Tailor My Zwift: How to Design for Amateur Sports in the Virtual World

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Physical activity is entering the virtual realm. Zwift is an at-home cycling system that is enjoying increasing popularity, yet the specifics of the experience of a virtual cyclist have not been studied to date. Building virtual sports systems can make physical activity accessible to more diverse user groups. To understand how and why users engage in virtual cycling, we conducted n=22 interviews with Zwift users. Through charting the motivations behind using Zwift, we determined that it allowed users to engage in a range of cycling activities traditionally reserved for professional cyclists. Our work reports on key motivations and identifies five key strategies which Zwift uses to create an engaging virtual sports experience. Further, we discuss how Zwift creates a world of virtual professionalism. Our findings offer a structured understanding of the experience of Zwift which can be used to inspire the design of future virtual amateur sports systems.

CCS Concepts: • **Human-centered computing → Empirical studies in HCI**.

Additional Key Words and Phrases: zwift, indoor cycling, virtual sports, physical activity

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1 INTRODUCTION

Zwift[1] has taken the at-home sports market by storm. The interactive cycling application which enables users to traverse virtual routes in their living rooms while riding their bicycle on a trainer, is constantly growing in popularity. The system has hundreds of thousands of users and close to fifty thousand active users at any given time [23]. Arguably, Zwift represents the first virtual sports system with a large user base. From the perspective of Human-Computer Interaction (HCI), studying how Zwift manages to deliver a positive user experience to amateur sportspeople at home offers a unique opportunity to understand the design space of virtual sports.

Being physically active in the virtual world is an established idea. Commercial products, often classified as exergames [49], are based on motion controllers and offer opportunities for physical

[1] https://www.zwift.com

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Fig. 1. A typical hardware setting for using Zwift. The bike is placed in a smart trainer which adapts to the route on the screen, thereby offering a resistance in line with the virtual route.

activity. Possibilities include virtual exercise packages such as Zumba Fitness Rush[2], which offers a set of static exercises to be performed in front of a screen. A number of products marketed as games also include a physical activity element. Wii Sports[3] is a widely sold game which offers simplified versions of multiple sports, and may even make the users sweat. While these and similar interactive experiences do let users burn some calories, they are very far from becoming amateur sports [10]. Exergames most often focus on casual experience [25] and are not designed for continued practice or the level of control required by amateur athletes [49]. In contrast, physical activity which does not happen in a virtual world requires the right location, facilities and time of day, and often needs to compete for time with other commitments [35]. Thus, understanding how to design engaging amateur sports experiences in the virtual world can make sports more accessible and flexible. In this paper, we study the experience of long-time Zwift users to understand what design qualities in the system led to its success. Thus, we aim to learn how to design for virtual sport amateurism.

HCI research is still exploring sports experiences with a virtual component. Notably, Mueller et al. [53] connected joggers to virtually run together and showed that this experience could be built through providing audio broadcast. Møller Jensen [30] designed a set of handball exercises augmented with projections. Ahn et al. [2] studied increasing the enjoyment of static exercise by adding a game to running on a treadmill. Mueller and Gibbs [51] added virtual players to a table tennis game. Overall, there is consensus that virtual elements can make sport more engaging and social, and can aid in training. However, the majority of HCI studies in virtual sports are based on research prototypes studied at single instances of time. Consequently, there is a need to further understand the long-term lived experience of virtual sports. To our knowledge, HCI's understanding of the experience of sports systems where the entirety of the performance and competition is enacted in the virtual realm has so far been limited to studying the running narrative game 'Zombies, Run' [32]. Studying Zwift and its users offers a unique possibility to understand the lived experience of a large-scale virtual sports system, used over a prolonged period of time. Such an investigation is interestingly different than studies of exergames as Zwift focuses on performance in

[2]https://www.metacritic.com/game/xbox-360/zumba-fitness-rush
[3]https://www.nintendo.co.uk/Games/Wii/Wii-Sports-283971.html

a virtual world rather than the promotion of physical activity (as is inherent in exergames [56]).We contribute to the area of HCI for sports by identifying key features of virtual sports systems which support amateur engagement. We study a traditionally mobile activity—cycling—and its virtual static version to understand how a physical activity can be engaging through an experience of virtual mobility.

This paper investigates the lived experience of long-term virtual indoor cyclists who use Zwift. We pose that Zwift offers experiences beyond exertion, thus escaping the analytical lens of interpreting Zwift as yet another exergame. Thus, we study what design qualities allow Zwift to elicit sustained engagement in users. Through understanding Zwift, we aim to understand how to design engaging systems for virtual sports. To that end, we conducted interviews with long-term Zwift users to understand their motivations for indoor cycling, the kind of activities in which they engaged and the personal and social context of physical activity with Zwift. We constructed five themes from this data: Flexibility, Communal sports, Control, Being like a pro, and Metrics. The results suggest that Zwift engaged users by making them feel as if they were professional cyclists. We propose calling this effect profification—the grey zone between professionalization and gamification. We use the themes to identify strategies which Zwift uses to achieve profification. We elaborate on these strategies to support the design of future virtual sports systems which support continuous engagement.

This paper contributes: (1) an interview study of $n = 22$ long-term Zwift users; (2) five themes which characterize the lived experience of physical activity using Zwift; (3) the concept of profification as enacted within Zwift and (4) descriptions of five strategies for supporting engagement through profification. Here, we first introduce the Zwift system. We then discuss related work in sports, bicycles and HCI to situate our work within existing research, followed by providing the details of the interviews with Zwift users. Next, we report on the five themes we constructed from the interview data, introduce the concept of profification to describe the creation of virtual professionalism in sport and the strategies which support it, and conclude with a discussion of the future of virtual sports systems and the impact of profification on HCI for sports.

