CHAPTER 3

Managing Technological Innovation in Sport

Abstract The promotion of the electric car as part of the solution to continued economic growth and improved environmental sustainability forms the core of Formula E's technological innovation strategy. In this chapter we therefore contextualize the emergence of electric cars in modern society where the car is laden with symbolic value to a variety of consumer groups. We then discuss, with BMW as main example, how the technologies promoted by Formula E are related to road-going cars and how the championship acts as a transfer mechanism between the race engineering laboratories and the urban mobility solutions in city areas.

Keywords Cultural consumption • Technology transfer • Energy efficiency • BMW

Introduction

Research on technological innovation in commercialized elite sport has been concentrated into two main areas. The first is the enhancement of competitive advantage and athlete performance, including technological innovations in sports equipment such as the recent development of carbon-fibre running shoes and improved engines in racing. The second area relates to the experience and consumption of sport for fans, such as FC Bayern Münich's AR app that allows fans to take selfies with the team's

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stars. For Formula E, these two areas merge. We will return to the second area in Chap. 4, as that overlaps with commercial innovations. In this chapter we explore technological innovation related to competition, because competition—the race—is a tool that ultimately showcases the efforts of car manufacturers, independent teams and their sponsors to develop a winning racing car that is battery driven.

The promotion of the electric car as part of the solution to continued economic growth and improved environmental sustainability forms the core of Formula E's technological innovation. To achieve something that has been tried by many before them, Formula E has partnered with car manufacturers such as BMW to deploy a marketing stunt usually reserved for conventional cars. Formula E applies the same logic here as that of motorsport funding since the early 1900s: a trickle-down effect from the racing circuit and at rallies will occur because cars are tested to their limits. By pushing them to their limits, parts will either break or hold, and either way will affect quality, safety and design. The difference from conventional motorsports is that the sustainability theme, rather than performance, apparently influences every technological innovation in order to reduce CO_2 emissions and supporting a decarbonized economy.

To understand why Formula E nevertheless is so difficult to separate from the car-centred world in general, and why its management tries to escape from relations with other motorsports, we need to contextualize the role of the car in society and its electric alternative. Second, on this basis, we turn to how Formula E has attempted to differentiate itself from this image of the car and motorsport by technological solutions to racing cars and the championship itself. Novel technology associated with the futurist image of Formula E also transfers into corporate exploitation of the championship, as in the case of BMW. Finally, we summarize what these examples mean for Formula E's drive towards technological innovation as part of the concept.

A Car-Centred World

Between the demise of 'La Jamais Contente' (see Chap. 1) and Formula E came the electric car, an obscurity in motorsports not merely because the competing technology was better adapted to the industrialized lifestyles of the twentieth century, but also because the fossil-fuelled car was tied to identity and class. Above all, the evolution of the car impacted Western societies, as it compartmentalized progress and modernity. David Gartman

(2004) outlines three ages of automobilism. He calls the first 'The Age of Class Distinction', starting in the late nineteenth century. Drawing on Bourdieu's theories on distinction, 'in which different classes compete for cultural capital or status honor' (Gartman, 2004, p. 170), the exclusiveness that is tied to production (craft skills) and expensiveness (they were unreachable to all but the wealthy) and the first impact on society 'solidified their association with class privilege' (Gartman, 2004, p. 171). According to Gartman, cars soon became 'an essential accessory of the leisure class, which used them for touring, racing and parading down fashionable boulevards' (2004, p. 171).

