at gravel events. Among these firms was Salsa Cycles, the first company to bring to market a model explicitly intended for gravel competitions. That was in 2012 following testing in the Trans Iowa race from 2009. The Warbird – the first gravel bike – was a direct descendant of the cyclocross bike, but with the addition of disc brakes (at that time common only in mountain bikes, but not in cyclocross), the ability to fit wider tyres and a frame geometry more suitable for rides lasting many hours (unlike cyclocross races, which often last just 45 minutes). The business strategy of Salsa Cycles was an example of what Schot and Geels (2008) see as a form of niche management of niche innovation, in which new technologies are developed by small networks of specialized actors that rely on cultures, relationships and activities taking place in distinctive social domains, which are not relevant for mainstream industrial actors.

The history of Salsa Cycles helps explain why this company was the first to develop a gravel bike model. Salsa Cycles was founded in the early 1980s in the wake of the success of the first wave of mountain bikes, focusing on the production of niche components, primarily handlebar stems (the parts that connect the fork to the handlebar, which are supplied in standard sizes on bicycles and are the easiest way to change a cyclist's position on a bike). Then, in 1997, the company was taken over by the US bicycle distributor QBP, though retaining complete creative autonomy. Over the years, Salsa Cycles has specialized in creating bike models that meet a growing demand for adventurous cycling activities without embracing the mainstream of most mountain bike firms, which is based on increasing complexity and focusing on competitive races or bike parks.

This distinctive approach to bike design and marketing allowed Salsa Cycles to be among the first firms to identify gravel events as relevant places for unfolding niche marketing activities and testing new bike prototypes. Some of the staff from Salsa Cycles participated as riders in some of the earliest gravel events, including Warbird's designer, Sean Mailen, who rode in Trans Iowa in 2010 and 2011, and the senior product manager, Joseph Meiser, who participated in Trans Iowa from 2007 to 2010, winning the 2008 event and testing the first Warbird prototype at the 2009 event:

At the 2009 Trans Iowa, I rode a one-off titanium frame we had made to test geometry. It had a lower bottom bracket and better tire clearance, but what really shined was the compliance it delivered. I won the race, but perhaps more importantly, I could stand up after completing the 300-plus miles of Iowa gravel and B-roads. (Salsa Cycles, 2018)

After testing a Warbird titanium prototype in 2009, Salsa Cycles introduced the first commercial gravel bike at the end of 2012. However, while in one respect the Salsa Warbird was the first bike explicitly marketed as a gravel bike, it was still a largely niche product and was likely produced in just a few hundred units. A key step in the success of the gravel bike was the subsequent decision of some of the major US bike companies to tentatively embrace the gravel sector and offer models explicitly targeted at this sector, starting in 2014. The first bicycle model from a major company to be sold explicitly as a gravel bike – the Diverge – came from Specialized, the same company that introduced the first mass-produced mountain bike in 1982. Although equipped with disc brakes, the Diverge could accommodate tyres up to 35 mm wide (as opposed to the 42–5 mm typical of later gravel bikes), as well as a steering angle of 72.5° (as opposed to 70°/71°) and rear chain stays of 415 mm (as opposed to 425/435 mm), more similar to those of the road bike or the cyclocross.

It took a few years for Specialized and other major global bike firms to embrace fully the growing trend of gravel bikes. They initially adopted a conservative strategy, represented by introducing models generally designed for cyclocross under the commercial label of 'gravel'. This was also the case with Trek, which introduced the Domane Gravel model in 2017, essentially a road bike equipped with disc brakes that could accommodate tyres up to 32 mm (way less than what would become a gravel standard). Other major mass production global brands, such as Trek and Cannondale, came to present gravel models in 2018 (with the Checkpoint and Topstone models, respectively), followed by other relevant brands, including such Italian flagship firms as Pinarello (with the Grevil model in 2019), Colnago (GX-3 model in 2020) and DeRosa (gravel model in 2020). In sum, at the turn of the decade, almost all major sports bike brands had jumped on the gravel bike bandwagon, offering models expressly dedicated to this sector.