2 ZWIFT: A LARGE-SCALE VIRTUAL SPORTS SYSTEM

In recent years, a multitude of products which support at-home cycling reached the consumer market, e.g. Peloton[4], Echelon[5], NordicTrack[6]. Most of these platforms offer household access to studio fitness classes such as spinning classes, yoga classes, stretching, meditation, and HIIT cardio. For instance, Peloton and Echelon offer an exercise bike that allows users to join a livestream of a spinning class led by an instructor [6] and joined by hundreds or thousands of users at the same time. In comparison to Zwift, the cycling experience that these platforms offer differs considerably. Platforms such as Peloton give users the possibility to follow live classes from their living room, thereby offering a 'gym-like' experience from home, in which users interact with an instructor in a exercise environment. Zwift, on the other hand, creates a virtual experience of cycling, which makes it a novel experience. Our inquiry focuses on users actively engaged in virtual cycling on the virtual sports platform Zwift. Zwift is online cycling and running software that enables users to interact, train and compete in a virtual world [57]. Users of Zwift often use their regular road bicycles in combination with a stationary smart trainer that allows them to navigate through a virtual world (as depicted in Figures 1 and 2). These smart trainers include a built-in power meter which converts the user's power output (adjusted to weight) to their avatar's cycling speed in Zwift's

[4]https://www.onepeloton.com/
[5]https://echelonfit.uk/
[6]https://www.nordictrack.com/

virtual world. The device adapts the resistance to the incline of the virtual track, thereby creating an immersive virtual cycling experience. Currently, Zwift offers nine virtual worlds [83]. Watopia, Zwift's first and largest world, is always available, while two rotating guest worlds change on a monthly schedule. During a ride, a user collects experience points (XPs), which unlock levels [84]. There are 50 levels in total, and with each unlock a user receives virtual gifts such as socks, jerseys, or bike parts. Besides the XPs, a user can also collect sweat drops (for acquiring materials from the garage), route badges, or a special bike with neon wheels (the Tron bike) through climbing 50.000 meters.

There are different types of rides available [82]. A user can train in solitude, using a structured work-out or training programme. Further, many events are organised on a daily basis, consisting of group rides, workouts and races. The races are organised in different categories, based on a user's Functional Threshold Power (FTP). FTP is defined as the highest power output a cyclist can maintain in a quasi-steady state for approximately 60 minutes [14], and it is expressed in watts. Zwift in turn corrects FTP for a cyclist's weight and uses watts per kilogram to divide cyclists in categories, to ensure competitors are evenly matched.

Despite its popularity, studies aiming to understand the Zwift experience are limited. Within sports science, McIlroy et al. [46] conducted an analysis of opportunities and threats involved in virtual cycling. In their essay, they concluded that Zwift and other similar platforms offered possibilities for increased engagement and flexibility. They also pointed to threats such as cyber-doping and de-skilling [22]. These findings were based on a theoretical analysis rather than studying Zwift users. To our knowledge, the only systematic, empirical study of Zwift in the literature is by Westmattelmann et al. [77] and presents Zwift from an information systems perspective. Their study focused on the acceptance of Zwift as an example of a mixed reality technology and using information systems acceptance theory to identify factors contributing to acceptance. In contrast, this paper aims to introduce an understanding of Zwift to the HCI community, focusing on the lived experience of virtual cycling and understanding the design qualities and resulting user behaviours in Zwift which enable engagement in a virtual cycling world. By doing so, we aim to build an understanding of the interaction involved in an engaging virtual sports experience. This, in turn, offers new opportunities for understanding how to design virtual experiences for sports. Zwift escapes the traditional lens of exergames as 'videogames that require physical activity' [56]. Instead, it is a physical activity enacted in a video game. Further, Zwift cannot be fully interpreted using our understanding of gamification—while Zwift does introduce game elements to cycling, the activity of cycling (in real life or using Zwift) already constitutes play [16] and thus does not fulfil the definition of 'the use of game design elements in non-game contexts' [21]. Consequently, this paper argues that Zwift represents a prime example of a potentially new class of systems for virtual sports. Zwift users represent a new class of users for HCI for sports beyond the two widely studied user types: those who require motivation to start an exercise routine (e.g. [72, 73]) and highly active users looking for technologies to improve training (e.g. [28, 34]). Those using Zwift have decided to (temporarily or not) move their physical activity to a virtual system. This constitutes a user group which is likely to demonstrate a different set of motivations, attitudes and behaviours than users of earlier exergames and gamification systems.

3 RELATED WORK

Our inquiry extends beyond previous work in the HCI for sports area. First, we discuss past efforts in building engaging systems for sports with virtual elements. Further, we discuss previous research on sustaining motivation and engagement in sports with the support of technology. Finally, we chart past studies on interacting with technologies while cycling.

Fig. 2. Zwift offers nine worlds to the user. Zwift's biggest world, called Watopia, is always available. The app also features two rotating guest worlds that change on a monthly schedule. While some of the routes are a simulation of the real world (i.e. the 2015 UCI Road World Championships in Richmond), other routes are fictional, e.g. Watopia.

3.1 Adding Virtual Components to Sports

This HCI field has established HCI for sports as an active research area. Past research addressed different kinds of physical activity [55], including jogging [52], outdoor sports [31], or cycling [66]. As the research matures, we see a shift from the need to understand usability constraints and charting the design space of sport applications to understanding the specific intricacies of how technology mediates our experience of sports [74]. From that perspective, studying virtual sports offers the possibility of broadening the scope of HCI for sports. While many works have to date focused on dealing with the unique requirements for technology for sports and the messiness inherent in using technology while being physically active [71], the study of virtual sports allows focusing on the technology-mediated experience of sports. Our work is interestingly different from past efforts in HCI for sports, because it explores how technology creates new types of engagement and builds new possibilities of experiencing sport.

Work in the HCI for sports [48] area has until now focused primarily on generative contributions based on prototypes that alter the nature of particular exercises. Notably, Mueller et al. [53] explored how running could be made more social by building a system which allows audio sharing between running users. Tang at al. [70] applied this idea to design a system which allowed completing rehabilitation exercises with remote users. Similarly, Møller Jensen et al. [29] added interactive elements to football practice to make exercises more engaging, and Turmo Vidal [73] augmented physiotherapy with light feedback to increase body awareness. These examples show that adding virtual elements to sports can have a positive impact on the user experience and enhance particular aspects of sports practice.

Another strain of work explores how interactive technology can be used to solve particular difficulties associated with a sports discipline. Clairbuoyance [34] was a system which helps users navigate while swimming and train for open-water races. Altimira et al. [5] showed how skill differences between players could be adjusted to offer more equal play in a tennis game where players have different skill levels. Gradl et al. [27] conducted a survey which showed that players at clubs were eager to use augmented reality to aid in elements of their training. While these systems show that delegating parts of sports performance to technology is appreciated by users, the core of

the activity in these examples remains in the real world. Few systems have attempted to move the core of the physical activity to the virtual realm. A notable exception is the application 'Zombies, Run!' [32], which featured a series of audio stories which dynamically reacted to the user running. Here, the exercise performance was fully controlled by the virtual system and the system offered an alternative to classic training.