The status of the car was amplified by the emergence of road races in France, from Paris to Rouen (first run in 1894) and Paris to Bordeaux and back (1895), and even in the US, from Chicago to Evanston (1895). Despite Jenatzy's record run in 1899, it became clear that petrol-fuelled engines outperformed steam and electricity as power sources. In 1904 the Association Internationale des Automobile Clubs Reconnus (AIACR) (renamed Fédération Internationale de l'Automobile (FIA) in 1946) was founded in Paris, and French newspapers invented a vernacular to cover motorsports and even became event hosts. Sometimes these connections linked the US and Europe. The Gordon Bennett Cup, for example, ran between 1900 and 1905 and was initiated by the owner of the *New York Herald*. Eyeing a wider market in which cars were 'testifying to refined cultural tastes' (Gartman, 2004, p. 172), car manufacturers found a broader incentive to utilize motorsport as a brand enhancing tool to showcase performance, design and technological ingenuity. Simultaneously, whereas British car manufacturers would 'shun standardized production for fear it would undermine the distinction of auto ownership' (Gartman, 2004, p. 173), the emerging interest amongst the lower classes, together with an economic upswing, stimulated automotive manufacturers in the US to diversify their product lines.

According to Gartman (2004), it became a trade-off where 'mere ownership lost its ability to convey distinction' (p. 173), but in return required car manufacturers to put more effort into making their products distinguishable. This is the start of what Gartman calls 'the era of mass individuality', which was characterized by the creation of artificial differences between qualitatively similar cars to meet 'the demand for cultural legitimation of the new system of mass production' (Gartman, 2004, p. 177). These creations took the form of an expanded model portfolio and an annual renewal of the car models. After World War II, Fordism became the

victim of its own success. In the third age of automobilism, which Gartman calls 'the era of subcultural difference', car manufacturers realized that consumers demanded real difference between cars, instead of cosmetic variations. Consequently, manufacturers increased model offerings to include niches rather than broad groups. Incompatible with the old Fordist system, the new reality for car manufacturers required new production models, technological focus (due to the oil crisis and environmental concerns in the 1970s) and brand orientation. The long-term effects of this surfaced in the late 1980s, when a postmodern consumerist logic gained a foothold in the car world and product diversity exploded. From here on car manufacturers sold a way of life, not just a car.

Due to this convergence of consumerist preferences and identity-generating elements, as well as a rapidly expanding infrastructure and suburbanization, electric cars were far and few between. As oil companies grew massively in the 1960s, the electric car disappeared into oblivion for the next century. However, in the 1970s a potential comeback was nascent. In 1973, in the wake of the revolutionary years in France and the oil supply crisis caused by the Arab oil embargo on nations supporting Israel during the Yom Kippur War, a group of engineer-sociologists working for Electricité de France (EDF) 'noticed a ground swell of opinion against conventional fossil fuel-based cars' (Parayil, 2002, p. 56). As cars were seen as a necessity in France due to the major industrial employment and the national identity that was generated through major businesses like Peugeot, Citröen and Renault, the EDF engineers approached the car's place in society from a different angle. As Callon (1986, p. 84) dryly observes: 'It is by no means easy to create a new market of this sort in a society organized entirely around the traditional motorcar.' Partnering with Renault to achieve the aim of creating a *véhicule électrique* (VEL) was thus not enough for EDF. Actors from the political system (from municipalities to the Ministry of Quality of Life), social movements and environmentally conscious consumers were also included to optimize the chance of success (Callon, 1986).

One reason for including this broad range of stakeholders was an awareness of VEL's technological limits. Unable to go particularly fast and with a low range, political support was needed for a society in which the everyday rhythm was designed to be less stressful and immobile than that based on fossil fuel cars. Blessed by politicians who drove electric cars in front of journalists and spoke condescendingly about Americanization and the vulgarities of consumerism, the project therefore seemed to be at the right

time and in the right place (Griset & Larroque, 2006). But VEL failed, and apart from the technological aspects—the product was useless against its competitors—the engineers' sociological analysis was flawed. Above all, they were wrong in their analysis of society, in which 'the internal combustion engine is the offspring of an industrial civilization that is behind us' (Callon, 1986, p. 85). Consumption was not dead. As the car embodied a symbol of social standing, it was natural for consumers to want more differentiation in cars in accordance with their tastes and preferences. What Gartman (2004) saw as a postmodern idea of the car, emerging as a yuppie phenomenon in the 1980s, had actually already existed for several decades.

