5.1 Case study: the (re)invention of the bicycle[1]

Objective

This mini case study shows how innovation in product design follows the 'discovery' of clusters of emerging users' needs and how product design evolves by creating new product categories that are better positioned to serve these needs. The production of this variety is easy to observe in the case of the bicycle; one of the most efficient and effective transportation means ever invented. Students are asked to observe and analyze different models of bikes to understand how new products can be designed, starting from the way user needs are grouped and classified.

Background

In the last couple of decades, the bicycle market has been growing thanks to many factors, including green mobility, the development of e-bikes, and the growing demand for fitness use. The COVID epidemic gave further impulse to using the bicycle as a commuting solution that is private, eco-friendly, and affordable (not to mention the growing demand of riders for online delivery services). Even though most bicycles share the same basic design (two wheels, one diamond frame, handlebar, human or machine-aided propulsion mechanisms), the consumer market is highly diversified and characterized by a large variety of product categories, diverse designs, a multiplicity of applications, and endless customization opportunities.

One reason behind this diversity is that a bicycle is a complex machine working under intricate physics (Wilson, 2004). Other important reasons are commercial: bicycles are highly versatile vehicles fulfilling different functions and needs. As with more expensive vehicles such as cars, the price range is quite extensive, spanning a few hundred dollars to several thousand.

Because of this versatility and variability, bicycle designers have to deal with several non-trivial technical challenges that have been addressed in many ways at different times and places during the history of this product.

While bicycles have been around for a while, and we are all quite familiar with them, modern bicycles are fairly different from earlier models. The first documented attempt to design and build a bicycle was performed by Karl von Drais, an employee of the University of Heidelberg in Germany, at the beginning of the 19th century[i]. The Draisine could be ridden as a modern bicycle but had no pedals or chains, and the vehicle was propelled directly by the rider's legs, as shown in fig. 5.1a. The frame and the wheels were made of wood, there were no tyres, but the Draisine could be driven through a steering device anticipating the modern handlebar.

In less than one century, the variety of designs available on the market skyrocketed (fig. 5.1), although not all the models achieved the same level of popularity. The pedals attached directly to the wheel hub were among the most significant additions to the design in those years. Improvements in metallurgy allowed the wood to be replaced with metal to make the

[1] An extended version of his case study as a design thinking exercise is in Iandoli and Jusczczak (2020)

frame lighter (today, some manufacturers have rediscovered wooden bicycles). Reduced weight and the addition of the pedals made the bicycle much faster than the Draisine. The only way to increase speed, besides the tyres and the modern propelling system based on a transmission chain and gears, was to enlarge the size of the front wheel. The high-wheel bicycle became very popular and was used for the first bicycling races. However, the high wheel design was highly unsafe, despite a new braking system. A safer alternative would emerge by the end of the 19th century through the Safety Bicycle, the progenitor of modern bicycle design: the Safety Bicycle had two wheels of the same size and a chain drive. The addition of the tyre was the final step toward something we recognize to be the base design of most modern bicycle models. Pinch and Bjker (1984) analyzed these design changes resulting from the evolution of social problems and technology. Their theory, the Social Construction of Technology, has been applied by Roosen (1993) to analyze how the design of the mountain bike came to be.