All in all, the examples above show that interactive technology has been primarily used to augment the experience of sports. This was achieved by making sport more social, including players of different skills, increasing training awareness or helping with particularly difficult tasks. Hence the design goals were primarily lowering entry barriers and/or making sport more enjoyable at a given time, rather than fostering long-term engagement. Martin-Niedecken et al. [44] observed that that there was a trend for designing games for physical activity with either fitness or play as the focal point. Our work explores a different case—creating an experience where the physical activity is enacted entirely in the virtual realm. In Zwift, the design goal is neither play nor fitness; it is enacting an activity already enjoyed by the user in a new environment. Further, contrary to most past examples, we look at the experience of long-term use of a commercial system rather than focusing on atomic studies of prototypes. Our work challenges the notion of interaction in motion [43] as a lens for understanding HCI for sports, as motion becomes a relative term in the world of virtual sports.

3.2 Motivation for sports and amateurism

Recent years have seen a proliferation of technologies which claim to increase the users' motivation for practicing sport, e.g. Runtastic, My Fitness Pal. These platforms let users track their performance and compare it against others while using gamification concepts to keep them engaged and motivated [64]. In HCI work, motivating physical activity is also a strong theme. Early work in HCI for sports focused primarily on helping inactive users start physical activity routines. This design goal was supported by design guidelines by Consolvo et al. [17] and numerous examples of applications such as Chick Clique [72] or RunWithUs [26]. Later work investigated the need to support those already committed to an activity routine [35]—advanced amateurs. So far, studies of advanced amateurs focus on understanding the design constraints for technology, e.g. [71] or supporting competition performance [18, 78]. While these examples have charted the path for technologies for advanced amateurs, there is still a need to study how they can be supported to sustain motivation over a longer period of time. To that end, our work explores how advanced amateurs use training technologies over multiple seasons.

3.3 Cycling in HCI

Cycling is a topic which has recently received increased attention in HCI. The research field of HCI for cyclists encompasses various domains such as mobile interaction [20, 75, 79], safety, and simulation [41, 58, 76].

HCI studies cycling both as a means of transport and as a sport. A recognized challenge is designing systems which allow cyclists to complete secondary tasks while cycling. Dancu et al.[20] attempted to increase the safety of cyclists by moving the map used for navigation to in front of the bicycle using a small projector. Thus, cyclists were able to observe their environment while keeping track of their position and upcoming turns. Woźniak et al. [79] designed a solution to interact with a mobile device via buttons built into the handlebar. As cyclists prefer not to take their hands off the handlebar during interaction, this allowed them to stay safe while accepting phone calls or switching songs. In these and many other [4, 19, 20, 60, 75, 79] systems, the underlying design goal is cycling safety, which takes priority over other aspects of the systems. In contrast, our work

explores a case where safety is not a concern as the experience happens at home, allowing us to focus on other aspects of cycling.

Understanding and improving cycling performance was also a topic of past studies. Through an online survey with 227 participants Piwek et al. [59] found that self-monitoring was mainly suitable for performance-oriented rather then recreational cyclists. This suggests that performance metrics are relevant for supporting amateurism in cycling. Multiple systems which used virtual bike simulators were developed to build systems to enable cyclists to ride more safely or improve their navigation. Solutions used in past work range from external screens in front of the fixed bike [45], through cave setups [76], to immersive virtual reality setups [41, 58]. Such environments were used not only to improve participants' safety, but also to increase their athletic performance [37]. While these works show that virtual environments can be used to enhance cycling performance, no prior systems studied in research attempted enacting a group cycling experience in the virtual work nor did they propose virtual cycling beyond training. Zwift is interestingly different from past systems as it offers an engaging, competitive and social experience.

We observe that the majority of the work in HCI and cycling focused on the bicycle as a mode of transportation. Further, research investigated interaction techniques and feedback modalities with the design goal of deploying such techniques in traffic. Our work offers an alternative lens to understanding the role of HCI in cycling. As Zwift is designed to be a controlled environment which removes safety hazards like fast movement speeds and traffic due to its lab-like setup, the focus of the interaction shifts towards the virtual world of cycling. Thus, studying Zwift enables investigating aspects of cycling which have been less prominent in HCI to date, such as the experience of exertion, cycling as a social activity, or engagement in cycling training.

4 METHOD

We conducted semi-structured interviews with Zwift users. We chose the interview format as it enabled us to build an in-depth understanding of users' experiences with indoor cycling and using Zwift. A retrospective interview was our method of choice, as we endeavoured to study users who were committed to using Zwift regularly and had considerable experience in using the system to study it long-term experiences.

4.1 Participants

We used our social networks combined with snowball sampling to recruit $n = 22$ participants. One criterion was used, namely, all participants had to use or have used Zwift. The participants were aged 25–59 years, $M = 41.64$, $SD = 10.80$. Fourteen interviewees identified as male and eight as female. One participant was a resident of Turkey and all others were residents of the European Union. Participants were interviewed in their native language or English. We used Zoom and Microsoft Teams to conduct the interviews and record audio. Before the start of the interview the participants were asked for consent for recording and were informed that they were allowed to terminate the interview at any time. We provided gift vouchers for EUR 15 as remuneration. Table 1 presents details about the participants.

4.2 Interview protocol

The interview started with obtaining consent for recording and basic demographic data collection. We then inquired about the user's background with exercising in general and their reasons for starting to use Zwift. We also asked participants about their set-up (e.g. the type of smart-trainer, emplacement in their home) so that we could properly contextualize later parts of the interview. Additionally, we asked questions about their training sessions in Zwift (e.g. Can you take me through an average week of training?), followed by an inquiry of the participant's experience

Table 1. An overview of the participants in the interview study. Participants use different types of trainers to interact with Zwift. Most participants use a direct-drive smart trainer, which requires them to remove the rear wheel of their racing bike and connect the bike to the trainer via a standard cassette. A wheel-on requires the user to clamp the rear axle of their racing bike into a support while the rear wheel rests on a roller drum. This drum is connected to a resistance unit that interacts with Zwift. Finally, a smart bike trainer is an indoor bike that adapts its resistance to Zwift.

