The role of smart objects in consumption practices.
An assemblage theory perspective on amateur cycling

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Abstract
Smart objects are more and more important in consumer behavior and consumption culture. The more these objects are integrated with the Internet, the more the consumers discover new dimensions of their preferred activities. In some cases, objects interact directly with the consumers, and some of them can be connected between each other and digital resources (platforms, social networks, etc.) giving consumers further opportunities in terms of original, varied, and changing patterns of self-expression.
In this paper, I focus on amateur cycling, which is increasingly characterized by the introduction of sensors, smart objects, and IoTs, which add new layers of meaning and experience to traditional cycling practices. This paper presents an overall framework of the complex assemblage in which amateur cycling is embedded. In describing it, I employ a special version of assemblage theory, defined as object-oriented ontology inscribed in a so-called post-humanist perspective. Empirically, the paper is grounded on secondary data and introspection.

Key words
Amateur cycling, smart objects, assemblage, digitalization, post-human

Introduction

A large body of literature exists about the relationship between consumers and consumption objects: current conceptualizations of objects as entities in a relationship with consumers are largely subject-oriented. Moreover, this literature is often implicitly grounded in a humanist epistemology, in which reality is described from the point of view of the (human) subject and objects are activated or de-activated according to the needs of humans (Novak and Hoffman, 2019). While this approach has proven to be effective in highlighting the relational properties of many consumption objects in related consumption processes, the growth of smart objects with increasing degrees of autonomy, authority, and agency suggests considering alternative approaches, namely object-oriented ontologies (Canniford and Bajde, 2015; Franco et al., 2022). Smart objects can *act* independently from consumers, engaging in relationships with other objects and resources. In some cases, these objects hold the authority to drive human behavior, as it happens with sat-nav devices. Then, it could be useful to describe IoTs and their interactions with humans and other resources as parts of larger networks and how they evolve.
In this paper, I describe a specific context, amateur cycling, to answer the following research question: how smart objects are changing how consumers consume? More in detail, how do consumers and smart objects interact, expanding or reducing the boundaries of consumption, across offline and online worlds? How did the online dimension of cycling and related activities, driven by smart objects, change the practice? At what levels of the micro-macro scale do these objects drive these changes, and how do consumers perceive the change? Are there specific attributes of IoTs that facilitate or hinder consumers' integration? Which individual traits or profiles affect the willingness of consumers to increase their use of IoTs?
Following Novak and Hoffman (2019), objects can be considered smart to the extent of their agency, autonomy, and authority. Agency is the capacity to affect - and be affected by - other entities, autonomy is the capacity to function independently, and authority is the capacity to control other entities. When smart objects are embedded in networks together with other elements, among which also humans, they express their agentic properties and affect other entities: these networks can be observed through the theoretical lens of assemblage theory (DeLanda, 2016).
Assemblage is a theoretical framework that views consumer behavior and consumption as dynamic, complex, and ever-changing constituted by relational arrangements of heterogeneous material and expressive components (Roffe, 2015). Consumers are not isolated individuals nor the sole agents in the process of consumption: they are linked to each other and physical (e.g., devices), digital (e.g., website), and symbolic objects (e.g., brands). Consumers are embedded in these assemblages, which, in turn, are integrated into further levels of assemblages, like national culture or institutional settings in which ideological, cultural, and religious forces operate and affect the structural and processual properties of the assemblages. These elements come together in unique combinations, and their relationships constantly change. This means that a given assemblage can be isolated and described in a limited period and represented as an intermediate level between lower-scale and higher-scale assemblages (Franco et al., 2022).
Regarding this paper, I consider at least two aspects from the assemblage literature that will be useful to understanding how amateur cycling is changing due to smart objects. First is the distinction between agency and communion (Novak and Hoffman, 2019). Consumers express an agentic role when they affect the assemblage, either by enabling it (e.g., activating services, adding new smart objects, and letting them interact with other objects) or constraining it (e.g., defining limits to smart objects' operations). Objects within an arrangement also express agentic roles when they affect consumers and other elements of the assemblage, enabling them to do more and diversified things (e.g., driving the consumer to a destination in unknown neighborhoods) or constraining the assemblage (e.g., red alert on the display when heart frequency goes beyond target).

