

Undergraduate Thesis Prospectus

Automating Chess: Creating a Hands-Free Chess Board
(technical research project in Computer Engineering)

**Technology Doping: The Role of
Technology in Competitive Environments**
(sociotechnical research project)

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

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General research problem

How may the disadvantages of disabilities be mitigated?

Over the past several decades, social awareness of disability issues has greatly increased, as a result of legislation such as the Americans with Disabilities Act. Researchers in laboratories around the world are constantly working to diagnose and potentially cure disabilities from debilitating diseases. However, the realization of this goal may be far in the future, and thus, in the absence of a cure, an equally important endeavor is the mitigation of disadvantages associated with disabilities. In 2020, the Center for Disease Control and Prevention (CDC) estimated that a significant 24.8% of adults aged 18 years or older in the United States suffer from some form of disability. It is clear that the improvement of quality of life for people with disabilities is a necessary and worthwhile undertaking for scientists, engineers, and society as a whole.

Automating chess: creating a hands-free chess board

How may an over-the-board chess match be played without players manually moving pieces?

For my engineering capstone project, I and several other engineering students will be designing a chess board with mechanisms for self-moving pieces. This project is intended to provide accommodations for chess players with physical disabilities, such that they can play over-the-board chess without assistance. The project is being advised by Dr. Harry Powell in the Electrical and Computer Engineering (ECE) Department. In order to meet budget and time constraints, the scope of the project has been reduced to returning chess pieces to their original positions following the conclusion of a match.

The idea of self-moving chess pieces is not completely revolutionary, as there are already boards on the market which incorporate this function. One such product is the Square Off Grand Kingdom Set, which gives users the choice of playing against another human or against an AI. However, automatic piece movement is limited to the AI opponent's moves, and human players must still make their moves manually. Thus, there is room for improvement of this concept, and our project aims to further develop this function. To achieve this, we will be building a prototype board, and performing extensive testing on it and the software algorithms which will drive the board operation. At the conclusion of the project, we expect to have a fully functioning board which, at the press of a button, will automatically move pieces to their starting positions. Future iterations of the board could build upon this framework, and incorporate various forms of user input to allow user-defined piece movement.

Technology doping: the role of technology in competitive environments

How do critics of technological aids in competitive environments advance their agendas?

Presently, the discussion over performance enhancing drug use (doping) in competitive sports has all but run its course. Most athletes agree that doping is dishonest, and is against the ethical spirit of sports (Morente-Sánchez and Zabala, 2013). However, a newer and less regulated means of gaining an advantage has emerged: performance enhancement through the use of technology, colloquially known as technology doping. This issue came into focus during a 2019 marathon, where Kenyan runner Eliud Kipchoge beat the previous record time while wearing a pair of Nike's Vaporfly Next% shoes, which specifically were designed to boost running performance (Kilgore, 2020). This is not the first occurrence of controversy over sports equipment. During the 2008 Olympics, a staggering amount of swimming records were beaten

by athletes wearing full body suits also designed to improve swimming performance, which spawned concerns about legitimacy of medals earned. In the aftermaths of these events, how have critics of technology doping advanced their agenda?

Participants include athletes, among which there are two main schools of thought. The first proposes that technology doping is inherently unfair, and should not be allowed in competitions. As one would expect, these athletes did not use the controversial technologies. For some, this may raise concerns about the motivations behind their belief. After all, if technology doping were to be banned, athletes who previously relied on it would most likely see a decrease in performance, leading to an opportunity for better results for those who did not. While vocal opponents of technology doping may believe this, admitting so publicly would harm the legitimacy of their argument. Instead, they appeal to ideals of fairness and competitive spirit in interviews. One example of this is an Associated Press interview with Olympic swimmer Janet Evans, in which Evans protested against the use of swimsuits that aid buoyancy, stating that it promotes inequality among athletes and threatens to make a mockery of the sport (Associated Press, 2009). Rather than take away records set using the suits, Evans proposed that new records should be marked differently from previous records set without the suits in order to avoid discrediting athletes' accomplishments. This proposal reiterates Evans' belief that technology doping should not be allowed, while also attempting to establish that she is not motivated by self-interests. High profile runners such as Usain Bolt have also spoken out against the unfairness of technology doping. During an interview with Reuters, Bolt stated that advances in spike technology in shoes that could help wipe out his world records are laughable, and that the new shoes give an unfair advantage over any athletes not wearing them (Raynor, 2021). Opponents of technology doping also use logical arguments, likening technology doping to

traditional doping. In an interview with BBC, British Olympic marathon runner Mara Yamauchi said the following:

If they say doping is not allowed because it's performance enhancing but we're OK with these shoes which are also performance enhancing, there's a bit of inconsistency there (Hodgetts, 2020).

Following her interview, Yamauchi took to social media to defend her beliefs. In response to a Twitter post, she expressed disappointment in World Athletics, the main governing body for international running events, and said "I'd hoped to see much more robust leadership to enforce fair & inclusive competition" (Yamauchi, 2021). She again emphasized that the discussion is not about her, but rather about fairness, and a level playing field for everyone. On the other side of the debate, supporters of technology doping claim that that athletes must adapt to growing technology, and that specialized equipment should not be banned. They address the concerns of inequality by pointing to their individual talent. Speaking with Reuters, American runner Florence Griffith-Joyner said that if someone else were given her shoes, they would probably not be able to do the same things as her (Raynor, 2021). In her point of view, the technology does not single-handedly explain her stronger performance. Kipchoge also effused this sentiment, saying "it's the person who is running, not the shoe" (Bloom, 2020). In response to claims that technology doping is unfair, Kipchoge and other supporters argue that the technology is available to all competitors, and therefore should not be banned. Aside from the athletes, participants also include the governing bodies of competitive sports. These organizations are responsible for determining the rules and regulations for international sporting events. Events for the sport of athletics, which covers track and field, cross country, and various other types of running, are overseen by World Athletics. As such, following the controversy involving Kipchoge and the

Vaporfly shoes, World Athletics was spurred into action, and assembled a panel of technical, scientific, and legal experts in order to examine the controversial shoes. This panel concluded that the shoes “may provide a performance advantage and there is sufficient evidence to raise concerns that the integrity of the sport might be threatened by the recent developments in shoe technology” (Hodgetts, 2020). With this conclusion, World Athletics imposed a new set of regulations on shoes worn by athletes, limiting the sole thickness, and requiring that shoes worn at competitions must have been available on the market for at least four months prior to ensure equal availability. According to World Athletics president Sebastian Coe, the organization is not responsible for regulating the entire sports shoe market, but needed to intervene to preserve the integrity of competition (Hodgetts, 2020). This new regulation appeased both sides ahead of the Tokyo Olympic Games held in 2021, and allowed World Athletics to show that it was upholding its values. Finally, participants include the sports technology manufacturers that supply competing athletes with equipment. The material interests of this group are clear. Having their products banned from competitions negatively impacts their bottom line, so they must seek to avoid this outcome while still proving their products superior to other brands. Following the controversy in the 2008 Olympics after which the Speedo LZR swimsuits were banned, Speedo released a statement protesting the decision. In their statement, Speedo cited the fact that their swimsuits had previously been approved and deemed acceptable for competition (Ryan, 2009). They also brought up their long history in designing competitive swimwear, and argued that the ban could be detrimental to the future of swimming. In doing so, they reframed their argument around the ban’s effects on the future of swimming, as opposed to their profit margins, which could potentially garner more support from swimming enthusiasts and athletes alike.

The claims that technology doping provide an advantage are not unfounded; there has been substantial research on the efficacy of these technological developments. For example, Kim et al. (2022) found that Nike Vaporfly 4% running shoes on average reduced oxygen consumption by 4% compared to other brands. After studying the performances of swimmers over a period of roughly 60 years, Foster et al. (2012) found that incorporation of new technologies into the swimsuits was correlated with better performances. Lastly, Kesebir et al. (2019) conclude in their study that competitive motivation is on average stronger in men than women, which could be helpful in considering the reasons for attitude differences regarding technology doping.

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