PID	Gender	Age	Brand	Type of trainer	Using Zwift
P1	Female	56	Elite	direct-drive	6-7 years
P2	Male	42	Elite	direct-drive	4 years
P3	Male	31		smartbike	1-2 years
P4	Female	45	Elite	direct-drive	1 year
P5	Female	47	Wahoo	direct-drive	1-2 years
P6	Female	49	Elite	direct-drive	4 months
P7	Male	40	Tacx	direct-drive	5-6 years
P8	Male	25	Elite	direct-drive	3 years
P9	Male	54	Tacx	direct-drive	1-2 years
P10	Male	46	Wahoo	direct-drive	1-2 years
P11	Male	29	Tacx	direct-drive	2 years
P12	Male	59	Wahoo	direct-drive	1-2 years
P13	Male	40	Elite	direct-drive	5 years
P14	Male	41	Elite	direct-drive	1-2 years
P15	Female	49	Tacx	direct-drive	1 year
P16	Male	28	Tacx	direct-drive	3 months
P17	Female	25	Tacx	direct-drive	1-2 years
P18	Male	54	Tacx	direct-drive	5 years
P19	Male	54	Tacx	direct-drive	5-6 years
P20	Female	39	Elite	direct-drive	1-2 years
P21	Male	25	Elite	direct-drive	2-3 years
P22	Female	38	Wahoo	on-wheel	1-2 years

regarding Zwift's virtual world. Furthermore, seeing that Zwift collects data of the ride and shows this both during and after a ride, we inquired about the user's understanding and use of this data. Lastly, we asked participants about their social interactions with other Zwift users[7].

4.3 Data analysis

We recorded audio throughout the interviews. In total, we collected 14 hours and 53 minutes of audio. An interview lasted 40 minutes on average, $SD = 8.34$ minutes. All interviews were transcribed verbatim. The transcripts were imported into the Atlas.ti analysis software for further analysis. To build an inductive understanding of Zwift users' practices and their indoor cycling experience, we applied an iterative analysis process [61]. As a starting point of the analysis process, two authors coded a representative sample of 10% of the data using open coding in line with Blandford et al. [11]. Through iterative discussions an initial coding tree was established, which was then used by the first author to code the remaining material. Subsequently, we applied inductive coding [65] combined with iterative discussions to refine our understanding of the data. We followed the six

[7]The full protocol is included in the supplementary material.

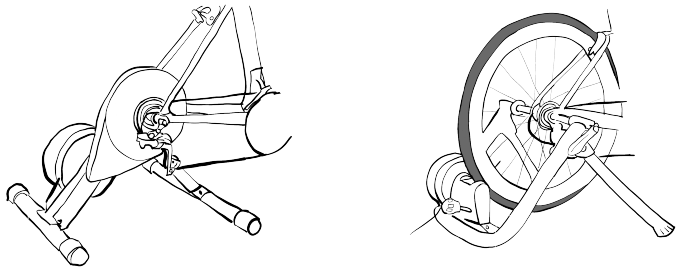

Fig. 3. Direct-drive (left) and and on-wheel (right) bicycle trainers are two devices most commonly used with Zwift. Additional equipment such as front wheel plates or dedicated bicycles (as used by P3) provide additional features such as steering with the front wheel, road surface simulation or virtual fear shifting.

phases of thematic analysis as described by Braun and Clark [15] to structure our analysis process, and through these iterative discussions, we grouped codes into candidate themes, reviewed the emerging themes, and subsequently defined and named these themes. This resulted in five themes thatdescribe the lived experience of exercising with Zwift.

5 FINDINGS

We analyzed our interview data using inductive coding in order to discover recurring themes. We constructed five themes: Flexibility, Communal sports, Control, Being like a pro, and Metrics. The themes described the lived experience of indoor cycling and the key motivations for using Zwift. In the following, we discuss each theme in detail and illustrate our findings with excerpts from the interview transcripts.

5.1 Flexibility

Many participants reported that the flexibility of virtual cycling was one of the motivators for using Zwift. Zwift enables users to more easily combine exercise with other responsibilities, such as taking care of their children. An example comes from P7, who stopped cycling on a competitive level upon becoming a father. He mentioned that having two children, a busy job and other social obligations sometimes limited his abilities to do exercise, but Zwift enabled him to do work-outs after his children were in bed:

> I now have two children, a busy job and other social obligations, while I do want to keep exercising, preferably 4-5 days a week. Zwift enables me to do work-outs while the kids are in bed in the evening. I can easily cycle for an hour, an hour and a half or do a competition (P7)

This was also recognised by P14, whose partner often has to work night-shifts, which makes him housebound several days per week. On these nights he cannot leave the house for a ride outside, yet a ride on Zwift enables him to do a work-out while his children are enjoying themselves playing with Duplo next to him.

Hence, Zwift effectively supported combining exercise with family life. Further, Zwift also creates a world in which cyclists can always pick the type of workout or event that is suited to their needs, irrespective of the time or day and without being dependent on other peoples' schedules. While this flexibility was highly valued by many participants, some reported that Zwift's flexibility could lead to injuries and excessive training. Several participants mentioned that having the option to

join a race or a social event at any given time tempted them to overdo it. Furthermore, some users were so motivated by the social and competitive side of Zwift that they neglected the need to take enough time for recovery between rides. This, in turn, led to over-training and even injuries.

Another advantage to Zwift noted by users was that the system allowed for escaping the stereotypes associated with cycling. Users reflected on how the sport of road cycling is associated with a complex sports culture which can often be exclusive or biased (also shown in the field of leisure studies [7]). Thus, users who were uncomfortable with some of the parts of the culture, but still attracted to the physical activity would choose Zwift:

> Health problems run in my family, which is a motivator to exercise and not gain weight. That's why I started running, but this actually makes me very cranky. When a friend mentioned Zwift I gave it a try. I figured that the game elements in Zwift would work well for me. Trying to get a badge, doing an extra hill climb for the achievement, and other of those small things. And I can do it at home, so I don't have to travel or deal with other people. And most importantly, I can do it indoors, so I don't have to ride around like a middle-aged man in lycra. (P16)

5.2 Communal sports

Almost all participants mentioned the social aspect of riding on Zwift. Even though users were riding by themselves in either their living room, attic or garage, most described that they felt part of a community. For instance, P1 mentioned that even though she cycles alone, she still feels connected to the other cyclists on Zwift, which makes it a different experience. Knowing that there are living people behind the avatars who are also exercising in that exact moment was motivating to her, as is sending messages and so-called ride-ons (thumbs up) during a ride. For several participants (P1, P6, P15, P21) it was not necessarily talking to other users that created this sense of community, but more the feeling that they were not the only ones on their bikes at a given time. P1, for instance, mentioned that she likes that Zwift enables her to cycle with people who are just as slow as she is, while another participant described it as shared masochism. However, for some participants, riding solo on Zwift was not motivating enough. Thus, they sought new forms of social engagement.