At the same time, consumers express a communal role when they are affected by the assemblage, either by being enabled by the assemblage (e.g., receiving information on challenging or simply amazing tracks to follow) or by being constrained by it (e.g., receiving an alert about traffic increase). The same holds for objects and the assemblage in general when activated and progressively expanded or limited to specific conditions.
Agency and communion define the active and passive roles that the elements (humans, objects, and other resources) play in each assemblage. These dimensions describe the development of the assemblage as, for instance, its configuration changes over time with further inputs of local technologies (new accessories or apps in a device) and Internet access (smart objects linked to dedicated platforms via web or app), as it is the case of amateur cycling.
Second is the problem of the scale. Assemblages are scalar concepts that range from very small units like bacteria to very complex social and institutional systems. Franco et al. (2022), following Harman (2018), recommend considering the scale of analysis (e.g., somewhere in between micro and macro) in such a way as not to *undermine* important emergent features of an assemblage that its parts do not express alone. For example, breaking down a bicycle into parts could be interesting for the technical problems of each category of these components and related industries, but this should undermine their ability as *as-a-whole* for leisure or sports activities. On the other side, when increasing the scale of analysis, the risk is to consider a given assemblage only from the perspective of its effects on wider contexts and not on itself and its components. Harman (2008) uses the term overmining: the tendency to analyze and explain an object in terms of its effects presently registered by other objects within broader assemblages.

Context

In this paper I focus on amateur cycling, kind of halfway between purely competitive and leisure cycling. There are several patterns of amateur cycling (Ferrucci et al., 2021) which can be described as more or less oriented toward competing. Competition in amateur cycling is not restricted to actual races: amateurs compete among each other as well as with themselves during ordinary or training rides. As an example, it often happens that an ordinary, leisure-like ride, transforms into a harsh and ruthless, all-out effort, in which amateurs struggle neck and neck for the very sake of it.
Cycling is an inherently object-oriented consumption practice: every cyclist must have a bicycle, which – in turn – is a bundle of different objects (frameset, components, wheels, saddle, etc.). Bicycles can be bought as a bundle or assembled, buying different objects separately and then assembling them, usually with the help of a mechanic. Moreover, cyclists need accessories (apparel, helmets, etc.) that can be classified between essential and simply useful.
Within this complex network of physical objects, there is a special category whose importance is growing: sensors, bike computers, GPS devices, powermeters, smart lights, e-trainers, etc. Some of these products can be connected (in real-time or before and after the ride) to internet platforms to plan rides, check and compare results, share experiences, and virtual riding.
Thanks to these smart objects, the practice of amateur cycling is rapidly changing. Rides are safer, cyclists plan and check their training activities, often interacting with virtual trainers, they share their results, often teasing each other online, both on dedicated and ordinary social networks. Thanks to these opportunities, amateur cycling begins early before actual rides as cyclists individually or collectively decide how long, where, and at what time to ride, and ends up largely after, as they connect online to exchange evaluations, personal performances, pictures, and comments. Smart objects play a significant role in this development as much of the data and resources exchanged online are specific (e.g., power data or heart frequency) and dependent on dedicated sensors.
In this sense, an intricate assemblage of subjects, objects, and resources emerges in which individual cyclists and groups interact in a complex, articulated, and ever-changing pattern. In

the following section, I will describe some aspects of these interactions from the perspective of the object actually involved in this process to develop a general framework for current smart-object-assisted amateur cycling practice.
These descriptions derive from personal knowledge as an amateur cyclist, secondary data and extant information available online and offline, and introspection. Therefore, it is a preliminary and exploratory analysis that aims to test a general framework to be further validated through more systematic and reliable data collection.

