# Bridging the Ball Gap

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## Introduction

A significant portion of revenue and brand reputation for many golf companies stems from partnerships with professional players, driving their concentration towards producing golf balls tailored for the PGA Tour. This is why golfer performance has been solely analyzed on the PGA Tour, primarily because of the difficulties creating handicap indexes for amateur golfers because of how strokes gained analyses[1] only applies to professional golfers.[2] Previous research has analyzed the motion of golf balls, but solely with professionals used as samples. My research addresses the gaps in prior research regarding amateur demographics by answering, "How do golf ball flight behavior and design patterns affect the ball preferences of amateur golfers with handicaps greater than 15?"

Despite the wide variety of golf balls available to amateur golfers, those with handicaps above five do not have them with optimized dimple patterns and core designs tailored to their performance. Professional golf balls are high-spin and are optimized for extremely high swing speeds — amateurs do not have these swing speeds, so professional balls such as the Titleist ProV1 do not perform as well for those golfers[3]. This mismatch highlights a significant limitation for amateur golfers, who lack access to balls that properly accommodate their performance needs. If a golf ball is specifically designed for amateur golfers, those who join the game may be further encouraged to play when they experience the ease of ball use.

This project designed a golf ball tailored for amateurs through a mix of a survey and experimental study. I hypothesized that hexagonal dimples would be the most effective at changing golf ball flight and that golfers would prefer a straight/medium flight.

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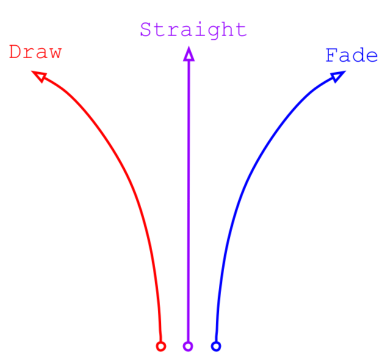
[1] A method of analyzing golfer performance and swings
[2] Broadie, M. (2012). *Assessing Golfer Performance on the PGA TOUR*. Interfaces, 42(2), 146–165.
[3] Cross, R. (2010). *Enhancing the Bounce of a Ball*. Physics Teacher, 48(7), 450–452.

# Literature Review

## Key Terms

To understand the concept of golf ball design, some key terms must be addressed:

- Handicap: A numerical index that determines a golfer's skill level. Any number above 0 is considered to be attributed to a non-professional golfer.
    - I self-defined golfers as golfers with handicaps above 5. I excluded the 0 - 4 range to account for any errors throughout my research study.
- Coefficient of Restitution: The coefficient of restitution is a physical quality, described by a number, that dictates how much a spherical object can bounce. Coefficient of restitution (COR) numbers can vary based on the type of surface and the condition it is in; this research will focus solely on the COR conditions with low-speed impacts.
- Golf Ball Appearance: The type of dimple pattern on the ball. Dimples are the indents on the surface of a golf ball that affect how much a golf ball spins. These can create different types of golf ball flights (see *Figure A*): push flights (high shots, draw shots), pull flights (low shots, fade shots), and medium flights (medium shots, straight shots).



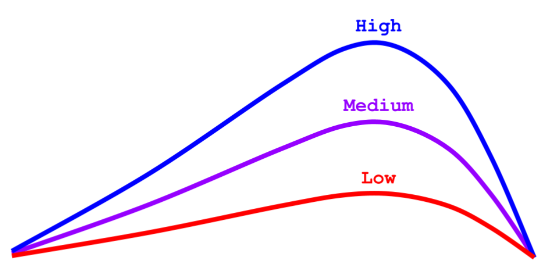



*Figure A: Types of Golf Ball Flights*

**Dimple Patterns vs. Core Design**

The surface design plays a significant role in the spin of a golf ball in terms of changing the tangible effects of dimple patterns and the coefficient of restitution (COR) of a golf ball. While dimples can enhance/hinder spin, the surface design creates the initial spin of a golf ball that can dictate a range of spin possibilities that the ball can have. This is caused because balls do not roll off the club face at contact; rather, they grip the club face and push off. X. W. Zhang (2014)[4] and their colleagues observed the gripping phenomenon of golf balls in the Latin American Journal of Solids & Structures by using balls made of different materials and bouncing them off a rigid surface. They proved that some objects could maximize the distance flown despite having a lower COR at lower impact speeds, depending on how much the ball can grip the impact surface. I can use this information within my research to enhance the golf ball design by incorporating a more gripping surface with varying types of dimple patterns.

Two sources contradict the conclusions of X. W. Zhang's foundational source. One contradiction derives from Rod Cross' (2010)[5] findings in Physics Teacher, which suggest that golf balls, regardless of materials, are optimized for professional swing speeds and that those materials will behave uniformly for amateurs rather than providing any noticeable benefit. The other contradiction derives from Kohei Moriyama's and Hikoo Okanaga's (2023)[6] study, which utilizes previous studies of golf ball flight patterns to discuss the implications of golf balls. This source argues that it is primarily the core design that dictates the efficacy of golf ball flight. However, this conclusion is refuted by other sources. X. W. Zhang's work contradicts Kohei

[4] Zhang, X. W., Tao, Z., & Zhang, Q. M. (2014). *Dynamic behaviors of visco-elastic thin-walled spherical shells impact onto a rigid plate*. Latin American Journal of Solids & Structures, 11(14), 2607–2623.
[5] Cross, R. (2010). *Enhancing the Bounce of a Ball*. Physics Teacher, 48(7), 450–452.
[6] Moriyama, K., & Okanaga, H. (2023). *Effects of golf ball dimple surface occupancy, volume ratio and depth on aerodynamic characteristics during rotation*. Sports Engineering (Springer Science & Business Media B.V.), 26(1), 1–9.

Moriyama's and Hiroo Okanaga's study, proposing that surface design affects ball flight more than core design statistics. These contrasting views underscore the critical debate within golf ball design, highlighting the need for a more nuanced approach to understanding the implications of golf ball design on flight. Overall, the sources agree that surface design, core design, and the appearance of a golf ball play a significant role in a golfer's game in terms of the performance of a golf ball and a golfer's confidence. So, those are the factors that I observed throughout my research study.

This follows a logical path because surface design would visibly change the appearance of a golf ball, affecting the comfort of the ball's appearance, which in turn affects how confident a golfer is with a ball. This is corroborated by Yeemin et al.'s (2020)[7] study of the mental state of golfers and how that may affect their playing level based on the comfort level that the golfer has with the ball.

