**Exploring the Influence of Data Visualization on Trends in the National Hockey League**

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**Introduction**

The National Hockey League (NHL) is a dynamic and ever-evolving sports landscape where data plays an increasingly pivotal role. Data visualization techniques have become integral tools for analyzing player performance, team strategies, and overall game trends. This project proposal aims to investigate how data visualization influences trends in the NHL, providing insights into how teams strategize, fans engage, and the league evolves. By understanding how data visualization shapes player performance, team strategies, and fan engagement, stakeholders within the NHL can make informed decisions to further enhance the sport's dynamics and appeal. Moreover, this research will contribute to the broader field of sports analytics, showcasing the power of data-driven insights in shaping the future of professional sports.

Wayne Gretzky is widely regarded as one of the greatest hockey players of all time and was one of the most influential players in NHL history. Gretzky learned many valuable lessons from his father, Walter Gretzky. One of the notable techniques Walter taught Wayne was to trace the movement of the puck on a notepad during games. This method involved drawing lines to track the path of the puck and the movement of players on the ice. By doing so, Wayne could gain insights into the flow of the game, identify patterns in play, and anticipate where the puck might go next. This exercise was not just about following the puck but also understanding the dynamics of the game, such as the positioning of players, the strategies employed by both teams, and the opportunities that emerged during play. By observing and analyzing the movement of the puck over a period, Wayne could develop a deeper understanding of the game's nuances and improve his decision-making on the ice.

Gretzky was effectively creating data visualizations by generating heatmaps on the ice to understand how the game works. Through this hands-on approach to learning and analyzing the game, Gretzky honed his exceptional hockey sense, intuition and vision on the ice. His ability to anticipate plays, find open teammates, and exploit scoring opportunities was unparalleled. Gretzky's dedication to studying the game, coupled with his natural talent and work ethic, propelled him to unprecedented success in the NHL and solidified his legacy as one of hockey's most iconic figures. The tracing technique exemplifies the importance of attention to detail, understanding game flow, and continuous learning in the pursuit of excellence in hockey.

Analysts today use similar techniques to understand the game and teams throughout the league employ analysts to help coaches and players prepare and train for matchups against opponents. Whether it is understanding a team’s style of play, power-play execution, or simply analyzing few star players’ performances or the analytics of the goaltender’s skills to effectively plan strategies in order to win.

Some teams have such effective strategies that other teams adopt it in their own play. For instance in the 1990s, the New Jersey Devils employed a defensive-minded style of play that contributed to what is known as "the dead puck era" in hockey. The Devils' strategy focused on tight defensive systems, disciplined positioning, and strong goaltending, which stifled offensive opportunities for both their opponents and themselves (Pickens, 2014). The Devil’s style of play lead them to championships in 1995 and 2000 (NHL.com).

Key elements of the Devils' style of play during the 1990’s included:

1. Trap Defense: popularized the neutral zone trap, a defensive strategy where players clog the neutral zone to disrupt the opposing team's ability to transition into the offensive zone effectively. This defensive tactic slowed down the pace of the game and limited scoring opportunities (Pickens, 2014).

2. Shot Blocking: The Devils emphasized shot blocking as a defensive strategy, with players sacrificing their bodies to prevent shots from reaching their goaltender. This tactic reduced the number of shots on goal but also contributed to a less dynamic and exciting style of play (Pickens, 2014).

3. Counterattacking: While focusing on defense, the Devils also capitalized on counterattacking opportunities. They would quickly transition from defense to offense, often catching opponents off guard and generating scoring chances through fast breaks (Pickens, 2014).

4. Goaltending Excellence: The Devils boasted strong goaltending during this era, with players like Martin Brodeur anchoring their defense. Brodeur's exceptional goaltending skills complemented the team's defensive style, making it even more difficult for opponents to score (Pickens, 2014).

Overall, the New Jersey Devils' defensive-minded approach in the 1990s, characterized by the trap defense, shot blocking, and counterattacking, contributed to the low-scoring nature of the game during the "dead puck era." While effective for the Devils in terms of winning games and championships, this style of play was criticized for its lack of excitement and offensive creativity, ultimately leading to changes in NHL rules and strategies to increase scoring and restore the game's entertainment value (Pickens, 2014).