Cycling assemblages and scale: preliminary and descriptive findings
Following an object-oriented ontology perspective, I will describe the amateur cycling assemblage starting from the most important object, which is the bicycle, and add further dimensions declining and expanding the scale of analysis (Franco et al., 2022).
The bicycle is a whole made of several components which can be purchased all together or even assembled from multiple sources for personalization purposes. I will split these elements in two categories of items that are physically attached to the bicycle:

- Traditional components and accessories: frameset, wheels, tires, handlebar, saddle, etc. are essential *components* of the bundle. *Accessories* enrich the cycling experience, but they are not strictly necessary: bottles, tools, bicycle bells, etc.
- Smart accessories: bike computers, often with GPS, powermeters, smart lights, cadence, and speed sensors, and e-trainers. These objects present two characteristics: a) they get data from the bicycle and the cyclist, and b) they connect between them and/or to external sources. This occurs due to the Bluetooth or the Ant+ communication technologies, plus the smartphone, which can be coupled with the bike computer. During the ride, most of the sensors and other accessories are connected to the bike computer, a sort of local gateway that collects and displays data and eventually transfers them to external sources, in real-time or after the ride.

Looking at cycling from this level of analysis, the amateur cyclist takes part in this assemblage of (more or less) smart objects interacting with them in various ways. I will focus on smart objects, taking for granted the traditional aspect of cycling:

- Checking speed, power, heart frequency, pedaling cadence, etc., and acting accordingly. For instance, depending on heart frequency and training objectives, cyclists decide to push harder or push back. In special conditions, sensors send alarms: high levels of heart frequency or cars approaching from behind. These inputs are directly dependent on sensors collecting data in real-time. With these data, cycling becomes more and more effective and satisfying, and less dangerous.
- Checking track, one's or competitor's performances, distance to finish, etc. In these cases, the bike computer links data from sensors to other sources of information that have been pre-downloaded from the Internet or accessed in real-time. For example, the bike computer alerts the cyclist that he/she is approaching a climb and asks for what to do: climbing or not, and if yes at which pace (best performance available, one's personal best, best friend's, etc.). During the climb, the cyclist receives data about the gap from or over the target to adapt pace. In case of an accident, due to a sudden slowdown or an abrupt change of position, which is not followed by any movement, the bike computer connects with the phone and sends emergency messages to family or 911.
- Checking where are cycling mates and managing calls and messages. Through the phone, the bike computer connects with its platform on which participants to the same group allow position tracking and sharing and signal the position on the map, driving cyclists to meet. When the phone is coupled with the bike computer, it is possible to see incoming calls and messages and decide whether to stop and reply. Also, friends and

relatives at home can follow cyclists on the go as they can access the platform used for tracking and see them on a map.

In essence, smart objects enable amateur cyclists to do three things: improve the riding experience through the growing variety of data available on the run, expand the scope of the experience to data, services, and resources that are not available on the run, but can be accessed through the Internet, and increase the social dimension of the experience connecting to other people while riding. These activities are dependent on various smart objects interacting with each other and connecting online. Among these objects, the most important is the bike computer whose role, beyond its specific characteristics and abilities, can be defined as both a *dashboard* displaying information and *gateway* which connects to other sensors and the Internet.

As it emerges from this description, the temporary assemblage between the cyclist, the bicycle, and smart objects allows amateur cyclists to benefit from innovative and interactive services and support from a) inner elements of the local network and b) external resources before, during, and after riding. In this sense, the assemblage we are describing can be seen as an assemblage of assemblages (the bike per se is an assemblage) and it is in turn embedded in a more general assemblage that can be described following two dimensions:

- Community and interpersonal relations. Other cyclists can be classified in various ways: best friends, inner circle, riding club, acquaintances, communities, etc. Data and results from sensors and related services can be shared selectively: both devices and platforms can be configured in such a way that they enable different sharing patterns according to the characteristics of various subjects. It is also possible to share unconditionally, in a systematic or episodic way, and this helps cyclists to feel integrated into a culture or sub-culture of choice (e.g., mountain bike or road bike) and take an active role in it.
- Platforms: there are specific, dedicated platforms for amateur cyclists. Here are a few examples to give an idea of the services and resources that can be accessed, either in real-time or not, in three areas: ride tracking, training, and indoor cycling.
    - Strava is one of the best-known platforms that cyclists use to record and register their rides as its basic function. Other services are related to scheduling, training plans, performance analysis, ride design, and many others. Strava is also a social network in which members interact as in ordinary networks. It became so diffused and recognized as a legitimate source of data that a specific mantra was coined, “If it isn’t on Strava, it doesn’t exist, right?” to say that if you do not have a registered track on the platform your mates don’t believe you have made that ride. See Barrie et al. (2019) for an application to Strava.
    - Training Peaks and Trainerroad are dedicated training platforms. They can be configured according to objectives, needs, and fit to improve performance. Professional trainers access the platform to look at the data of the cyclists they support for checking results and assigning tasks. Trainerroad customizes training plans and can be coupled with an e-trainer to control assignments in real-time and support, cheer, or even tease the athlete if he or she does not push hard enough, and this is usually made by a virtual trainer.
    - Zwift is probably the most popular indoor cycling platform which allows riders to use an e-trainer to connect in virtual environments, ranging from Central Park in New York to fantasy places (like riding in a volcano) and participate in group rides and races. It interacts with the e-trainer, increasing or reducing the resistance (and hence the effort) during uphill and downhill and simulating the effect of drafting. It is connected to cadence and power sensors to manage the position of each rider in the virtual ride/race.

There is a grey zone between communities and platforms, as they often integrate into each other: on one side, communities are often created and managed through platforms, and – on the other side – platforms are designed *also* to host communities or specific communal activities. In the following image, a general framework of the various objects that combine to form the amateur cycling assemblage is presented.