Standardization, closure and reopening of flexibility of the gravel bike

By the turn of the decade, gravel bikes were the most attractive sector in the sports bicycle market, the new focus of the entire global bike industry. Around this time, the geometry of gravel bike frames was almost standardized around some common features, though soon different subcategories soon started to emerge, following a pattern of differentiation similar to that seen with mountain bikes.

From both a material and cultural point of view, at this stage, the gravel bike reached, in SCOT terms, a closure in the flexibility that characterized the early phases of its development. At the beginning of the 2020s, a standard version of a gravel bike corresponded to the shape of a racing bike, but with a few additional features to make it more suitable for rough and uneven terrains as well as longer rides. These features included a chain stay of around 430/435 mm, a steering angle of around 70°/71° and the ability to accommodate tyres of 40–50 mm. One element that distinguished early gravel bikes from road bikes was the use of disc brakes. These brakes also started to become standard in proper racing bikes, almost completely replacing the old rim brake systems, which showed the direct influence of the technical characteristics of the gravel bike on the road bike sector.

A relevant element in the standardization of the gravel bike was the involvement of major global drivetrain component manufacturers, represented by three main firms: Shimano, based in Japan, Sram in the US and Campagnolo in Italy. Between 2019 and 2021, all three introduced transmission systems specifically dedicated to gravel bikes. Shimano, the world's leading drivetrain company, was the first to introduce a new gravel line (called GRX) in 2019, followed in 2020 by Campagnolo with Ekar and in 2021 by Sram with AXS. Other component firms developed a similar interest in the gravel bike, particularly for tyres, which are probably the element that most clearly differentiates gravel bikes. Gravel tires, both in terms of their size and tread design, constitute an innovation whose absence limited the development of gravel bikes in the early years, where only niche companies (including Clement, Panaracer, WTB and Compass Cycles) were offering limited models for gravel rigs. However, as of 2018, all the major global tyre companies (such as Continental, Schwalbe, Michelin and Pirelli) had introduced new tyre models especially dedicated to this bike category.

The stabilization of a new gravel bike standard and its integration into the global sport cycling market has quickly triggered the reopening of the closure process. Starting around 2020, the gravel bike market category began to evolve into different sub-categories much as had occurred with the mountain bike. At the beginning of the 2020s, it was possible to identify gravel bikes on the market for slightly different uses: those closer to racing bikes, to be used only sporadically on unpaved terrain, under the category of endurance or all-road bikes (with tyres between 28 and 32 mm); the gravel race category, which included bikes specifically dedicated to gravel competitions, usually based on expensive carbon frames and optimized for fast performance on rough terrain, as in the case of the Salsa Warbird (with tyres between 35 and 42 mm); the bikepacking category, which was explicitly intended for hiking and off-road touring and takes its name from the need to attach different types of small to medium-sized bags to the frame (with tyres that can exceed 50 mm or 2 inches); and the e-gravel category, which was characterized by the addition of an electric motor and batteries to a standard gravel bike, making it capable of helping cyclists in need of artificial support.

The market interest in gravel bikes is also reflected in the rapid evolution of gravel biking as a sport discipline. An essential marketing approach in the sports bike sector is using the sponsorships of cycling athletes and races as key marketing tools (Mari, 2021: p.77). It is therefore interesting to focus on the process of integrating gravel cycling into the official bike disciplines sanctioned by international bodies, with the support of large bicycle corporations. From 2018 onwards, efforts by the UCI to propose gravel biking as one of its official disciplines began to multiply. This strategy was not an immediate success because when the representatives of US cycling met with the organizers of original grassroots events, they met with a rather cool reception (Welch, 2020). This was predictable as the earliest events embodying the original Spirit of Gravel had been in open opposition to the rules and organizational constraints of the UCI-sanctioned *gran fondos*.