All this can be substantiated by reviewing the influx of sponsors in motorsports. The cloverleaf of races, the media, sponsors and professionalization became instrumental to the principle that in the 1960s was known as 'win on Sunday, sell on Monday'. Coined by an American wheeler-dealer and Ford engineer (Tasca & Caldwell, 1997), it represented a philosophy that fitted all kinds of motorsports. Although the slogan has been contested by empirical studies, the idea of honing the identity of the brand, searching for technological trickle-down effects and getting brand exposure have been important aspects of the automotive industry since its inception. Motorsports were seen as a form of 'live advertising' for car manufacturers, suppliers and sponsors wanting to be associated with the performance symbolic of racing. With the advent of television sports in the 1960s, where rallying in the UK and NASCAR in the US stood out as particularly popular, this cloverleaf slowly began to form a business model. From that point on, sponsors viewed the world of motorsport as a symbolic treasure chest—despite questionable financial results (Jensen & Cobbs, 2014)—for brand activation, products and services associated with the icons of racing: competitiveness and winning mentality, coolness and glamour.

Inducing this business model was that the varieties of motorsport began to settle into particular formats in the 1970s. Even though they had been there since the early days of FIA, with long-distance rallies (Europe) and track-racing (US) as the two most distinct ones, the commercialization of motorsport in the 1960s allowed car manufacturers, the media and FIA to see diversity as a way of exploring niches, rather than mutual threats. These niches did not evolve automatically, but were explored by business-savvy entrepreneurs either with or without FIA's approval. While today Formula 1 is a €8 billion business, in the early 1970s it was a poorly organized championship with lax rules, ad hoc logistics and no real financial plan. To

British entrepreneur Bernie Ecclestone, who had been involved in Formula 1 for some time and also owned a team, this situation made little sense given the global interest in racing. At a meeting between team owners in 1972, he aired the idea of creating an organization that would deal with all of the above on behalf of the teams. Although he did not put himself in charge from the beginning, the absence of interest from the others made him jump on the bandwagon together with fellow team associate Brit Max Mosley. That was the start of a relationship between someone who would turn out to be one of the UK's richest men, and another who would become FIA's president (1993–2009), thereby leading to the development of Formula 1 as a techno-cultural complex characterized by a stimulating bad-boy imagery, the sexualization of women and bloodsport narratives.

In this development of motorsport the electric car had no credibility for a long time. Then four things happened in the early 2000s. First, the global financial crisis spurred new collaboration forms in the automotive industry. Responding to two needs at the same time—a more efficient use of energy to ease the ecological strain on contemporary consumption patterns (Eriksen, 2016) and the growing understanding that a race has never been won inefficiently—Skeete (2019) argues that a new type of knowledge transfer occurred between UK-based motorsport entrepreneurs and the automotive sector after the 2008 financial crisis. Unlike the traditional view the current focus, as exemplified by Skeete with Audi's involvement in motorsports, was on engine technology, not engines. Second, when Tesla's Model S was introduced in 2012, after the company had escaped bankruptcy, the view of the electric car was ready to change. Third, 'Dieselgate' emerged, where Volkswagen in 2015 was caught cheating with emissions and tried to cover it up. This led to a tremendous PR scandal and large fines from the European Commission, as well as a rebuff of diesel cars in general, which gave politicians (European in particular) who were otherwise reluctant to criticize the car industry a forceful incentive to evoke green demands (see Gaim et al., 2019). Finally, Formula E survived its start-up issues and became a world championship in a few years.

