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Deliverable 3: Synthesis and Report Writing

Introduction.

The term “data-driven” baseball is an idea that the baseball world is slowly embracing. With the advancement of new high-tech motion sensors, high-resolution cameras, and other methods of capturing different metrics, baseball performance and development is transformed immensely. This transformation helped baseball athletes reach potentials that we would not get years ago, raising their performance and skill ceiling.

With new technologies and its complexity, comes new importance of understanding how to utilize them properly and effectively. This is where system analysis and design principles are relied upon. While data is more easily accessible, it also presents new challenges. Without a systematic approach of data gathering, analysis, and interpretation, organization may mishandle these data and risk losing opportunities to capitalize on advancing player development. This would also prevent organizations from losing money and time.

This is where the motivation for this research came from. I want to explore how system analysis and design can serve as a guide for navigating the complexities of data-driven baseball. By looking at different literatures on baseball biomechanics and performance tracking, we seek to identify system and analysis principles implemented in these literature pieces so we can understand the strategies and methodologies used to leverage the new technology effectively. By doing this, our goal is to uncover best practices, common challenges, and innovative solutions that can inform and inspire us in baseball player development and performance optimization.

This research is driven by our commitment to advancing our understanding of the crossover between technology and baseball, with the final goal of helping people in baseball to grow the game that we love. By highlighting the system analysis and design principles in these literature pieces, we hope to continue and improve “data-driven” baseball.

Background.

I’ve always had an interest in data-driven baseball. Being a former player who came from a country with baseball being underdeveloped, I dreamed of playing baseball at the highest level. I got the opportunity to go half-way across the world to develop my skills even further in a high school baseball academy in Canada, where I first got exposed to data-driven baseball. I kept following the development of the field all throughout high school and college, trying to implement some ideas from the field into my own training and performance. My attempts though, were very limited as I do not have the same technology or fundings as these baseball organizations that performs baseball research.

With pursuing my Masters in Analytics, I thought that it would be beneficial for me to get a better understanding on how these baseball organizations find new problems within data-driven baseball. Not only that it will help me gain a better understanding of what data-driven is specifically, it will also understand the complexity of data-driven baseball and

look at what these baseball organizations do on the daily basis. This will help me understand what it would take to get into the baseball research field and do my own projects with public data that's available. Most importantly, this literature review will deepen my understanding of system analysis and design in general, which is something that will be useful when I dive into the professional world in any other industries.

Findings.

I found four recent articles specifically that I could relate to system analysis and design (Driveline Research Review). Most of them were also studies done by Driveline Baseball, and the importance of using more advance technologies in these studies were stressed. By focusing more on these four articles, I thought that I could effectively evaluate system analysis and design implementation in baseball.

Even though these four articles did not specifically talk about system analysis and design in baseball, there are aspects of the literature pieces that can be related to system analysis and design principles. There are two articles that specifically focuses on different techniques of capturing data, while the other two are more focused on mechanics and performance.

The first two literature pieces were studies done by Driveline Baseball themselves on validating data from MotusBASEBALL sensors (Motus Global, 2016) and pitchAI (3motionAI, 2020) by comparing their results to a gold standard marker-based motion capture system. Their studies consist of testing athletes in their facility. They also made sure that the athletes threw similarly and were capable to throw maximum effort as a control. Incomplete captures from different methods of data collection were also excluded within the experiment.

Throughout the studies, there were many methods and processes that can be related to system analysis and design. One of them is the fact that both studies were done because they identified the need for a low-cost, accessible alternative to marker-based capture systems for biomechanical analysis of pitching mechanics (Boddy et al., 2019). This aligns with the requirements gathering phase in system analysis and design, where they define their desired functionality and performance criteria. They also dove into the requirements for accurate joint angles and descriptive metric measurements during the pitching motion (Dobos et al., 2022). Not only that they identify what their business (baseball development) needs, they were specific in their requirements, which is helpful further into the study. By having specific requirements, they can have a good foundation to create a system that will help them reach their goals in their study (biomechanics analysis).

Both studies modeled a biomechanics analysis system using marker-based motion capture and the MotusBaseball and pitchAI system that were created outside of their company. They calculated kinematic and kinetic values like joint angles, velocities, and torques (Boddy et al., 2019). By doing this, they are creating an abstract representation of the real-world systems, which is a key aspect of system modeling. They also integrated the system with a user interface for video input and analysis output (Dobos et al., 2022). The integration of MotusBaseball and pitchAI in the biomechanics analysis system paired with the marker-based system is a part of the implement stage of system analysis and design.

Finally, they evaluated the system they are testing and evaluating their performance specifically at different stages of the pitching motion and for different joint angles/metrics. They analyzed the performance of both MotusBaseball and pitchAI to see if they can use these methods to develop a biomechanics analysis system that's cheaper but matches the high standard of the marker-based capture system (Boddy et al., 2019, Dobos et al., 2022). They also provided some limitations of the two applications since pitchAI is an application in a phone that captures 2D space instead of 3D and MotusBaseball is a cheaper sensor that only captures one part of the body (Boddy et al., 2019, Dobos et al., 2022). Even though the studies were not focusing on system analysis and design specifically, they showed that Driveline Baseball utilized part of the system analysis and design process to improve biomechanics data collection methods and improve "data-driven" baseball overall.

The other two articles were more focused on the throwing motion as a system. The goal of the studies is to evaluate the throwing mechanics so they can use them to improve the design of a recovery exercise routine for baseball pitchers and reduce injury risk. They used electromyographic amplitudes (Fortenbaugh et al., 2009) and biomechanics model (Caravan et al., 2018) to calculate different exercises and analyze different "subsystems" of the pitching motion. They also used their findings to evaluate the throwing motion and exercises that can help pitchers throw hard while also minimizing injury risk. These two articles weren't as technologically advanced as the other two literature pieces that I've covered earlier, but they can still be related to system analysis and design due to the process of their studies and the steps they took to solve their problems.

Conclusion.

There were about 8-10 literature pieces that I analyzed. I mostly looked at a research review page from Driveline Baseball (Driveline Research Review), where they collected different studies and reviews to validate their research and experiments. To be honest, it was challenging to find literature pieces directly relating to system analysis and design, as most of the articles are specific to sports science and athletic performance evaluations. They were also mostly articles published almost over 10 years ago. I decided after reading them, I would choose 4 articles that I could relate to system analysis and design the most. But the limitation of peer-reviewed journal entries for system analysis and design in baseball was something that I had to deal with.

Even though it was tough to find specific system analysis and design articles within baseball, we can see that there are some principles being implemented with baseball research. The studies and experiments that I found were effective in doing so. They prove that these principles are essential to designing and innovating new systems within baseball research. Without them, it would be tough to design and execute a system that help supplement the advancement of "data-driven" baseball.

My personal reflection on the report findings is that I was in awe on how specific their requirements for their systems are. I think that's the foundation of "data-driven" baseball. As an athlete, it can be challenging to quantify different things that you do within the sport, and the specificity of what these companies focus on within the athlete's

movements and performance is what makes them successful. In the future, I'll look forward to reading new baseball studies that uses system analysis and design principles and help advance the game!

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