

Undergraduate Thesis Prospectus

A Battery Management System for Electric Racecars

(Technical Research Project in Electrical Engineering)

Crude Capital: The Impact of Oil Money on European Football

(Sociotechnical Research Project)

by

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On my honour as a University student, I have neither given nor received unauthorised aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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## **General Research Problem**

*How have petroleum-exporting countries responded to the global energy transition?*

Many oil-exporting countries have been investing in international football to diversify their income sources and, in some cases, “sportswash” their image. Sportswashing is the use of sports investments to enhance a country's international image. For example, football club Manchester City, under the ownership of UAE royalty Sheikh Mansour, has faced allegations of being a tool for sportswashing. Amnesty International and Human Rights Watch have criticised the UAE for inhumane treatment of political dissidents and migrant workers (Doward, 2018).

Still, Mansour and his brother, Crown Prince Mohammed, are actively enhancing the UAE's relations with the West through their investments in football. Outside of football, Mansour has also invested millions in the urban development of Manchester, namely New Islington and Ancoats. Overall, many believe these investments were made solely to enhance his and his country's reputation (Chakraborty, 2022).

Also, European football has become notably profitable in recent years, though not all clubs share this potential. Paris Saint-Germain (PSG), owned by Qatar Sports Investments, was bought for 70 million euros in 2011. In 2022, according to PSG president Nasser Al-Khelaifi, Qatar received an offer of 4 billion euros for the club (Gentrup, 2022). Given the economic allure and the scope for sportswashing, many oil-exporting nations are investing in European football clubs. And I am keen to highlight the implications and long-term consequences of this trend for the global football industry, its stakeholders, and the world.

## **A Battery Management System for Electric Racecars**

*How can we construct a high-quality battery management system (BMS) for an electric vehicle that can excel in competitive, high-speed environments, such as the annual Formula SAE Competition in Michigan?*

My Capstone advisor is Adam Barnes, and this is for the Electrical Engineering & Computer Engineering majors; I am a double major. I am working in tandem with Silas Schroer, John Link, and Gabriel Binning. Our group is the BatteryBoyz.

A battery management system is embedded into battery packs of electric vehicles, and it balances voltages amongst battery cells to ensure that SoC's (state-of-charges) remain high amongst the batteries, and that excess voltage/energy does not get wasted as heat.

Battery management systems exist in abundance, but not for race vehicles. The high heat, current, and velocity conditions mandate more safety features than one would find in a Tesla's BMS, for example. Our group will implement these features using thermistors, precharge and discharge circuits, and isolator chips. The BatteryBoyz group plans to have three functional printed circuit boards (PCBs) at the end of the semester: precharge/discharge, battery module, and main controller. With our specialised designs, we hope to gain efficiency and power advantages in racing competitions.

In our streamlined setup, we will utilise a single battery module PCB for testing, ensuring a focus on the project's core features (e.g. cell balancing and safety). Despite not being embedded in a vehicle, this approach will still showcase the system's capabilities. The microcontroller, programmed in C via STM32CubeIDE, will handle voltage balancing and safety protocols. However, after this semester, we will have 5 module PCBs, and we will embed our

designs into one of Virginia Motorsports's cars. Hopefully, they will allow the organisation to improve upon its 41st place finish (out of 119) in last summer's FSAE competition.

### **Crude Capital: The Impact of Oil Money on European Football**

*Through their efforts to diversify their economies, how have oil-exporting Gulf states influenced European football since 2003?*

The oil money phenomenon in European football began with Russian oligarch Roman Abramovich. Following his financial success with Gazprom, Abramovich bought English club Chelsea in 2003. In the following 18 years, he bankrolled the club to two European Cups and five Premier League trophies. This move inspired other foreign investors, like Sheikh Mansour and Mohammed bin Salman, to purchase Manchester City (2008) and Newcastle United (2021), respectively (Knight, 2022). The trend is not limited to the Premier League: Tamim bin Hamad Al Thani acquired Paris Saint-Germain through Qatar Sports Investments in 2011 (Dorsey, 2011). Given the rising influence of oil-rich nations, how have they helped shape European football?

There are two primary groups of participants. The first are the wealthy, Gulf-based oligarchs, e.g. Sheikh Mansour and Mohammed bin Salman. They have influenced European football through their purchases of major European clubs, such as Manchester City and Newcastle United (Knight, 2022). Under such ownership, Manchester City, for instance, have influenced the footballing landscape permanently, mainly through their lavish spending.

Between 2008 and 2010, Manchester City incurred a total loss of £237 million, the highest in English football. This was due to their hefty investments in players like Carlos Tevez,

Emmanuel Adebayor, and Robinho, all of which were personally funded by Mansour. This spending spree was widely criticised as the time (Wilson, 2013). Moreover, from 2010 to 2016, City's continued expenditures on the likes of Javi Garcia, Jack Rodwell, John Stones, and Raheem Sterling faced similar scrutiny. Such aggressive spending tactics not only drew criticism, but it also disrupted the transfer market, compelling other clubs to overspend in order to compete (Victor, 2023).