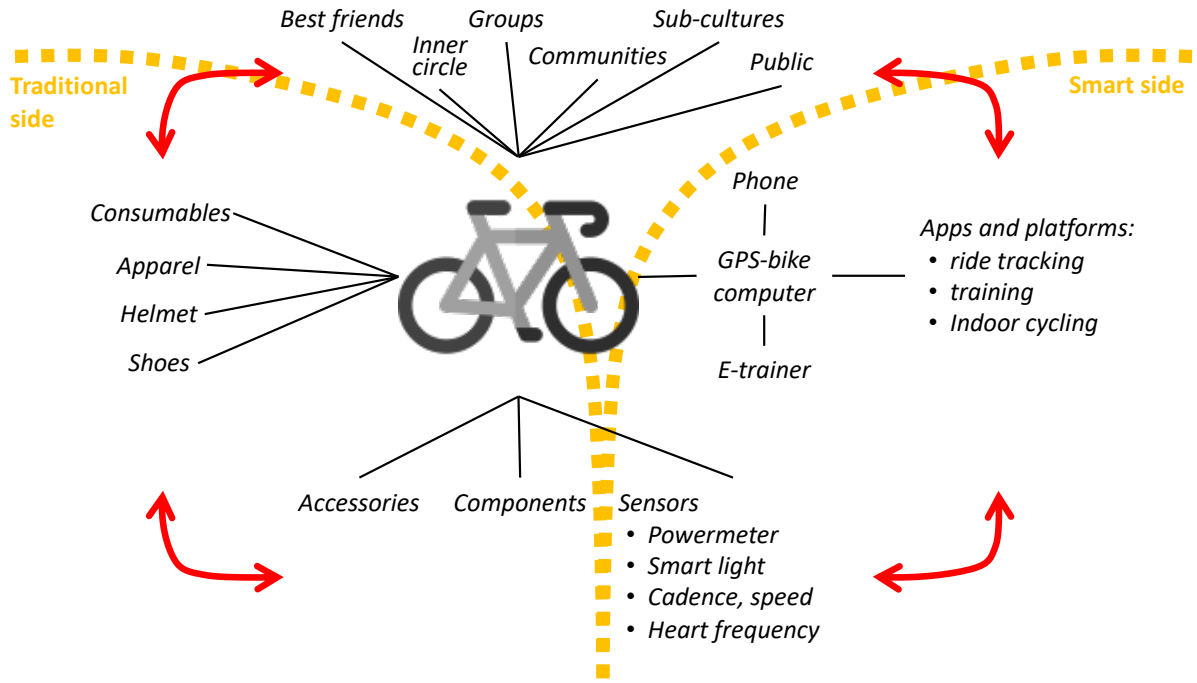

Fig. 1 – Amateur cycling assemblage with smart objects

In this picture, I highlight the following. First, the smart side is quickly expanding, thanks to new smart objects, applications, platforms, and services. Data from the local assemblage (the cyclist riding his bicycle equipped with traditional and smart objects) are pooled together, displayed, and forwarded to other smart objects that belong to higher-order assemblages. The same happens when the rider is at home, mounting his bicycle on the e-trainer and riding online together with other cyclists connected to the same platform: even in this case the local assemblage is temporarily connected to a higher-order one with which data, services, and other activities are exchanged.
Second, the social side of amateur cycling (red arrows) can be observed at various levels on both the traditional (riding with your best friend during lunch break) and the smart side (taking part in an online event in which hundreds of cyclists are connected to the same platform). The social side is very important as it is the context in which cyclists interact and, among other things, decide which products to use, how to solve technical problems about fixing bugs in smart objects, and so on. Smart objects, platforms, and social networks added further layers and opportunities for interaction, and cycling – together with other sports and leisure activities – is strongly integrated online.

Discussion

Amateur cycling appears to be an interesting context to apply assemblage theory for discovering how the introduction of smart objects is transforming consumption practices. This paper is mainly descriptive, and the findings presented above are preliminary as they depend on episodic secondary data collection together with some introspection and participant observation.

Moreover, these data are very specific to amateur cycling and data from other sports and contexts are necessary to produce reliable generalizations.
However, some interesting insights emerge from this description for preliminary answers to the research questions proposed in the introduction and paving the way for further research.
Amateur cyclists are changing their habits in at least three ways:

- Cycling is becoming a richer experience per se. While riding, cyclists receive, use, and share data and access various resources, increasing the variety and depth of the lived experience. It is also a safer activity, and families and friends appreciate the benefits of remote control. In this sense, a post-humanist (or trans-humanist) drive is emerging in sports, particularly in cycling, where the diffusion of a varied set of smart objects is increasing (Akdevelioglu et al., 2022). While improvements are clear and relevant, critical reasoning suggests that also power dynamics are emerging in this context in which consumers are given new possibilities toward which they are *driven* by platforms, companies, and interest groups, and their autonomy, definitely freedom, can be questioned. Further research efforts are necessary to better understand how much the balance of power between the consumer and the supply side is changing due to technological and business innovations.
- The cycling experience begins much before the actual ride and finishes much after it. Smart objects allow consumers to experience riding in a new way, and activities performed before and after riding contribute to increasing the number and variety of things that they do. Some of these activities increase the overall commitment and satisfaction of pure riding. This means that consumers have expanded and extended their involvement in the assemblages they take part in (Novak and Hoffman, 2018, 2019). At the same time, this new dimension of cycling has "reduced" the importance of the traditional side of it: looking at nature, relaxing, simply enjoying the wind and the sun, etc. Today, amateur cyclists have more opportunities to live their cycling experiences beyond the mere *act of cycling*.
- The boundaries of amateur cycling have expanded, thanks to smart objects and their connections with the Internet. Consumers perceive the real-time experience as *enriched* by the data they look at on their bike computer (dashboard) as they follow the track they have designed at home the day before. They can manage the effort according to the difficulties they know they are going to face, and expect further gratification, when later – at home – they will check for the results of their ride. The same applies to the home virtual cycling sessions. In this I see at least two different scale effects (Franco et al., 2022):
    - Local assemblage: the relationships between the elements of the cycling assemblage have changed dramatically as the bike computer has taken a new, central role as the focus of attention (dashboard) and the main gateway between the experience and the Internet resources which help cyclists on the run, but also before and after it.
    - Higher-order assemblage: cyclists and their endowments, smart or not, are embedded in higher-order networks that allow them to access services, data, and resources. As such they do not participate in the social discourse as individuals as they bring with them all their data (e.g., personal best on a given climb) which derive from lower order assemblages and give authority and legitimation, and vice versa.

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