Thesis Portfolio

Modeling Biological Rhythms to Predict Mental and Physical Readiness
(Technical Report)

An Analysis of the Social and Technological Barriers of Instant Replay Technology in the National Football League
(STS Research Paper)

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Society and technology are interdependent forces that both depend on and influence each other. As a society, we are presented with opportunities to research, develop, and apply technologies to enhance our standard of living and increase efficiency. For example, in the National Football League (NFL), wearable technology has become increasingly relevant with innovative player and ball location tracking. This provides NFL teams with data to analyze their players and opponents while simultaneously improving the gameday experience of fans through advanced statistics. The manner of how the data is used, processed, and shaped by the societal actants involved in the league is limited at times.

Similarly, wearable technology has recently exploded onto the scene. This technology has been primarily focused on the health and fitness industry and focuses on physical health tracking. Advanced wearables in the healthcare industry include items that can predict relapse likelihood for addicts, measure blood glucose and insulin levels for diabetics, and even have the ability to pre-determine onset signals of strokes for epileptic patients.

However, in both of these two scenarios, there is a limitless possibility of research and often that research is inhibited by lack of formal study or investigation. Often the technology exists, yet the proper research has not been performed to provide actionable conclusions. In the NFL, innovative technology implemented to aid refereeing has been discussed, exists in other sports, but has never been carried out. With wearable devices, Empatica E4 and Oura Ring provide continuous biological and physiological data but the studies of rhythmic patterns specifically regarding overall mental and physical readiness are limited. These two cases provide the bridge examples of consumer technology that exist but limited research inhibits future innovation.

Modeling Biological Rhythms to Predict Mental and Physical Readiness

The human body is composed of individualized biological clocks based on repeated internal and external events. These rhythmic clocks consist of biological, mental, social, and environmental events that impact the overall health and wellbeing of individuals. When individuals become increasingly aware of their personal rhythms, productivity tends to increase and overall health and wellbeing increases as well. The technical research explores an in-depth, longitudinal study of biological features using consumer wearable devices and their associated effects on overall readiness.

The system our technical research team created tracks and processes biological and physiological data. The system models the data based on daily periods and provides personalized information through machine learning algorithms to find the greatest predictors of overall readiness. The research finds an overall strong negative correlation (-0.71) between the rhythm-adjusted mean (MESOR) value of heart rate and average readiness. Additionally, the research finds contradicting findings in the best predictors of overall readiness per individual. This can be attributed to varying internal and external events affecting the biological clocks of individuals differently, which is why recommendations must be personalized rather than extrapolated to larger, more generalized populations.

An Analysis of the Social and Technological Barriers of Instant Replay Technology in the NFL

The NFL has created an interesting scenario deciding on how to move forward with their instant replay technologies. With other sports adopting innovative technologies such as the Video Assistant Referee (VAR) in soccer, and magnetic field sideline technologies in tennis, the NFL has been pressured to respond. The league must respond by incorporating the appropriate technology in the fairest and just manner without jeopardizing traditions that have been set for the hundred years the league has been playing. These decisions must be supported by all of the key stakeholders that put on the league every year including players, fans, coaches, referees, and varying league officials.

The STS research focuses primarily on the current technological advances that exist and the social barriers that are prohibiting wide-scale implementation in the NFL. A few of the main technologies discussed are precision-based technologies from a company named Hawkeye which currently operate sideline tech in soccer, cricket, and tennis. The larger social issues defined in the analysis are the breaking of traditions and suspenseful moments that the league has created, the proper definition of referee productivity, and transparency through referee and fan perception.

The findings of the analysis show that technologies exist for implementation but larger political and societal issues define how they can be used. While the technology can aid in certain aspects of refereeing such as ball placement, there are subjective lines that are immeasurable through technology that human referees will always be needed. Additionally, eliminating the human aspect of refereeing is an additional fundamental issue that must be discussed throughout all sports. The best proposition would be a combination of increased technology to aid referees in their decision making while still leaving calls up to final human interpretation.

Conclusions

The technical project was in the first year of existence but has great potential for future applications. The sample size was limited to four participants within the research team with hopes to expand that number in future applications. Additionally, the goal is to build personalized recommendation systems to be integrated into smart technologies. These technologies might include lights that dim to more natural lighting when it is the optimal time for an individual to sleep, or smart calendars that recommend when productivity is down and it is a good time to break.

The STS research project found substantiate evidence of underlying social barriers inhibiting instant replay technology from advancing more liberally. The project details the mutual shaping between innovative technologies and the NFL's social traditions. As the NFL continues, the idea of integrated advanced technology interfering with social aspects of the game will only become more prevalent. Future work may detail a more in-depth plan of the cost of implementation of the technology and the implicit unintended consequences.