What is ironic is that while Tesla benefitted from Dieselgate, the company has refrained from competing with a 'works team' in any form of motorsport. In return, Musk's competitors have used the momentum created by Tesla to expand their product portfolios to include EVs—for example by establishing Formula E teams. Others are still not impressed. In 2017, the Formula E race in Montreal proved to be unpopular amongst

residents due to its detrimental impact on local businesses. In contrast to the rhetoric of stakeholder inclusion, the reality was, according to a survey, that local restaurants suffered from Formula E's food trucks. Hence, the city council abandoned its support for the following year and was dropped from the race calendar (Sylt, 2018; see also Chap. 2). In 2019, Helmut Marko, a senior consultant to the Red Bull Formula 1 teams and representative of one of the largest corporative actors in motorsport (individual sponsor, media house, team owner), said, 'Formula E is for us only a marketing excuse from the automotive industry to distract from the diesel scandal.'[1] Some have also questioned the credibility of the series as long as they race in gas-guzzling car cultures such as the US, or in Saudi Arabia, a country which apart from its human rights issues is also the second largest producer of crude oil (see Chap. 6). But whether it is a gigantic marketing ploy or a wholehearted attempt to accelerate the development of environmentally friendly cars is not the main issue here. Rather, it is to what degree Formula E is helping electric cars on their way to becoming mainstream.

The Significance of Technological Innovation in Sport

A question arising from the discussion above is how technological innovations reach cultural acceptance. As mentioned at the beginning of this chapter, technological innovation in commercialized elite sport history generates two kinds of research: on the enhancement of sporting *performance* and on technology's impact on the *experience* of sport. Beginning with the latter, many sports organizations have explored novel ways of how teams and players can engage with fans through social media. Additionally, virtual reality (VR) and augmented reality (AR) technologies represent a current 'hot potato' in sport spectatorship. For instance, the local hosts of the Olympic Games in Paris in 2024 have made several statements about their work in using VR and AR technology to host virtual events for fans alongside the Olympics.[2] The COVID-19 pandemic has also led several sports organizations to experiment with digital technologies previously novel to sport. For example, in the Virtual Tour de France in 2020, the online game Zwift made it possible for fans to cycle the traditional stages of the race at home in the comfort of their living rooms. As

we will see in Chap. 4, Formula E has also made advances in the eSports community to race online.

In terms of performance, there has since the introduction of the modern Olympic Games in Athens in 1896 been a relative linear progression of athletic performance in elite sport. Historically, this is due to a number of converging factors, such as the professionalization of sport, technological innovations in sports equipment, the development of new techniques, the development of new scientific knowledge about training, nutrition and sports psychology, as well as increased participation in elite sport. Lippi et al. (2008) however argued that human physiology could only take athletic performance so far and prophesied that 'future limits to athletic performance will be determined less and less by innate physiology of the athlete, and more and more by scientific and technological advances' (Lippi et al., 2008, p. 8). Balmer et al. (2012) even claim that the increasing stagnation of world records and enhanced elite sport performance in Olympic events are caused by a lack of technological innovation in sport and describe it like this:

> In the absence of technical or technological intervention, no general improvement in performance (i.e. across finalists) should be expected. Of course, this is not to say that an extraordinary performance could, for example, break a jumping world record, simply that, based on historic growth across finalists, there is no reason to expect further general improvement. (Balmer et al., 2012, p. 1081)

A similar argument can be made for motorsports. Without technological development that resonates with mobility trends in society, motorsport will lose its relevance as engineering laboratory and showroom for the most exciting products car manufacturers have. Today's cars are generally faster, safer and more energy-efficient than in the past (albeit not always as muscular in terms of horsepower and the like). But whereas technological advancements hitherto have been sought after in the name of speed and safety, Formula E has added the challenge of increasing performance and reducing CO_2 emissions at the same time while making it 'cool' for ordinary car buyers. A relevant framework to analyse this situation was developed by Ringuet-Riot et al. (2014), whose rationale is 'to identify needs and opportunities for innovation through technology advances' (p. 2). The model consists of three parts, the first of which is determinants for innovation (environmental, organizational and managerial/individual).

The second part consists of a needs assessment, in essence 'a problem analysis and a method that is used to map the needs and resources within sport organizations to better understand how services or programmes may serve an individual or group' (p. 4). The third part concerns stakeholder relations, which in sport consist of groups and individuals described as 'experts' who have an objective and highly technical view of need, offer unique insights into need and act as arbiters of the need criteria based on their expertise and experience. Ringuet-Riot et al. (2014), p. 5) also 'identified that few studies have reported key stakeholders' perceptions of need for technology and process innovations in elite sport'. This could be caused by a weak identification of stakeholders, or an incomplete understanding of how stakeholder interactions could benefit innovation processes in a firm, given a particular target. Based on these elements, the operationalization of the model includes three phases: needs assessment, needs analysis and innovation and review.