This negative reaction to US cycling attempts to co-opt several of the earliest grassroots events led to a delay on the side of the UCI in establishing a gravel championship. This was held only in 2022 when two different gravel-sanctioned events were organized: the Gravel World Series, which consisted of a series of 12 races organized on three different continents; and a single World Championship race, organized in Italy in October 2022. Although these UCI-sanctioned events

attempted to keep alive some of the characteristic aspects of the original gravel events, including allowing amateur riders to participate, they nevertheless radically transformed the overall approach of the original gravel events, making them much more similar to the European model of road races and thus embracing pro-cycling established business models. The organization of the first gravel world championship in Italy, rather than on the original gravel roads of the US Midwest, was criticized by the original gravel community because it was evidence of a disconnection of the new gravel cycling discipline from the original roots of gravel cycling, a disconnection that included the reintroduction of the segregation of women from men in the race (Torres-Davis, 2022). Overall, the emphasis on the participation of professional or semi-professional riders and the emphasis on a competitive dimension are examples of how the original gravel spirit had been overturned to accommodate a different sociotechnical framework.

At the same time, some of the original grassroots races underwent a process of commercialization and consequently refocused their approach, emphasizing the presence of sponsored riders and monetary prizes for winners, as in the case of the Dirty Kanza, the most famous race of the original gravel scene. This race, which was born as a local, volunteer-based event in 2006 with about 50 participants in the inaugural event, by 2015 had been turned into a large competition with 3,000 paying participants, and was acquired in 2018 by a sports events agency, Life Time Grand Prix. After changing its name to Unbound Gravel, the event adopted a market model similar to gran fondos and other sanctioned competitive bike races, charging high entry fees (up to \$270) to a mass of participants in order to pay large prize money to ‘privateers’ supported by corporate sponsorship. This was all too apparent in the Unbound Gravel of 2022 when the global firm Specialized sponsored the participation of Peter Sagan (three-time world road champion). Sagan competed in the event as a marketing strategy to give visibility to a new gravel bike model, expressly targeting a new consumer sector interested in buying expensive gravel bike optimized to gravel races (Scott, 2022). In short, a new sociotechnical framework had emerged under pressure from an array of commercial actors, which included bike firms, sports agencies and sporting bodies. In this new framework, the original approaches and motivations of early gravel enthusiasts were downplayed in favour of the marketing-driven, competition-based model of cycling racing.

Conclusion: user betrayal in the gravel bike case

The sociotechnical evolution of the gravel bike offers a clear example of how end users, cycling enthusiasts, and other amateur figures played a pivotal role in developing a new cycling practice, which ultimately led to the creation of a new technical artefact. Early gravel enthusiasts pioneered an informal but coherent practice – riding race bicycles on rural gravel roads – that fostered a sociotechnical framework distinct from the one promoted by the sports cycling industry and its institutions. Their efforts laid the foundations for innovation, allowing gravel amateurs and small firms to develop niche strategies by testing new bike prototypes. Grassroots gravel events also helped define a new category of bike consumer who embraced the early commercial gravel bike models as they entered the market. On a cultural level, the emergence of a distinctive narrative around gravel cycling, encapsulated in the phrase Spirit of Gravel, provided industries with a technical and symbolic resource for their marketing strategies. These strategies soon expanded from local and national levels to the global stage that characterizes the contemporary cycling industry. In this sense, the values, needs and visions shared among early gravel enthusiasts were fundamental in shaping the development of both gravel bikes and the broader gravel cycling culture.

By introducing the concept of user betrayal, this paper highlights how the commercialization and institutionalization of gravel cycling in recent years have diverged from the original values and inputs of the early enthusiasts. The transformation of the gravel bike into a global industry product, the shift of grassroots events toward a competitive, sponsorship-driven model and the formalization of gravel cycling as a regulated sport all reflect a departure from the core values that once motivated the Spirit of Gravel. What began as a practice in opposition to the commercially

driven, institutionally regulated and marketing-led cycling world ultimately generated a new commercial market that betrayed many of the original users' values and motivations. By framing the development of the gravel bike as a case of user betrayal, this paper seeks to illustrate the tensions and contradictions inherent in user-driven innovation processes. It emphasizes how commercialization and institutionalization can reshape – or even subvert – the original values, visions and needs of user collectives. In the end, the concept of user betrayal offers an analytical tool for examining the exploitation of user input in innovation processes, bringing into focus the contradictions that arise when alternative social and cultural visions developed by user collectives are absorbed into commercially oriented innovation outcomes.

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