> Zwift was a very individualistic thing to me when I just started. In the beginning, I was basically just going for rides on Zwift on my own. And the fun in that waned quickly. I also did some individual races. That wasn't much fun either. It's a nice challenge every once in a while, but that's about it. (P17)

Participants would rely stories of how they joined Zwift communities and began using the system competitively. Zwift provided almost on-demand competition with community maintainers ensuring that users at different levels could compete together. One participant described how they developed a routine of competing regularly:

> I joined the community of *The Herd*, and at a certain point during those Sunday rides—which I was doing more often—I heard something about the competitions *The Herd* hosts and their competing teams. I found out that I could register myself every Thursday for a race. I could join these races whenever they suited me, so it wasn't a big commitment. After signing up the organizers create the teams, making sure that all team members have a comparable amount of experience with Zwift, as well as comparable fitness levels. (P17)

Through these communities Zwift offered riders the opportunity to ride in a league (i.e. a ranking list based on multiple races spread over time) with riders that share the same level of performance, which was highly motivating to several participants. Some users participated in leagues effectively as they found the ranking to be an opportunity for constant improvement:

> There are always races, at any time of the day. And during these races you can always measure yourself against people of a similar level. And that is incredibly motivating; it challenges me to get better and better. I just want to beat the person who is riding in front of me. (P13)

Some participants who were more involved with the Zwift races and competitions also mentioned that the platform allowed them to connect to people with the same passion and mindset. Furthermore, they highly valued the contact they had with fellow team mates during the team meetings, enjoying the shared race anticipation:

> So I ride in a team [consisting] of six people. We've never met in real life. But nowadays, with social media and with Whatsapp, you have so many options to communicate with each other. And because you also share the same passion for sports and you are all on the same level, it also gives you a lot of motivation to improve, you motivate others to improve. During the races there is just real live communication with each other about tactics. (P13)

5.3 Control

Being more in control of their ride was an important motivator for participants to use Zwift. This extended itself to seasonal changes, weather conditions, having full control over the training schedule and safety. Several participants only used Zwift in the winter, or when it was raining outside. However, for most participants the control that indoor cycling offers them regarding the structure of their training was what most attracted them to Zwift. Often, participants mentioned the use of its ERG mode. In this mode the trainer automatically adjusts the resistance to the structure of the training. This proves to be very useful when riding intervals, where the rider needs to switch back and forth from low to high power outputs. Doing interval training outside is not only more difficult because of the lack of an ERG mode, it is also because of all the external factors that are impossible to control, such as traffic lights and other traffic:

> It is much more difficult to do a structured training outside. That's really tricky outside, [because of] traffic, intersections, and traffic lights. So [outside,] you really have to look for specific stretches of road, while if I set that on Zwift I just get a minute high, a minute low. Done. (P2)

For other participants mostly the unpredictability and possible safety hazards caused by other traffic was a motivator to use Zwift. For instance, P15 mentioned that she dares to ride faster on Zwift because falling is not a risk. On Zwift she races down a mountain, while she would never dare to do so outside. This is in line with a comment made by P10:

> When I cycle outside, and I think that this also might be my age, I find it too nerve-racking to cycle in a peloton. You have a very high risk of falling, you are close to other cyclists. In Zwift you do not have that risk, and after five minutes I no longer realize that I am cycling inside. Then I am completely in that world, only focused on what is happening in front of me on the road and who I can and cannot overtake. So then that difference disappears and I can still do the things I wouldn't do outside. Like cycling competitions, because you will not see me cycling a competition outside. I think that's too risky. Outside I am more of a touring cyclist; inside I put on the competition hat. (P10)

5.4 Being like a pro

Several interviewees showed almost a professional attitude towards training and competing using Zwift. These participants still considered themselves to be amateurs, but were, at the same time, very serious about the competition:

> I ended up in the team time trials *The Herd* organizes on Thursday. As a newbie the more experienced riders really take care of you. They are very supportive. And when there was a shortage of riders in The Dolphins team (one of the teams of The Herd) I received a Facebook message asking me if I could join that team for one of the races, which I did. After that race, I was completely hooked. The team is just so supportive, the more experienced team members share many useful tips and tricks, and everyone helps each other out. This really encourages me to try to be the best version of myself and to me that's just awesome. (P17)

Participants would organize team meetings in which they discussed race strategies the type of (virtual) bike that would be fitting for the parcours (i.e. the virtual level on which the next race would take place). For these participants, the race anticipation and the discussions and meetings with team members are a source of enjoyment and fun. Many participants were formal and serious about the strategic planning. This was particularly important for advanced users who also engaged in forms of verification and additional means of ensuring fair play:

> It is so serious that, for example, in the premier division you also have to make a video there, and indicate the weight you have entered is also correct with the scales. You have to make a video of that; your height, your power source, and your trainer, but you also need to have a second power source, so you have to supply a power meter with data. So it is all pretty serious, you don't just do these [Zwift] competitions on the side. You really have to train for it if you want to compete at that level. (P18)

The training schedules which most of these participants used were also subject to team coordination and a professional attitude. P17 mentioned that her (and her partner's) Zwift schedules were almost sacred; all other responsibilities and activities were planned to accommodate Zwift. Participants would rehearse strategies which would be later enacted during a race with intense communication between teammates, as seen in professional cycling:

> We use Discord and through that platform we communicate live during the race, just like the pros. Not that we see ourselves as pros, not at all. But we talk a lot about tactics, about how people are feeling during the race. [...] We also have a coach, who is watching the competitors during the race. And the coach gives tips about heart rate, how fast they [the competitors] are riding, how much power output they have. So we even take those kinds of things into account. We handle these things very professionally, despite riding on an amateur level. (P13)

5.5 Metrics

Many participants value the ride data that Zwift collects. Both during and after the ride the platform shows several metrics, such as wattages, speed, cadence and heart rate (when using an external HR monitor). These metrics allow users to monitor their improvements, which most considered to be very motivating. P12 mentioned that looking at the data after a ride is always enjoyable to him. Especially when his ride went really well, he felt like it gave him an extra boost, and was a big motivator to get back on the bike again the day after. Furthermore, Zwift offers users a controlled setting in which cycling performance data can be collected with more accuracy. Cycling indoors on a smart trainer creates a lab-like setting in which there is less noise from external factors, allowing

for 'cleaner' data. One of our participants mentioned that he often uses a specific route in Zwift to measure his improvements:

> What I really like is the Alpe du Zwift, a [virtual] replica of the Alpe d'Huez. I am always trying to improve my time, and I really feel like I am working towards something when I climb a mountain. With climbing there is less to gain from cycling with others, because you're only riding 10 kilometers per hour, so you have less air resistance. This really gives the feeling that you have only yourself to thank for the accomplishment; your time is not influenced by cycling together with others. So in my opinion that creates a 'true test' so to speak. (P21)