To explore how this model relates to Formula E and helps us in our aim to develop a theory of sport management innovation, we have applied it to the relation between Formula E and car manufacturers. Principally, Formula E's concept challenges car manufacturers to hone performance through innovations where success depends on adapting to an electric car, instead of just blueprinting solutions from other racing series. Although all FIA-governed championships have rulebooks laying down the principles for participation in competition, the room for creative engineering is larger in Formula 1 or the World Rally Championship (WRC), as only 20 per cent of the mechanical stuff of Formula E cars is said to be counted as being the 'differentiator' between teams.[3] Apparently, the rest is about digitally 'mapping' the performance.[4] Hence, the championship serves the purpose of improving the electric car as a racing product so that its benefits can be adapted to the road. As such, it continues a long tradition in motorsport. The list of things we associate with road cars stemming from racing is quite long and ranges from rear view mirrors (debuted at the Indianapolis 500 race in 1911) to caliper-type disc brakes (first used by Jaguar in a race in 1953) and traction-control systems (pioneered by Formula 1 in the early 1980s).

At the same time, the technology transfer between Formula E and ordinary car manufacturers is not yet a mass-scale phenomenon, as most vehicles are still conventionally built, engineered and designed, as well as being haunted by the everlasting problem of the lack of a charging infrastructure in many countries. Yet the relations are growing, especially in terms of

energy conservation. Whereas the three magic components in motorsport have been power, grip and driver, Formula E uses efficiency, efficiency, efficiency. Dilbagh Gill, team principal of Mahindra Racing, said in November 2019 that 'the Mahindra car runs at about 95 percent efficiency, meaning 95 percent of energy is converted to power through the wheels, compared to 82 percent efficiency when the series started in 2014. That's compared to about 82 percent for road EVs, about 49 percent for Formula 1 engines and 36 percent for combustion engine road cars.'[5] Formula E, apparently, combines this legacy with particular attention to energy efficiency through material and digital reciprocity between race and road cars. As the battery technology is standardized and shared by all teams through an exclusive provider approved by FIA,[6] it finds other ways of translating technological innovation to its road cars. As the weight of electric cars (due to batteries that are heavier than fossil-fuelled cars) ultimately impacts the range of electric cars—a common criticism—Audi, for example, has concentrated on reducing mass. BMW, on the other hand, re-uses software from its race car for the i3 model, as they both share electric motor control coding.[7] Jaguar's Richard Devenport says that 'the company's racing and I-Pace electric-car development efforts "a technology partnership," noting that he "takes back relevant engineering" to the vehicle program and sometimes "the other way too."'[8] The marketing implications can therefore be vast, as the condition for turning EVs into a mass phenomenon is cultural acceptance and avoidance of the errors made by the VEL project in the 1970s.

The Case of BMW

A relevant example to explore the link between technological innovation and brand added value in the context of Formula E is BMW. In an earlier study, Næss (2020) explored how Formula E sponsors utilized the championship as a way of 'corporate greenfluencing'. Among the most eager to join Formula E was BMW, which is one of the most credible actors to have a view on this matter due to its successful motorsport history. Since its turn from making family sedans to sporty saloon cars in the 1970s—famously captured under the M logo (which meant that high-performance cars were named M3, M5 etc.)—the German manufacturer has now become one of the world's premium brands, known for its slogan *Freude am Fahren*—the joy of driving. BMW Vice President Brand Strategy and Brand Management, Bernd Körber, said in 2018 that:

> The BMW brand stands for sheer driving pleasure or simply: joy. That has always been the promise and purpose of our brand; it is our company's "why." (…) However, just as the world around us is changing dramatically, we are transforming how joy from its original intent of "joyful driving" to joy of individual mobility, as BMW is evolving from a car company to a tech company and a premium mobility provider.[9]