**Golf Ball Design and Connections to the Mental Game**

In terms of golf ball design, sources such as Mark Broadie's Interfaces (2012)[8] and Chung et al.'s (2013)[9] study for Marketing Science converge on the concept that the golf ball market drifts towards professional players due to their brand associations. They agree that this generally also neglects the needs of amateur golfers, which is supported by the lack of strokes gained analyses for amateur golfers, as stated earlier by Mark Broadie. However, Choi et al.'s (2018)[10] research in the Journal of Mechanics and Medicine & Biology suggests that while golf balls are tailored toward professionals, differences in performance are partially due to the

[7] Wichai Yeemin, Supatcharin Kemarat, & Apiluk Theanthong. (2020). *The effects of post activation potentiation warm-up and pre-shot routine programs on driving performance in amateur golfers*. PLoS ONE, 15(10), 1–10.
[8] Broadie, M. (2012). *Assessing Golfer Performance on the PGA TOUR*. Interfaces, 42(2), 146–165.
[9] Chung, K. Y. C., Derdenger, T. P., & Srinivasan, K. (2013). *Economic Value of Celebrity Endorsements: Tiger Woods' Impact on Sales of Nike Golf Balls.* Marketing Science, 32(2), 271–293.
[10] Choi, J. S., Seo, J. W., & Tack, G. R. (2018). *Differences in Putter Trajectory and Psychophysiological Variables between Professional and Amateur Golfers under Stress Condition.* Journal of Mechanics in Medicine & Biology, 18(7), N.PAG.

confidence of professional golfers in their golf balls. The preceding two sources later counter this because they explain how focusing on swing patterns plays a more significant role in skill level over mental state.

The divergent perspective between Chen et al.'s and Broadie's research exists because of their opposing views on the need to design golf balls tailored to amateur players regarding how much better golfers perform with balls tailored to them. As stated in Chung's study, knowledge of ball choice is necessary because golfers tend to gravitate towards balls that have brand associations with famous golfers. This can create blindness when choosing a golf ball that would fit the golfer because golfers assume that if a ball performs well for their favorite professional, it will perform well for them. Broadie and Chung provide insights into professional endorsements' economic and skill-based aspects, while Chen and Choi's research emphasizes the importance of confidence and appearance throughout the golf game. The synthesis of these sources shows how the choices a golfer makes when choosing a golf ball and the appearance of the ball can affect the confidence that the golfer has in the ball, explaining why an amateur-oriented golf ball can increase golfer performance from a mental standpoint because amateurs can choose golf balls that they know are tailored specifically for them.

## Further Research and Bias

### *Further Areas of Research in Golf Ball Design Studies*

The gap in the academic literature that my research addresses is the lack of consensus regarding the most important factors when designing an amateur-oriented golf ball. One notable bias lies in the lack of representation from amateur golfers within both existing studies and products sold, creating a gap in understanding this demographic's specific needs and preferences. This absence can skew golf ball research conclusions exclusively toward professional players, neglecting most players who do not fall within that strata. Some balls that work for players at a higher level may be less effective for those with slower swing speeds, so there is a need for golf balls tailored to amateur players. The Broadie and Chen sources concur regarding the efficacy of core design and dimple patterns when they complement each other (Chen, 2022; Broadie, 2012)[11] [12], but this was only studied for professionals. X. W. Zhang introduces a contradictory perspective that introduces the idea of surface design affecting golf aerodynamics, showing a lack of consensus within the field.

***Identification of Biases***

Wichai Yeemin (2020) [13] introduces another perspective that contains another reason for the differences in levels of golf performance: existing state and pre-shot routines. This could be a source of bias that would need to be accounted for within this research study because the degree of experience an amateur has is not a metric that can be fully measured. Varying degrees of experience lead to different types of structure (or how rehearsed a pre-shot routine looks) within pre-shot routines. The varying degrees of structure within amateur golf swings make it difficult to create subdivisions of amateur classifications based on skill. Therefore, in my research study, I grouped all golfers with a handicap greater than 5 as an amateur golfer. On a side note, none of the sources included data from amateur sources either, which corroborates one of the major gaps within the current literature. Another major source of bias is the sway of celebrity endorsements, as outlined by Chung (2013)[14], which significantly affects the perceived efficacy of a golf ball among amateur golfers. These biases could arise from the differing perspectives of golfers,

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[11] Chih-Chia (JJ) Chen, Yonjoong Ryuh, Luczak, T., & Lamberth, J. (2022). *Examining Different Foci of Attention on Golf Putting Performance in Novice Learners*. Physical Educator, 79(4), 466–483.
[12] Broadie, M. (2012). *Assessing Golfer Performance on the PGA TOUR*. Interfaces, 42(2), 146–165.
[13] Wichai Yeemin, Supatcharin Kemarat, & Apiluk Theanthong. (2020). *The effects of post activation potentiation warm-up and pre-shot routine programs on driving performance in amateur golfers*. PLoS ONE, 15(10), 1–10.
[14] Chung, K. Y. C., Derdenger, T. P., & Srinivasan, K. (2013). *Economic Value of Celebrity Endorsements: Tiger Woods' Impact on Sales of Nike Golf Balls*. Marketing Science, 32(2), 271–293.

making it necessary to conduct a survey that solely asks golfers for their ball flight preferences rather than their ball preferences. If this gap is addressed, golf companies will be able to manufacture golf balls specifically for amateurs, and amateur golfers will be able to use more effective golf balls that are tailored to their skill sets.

**Model Studies**

Two major sources (originating from the late 90s and early 2000s) affect the development of the current academic literature and prove the importance of flight dynamics. The first one is Taguchi's experiments, and the second is the book of Wu and Wu, which attempted to determine golf ball spin ratios, both of which were reevaluated by Queiroz et al. (2023)[15]. Chen's study was based on those two studies because the Book of Wu and Wu outlined the process of collecting experimental data. The methodologies outlined by the Book of Wu and Wu and Taguchi's experiments, in particular, outlined techniques for data collection that significantly influenced the method design of my studies. These sources provided several statistical analysis techniques (including a readjusted 2-Sample T-Test, which was used in this study) for golf balls to determine COR constants and the spin effects that dimple patterns have on ball flight. The authors conducted a statistical analysis of Taguchi's experiments by using a machine to hit golf balls and categorizing their flights into high, medium, low, draw, fade, and straight groups. Most of this study was experimentally based, which aligns with the purpose and approach of the research study I aim to conduct.

Rod Cross (2010)[16] used a similar technique to Taguchi's experiments (but a more sophisticated one) and combined it with the technique used by a previous source by Chaisuwan

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[15] Queiroz de Moura, R., Magalhães Rodrigues, I. A., & Antonio de Souza Sampaio, N. (2023). *Using Taguchi's experiments part i: creating a golf ball that reaches a maximum range.* GeSec: Revista de Gestao e Secretariado, 14(7), 11748–11757. https://doi.org/10.7769/gesec.v14i7.2502

[16] Cross, R. (2010). *Enhancing the Bounce of a Ball*. Physics Teacher, 48(7), 450–452.

et al. (2019)[17] that used an iPhone camera to measure the coefficient of restitution of a golf ball. That source used the gyroscope sensor and motion sensors available in the recent iPhones to analyze the compression of a golf ball. Slow-motion cameras were also used to determine the relationship between ball distance and bounce length, which directly indicates the ball's coefficient of restitution. Insights derived from Taguchi's experiments offer a foundational understanding of how ball characteristics affect flight dynamics. Leveraging these findings along with the data regarding iPhone cameras can be used to specifically improve performance for amateur players with slower swing speeds and higher handicaps by creating a feasible method to design a golf ball.