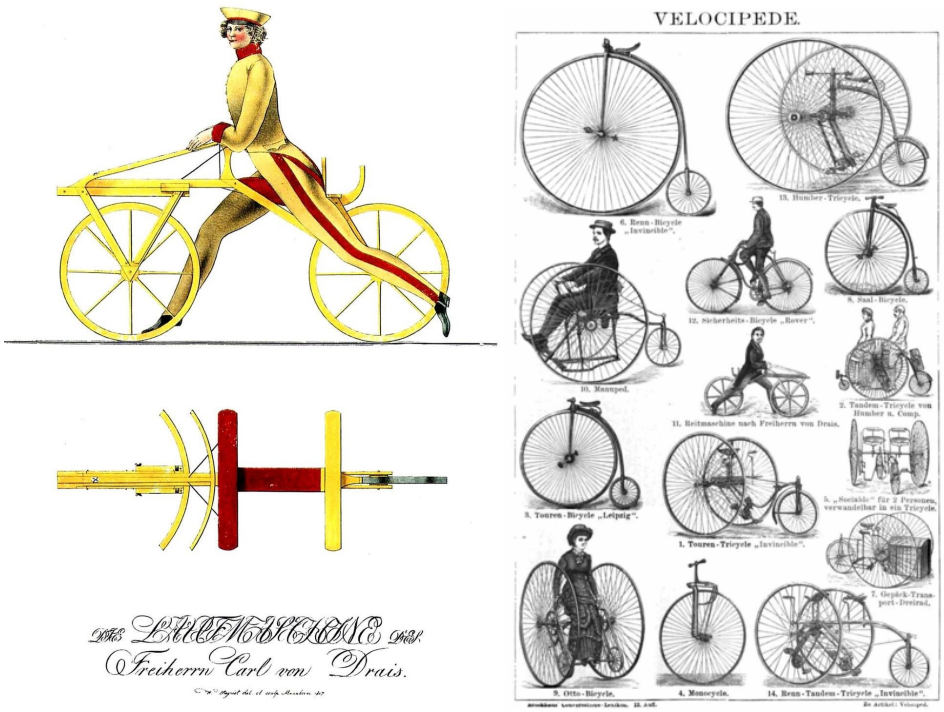

Figure 5.1a: the Draisine (left side), bicycle designs produced at the end of the 19th century - *Source*: F.A. Brockhaus, Ed. (1887) Brockhaus' Conversations-Lexikon, 13th Ed., Vol.16, F.A. Brockhaus, Leipzig, Germany, facing p.142 (both images are released in the public domain via Wikimedia Commons)

While some bizarre solutions present in early models, such as the wheels of different sizes, have disappeared, and most modern bicycles are based on safety design, the variety of models and types available on the market has never been wider than today. A Wikipedia article on types of bicycles lists more than 120 types and ten different classification criteria. While some manufacturers specialize or excel in producing a specific type, most companies try to serve many market segments and develop a pretty extensive product portfolio.

Instructions

1. Pick a type of bicycle, e.g., city bike, race bike, mountain bike, foldable bike.

2. Select and analyze at least one specific model (if the exercise is done as a team, each team member can work on a model). The analysis can be done on a bike you own, on the internet, or in a store (this last option would give you a valuable opportunity to talk with the store personnel, who are typically very knowledgeable about bikes).
3. For the chosen model, make a list of user needs that that model typically is designed for. Group needs into higher-level functionalities such as safety, comfort, etc. Try to be as specific as possible and do not limit your analysis to very high-level needs. An example of a generic need is 'comfort', since most bicycles need to offer some level of comfort in the ride. However, comfort means different things for different users in different situations, such as riding a bike in a city as part of your commute versus riding on a gravel road for recreational purposes versus riding a race bike.
4. Identify one or more groups of users for which the need is critical.
5. Observe how different user needs and applications may require designs that are profoundly different and map groups of components versus a cluster need they serve.
6. Observe how the same need assumes a different meaning depending on the situations in which the product is used and how it requires very different design solutions in terms of technology, materials, and/or quality of the solution.
7. Finally, pick up a specific need-group-feature set and brainstorm about how to improve the design to serve those needs better.

Model group/category	**Identify 1-3 user needs categories**	**Identify one or more group of users for which these needs are critical**	**Identify and design features that respond to these needs**	**How we might improve?**
City bike (model X produce by manufacture)	Transportation • Regularly carrying large containers such as big boxes. • Occasionally carrying small packages (e.g., backpack)	Delivery workers Commuters	Racks trailer's mount Removable racks (rack mounts)	Make the rack sturdy and capable of carrying significant load Make the rack easy to mount and remove

References

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