Manchester City has also destabilised English football's competitive balance. Beyond Chelsea, City are the only club to have leveraged their financial backing to win trophies. In June 2023, City won the Treble, matching the hallmark achievement of their arch-rivals, Manchester United. Since 2013, the club's newfound financial firepower has yielded them 7 Premier League titles, 3 FA Cups, 6 Carabao Cups, and 1 Champions League (Wasistha, 2018). No other English club has come close to matching this haul during this period.

The club's achievements have played a significant role in enhancing the UAE's global image. Khaldoon Al Mubarak, chairman of the City Football Group, was appointed by Mansour. His involvement with the Executive Affairs Authority (EAA), a body focused on boosting the UAE's international image, highlights the UAE's intention to leverage football to improve its reputation ("About Us," 2023). Additionally, Garry Cook, City's former executive chairman, claimed Abu Dhabi wanted City to become a "proxy brand for the nation of Abu Dhabi", which enticed Mansour to buy the club (Pagnamenta, 2019).

Mansour's success has influenced other oligarchs. When questioned about his investment in sports, Mohammed bin Salman, Newcastle United owner, said, "when you want to diversify an economy you have to work in all sectors [...] if you want to develop tourism [...] part of it is your sport sector." Addressing allegations of sportswashing, he said, "if sport washing is going to

increase my GDP by way of 1%, then I will continue doing sport washing” (MacInnes, 2023). In light of Abu Dhabi's rise as a tourist hotspot, it is clear that Mansour's achievements influenced bin Salman's decision to purchase Newcastle United (Kamel, 2023).

The second group of participants is match-going fans. Many, like David Conn, have mixed feelings about foreign ownership. Sheikh Mansour's takeover intensified Conn's disillusionment with football, leading him to give up his season ticket (Conn, 2013). On the topic of Mansour's ownership, he said, “ownership by one billionaire sheikh is the antithesis of [...] mutuality” (Conn, 2012). Others embrace the oil money; some Newcastle supporters celebrated the Saudi takeover by donning keffiyehs before the club's first post-takeover match (Brown, 2021). In addition, media figure & Newcastle fan Mouth of the Tyne claims Mohammed bin Salman's takeover gave the club and its fanbase a “a new lease of life” (Arab News, 2023).

Overall, the influx of oil money has shaped European football significantly. Research has indicated that the creation of Financial Fair Play (FFP) in 2009 was a result of financial doping in European football, stemming from the likes of Mansour and Abramovich. FFP is a UEFA-based initiative, launched in 2009, that limits clubs from spending more than they earn. When Michel Platini became UEFA president in 2007, he was vocal about his ambition to tackle financial doping in football, and FFP emerged as a strategy to curtail it (Schubert & Hamil, 2018).

Further, Reikin (2021) contends that excessive spending distorts the transfer market. For example, in the summer of 2017, Paris Saint-Germain spent €400 million combined on Neymar and Kylian Mbappé. Real Madrid and Barcelona, two of the wealthiest football clubs in the world, complained about PSG's spending and believed that the Parisian club were breaking the rules and limiting competition. This prompted an investigation by UEFA (Conn, 2017).

The escalating financial outlays played a pivotal role in the formation of the controversial Super League in 2021, a "closed-shop" competition designed to generate an immense amount of revenue. This competition featured nine of Europe's most distinguished clubs, with Chelsea, Manchester City, and Tottenham also participating. Real Madrid's president, Florentino Perez, emphasised that this move was the best way to "prevent the increasing proliferation of unacceptable situations in which clubs receive indiscriminate financial support from states or other sources" (Sportstar, 2021). In essence, the leadership of the Super League clubs—barring Manchester City and Chelsea—viewed the competition as a means to level the financial playing field with their oil-rich counterparts.

Amidst the evolving financial landscape, many historically dominant football clubs, including Ajax, have faced challenges. While Ajax are a massive football club, having produced legendary footballers like Johan Cruyff, Ruud Krol, and Marco van Basten, they have been dwarfed financially by clubs in bigger markets. This is especially true in English football, as a result of oil money and enhanced television rights. In 2019, Ajax's Erik ten Hag underscored the financial imbalance, noting the stark TV revenue difference between Ajax and the club's then-opponents Tottenham (Treadwell, 2019). The financial disparity, coupled with its adverse effects on competition and community bonds, has led many fans to feel disillusioned by the sport. A prime example of this is the establishment of FC United of Manchester, a breakaway from Manchester United. The club was founded by traditionalist supporters, who were disheartened by numerous factors, such as Chelsea's lavish spending and the crippling acquisition of the club by Malcolm Glazer (Howard, 2005).

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