[17] Chaisuwan, P., Khemmani, S., Wicharn, S., Plaipichit, S., Pipatpanukul, C., & Puttharugsa, C. (2019). *Measuring the Coefficient of Restitution for Tennis and Golf Balls Using Smartphone Sensors*. Physics Education, 54(6).

# Methods

## Method Overview

This research project was conducted in two steps: the first step used a survey to determine the preferred ball flight among amateur golfers because I could not directly assume that golfers preferred a straight and medium golf ball flight due to the lack of studies regarding golfer preferences. This project aimed to design a golf ball tailored for amateurs through a 2-part mixed method study to isolate ball variables. Human participants were surveyed in person and asked to fill out a form regarding their golf ball preferences for the first part. The second part experimentally designed a golf ball tailored to those preferences by analyzing the ball flights of existing golf balls.

## Method Justification

Utilizing a survey method is ideal due to its feasibility and the insights that response data can provide into golfer preferences, thus addressing the first part of my research question. Previous sources have already dictated that golfers want increased distance and enhanced control but are unaware of their preferences regarding shot shape, which this survey gauged. The results from that survey provided insight into the ball flight preferences of amateur golfers, which was used in the experimental design. Overall, the survey aspect of my research question addressed the ‘ball preferences of amateur golfers’ aspect of my research question.

An experimental design is crucial for isolating the impact of specific factors, such as golf ball dimple patterns and core designs, on ball flight. This approach will work particularly well because the experimental design complements the survey design, enabling the analysis of the specific preferences of amateur golfers. The experimental design will address my research question's 'flight behavior and design patterns' aspect. Existing studies have analyzed the effects of golf swings and the respective properties of golf balls at high-speed (professional) impacts but have yet to optimize golf ball flight to the preferences of amateur golfers. If done correctly, this method will utilize the survey to analyze the preferences of amateur golfers and experimentally design a golf ball that meets the needs of those golfers.

**Survey Questionnaire**

The survey (see *Appendix B*) aspect of this research study aimed to find the ball flight preferences of amateur golfers. It is important to note that the results from GBBI[18] indexes affected how the data from the experimental aspect was interpreted. The survey (see *Appendix A*) was prefaced with a question asking for a golfer's handicap — this was used as a fail-safe to ensure that the data collected would be specifically from amateur golfers. The rest of the survey asked questions such as, "What is your preferred ball flight height?" to determine the preferred ball flights of golfers. When interpreting the data, each response (see *Appendix E*[19]) that included a push preference (a high shot or fade shot) added 1 to the GBBI index I created. I created two indexes: one for x-axis ball spin statistics that included draw shots, straight shots, and fade shots, and another for y-axis ball spin statistics that included low shots, medium shots, and straight shots. Each response that indicated a pull preference (low or draw shot) subtracted one from the GBBI index. Both GBBI indexes started at 0 to indicate a resting preference for a medium ball flight and a straight shot. I included a tolerance of 5 to account for any errors. The key is as follows:

$X < -5$: Pull Preference

$-5 < X < 5$: Straight/Medium Preference

$X > 5$: Push Preference

[18] A numerical index used to classify preference
[19] Responses highlighted in red were not used because of their suspicious nature

Survey Collection Procedure

To collect the information for my survey, I posted the link on United States golf forums across the social media platform, Discord. I would share the link 3-5 times a day, and on some days, I posted it approximately twice an hour throughout the entire day. Additionally, I shared the survey on Google Classrooms for both the boys' and girls' golf teams at my school. Because there was no research dissemination and to maintain anonymity, I did not collect the contact information of those who completed the survey.

**Experimental Setup**

The experimental aspect of my research used the GBBI indexes to determine the ideal golf ball design pattern tailored to amateur golfers' preferences. Overall, the experimental design stage was broken into three parts (hex dimple tests, round dimple tests, and warped dimple tests), with each part measuring a specific aspect of golf ball flight. For each test, I spun golf balls on their center line on a wood plate along three axes: the x-axis (to reflect the results from the shot shape part of the survey), the y-axis (to reflect the results from the ball height part of the survey), and a diagonal axis in between as a control. I used the Titleist ProV1 golf ball as a control group for all three axes. So, I ran one trial with the Titleist ProV1 and another trial with the specific golf ball being used in that trial while noting their displacements. The Titleist ProV1 was used because the current literature dictates that the Titleist ProV1 golf ball is known to have a consistent ball flight and is used by most professionals[20].

**Materials**

A wood plate was used for the bouncing of each golf ball (see *Appendix C*). The Titleist ProV1 golf balls were labeled as balls A, B, or C to correspond to each test.

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[20] Couceiro, M., Dias, G., Mendes, R., & Araújo, D. (2013). *Accuracy of Pattern Detection Methods in the Performance of Golf Putting*. Journal of Motor Behavior, 45(1), 37–53.

Balls used in the hex dimple test:

1. 3 Callaway Apex golf balls
2. 1 Titleist ProV1 golf ball (A)

Balls used in the round dimple test:

1. 3 Callaway Supersoft golf balls
2. 1 Titleist ProV1 (B)

Balls used in the warped dimple test:

1. 3 Polara golf balls
2. 1 Titleist ProV1 (C)

**Organization Plan**

I collected the data by noting the displacements along each of the axes and averaged them for each golf ball along that axis. After completely conducting surveys and running the experiments, the patterns in golf balls were observed. If there was a golf ball that showed a certain proclivity along a certain axis in comparison to the Titleist ProV1, a readjusted 2-Sample T-Test was conducted to determine if the results were truly significant and were put on a consideration list. Then, the significant results from the consideration list were matched with survey results. If there was a match between the data that the survey displayed and any of the data values from the consideration list, then that data was implemented into the final golf ball design. Amateur golfers were selected at random to ensure maximum generalizability and credibility and golf balls were chosen based on how radical their characteristics were. For example, golf balls with circular dimples were chosen if they had a relatively high number of round dimples.

**Assumptions**

Throughout my research process, there were certain assumptions that I had used to ensure credibility and accuracy throughout my methodology. These assumptions included:

1. Representation of the amateur golfers: There are varying degrees of 'amateur golfers' due to their varying handicaps. However, I decided to assume that while efforts were made to recruit a varied sample of golfers, grouping all amateur golfers would sufficiently distinguish them from the average professional golfer. This assumption also includes that golfers generally keep a handicap.
2. Influencing factors in the relevance of design preferences: I assumed that the factors in the survey accurately represented the preliminary factors that affected the design choices of amateur golfers. This was decided based on the previous literature. However, individual preferences such as personal playing style and brand loyalty may play a role.
3. Generalizability: The findings of this study were assumed to play a role and represent the proportion of amateur golfers with specific swing speeds and handicaps. However, the scope of my study may have been limited because my survey was mainly posted on golf forums. It is possible that some findings may not be able to be generalized to specific demographic groups that do not use Discord.
4. Validity of the experimental setup: The purpose of the experimental setup was to replicate the conditions that a golf ball would experience in the real world. However, inconsistencies (especially regarding spin statistics) may have been present. While I tried to account for those inconsistencies, there is always the possibility that they played a role in my results.