Yet, to some users the data analysis capabilities and metrics that Zwift collects are a bit too minimal. P2 described that the data overviews are useless to him because the metrics are gamified. He wants to do further analysis of the data, but Zwift doesn't offer enough abilities to compare workouts. Instead, he uses Training Peaks, a platform specialized towards endurance sports training analysis and schedules. Almost all participants reported using additional platforms next to Zwift. Often mentioned platforms were Strava and Garmin Connect, yet the interview data showed a wide variety of different platforms, plugins, and other workarounds such as manually entering data in a spreadsheet. Some participants used Strava to combine their Zwift ride data with the data collected during rides outside. For others the motivation to use additional platforms was fueled by the lack of data analysis possibilities within Zwift, cf. P2. Yet, more notable, was that several participants used other platforms or tools to view their performance through different or additional metrics. For instance, P8 links everything to Strava, because that platform gives him the possibility to see data about his fitness level and fatigue. He in turn uses these metrics to adjust his training schedule to his physical state. This is in line with what P19 mentioned:

> I use Xert, which gives very extensive statistics. You can also link it back to Strava, and everything I upload in Strava will automatically upload [to Xert]. So you can see all kinds of graphs in Xert. The only thing that is missing is a power meter for my outdoor racing bike, which Xert really needs [for the analysis of the data]. So for everything I do indoors, I can see exactly what my progress is, how things are going. (P19)

The use of this variety of platforms allows users to create a personalized ecology of metrics. The interview data demonstrates a lot of diversity regarding the types of metrics participants value. For instance, the more competitive Zwift users often mention watts per kilogram and how it influences a race, while users who are less focused on competing more often mention metrics such as calories and heart rate. This multitude of different performance metrics allows users to select those that are meaningful to them. Furthermore, through this selection each user assembles an ecology of metrics which leads to a personalized definition of achievement.

6 PROFIFICATION

To conceptualise how Zwift effectively engaged its users in a virtual experience, we first introduce the concept of profification. Next, we contextualize our findings within HCI for sports.

The strategies described below illustrate how Zwift managed to provide a sustained engaging experience for the participants, allowing them to dedicate time to their passion and experience achievement. We find that users were able to immerse themselves in a virtual world where they were cyclists in a virtual cycling group. This was achieved by introducing design elements which supported the users' motivation to keep practicing Zwift. In HCI literature, the inclusion of playful design elements to existing activities is known under the term gamification —'the use of game design elements in non-game contexts' [21]. While gamification could be a potential theoretical lens which could explain the observations of our study, Zwift does not fulfil this definition as

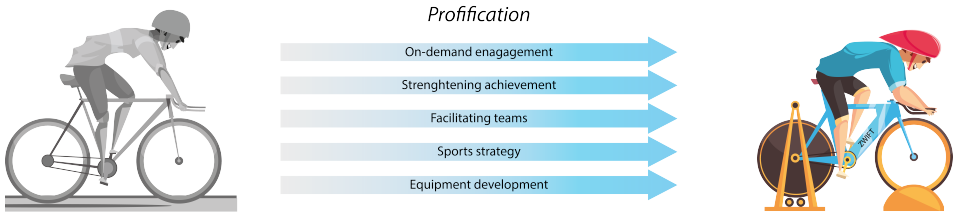

Fig. 4. Five strategies for a creating a profification experience in Zwift. We identified the strategies based on the themes constructed from qualitative data. The strategies can inform the design of future virtual sports systems.

the design focuses on an activity that is inherently playful (with inherent elements of agon and illinx [16]). Thus, it is unsubstantiated to conceptualize Zwift as a system which gamifies cycling.

Rather, Zwift makes users feel more like professional cyclists and strengthens the social aspects of physical activity through making group cycling more relevant to the cycling experience. Past research shows that playing roles different than one's identity contributes to playfuless (mimesis [16]) and social structures behind physical activity support motivation and engaged amateurism [68]. Thus, Zwift elevates indoor cycling to a higher level of engagement through making the user feel like a member of a professional cycling team, rather than altering the experience of cycling. Arguably, the design of Zwift, which embraces virtual world modelled after real-life cycling race stages endeavours to mimic real-life cycling as closely as possible. For brevity, we propose using the portmanteau term profification—the grey zone between professionalization (stemming from the Latin verb profiteri) and gamification (to underline the use of additional playful elements in the design of the system)—to describe this process. We argue that a new term is needed as the process observed is neither gamification (i.e. cycling is inherently playful) nor professionalisation (the hard to define [1] process of transforming a trade or occupation into a profession—cycling is already a profession for certain individuals). Finally, we propose using a new term to avoid ambiguity and differentiate our work, which focuses solely on the interaction and user experience aspects of the system, from extensive past work in the social sciences on the notions of profession, professionalization and professionalism [24].

Our results show that profification is a complex process which is enacted differently for a different users, yet the interview data shows that the users did experience an increased sense of professionalism, which is particularly apparent in the BEING LIKE A PRO theme. Further, we observed how users personalized their experience to engage in their preferred level of professionalism by tailoring their participation in competition and group activities (COMMUNAL SPORTS). To further understand profification and use the concept to inform the design of future sports systems, we identified five strategies, which Zwift uses to build a profification experience.

7 STRATEGIES FOR SUPPORTING PROFIFICATION

Figure 4 shows an overview of how Zwift employs the strategies to provide the user with a profification experience. We posit that these strategies create the unique lived experience of imaginary professionalism that is key to Zwift's success. Next, we describe each strategy in detail. Each strategy is based on one or more of the themes identified during the qualitative analysis. In each strategy description, the corresponding themes are marked using SMALL CAPS. We suggest that the strategies listed below can be selectively applied to develop new virtual sports systems. Enacting profification can lead to increased engagement and playfulness in physical activity in the virtual world.