BMW brought this legacy to Formula E as a founding partner of the championship and an official vehicle partner since Season 1. Moreover, BMW in Andretti Motorsport, a full BMW works team in partnership with Andretti Autosport, has also been racing competitively since Season 5. In 2020, BMW extended its official vehicle partner deal with the Formula E Championship with something that was worth substantially more than the €6m ($6.5m) per year the car brand is thought to have paid under the previous agreement. Jens Marquardt, motorsport director at BMW, commented in 2020 that a return to Formula 1—which BMW left in 2009, at the same time as the corporation's EV programme was initiated—was unlikely, because the race technology was no longer relevant to its road cars: 'The V6 Turbo Hybrid [used in F1] is an engine that has absolutely nothing to do with what we do in series production. From an engineering perspective, I have to say: hats off to what they do in Formula One, but the technology has no relevance for the road.'[10] Oleg Satinovsky, BMW's Formula E spokesperson, emphasized two transfers of technology in particular. The first regarded weight control by testing materials such as resins, titanium and ceramics in the electric engine 'during the race season to improve future road-car electric motors'.[11] The second was stopping power, more specifically an electronic brake-by-wire system in its Formula E car and its X5 and X7 SUVs and 8-Series coupe this year. This system allows BMW to offer consumers of its M8 an adjustment for brake pedal feel for the first time.[12]

To some, these innovations may seem like mere gimmicks. But for BMW, the Formula E connection is apparently part of a bigger image overhaul. Although it focuses on hybrid technology in its road cars, it is seemingly out to make its all-electric cars typical for the brand, concretized by the target of a quarter of BMW Group vehicles sold in Europe having an electric drive train by 2021, a third in 2025 and half in 2030.[13] A study by Blunck (2016) indicates that there are three reasons for the emergence of electric cars at BMW: political circumstances, a deeper commitment to sustainability and a chance to differentiate the product line. However, this

strategy, first passed in 2009, encountered obstacles in the form of a lack of know-how about electric cars. Blunck observes: 'The demand for traditional expertise in mechanical engineering and metal works is expected to be replaced by a need for know-how in electronics, battery technology, and lightweight composite technology materials' (2016, p. 78). It is therefore reasonable to see BMW's engagement as representative—and even perhaps ideal, as underlined in the 2019 documentary *Racing into the Future: Formula E as Techlab for the BMW Group*[14]—for car manufacturers wanting to take part in Formula E as part of a technological and branding overhaul adapted to a small, yet growing, market.

Research on conditions for EV adoption in the US and Europe seemingly agree with Liao et al.'s (2017) findings that 'uncertainty for technical progress has a negative impact on the intention to adopt an EV since EV is either considered as a "car of the future" or a "work in progress"' (pp. 264–266) (see also Brase, 2019; Haustein & Jensen, 2018). A French study, acknowledging the flaws of the VEL project in the 1970s, also pointed out that the readiness for purchasing an EV was there (three quarters of the sample), provided that it did not cost more than a conventional car and that it met the traditional desires of seeing the car as an essential 'accessory to life' (*accessoire de vie*) (Centre d'analyse stratégique, 2010). Most research is on EV's focus on the 'neutral' factors that potential buyers include in their assessments of whether to buy an EV or not: range, quality and cost. Hence, two important dimensions of the car as a social and cultural icon are overlooked: the relation to its mother brand and its role as symbolic differentiator, which are merged by the emotions that people have for their cars. By demonstrating that EV technology may even work in a racing car, BMW and others thus try to convince potential buyers that nothing from its mother brand is lost, even though the engine components are different from the key attributes that made them 'sporty' vehicles to begin with.