**Ethical Considerations**

The only point throughout my survey process that may not have been ethical was when I asked a golfer for their handicap. While this was not deeply personal information, there is a chance that golfers may take offense to reporting a higher handicap and might have been subject to response bias and lying. So, I made the handicap question optional and used it as a guideline to gauge the skill level of the overall golfer group surveyed.

## Data Collection and Preliminary Results

My research aimed to extend the applications of previous research by answering the question, "How do golf ball flight behavior and design patterns affect the ball preferences of amateur golfers with  handicaps greater than 5?" The general focus of the data collected was to understand how those preferences could inform golf ball design tailored to the needs of specific golfers. To maintain alignment of both aspects of the research question (one regarding the 'preferences' and another regarding the 'ball flight behavior' and 'design patterns'), the data was collected in two parts and analyzed. Both of those analyses were made on the same basis and index so that the golfer preferences can be used to design a golf ball that aligns with those preferences.

### Golfer Preference Data

The shaping effect was identified as a crucial factor in enhancing golf ball control. This data was collected through a survey that asked a golfer for their ball flight preferences and handicap. The approach of using a survey aligned with Rod Cross'[21] previous research experiments because Cross' method proved that surveys are an ideal method of gauging golfer preferences, although Cross' research was conducted solely with professionals. This data was then analyzed with a GBBI index that started at 0 (there are two of these, one for x rotation and another for y rotation). Then, for each interest in a draw/fade, one was added to the index for x rotation. For each interest in a high/low shot, 1 to was added to the index for a y rotation.

[21] Cross, R. (2010). *Enhancing the Bounce of a Ball*. Physics Teacher, 48(7), 450–452.

## Results

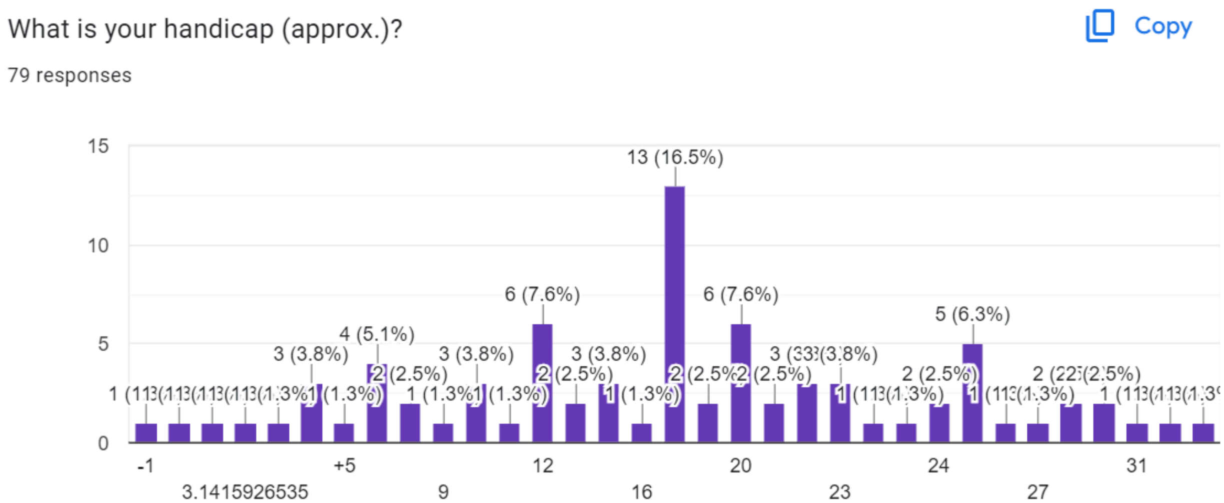



*Figure B: Reorganized Survey Handicap Results*

This data was collected solely for validity purposes. It is commonly accepted that golf handicaps follow a bell curve with a median handicap of 18[22], and this data adhered to that norm.

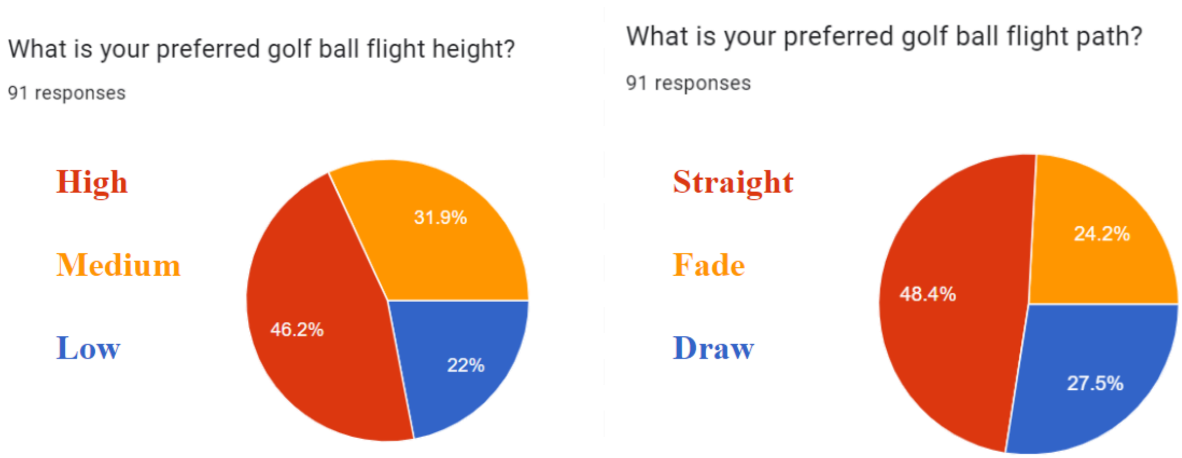



*Figure C: Survey Result Proportions*

GBBI Calculation:

[22] USGA. (2024). *U.S. Handicapping Statistics*, Handicapping Stats.

| | |
|---|---|
| Medium — 42: **+0**<br>High — 29: **+29**<br>Low — 20: **-20**<br><br>Height GBBI: +9<br><br>**Push Preference** | Straight — 44: **+0**<br>Fade — 22: **+22**<br>Draw — 25: **-25**<br><br>Horizontal Translation GBBI: -3<br><br>**Straight/Medium Preference** |

*Figure D: GBBI Calculations*

The data collected from this survey revealed a push and medium preference among amateur golfers, meaning that they prefer a straight and high golf ball flight (see *Figure A*).