7.1 On-demand engagement

Committing to practising a sport at an advanced level often requires commitment in terms of time. The days of professional athletes are filled with practice, but advanced amateurs often face tensions between their professional and social obligations and finding time to train [35]. As we observed in the FLEXIBILITY theme, Zwift facilitates practising sports when desired. Users in our study found many opportunities to engage in rides within their personal time constraints. However, once a training routine was established, any changes to timing were undesirable, cf. BEING LIKE A PRO. Compared to real-life cycling, Zwift more effectively enabled establishing a routine at socially desirable times. This led to lowering the effort required for regular group training and supporting profification. As being unaffected by the weather and the time of a day is a key asset for virtual sports systems, *future designs should emphasise the temporal aspect of training and support users in their virtual training to find a better consensus between training and other responsibilities.*

7.2 Strengthening achievement

Many amateur sportsmen declare that they train for the sake of training, while others are motivated by competition [81]. In real-life amateur sports, most participants do not compete to win. In contrast, Zwift offers an experience of the win being within reach by fostering team rides and matching users to leagues based on their performance level, as seen in the COMMUNAL SPORTS theme. This, in turn, not only serves as an additional source of motivation for users motivated by competition, but also contributes to building communities by setting a common goal. The feeling of achievement in Zwift is further strengthened by fostering an impression of a fair competition where riders are on a similar level and have access to similar, controlled exercise settings, as we observed in CONTROL. In BEING LIKE A PRO, we saw how users enforced additional community-driven safety techniques to further increase fairness. Thus, Zwift goes beyond the badge and achievement system known from classic gamification approaches by attaching an increased social meaning to progress. Consequently, *future virtual sports systems should foster socially relevant forms of achievement and a feeling of fair competition.*

7.3 Facilitating teams

Studies in sports ethnography have long shown that building a sense of community is important for prolonged engagement in amateur sports [68]. The results of our study show how Zwift uses that fact to sustain engagement with it. In the COMMUNAL SPORTS theme, we observed that the majority of users took part in team events and found that Zwift was a means of sharing their passion with like-minded individuals. Through providing extensive CONTROL over the training environment, Zwift empowered users to strive to become respected teammates and regular contributors. Interestingly, many users did not particularly value a direct connection with others, e.g. through voice chat. This is in contrast with systems like jogging over a distance [53], which postulated that a feeling of presence of another individual was desirable for a shared sporting experience. Rather than exchanging messages and sharing experiences, many Zwift users were socially engaged through the formalized network of teams, leagues and races. Strategy was discussed primarily outside of activities (BEING LIKE A PRO). Consequently, the experiences of Zwift reported in our study suggest that *future virtual sports systems should support formalized social relations and communication outside the sports activity while leaving in-exercise communication as an option.*

7.4 Sports strategy

In cycling, advanced strategies are usually the domain of professional teams competing in events. Professional cyclists optimize posture, equipment and their behavior to maximize results for the

team [12]. In our study, we found that Zwift provided its users with new possibilities to develop individual and collective strategies. In BEING LIKE A PRO, we observed how users discussed equipment choice and aimed to optimize their virtual gear for a particular course. The METRICS provided by Zwift allowed users to analyze how effective particular strategies were in races and plan for further improvement. Finally, strategy further increased the experience of COMMUNAL SPORTS as it provided triggers for content-oriented discussions within teams. This suggests that *future virtual sports systems can benefit from providing the facilities for amateur analytics for enhanced reflection. Further, providing users with the tools to discuss, plan and enact in-activity strategies is an effective strategy for fostering sustained engagement.*

7.5 Equipment development

Our results show that customizing clothes and bicycles was an important part of the experience for many of the users in our study, as seen in BEING LIKE A PRO. Changing virtual equipment was not only a means to personalize one's experience, but also a topic of team discussion and part of strategy. Zwift allowed users to enter a realm usually reserved to professionals—choosing from a wide variety of top-level equipment alternatives. This impression is further strengthened by showing the equipment in locations where professionals usually compete, e.g. by 'visiting' a famous parcours on a branded bicycle, cf. METRICS. By doing so, Zwift allows users to benefit from the positive emotions associated with using equipment which is used by professionals. This is particularly relevant as it has been shown that amateur sportsmen believe that professional equipment positively affects their performance [39]. Thus, Zwift effectively introduced equipment as another challenge and opportunity for sport performance. The lesson learnt for future systems here is that virtual equipment can have a social and personal meaning to users. *Future systems can make use of virtual professional equipment as a means of fostering motivation and enhancing social sports.*

8 DISCUSSION

So far, we have discussed how Zwift's success can be attributed to its users feeling more like professional cyclists. Here, we discuss how our understanding of Zwift contributes to the HCI for sports research area. Further, we discuss the limitations of our work.

8.1 Zwift in the HCI for Sports Landscape

Interactive technology for sports has primarily been used to augment the experience of exertion. Previous work on cycling in HCI mostly focused on cycling as a mode of transportation, and most technological solutions were aimed at augmenting the outside cycling experience [4, 19, 20, 60, 75, 79]. In contrast, Zwift creates an experience that is enacted entirely in the virtual realm. Consequently, Zwift is a case that challenges the notion of interaction in motion [43], as motion in Zwift is a relative term. In systems which were studied in the past, the motion happened in the real world and traversing space was key quality of the experience. Our study of Zwift illustrates a need to further study cases where motion happens in the virtual realm and the user is static. Based on our results, we observe that the limited relative motion of pedalling and the exertion associated with it can elicit strong emotions and engagement. This suggests that future systems for sports could possibly explore limiting motion in favor of virtual experiences as a means of engaging users. Further, redefining motion as an experience rather than a physical phenomenon emerges as a challenge for HCI.

Zwift shows new directions in which virtual sports systems can develop to better support engagement and the wellbeing of their users. The five strategies which we outline above can serve as design patterns for bringing other sports into the virtual realm. Further, they also show a need to

shift from the motivation-driven dominant narrative present in most exercise systems and research, e.g. [33, 72, 80] to a broader set of potential user goals which a virtual sports system should support. Our study shows that users employed Zwift for purposes of self-realization (BEING LIKE A PRO) and fostering team spirit (COMMUNAL SPORTS). This implies that Zwift showcases the importance of pursuing experiences of meaning in physical activity, cf. [47, 54] both on individual and social levels. Consequently, our study and the strategies proposed show how future designers can effectively explore new design goals and user profiles in virtual sports systems.

8.2 Physical Activity Beyond Exergames

Mueller et al. [50] defined an exergame as a digital game where the outcome of the game is predominantly determined by physical effort. Thus, it would be possible to conceptualize Zwift as an exergame. However, exergames are often framed as a potential solution for people who struggle with physical activity [13], and may be tailored to increase physical activity of users who are not intrinsically motivated to exercise [8]. Most exergames face the problem of users' motivations waning after the novelty of the game wears off [42]. This is in contrast with our participants' lived experience of virtual indoor cycling. As opposed to regular exergames, Zwift also attracts the more experienced athletes. It offers a tool that supports users to enact the plan they already have. Further, cycling with Zwift was perceived as entirely new activity and requires alternative equipment. Thus, Zwift is not comparable with exergames which add additional game elements to an existing activity, e.g. [40]. Consequently, we argue that Zwift cannot be classified as an exergame, but rather as a virtual sports experience.