What may become the differentiator in the future, in theory aided by Formula E, is the difference between generations of car buyers. BMW's Körber said that:

> Right now, we are paying special attention to upcoming customer generations for premium mobility: the Millennials and Post-90s generation. How these consumers interact with mobility, media, and technology differs greatly from preceding generations.[15]

To meet the consumer preferences of these groups, Körber states that the BMW Group's corporate strategy is centred on ACES (Autonomous, Connected, Electrified, Services/Shared), which will be merged under the BMW iNEXT launch in 2021, and the BMW iNext, a big and all-electric SUV apparently designed to meet the less-than-objective desires in that market segment. Robert Irlinger, head of BMW's i division, commented that 'iNEXT will be "all-in"—everything we can do technology-wise in 2021 you will see in iNEXT. People have been asking why we've waited so long, but we waited for the next step in technology—it's not only battery, it's autonomous driving and it's also new systems for communication and connection. All this technology will be new in 2021.'[16] In our view, iNEXT is a continuation of the line of thought found amongst car consumers in Moons and Pelsmacker's (2012) study. Using Belgian informants, their study attempts to rectify the innovation literature's lack of attention towards emotions as a cause of successful diffusion, and claims that 'Both in the general model and in all models for subgroups, emotions towards the electric car are the most or the second most important factor that determine electric car usage intention' (p. 217). Given that this still holds, BMW and others have realized that the environmentally friendly incentive will not be enough to convince potential buyers other than a small niche, and only then with generous political subsidies, unless the car appeals to those emotions usually attributed to driving and the brand itself. As emphasized earlier in this chapter, the cultural and social connotations of the car and the brand diversity of cars have a tremendous stronghold on consumer preferences due to their historical development as identity-generating symbols.

The choice of BMW to illustrate how car manufacturers think about the reciprocity between competition and road derives from Wilbaut's (2015, p. 90) claim from the eStory, Formula E's official pamphlet on strategy, that the concept has a bold, specific, concise and consistently communicated mission to 'Represent a vision for the future of the motor industry over the coming decades, serving as a framework for research and development around the electric vehicle, accelerating general interest in these cars, and promoting sustainability'. BMW's way of acknowledging this need—phase 1 of the model above—was to skip Formula 1 and enter Formula E as part of its corporate strategy for future mobility solutions. For example, a major incentive to enter Formula E was the championship's decision to have the same battery supplier for all teams. In phases 2 and 3 of the model, in which a needs analysis, innovation and the review

phases are concerned with the development of innovation solutions that address perceived gaps in knowledge and performance (Ringuet-Riot et al., 2014), BMW benefitted from the work by battery supplier McLaren's experiment with aluminium instead of cobalt as part of the liquid metal mix inside the battery. It could, if successful, save the car industry a lot of money (in that aluminium is cheaper than cobalt) and be reliably sourced from countries like Canada, instead of the home of cobalt, the Democratic Republic of Congo.[17]

It should be said that not all the technological innovations in Formula E—whether from car manufacturers of external parts or suppliers—are shared between stakeholders. However, as most of the innovations are closely kept corporate secrets, the competitive structure of Formula E and its stepwise progression when it comes to liberalizing the rules must be seen as a successful compromise when it comes to engineering creativity and cost control. Starting off with identikit five-speed Hewland gearboxes and McLaren-developed motors in Season 1, the subsequent seasons have seen an accelerating rate of innovations in line with the more flexible rules approved by FIA. In 2019, Phil Charles, Jaguar Racing's technical manager, said:

> When we first started, the rear of the car was a metallic maincase and all the teams had carbon. That's just one silly little example, but the more important things like the motor, inverter, the drive components—we did a big step (…) All the internal bits are going bananas as well. If you tried to race now with our season three powertrain we'd be in big trouble.[18]

In this light, BMW's partnership with Formula E—and vice versa—can be seen as a reciprocal agreement, the consequences of which were access to and conditions for innovative solutions relating to electric cars (BMW) and access to and conditions for innovative impact on the car industry by having a major player on their side (Formula E). As such, the partnership is a useful example of the applicability of the model for sport technology innovation as outlined by Ringuet-Riot et al. (2014), but also as a building block for our own theory of sport management innovation. By utilizing the goodwill and resources of political, industrial and corporate actors in their bigger commitment towards a well-established need in society, Formula E managed on the one hand to strike a balance between low entry cost and high brand gain, and on the other a simple rulebook that has gradually become more technically complex.