***Shaping Mechanisms***

Surface design, primarily highlighted through X.W. Zhang's[23] research study, is a critical factor used to maximize grip on a golf club face and to create a sort of pronounced shaping effect. In the secondary part of this experiment, dimple patterns and core design were explored in depth to find the influence on flight dynamics and overall shaping characteristics. The shaping effect contributes to the most change in a golf ball's flight, which relates to the primary research preferences because the direction of the shaping effect can be optimized to amateur golfer preferences. The horizontal displacement of each golf ball along each axis indicated the extent to which that golf ball would spin, an effect proven by the Book of Wu and Wu, reiterated by Queiroz de Moura[24]. So, multiple golf balls were spun along each axis, and their spin levels were compared to those of the control group of golf balls (Titleist ProV1s). The most significant test

[23] Zhang, X. W., Tao, Z., & Zhang, Q. M. (2014). Dynamic behaviors of visco-elastic thin-walled spherical shells impact onto a rigid plate. Latin American Journal of Solids & Structures, 11(14), 2607–2623

[24] Queiroz de Moura, R., Magalhães Rodrigues, I. A., & Antonio de Souza Sampaio, N. (2023). Using Taguchi's experiments part i: creating a golf ball that reaches a maximum range. GeSec: Revista de Gestao e Secretariado, 14(7), 11748–11757

was later put on a consideration list and matched to the preference index from the previous step. Below are the raw results associated with each type of golf ball result and its interpreted data.

**Control:**

| 45 Degree Offse | Angle (degrees) |
|---|---|
| 10.1 | 15 |
| 11.3 | 20 |
| 10.6 | 22 |
| 9.8 | 10 |
| 9.9 | 19 |
| 10.7 | 23 |
| 11.7 | 18 |
| 9.5 | 21 |
| 12.2 | 12 |
| 10.3 | 16 |
| | |
| 10.61 | 17.6 |

**Warped:**

| 45 Degree Offse | Angle |
|---|---|
| 7.2 | 22 |
| 8.9 | 30 |
| 9.4 | 29 |
| 7.8 | 27 |
| 9.7 | 35 |
| 8 | 28 |
| 8.3 | 31 |
| 7.9 | 33 |
| 10 | 30 |
| 9.9 | 29 |
| | |
| 8.81 | 29.4 |

**Hex:**

| 45 Degree Offse | Angle |
|---|---|
| 10.6 | 15 |
| 9.2 | 10 |
| 13.1 | 12 |
| 12.5 | 22 |
| 10.8 | 14 |
| 13.8 | 18 |
| 11.3 | 16 |
| 9.7 | 12 |
| 14 | 11 |
| 11.9 | 15 |
| | |
| 11.69 | 14.5 |

**Round:**

| 45 Degree Offset Test | |
|---|---|
| 7.8 | 17 |
| 10.5 | 19 |
| 8.2 | 21 |
| 13.4 | 18 |
| 12.3 | 22 |
| 9.6 | 16 |
| 11.9 | 20 |
| 14.1 | 24 |
| 7.4 | 15 |
| 14.8 | 23 |
| | |
| 11 | 19.5 |

**Average Distances and Angles**

*Figure E: Average Golf Ball Distances and Angles*

A readjusted 2 Sample T-Test was performed to ascertain whether each type of golf ball dimple pattern was significant compared to the control.

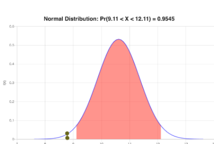
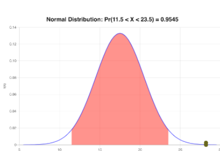
| | | | | |
|---|---|---|---|---|
| Warped Dimple Patterns | Distance |  | Warped dimple patterns do not have a significant effect on translational golf ball flight. | Rejected |
| Warped Dimple Patterns | Angle |  | Warped dimple patterns do not have a significant effect on directional golf ball flight. | Rejected |

*Figure F: Warped Dimple Statistical Analyses*

After using the normal model to determine significance with the readjusted 2 Sample T-Test (see *Figure F*), the ideal type of golf ball dimple pattern from each of the 12 golf balls was found to be the warped dimple pattern because of the significant degree that it changes directional golf ball flight along the axis that it is warped (see *Appendix D* for the full statistical analysis).

**Golf Ball Design**

The results of this research study reveal insights regarding the preferences of amateur golfers regarding golf ball patterns along with the overall dimple trends that need to be present in a golf ball to adhere to those references. The golf ball test results showed that warped dimple patterns were the most effective in changing translational and directional ball flight. When you take each one of those factors, the ideal golf ball to optimize for a straight and high ball flight (a push preference on the y-axis and a straight preference on the x-axis) requires a warped dimple pattern with dimple warps trending in the shape of a plus sign so that it matches the results from the GBBI index, with the larger axis being the vertical axis. It needs to be larger on the y-axis so that the push preference can be accounted for. The design looks as follows:

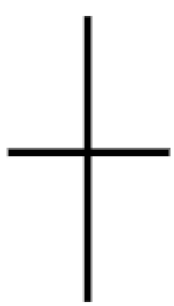


*Figure G: Golf Ball Dimple Pattern Outline*

It is important to note that while the vertical portion of the dimple pattern will need to remain constant, the horizontal portion will need to wrap around the entirety of the golf ball.

# Discussion and Conclusions

## Preliminary Discussion

Previous research has primarily focused on professional golfers and has not come to a consensus regarding the factors that influence the preferred golf ball flight among amateurs, neglecting the needs of amateur golfers. Because this research study specifically targeted golfers with handicaps above 5, it fills a gap in the insights into the design preferences of this amateur golfer demographic.

To summarize, the GBBI index came out to +9 for vertical movement and -3 for horizontal movement. This means that a high and straight shot is preferable. For the dimple patterns, the warping pattern proved to be the most effective in changing directional and translational ball flight patterns. Also, the ProV1 remained the most effective golf ball in terms of bounce height and energy loss efficiency. I reused Rod Cross' model studies when designing my survey and when analyzing my data. His survey results for professionals parallel mine and demonstrate that my study has implications regarding the understanding of the preferences and performance of amateur golfers regarding the golf ball design patterns that they use.

## Conclusions, Future Directions, and Discussion (cont.)

Before data collection and analysis, I had formulated two initial hypotheses based on personal experience: hexagonal dimples would be the most effective for changing directional and translational golf ball flight, and amateur golfers would prefer a straight and medium golf ball flight. From the analysis of the normal model regarding the readjusted 2 Sample T-Tests for each golf ball flight, it was evident that the only golf ball dimple pattern that rejected the null hypothesis (and, therefore, the only significant one) was the warped dimple patterns. The probability of the dimple patterns creating the angular and translational results they did had a chance of below 1% (reference the normal models in *Appendix D*), making it highly unlikely that the results I garnered merely happened by chance.