**Modern Era Boom in Scoring**

Gretzky himself said that the only way players will be able to score more goals is if the goalie equipment is changed back to similar ways from the 1980’s. Where the goaltender’s equipment is quite smaller and significantly heavier. This makes sense considering that high scoring was correlated with low save percentages during the years of high scoring. Yet, goaltenders today have equipment similar to how they have been starting in the 1990’s and we have seen scoring in the past few seasons that we haven’t seen in nearly 30 years (NHL.com). While Save percentages have declined in the NHL since 2016 as scoring has increased, the numbers are significantly better than they were during the years of Gretzky’s record setting years. Auston Mathews scored 60 goals for the first time in 10 years in 2022, followed by David Pasternack and Connor McDavid in 2023, and Mathews scored 69 this past season. This season McDavid, Nathan McKinnon, and Nikita Kucherov all had 132, 140, and 144 points respectively. In 2023 McDavid Scored over 152 points, something which hadn’t been achieved since Mario Lemieux in 1996 (NHL.com).

 Two data analysts wanted to explore a few hypotheses as to why save percentages are dropping on average league wide. They offered three hypotheses which they tested using data from the NHL. They hypothesized that either 1) worse goaltenders are playing more, 2) there is an increase in powerplays, or 3) shooters have improved their effectiveness, which has influenced league-wide save percentages (Robnett & Welsh, 2023).

 They found for the first hypothesis that although backup goalies have indeed been playing more frequently over time, the disparity in skill between starters and backups did not seem significant enough to be the primary factor. The second hypothesis was swiftly dismissed upon discovering that power play opportunities have actually been decreasing. The third hypothesis centered on the idea of improved shot quality over time. Analysis using expected goal models for each season revealed intriguing patterns in goal scoring dynamics. Notably, the save percentage has declined for shots taken from the 20-40 foot range, as well as for shots with angles exceeding 20 degrees (Robnett & Welsh, 2023).

The increase in scoring in the NHL over the last few seasons one can argue has been influenced by several factors, including changes in game play, rule adjustments, advancements in player skill and athleticism, and strategic innovations by teams and coaches (Starr, 2024; Revak, 2023).

1. Rule Changes: The NHL has implemented rule changes aimed at increasing scoring and enhancing the flow of the game. For example, the introduction of 3-on-3 overtime has provided more opportunities for teams to score, leading to higher-scoring games. Additionally, the crackdown on obstruction and interference has allowed skilled players more freedom to showcase their offensive abilities (Revak, 2023).

2. Skill and Speed: NHL players today are faster, more skilled, and better conditioned than ever before. Advances in training methods, nutrition, and overall athleticism have led to players who can generate scoring chances more effectively and capitalize on opportunities with greater precision (Revak, 2023).

3. Offensive Strategies: NHL teams have adopted more aggressive offensive strategies, focusing on puck possession, speed through the neutral zone, and generating high-quality scoring chances. Coaches are encouraging their players to play an uptempo style of hockey, leading to more offensive opportunities and higher-scoring games (Revak, 2023).

4. Analytical Insights: The use of advanced analytics has provided teams with valuable insights into offensive strategies, player tendencies, and scoring opportunities. Teams are using data-driven approaches to optimize their offensive tactics, resulting in increased scoring efficiency (Revak, 2023).

**How Analytics Influence Hockey**

Analytical insights in hockey refer to the use of advanced statistical analysis and data-driven approaches to gain a deeper understanding of the game. In recent years, the NHL has seen a significant rise in the use of analytics by teams, coaches, and analysts to evaluate player performance, assess team strategies, and identify areas for improvement. Key features of the game benefit from analytical insights:

1. Player Performance Analysis: Analytics allows teams to evaluate individual player performance beyond traditional statistics like goals, assists, and points. Advanced metrics such as Corsi, Fenwick, Expected Goals (xG), and Wins Above Replacement (WAR) provide more comprehensive assessments of a player's impact on the game. These metrics take into account factors like shot attempts, shot quality, possession metrics, and defensive contributions to provide a more nuanced understanding of a player's effectiveness on the ice.

2. Line Combinations and Matchups: Analytics can help coaches optimize line combinations and player matchups based on statistical trends and performance data. By analyzing the impact of different line combinations on shot differentials, scoring chances, and goal production, coaches can identify combinations that maximize offensive output or defensive effectiveness. Similarly, analytics can inform decisions about defensive pairings and matchups against opposing players.

3. Tactical Analysis: Teams use analytics to evaluate their tactical approach to games, including offensive strategies, defensive systems, special teams play (power play and penalty kill), and in-game adjustments. By analyzing game footage and statistical trends, coaches can identify patterns in play, assess the effectiveness of different strategies, and make informed decisions to adapt their game plan accordingly.