Moreover, in the context of the 'review' cloud of Ringuet-Riot, Hahn and James' model (2014), profitability may not be the overall target either, as manufacturers like Mercedes have voiced concerns that restrictions could remove the attractiveness of competing in Formula E. Mercedes team principal Ian James says: 'I see it incumbent on all of us to make sure it doesn't get out of control.' For Dieter Rencken, a motorsport journalist who has followed Formula 1 and its drama closely since the 1970s, concludes: 'That, and not growing revenues and profit sharing, would appear to be Formula E's biggest challenge as its new season nears' (Rencken, 2019). The next year, Rencken's prophesy came to life as BMW announced that they would quit as Formula E team. According to the company statement, which by the way was questioned by several commentators due to the team's poor results and internal disagreements,[19] the official reason was the lack of technological progress in the championship: 'When it comes to the development of e-drivetrains, BMW Group has essentially exhausted the opportunities for this form of technology transfer in the competitive environment of Formula E.' To make things worse and emphasize the Formula E's challenge with balancing its technological policy, BMW was accompanied by Audi in departing from the championship. It offered a similar explanation as BMW for its departure after the 2021 season, citing a thirst for more technical freedoms under 'the most extreme conditions' in which the Dakar Rally apparently 'provide a perfect test laboratory for us in this respect'.[20]

Conclusion

Technological innovation in elite sport often concentrates on ways of enhancing performance and, as of late, novel ways for spectators to experience major sporting events. Our analysis is that what is new with Formula E is the operationalization of the synergies between technological innovation and managerial innovation. According to Pinch and Henry (1999), 'In the case of motor racing, and especially in the most sophisticated forms of the sport, such as Formula One, in which the emphasis is upon technological innovation, it is easy to conceptualise developments as "technically driven"' (p. 680). Yet, Pinch and Henry, drawing on the emergence of Social Construction of Technology (SCOT) framework and Motorsport Valley in the UK, claim that societal circumstances influence technological development more than has been acknowledged by those who label motorsport as technology testbeds: to have an aim with these testbeds,

there must be a societal and cultural receptiveness to the outcome. This argument is supported by our analysis of technological innovation in Formula E in this chapter.

Unlike the French VEL project in the 1970s, which lacked technological know-how, receptive conditions and brand awareness—although the politicians believed they had it all covered—Formula E's cooperation with car manufacturers has meant that the electric car has gained acceptance as a symbol of freedom, modernity, identity and lifestyle. This is obviously not caused by Formula E alone, even though a study by the global consultancy firm Ernst & Young, cited in Wilbaut (2015), claims that Formula can accelerate the penetration of the EV market and make a positive impact on the environment by saving €25 billion on healthcare costs and productivity from pollution reduction. Also, in contrast to the attempts to introduce electric cars in the 1990s, when the electric car was for tree huggers only, some niche models like Jaguar iPACE and Audi eTRON actually sell well in electric car-friendly countries like Norway, because they harbour the same brand values as their petrol-powered sibling models but fail to reach the larger masses elsewhere.

However, as exemplified by the case of BMW, there is a danger in that the novel aspect of Formula E's technological impact on motoring may wane sooner rather than later, unless the next generation of Formula E cars presents something radically new and strikes a new balance between allowing manufacturers to evolve technologically and avoid spiralling costs, as was the case in Formula 1 a decade ago and is still noticeable in comparison with Formula E. In 2019, for example, the cost of running Jaguar's Formula E team was the equivalent of 6.4 per cent of Toro Rosso's spending on Formula 1 (Sylt, 2019). Moreover, despite the numerous examples of technology transfer in motorsport history that continue into Formula E, they are only credible as long as the championship is one step ahead—or at least on the same step—as the road cars.

Notes

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