By extension, my survey results disproved my initial hypothesis that golfers would prefer a straight and medium golf ball flight. After accounting for the GBBI, my results concluded that golfers preferred a push shot along the horizontal axis and a straight shot along the vertical axis. This meant that golfers preferred a straight and high golf ball flight (see *Figure A*). After synthesizing the information from an outline (see *Figure G*), the final golf ball design includes the vertical warping component to emphasize the push flight on the y-axis and warping dimples extending to the poles around the golf ball to optimize for the straight/normal flight on the x-axis (see *Figure H*):

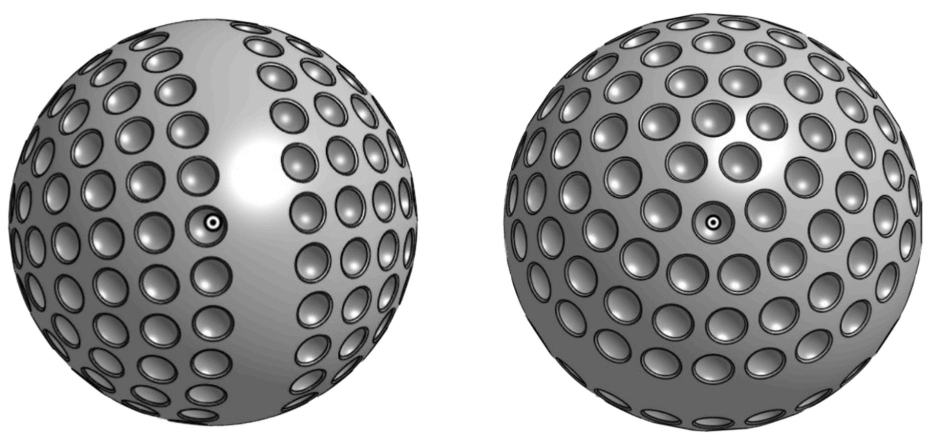


*Figure H: Final Golf Ball Design*

***Limitations***

The limitations of this study may impact the overall generalizability of the golf ball findings presented. The sample size was minimal (91) and the demographic of the participants was not collected in the survey, so the results may not be extrapolated to a broader population of amateur golfers. Also, I looped amateurs under one broad umbrella of ‘amateurs.’ In technicality, there are multiple levels of amateurs, but amateurs were generalized into one broad group for the sake of simplicity within my study. When I was trying to spin golf balls across the wood plate, I realized during one of my experimental trials that spinning the balls by hand could have been more consistent. In response, I created a setup by connecting a cup to a drill bit so that the ball could be placed in the cup and spun at a constant rate for each trial. One of the major issues regarding marketing is that most golf balls are created based on the aforementioned 'Tiger Woods Effect'[25], so an amateur-oriented golf ball may not perform well economically due to a lack of associated brand deals.

***Future Research and Implications***

Future research within the golf ball field could extend to the warping dimple patterns that were discovered. It can also explore additional factors that influence golf ball preferences among amateur golfers and the specific areas that play a role in those specific factors. Overall, if this research is furthered, golf companies can create golf balls that further benefit amateurs. A focus on warping dimple patterns may allow golf companies to maximize their profits if that golf ball is marketed properly. With all factors taken into account, an amateur-oriented golf ball such as the one I designed is beneficial for amateur golfers in terms of their performance and represents their demographic in the golfing world.

[25] Chung, K. Y. C., Derdenger, T. P., & Srinivasan, K. (2013). *Economic Value of Celebrity Endorsements: Tiger Woods' Impact on Sales of Nike Golf Balls*. Marketing Science, 32(2), 271–293.

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# Appendices

## Appendix A: Survey Questions and Coding Scheme

| Question | Answer | Code |
|---|---|---|
| **Question 1** (optional): What is your golf handicap? (approx.) | Answers Varied | N/A, solely for organizational purposes |
| **Question 2**: What is your preferred golf ball flight height? | Low | Pull |
| | Medium | Medium |
| | High | Push |
| **Question 3**: What is your preferred golf ball flight path? | Draw | Pull |
| | Straight | Medium |
| | Fade | Push |

**Appendix B: Research Consent Form**

You are invited to take part in a research survey to provide data regarding the golf ball flight preferences of golfers.

This study is aimed to design a new type of golf ball that is tailored specifically to the needs of amateur golfers. By understanding your preferences, the implications of amateur golf preferences will be situated in the broader context of golf ball designs.

Your participation will require approximately 2 minutes. There are no known risks associated with this survey. Benefits from this survey may include gaining knowledge about the overall preferences of amateurs regarding golf ball flights. Taking part in this study is completely voluntary.

Your consent is completely voluntary. You may withdraw from the survey at any time without consequences of any kind, and you can withdraw your consent at any time without consequences of any kind. Participating in this study does not mean that you are giving up any legal rights.

The records of this study will be kept private, and individual data will only be accessible by the researcher. You will not be asked for your name or contact information in the requested survey. Any report of this research that is made available to the public will not include your name or any other individual information by which you could be identified. The data from the survey will be kept on a personal computer and will not be accessible to any other sources.

You will be asked to complete a survey. There are 3 questions, and the approximate/average amount of time it will take for participants to complete the survey is 2 minutes.

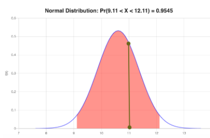
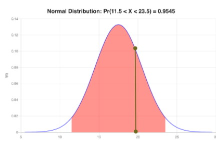
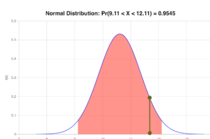
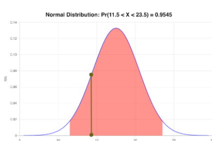
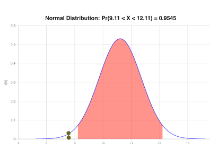
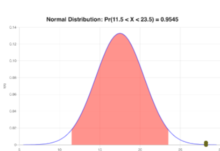
☐ By checking this box, you agree to be a part of this study.

________________________________ ______________________
Your Signature Date

**Appendix C: Golf Balls Used**

| Golf Ball | Image | Type | Quantity Per Test |
|---|---|---|---|
| Titleist Pro V1 |  | Control Group | 1 |
| Callaway Warbird |  | Hexagonal Dimples | 3 |
| Polara ED XD |  | Warped Dimples | 3 |
| Nitro |  | Round Dimples | 3 |

**Appendix D: Experimental Statistical Analysis (Readjusted 2-Sample T-Test)**

| Dimple Type | Test | Normal Distribution | Null Hypothesis | Null Hypothesis Status |
|---|---|---|---|---|
| Round Dimple Patterns | Distance |  | Round dimple patterns do not have a significant effect on translational golf ball flight. | Retained |
| Round Dimple Patterns | Angle |  | Round dimple patterns do not have a significant effect on directional golf ball flight. | Retained |
| Hexagonal Dimple Patterns | Distance |  | Hexagonal dimple patterns do not have a significant effect on translational golf ball flight. | Retained |
| Hexagonal Dimple Patterns | Angle |  | Hexagonal dimple patterns do not have a significant effect on directional golf ball flight. | Retained |
| Warped Dimple Patterns | Distance |  | Warped dimple patterns do not have a significant effect on translational golf ball flight. | Rejected |
| Warped Dimple Patterns | Angle |  | Warped dimple patterns do not have a significant effect on directional golf ball flight. | Rejected |