Our inquiry suggests that Zwift blends elements of eSports (treating virtual experience as equally meaningful to real life), exergames (sport equipment as controllers) and spectator sports (supporting teams) to enhance the cycling experience of its users. In Zwift the exertion is core to the experience and part of the motivation and enjoyment of users. Yet, unlike earlier systems that added additional features to training, e.g. [29], Zwift offers a new experience altogether. The participants in our study clearly differentiated between Zwift and real-life cycling, yet they had goals and aspirations in both (or, for some, only in Zwift). Thus, Zwift was not merely a training device, but a sport form of its own. This represents a possible new frontier for HCI for sports—designing virtual sports which can be practised alongside established activities, offering flexible engagement.

We hypothesise that many of the observation in our study can be explained by the fact that long-term use of Zwift caused the users' perception of the app shifting. For most, Zwift was initially an additional indoor training device, offering a reasonable alternative to outdoor cycling in adverse weather (or without the need to wear clothing which they found undesirable). Later, Zwift became on activity standing on its own—a form of activity that offered benefits distinct from other ways in being physically active in the lives of the participants (instead of simply replacing outdoor cycling). Profification enabled Zwift to offer an experience beyond a video game with a bicycle as a controller. Zwift became a form of serious leisure [69] where Zwift performance did affect the wellbeing of the participant and became a significant part of their life. One could draw parallels to the process of how gamers profesionalize and become participants in e-sports [67]. There are, however, key differences between the world of e-sports and Zwift. First, our results (cf. BEING LIKE A PRO) show that Zwift is deeply embedded in real-life cycling culture. Parallels to the professional world of cycling facilitate Zwift training transitioning into serious leisure practice. Second, despite users varying significantly in fitness levels, Zwift is designed for balancing user proficiency and, consequently, offers an inclusive experience. Thus, users are engaged in professional-like activities even if this would not be possible in real-world cycling. Our study implies that these two factors contribute to Zwift integrating into the fabric of the participants' everyday lives.

8.3 Limitations & Future work

We recognize that the framing of our work has certain limitations. First, we would like to emphasize that we endeavored to build an understanding of the widespread success of Zwift and the lived experience of its users. Hence, the reporting in this paper focuses mainly on charting the particular design qualities of Zwift which allowed it to achieve unprecedented success. Our participants also shared concerns, and shed light on some of the negative aspects of Zwift. For instance, some participants reported that Zwift's FLEXIBILITY could lead to injuries and excessive training. Several participants mentioned that having the option to join a race or a social event at any given time tempted them to overdo it. Furthermore, some participants were so motivated by the social and competitive side of Zwift that they struggled to take enough time for recovery between rides. This, in turn, led to injuries for some and even over-training for others. Consequently, our results suggest that sports addiction may be equally a problem for virtual sports as it is for traditional physical activity [38]. These concerns were also echoed by an analysis by McIlroy et al. [46] who noted that while Zwift did limit injury risks compared to real-life cycling, it also increased the risk of dehydration [62]. Recent reports also showed that a doping culture had developed within Zwift [63], which may indicate that Zwift competitions may reach unhealthy levels of intensity. Future virtual sports systems should investigate how excessive training can be prevented.

We introduced the concept of profification to accurately describe the phenomena which we observed in our study. We remark that, as any interpretation stemming from a qualitative analysis, profification is not a fully defined concept and it cannot be fully separated from other factors affecting the user experience. We cannot exclude the notion that, for example, the size of one's social network or the level of activity of real-life cycling clubs also significantly influenced how the users our study perceived virtual cycling in Zwift. It remains a challenge for future studies to examine if profification is present in other contexts and, potentially, develop theoretical models behind in it. This, in turn, would enable studying how making the interplay between users feeling like professionals and other factors previously known to influence the experience of play.

Moreover, most participants identified themselves as avid cyclists before joining Zwift. Finding motivation for exercising was not experienced by our participants. The scope of our work does not make it possible to determine if profification strategies are motivating to all types of users, and future work should inquire if these strategies would also motivate beginners. It is likely that the perception of proficiency should be gradually developed. We recognise that the lack of inexperienced cyclists in our sample could constitute sampling bias. Yet, we also observe that cycling is the unique sport where virtual competition has been present on the top professional level, contrary to e.g. skiing or golf [36, 77]. Thus, the visibility of Zwift is high among those actively interested in the sport. While there is no data available, to our knowledge, on how many Zwift (or other virtual cycling system) users are not advanced cyclists, our study and other evidence suggests that real-life cyclists are the primary user group. This is supported by Westmattelman et al.'s [77] study who recruited solely professionals and advanced amateurs.

Even though we consider our sample to be balanced in terms of Zwift experience, a possible limitation of our work could be that we interviewed primarily long-term Zwift users. This could mean that the data excludes users who were early in their Zwift journey or decided to quit Zwift early in their experience. However, the sustained growth of Zwift [23] suggests that there is a significant share of users who continue to use Zwift. While we focused on success stories in virtual sports, future work should also investigate failures and build an understanding of how to make virtual sports more inclusive.

We note that Zwift represents a single instance of a virtual sport system which focuses on a single sport. Cycling is a unique activity with its own culture and a large community [3]. While

we do believe that our observations and strategies for profification can extend to other sports, it remains to be explored by future studies. Arguably, different endurance sports share many features in terms of designing systems which support physical activity [9]. Consequently, we believe that our insights can be effectively translated to physical activity experiences which have a relatively long duration. We remark that the applicability of our work to more dynamic sports which require less endurance, e.g. strength training, or sports which can only be practised in a team is a limitation of the present study.

9 CONCLUSION

In this paper, we offer a structured understanding of the experience of Zwift through 22 semi-structured interviews with Zwift users. We constructed five themes based on the interview data: Flexibility, Communal sports, Control, Being like a pro, and Metrics. These themes describe the lived experience of indoor cycling and the key motivations for using Zwift. Additionally, we observed that Zwift made users feel like professional cyclists, and we introduce the concept of profification to describe the grey zone between professionalisation and gamification. Finally, our work offers five strategies that can be used in building a profification experience. We hope that our work contributes to the understanding of users' lived experience of virtual indoor cycling and will inspire the design of future virtual amateur sports systems.

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