4. Scouting and Player Evaluation: Analytics play a crucial role in scouting and player evaluation, both at the amateur and professional levels. Teams use statistical models and data analysis techniques to assess the potential of draft prospects, evaluate players in other leagues, and identify undervalued or overlooked talent. Analytics provide scouts and general managers with objective criteria to supplement traditional scouting methods and make more informed decisions in player acquisitions and trades.

Overall, analytical insights have become an integral part of decision-making processes in hockey, offering teams a wealth of information to improve performance, optimize strategies, and gain a competitive edge in the NHL. As technology and data analysis techniques continue to advance, the role of analytics in hockey is expected to expand further.

There are many analytical tools used to analyze hockey and more being created which can further develop the sport and how teams play it. For instance the SnapShot system (Pileggi et al., 2012). It is a visualization tool designed to integrate into the workflow of hockey analysts, providing them with enhanced capabilities to explore, analyze, and communicate insights derived from hockey shot data. It works by offering various visualization techniques tailored to the specific needs of hockey analytics, particularly focusing on shot data analysis.

One of the key features of SnapShot is its ability to display shot data in visually intuitive ways, allowing analysts to gain insights quickly and effectively. For example, it employs traditional heat maps to visualize shot distributions on the ice, helping analysts identify patterns and trends in shooting behavior. Additionally, SnapShot introduces a novel visualization technique called the radial heat map, which offers a unique way to represent shot length data. This radial heat map allows analysts to visualize shot lengths across different areas of the ice, providing a comprehensive view of shooting tendencies and preferences (Pileggi et al., 2012).

SnapShot also offers functionalities for filtering and drilling down into the data, enabling analysts to focus on specific subsets of shot data based on various criteria such as team, player, game situation, and more. This flexibility allows analysts to tailor their analysis to specific research questions or areas of interest, facilitating deeper insights into the underlying dynamics of the game (Pileggi et al., 2012).

Overall, the SnapShot system serves as a powerful tool for hockey analysts, providing them with advanced visualization capabilities to uncover hidden patterns, trends, and insights within hockey shot data. By integrating visualization into the analytical workflow, SnapShot empowers analysts to make more informed decisions, develop better strategies, and ultimately enhance performance in the realm of hockey analytics (Pileggi et al., 2012).

**Conclusion**

The NHL is in an exciting time, where data visualization techniques have emerged as transformative tools shaping player performance, team strategies, and fan engagement. From Gretzky's pioneering use of puck tracing to modern analytics-driven insights, the NHL has undergone a dynamic evolution propelled by data-driven approaches. Analyzing the recent surge in scoring within the NHL reveals a multifaceted interplay of factors, from rule changes fostering a more dynamic gameplay to advancements in player skill and athleticism. This resurgence underscores analytics serving as a guiding force in optimizing performance and strategic decision-making. Tools like the SnapShot system equips analysts with advanced visualization capabilities to uncover hidden patterns and trends within shot data, thus propelling the NHL into a new era of hockey excellence.

The integration of analytical insights into every facet of the game, from player performance evaluation to tactical analysis and scouting, underscores the transformative impact of data-driven approaches on hockey. Teams gain a deeper understanding of player contributions and team dynamics, enabling them to optimize line combinations, assess tactical approaches, and make informed strategic decisions. As the NHL continues to embrace the data-driven future, the role of analytics in hockey will only continue to expand, offering new opportunities for teams to refine strategies, optimize performance, and gain a competitive edge on the ice

**Research Proposal**

This research project will aim to assess how data visualization techniques affect player decision-making, skill development, and performance on the ice. By analyzing player trajectories, shot maps, and other visualizations to understand how players utilize visual data to improve their game and adapt to different playing styles.

Furthermore, this project also aims to assess the impact of data visualization on team strategies: This focuses on exploring how data visualization influences team tactics, lineup decisions, and in-game adjustments. By analyzing strategic visualizations such as heat maps, passing networks, and zone entries, to uncover patterns in team strategies and assess the effectiveness of data-driven approaches in optimizing gameplay.

**Methodology**

**Data Collection and Analysis**

Data will be collected from various sources, including NHL game statistics player performance metrics. Visualizations such as heat maps, shot charts, passing networks, and player trajectories will be generated to represent different aspects of the game.

Statistical techniques will be employed to analyze the relationship between data visualization and player performance, team strategies, and fan engagement. Correlation analysis, regression modeling, and comparative studies will be conducted to assess the effectiveness of visualized data in influencing various outcomes.

**References**

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