**Appendix E: Survey Results**

| Timestamp | Consent Form | Handicap | Preferred Ball Flight Height | Preferred Ball Flight Path |
|---|---|---|---|---|
| 12/29/2023 15:32:14 | By checking this box, you agree to be a part of the survey. | 7 | High (less distance, more control/spin) | Straight (more accurate, less distance than draw) |
| 12/30/2023 14:39:47 | By checking this box, you agree to be a part of the survey. | 5 | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |
| 12/30/2023 14:45:39 | By checking this box, you agree to be a part of the survey. | By checking this box, you agree to be a part of the survey. | High (less distance, more control/spin) | Fade (less distance, less accuracy, more control) |
| 12/30/2023 14:49:13 | By checking this box, you agree to be a part of the survey. | 6 | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |
| 12/30/2023 19:21:22 | By checking this box, you agree to be a part of the survey. | 34 | Medium (distance and spin at the expense of control) | Draw (more distance, less accurate) |
| 1/1/2024 10:17:20 | By checking this box, you agree to be a part of the survey. | | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |
| 1/1/2024 13:57:22 | By checking this box, you agree to be a part of the survey. | 15 | Low (extra distance, less control) | Draw (more distance, less accurate) |
| 1/1/2024 18:57:37 | By checking this box, you agree to be a part of the survey. | 25 | High (less distance, more control/spin) | Fade (less distance, less accuracy, more control) |
| 1/2/2024 8:04:17 | By checking this box, you agree to be a part of the survey. | 20 | Medium (distance and spin at the expense of control) | Draw (more distance, less accurate) |
| 1/2/2024 11:34:56 | By checking this box, you agree to be a part of the survey. | 18 | Low (extra distance, less control) | Straight (more accurate, less distance than draw) |
| 1/2/2024 11:35:12 | By checking this box, you agree to be a part of the survey. | 23.2 | High (less distance, more control/spin) | Fade (less distance, less accuracy, more control) |

| | | | | |
|---|---|---|---|---|
| 1/2/2024 11:38:16 | By checking this box, you agree to be a part of the survey. | 18 | Medium (distance and spin at the expense of control) | Fade (less distance, less accuracy, more control) |
| 1/2/2024 12:01:56 | By checking this box, you agree to be a part of the survey. | 11 | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |
| 1/2/2024 12:20:43 | By checking this box, you agree to be a part of the survey. | 18 | High (less distance, more control/spin) | Fade (less distance, less accuracy, more control) |
| 1/2/2024 12:22:23 | By checking this box, you agree to be a part of the survey. | 21 | High (less distance, more control/spin) | Draw (more distance, less accurate) |
| 1/2/2024 12:22:45 | By checking this box, you agree to be a part of the survey. | 18 | Low (extra distance, less control) | Straight (more accurate, less distance than draw) |
| 1/2/2024 12:39:26 | By checking this box, you agree to be a part of the survey. | 9 | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |
| 1/2/2024 12:45:06 | By checking this box, you agree to be a part of the survey. | 18 | High (less distance, more control/spin) | Straight (more accurate, less distance than draw) |
| 1/2/2024 13:54:09 | By checking this box, you agree to be a part of the survey. | 12 | Medium (distance and spin at the expense of control) | Fade (less distance, less accuracy, more control) |
| 1/2/2024 14:26:39 | By checking this box, you agree to be a part of the survey. | | Medium (distance and spin at the expense of control) | Draw (more distance, less accurate) |
| 1/2/2024 15:41:35 | By checking this box, you agree to be a part of the survey. | 6 | Low (extra distance, less control) | Straight (more accurate, less distance than draw) |
| 1/2/2024 16:37:49 | By checking this box, you agree to be a part of the survey. | 30 | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |
| 1/2/2024 16:58:44 | By checking this box, you agree to be a part of the survey. | 18 | High (less distance, more control/spin) | Draw (more distance, less accurate) |

| | | | | |
|---|---|---|---|---|
| 1/2/2024 17:28:36 | By checking this box, you agree to be a part of the survey. | 14 | Low (extra distance, less control) | Straight (more accurate, less distance than draw) |
| 1/2/2024 18:01:33 | By checking this box, you agree to be a part of the survey. | 25 | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |
| 1/2/2024 20:19:04 | By checking this box, you agree to be a part of the survey. | 18 | Low (extra distance, less control) | Straight (more accurate, less distance than draw) |
| 1/3/2024 7:50:45 | By checking this box, you agree to be a part of the survey. | 32 | High (less distance, more control/spin) | Fade (less distance, less accuracy, more control) |
| 1/3/2024 8:53:11 | By checking this box, you agree to be a part of the survey. | | High (less distance, more control/spin) | Fade (less distance, less accuracy, more control) |
| 1/3/2024 10:03:40 | By checking this box, you agree to be a part of the survey. | 18 | High (less distance, more control/spin) | Draw (more distance, less accurate) |
| 1/3/2024 12:14:22 | By checking this box, you agree to be a part of the survey. | 19 | High (less distance, more control/spin) | Straight (more accurate, less distance than draw) |
| 1/3/2024 12:57:30 | By checking this box, you agree to be a part of the survey. | 18 | Low (extra distance, less control) | Straight (more accurate, less distance than draw) |
| 1/3/2024 13:11:04 | By checking this box, you agree to be a part of the survey. | -1 | High (less distance, more control/spin) | Fade (less distance, less accuracy, more control) |
| 1/3/2024 15:26:05 | By checking this box, you agree to be a part of the survey. | 12 | Medium (distance and spin at the expense of control) | Fade (less distance, less accuracy, more control) |
| 1/3/2024 16:16:04 | By checking this box, you agree to be a part of the survey. | 7 | Low (extra distance, less control) | Draw (more distance, less accurate) |
| 1/3/2024 20:29:07 | By checking this box, you agree to be a part of the survey. | 24 | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |

| | | | | |
|---|---|---|---|---|
| 1/4/2024 0:03:30 | By checking this box, you agree to be a part of the survey. | 31 | Low (extra distance, less control) | Draw (more distance, less accurate) |
| 1/4/2024 8:21:59 | By checking this box, you agree to be a part of the survey. | 10 | Medium (distance and spin at the expense of control) | Fade (less distance, less accuracy, more control) |
| 1/4/2024 10:45:54 | By checking this box, you agree to be a part of the survey. | 6 | Low (extra distance, less control) | Draw (more distance, less accurate) |
| 1/4/2024 13:49:30 | By checking this box, you agree to be a part of the survey. | 22 | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |
| 1/4/2024 17:01:58 | By checking this box, you agree to be a part of the survey. | 30 | High (less distance, more control/spin) | Fade (less distance, less accuracy, more control) |
| 1/4/2024 20:13:46 | By checking this box, you agree to be a part of the survey. | 10 | Low (extra distance, less control) | Fade (less distance, less accuracy, more control) |
| 1/5/2024 7:50:30 | By checking this box, you agree to be a part of the survey. | 18 | High (less distance, more control/spin) | Straight (more accurate, less distance than draw) |
| 1/5/2024 8:31:35 | By checking this box, you agree to be a part of the survey. | 5 | Medium (distance and spin at the expense of control) | Draw (more distance, less accurate) |
| 1/5/2024 9:29:37 | By checking this box, you agree to be a part of the survey. | 23.3 | Low (extra distance, less control) | Draw (more distance, less accurate) |
| 1/5/2024 11:13:32 | By checking this box, you agree to be a part of the survey. | 6 | High (less distance, more control/spin) | Fade (less distance, less accuracy, more control) |
| 1/5/2024 12:18:22 | By checking this box, you agree to be a part of the survey. | 12 | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |
| 1/5/2024 23:20:07 | By checking this box, you agree to be a part of the survey. | 22 | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |

| | | | | |
|---|---|---|---|---|
| 1/6/2024 20:57:27 | By checking this box, you agree to be a part of the survey. | 28 | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |
| 1/7/2024 15:01:42 | By checking this box, you agree to be a part of the survey. | 12 | High (less distance, more control/spin) | Fade (less distance, less accuracy, more control) |
| 1/7/2024 21:16:01 | By checking this box, you agree to be a part of the survey. | 25 | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |
| 1/8/2024 8:20:32 | By checking this box, you agree to be a part of the survey. | 18 | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |
| 1/8/2024 12:44:48 | By checking this box, you agree to be a part of the survey. | | Low (extra distance, less control) | Fade (less distance, less accuracy, more control) |
| 1/8/2024 16:24:00 | By checking this box, you agree to be a part of the survey. | 19 | Low (extra distance, less control) | Draw (more distance, less accurate) |
| 1/9/2024 9:02:32 | By checking this box, you agree to be a part of the survey. | 27 | High (less distance, more control/spin) | Straight (more accurate, less distance than draw) |
| 1/9/2024 11:04:45 | By checking this box, you agree to be a part of the survey. | 12 | Medium (distance and spin at the expense of control) | Draw (more distance, less accurate) |
| 1/9/2024 17:07:27 | By checking this box, you agree to be a part of the survey. | | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |
| 1/10/2024 8:16:07 | By checking this box, you agree to be a part of the survey. | 18 | Low (extra distance, less control) | Fade (less distance, less accuracy, more control) |
| 1/10/2024 8:16:59 | By checking this box, you agree to be a part of the survey. | 20 | Medium (distance and spin at the expense of control) | Draw (more distance, less accurate) |
| 1/10/2024 8:20:16 | By checking this box, you agree to be a part of the survey. | 15 | High (less distance, more control/spin) | Draw (more distance, less accurate) |

| | | | | |
|---|---|---|---|---|
| 1/10/2024 8:27:00 | By checking this box, you agree to be a part of the survey. | 10 | High (less distance, more control/spin) | Draw (more distance, less accurate) |
| 1/10/2024 8:45:24 | By checking this box, you agree to be a part of the survey. | 25 | High (less distance, more control/spin) | Straight (more accurate, less distance than draw) |
| 1/10/2024 9:17:43 | By checking this box, you agree to be a part of the survey. | 20 | High (less distance, more control/spin) | Straight (more accurate, less distance than draw) |
| 1/10/2024 9:31:47 | By checking this box, you agree to be a part of the survey. | 16 | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |
| 1/10/2024 9:50:39 | By checking this box, you agree to be a part of the survey. | 23 | High (less distance, more control/spin) | Straight (more accurate, less distance than draw) |
| 1/10/2024 10:03:41 | By checking this box, you agree to be a part of the survey. | 23 | Medium (distance and spin at the expense of control) | Fade (less distance, less accuracy, more control) |
| 1/10/2024 10:50:03 | By checking this box, you agree to be a part of the survey. | +5 | Medium (distance and spin at the expense of control) | Draw (more distance, less accurate) |
| 1/10/2024 10:51:48 | By checking this box, you agree to be a part of the survey. | 20 | High (less distance, more control/spin) | Fade (less distance, less accuracy, more control) |
| 1/10/2024 11:52:27 | By checking this box, you agree to be a part of the survey. | 25 | Medium (distance and spin at the expense of control) | Fade (less distance, less accuracy, more control) |
| 1/10/2024 11:56:17 | By checking this box, you agree to be a part of the survey. | 21 | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |
| 1/10/2024 11:58:05 | By checking this box, you agree to be a part of the survey. | 4 | High (less distance, more control/spin) | Straight (more accurate, less distance than draw) |
| 1/10/2024 15:13:56 | By checking this box, you agree to be a part of the survey. | 12 | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |

| | | | | |
|---|---|---|---|---|
| 1/10/2024 17:01:08 | By checking this box, you agree to be a part of the survey. | 22 | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |
| 1/11/2024 7:44:39 | By checking this box, you agree to be a part of the survey. | 14 | High (less distance, more control/spin) | Draw (more distance, less accurate) |
| 1/11/2024 8:03:19 | By checking this box, you agree to be a part of the survey. | | Medium (distance and spin at the expense of control) | Draw (more distance, less accurate) |
| 1/11/2024 10:02:45 | By checking this box, you agree to be a part of the survey. | | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |
| 1/11/2024 10:11:50 | By checking this box, you agree to be a part of the survey. | 3 | Low (extra distance, less control) | Draw (more distance, less accurate) |
| 1/11/2024 23:35:13 | By checking this box, you agree to be a part of the survey. | 23 | Low (extra distance, less control) | Draw (more distance, less accurate) |
| 1/13/2024 12:23:27 | By checking this box, you agree to be a part of the survey. | 20 | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |
| 1/13/2024 13:10:18 | By checking this box, you agree to be a part of the survey. | | High (less distance, more control/spin) | Draw (more distance, less accurate) |
| 1/13/2024 19:41:26 | By checking this box, you agree to be a part of the survey. | 28 | High (less distance, more control/spin) | Straight (more accurate, less distance than draw) |
| 1/13/2024 21:10:57 | By checking this box, you agree to be a part of the survey. | | Medium (distance and spin at the expense of control) | Draw (more distance, less accurate) |
| 1/17/2024 10:05:43 | By checking this box, you agree to be a part of the survey. | 20 | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |
| 1/17/2024 11:02:37 | By checking this box, you agree to be a part of the survey. | 3.141592654 | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |

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| 1/17/2024 11:03:31 | By checking this box, you agree to be a part of the survey. | 2.7 | Low (extra distance, less control) | Fade (less distance, less accuracy, more control) |
| 1/17/2024 12:09:27 | By checking this box, you agree to be a part of the survey. | 15 | Low (extra distance, less control) | Straight (more accurate, less distance than draw) |
| 1/17/2024 12:09:50 | By checking this box, you agree to be a part of the survey. | 25.3 | Low (extra distance, less control) | Straight (more accurate, less distance than draw) |
| 1/17/2024 12:23:13 | By checking this box, you agree to be a part of the survey. | 18 | High (less distance, more control/spin) | Straight (more accurate, less distance than draw) |
| 1/18/2024 18:35:54 | By checking this box, you agree to be a part of the survey. | | Medium (distance and spin at the expense of control) | Draw (more distance, less accurate) |
| 1/19/2024 12:50:02 | By checking this box, you agree to be a part of the survey. | | Medium (distance and spin at the expense of control) | Fade (less distance, less accuracy, more control) |
| 1/20/2024 21:28:16 | By checking this box, you agree to be a part of the survey. | 5 | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |
| 1/22/2024 10:47:49 | By checking this box, you agree to be a part of the survey. | 24 | Medium (distance and spin at the expense of control) | Straight (more accurate, less distance than draw) |