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Development of a Notational Analysis System to Evaluate Setting Performance in Volleyball

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DEVELOPMENT OF A NOTATIONAL ANALYSIS SYSTEM

TO EVALUATE SETTING PERFORMANCE

IN VOLLEYBALL

by

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GRADUATE COMMITTEE APPROVAL

of a thesis submitted by

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This thesis has been read by each member of the following graduate committee and by majority vote has been found to be satisfactory.

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As chair of the candidate's graduate committee, I have read the thesis of Nina Puikkonen Mortensen in its final form and have found that (1) its format, citations, and bibliographical style are consistent and acceptable and fulfill university and department style requirements; (2) its illustrative materials including figures, tables, and charts are in place; and (3) the final manuscript is satisfactory to the graduate committee and is ready for submission to the university library.

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ABSTRACT

DEVELOPMENT OF A NOTATIONAL ANALYSIS SYSTEM TO EVALUATE SETTING PERFORMANCE IN VOLLEYBALL

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Master of Science

The purposes of this study were to develop a notational analysis system for volleyball to evaluate setting performance independent of the actions of the hitter and to use the data to develop a Markovian transitional matrix that would make known the probabilities of specific outcomes from each setting scenario. Setting performance was analyzed based on the sets distance from the net, height of the set, and position of the set in relation to the hitter as viewed from 13 filmed competitions of a Division I intercollegiate women's volleyball team. Data from the notation of 1353 sets were used to develop a Markovian transitional matrix. The data indicated that 26 different setting scenarios occurred. Overall, sets within 3-5 feet from the net resulted in the highest probability of a point and the lowest probability of a point for the opponent. Low sets, whether inside or outside in relation to the hitter also resulted in a high probability of winning a point. High sets, whether inside or outside in relation to the hitter, resulted in the lowest probability of success and the highest probability of a point for the opponent.

A notational analysis system such as described in this study can effectively be used by coaches to evaluate setting performance, provide effective feedback, develop team strategies and style of play, and allocate practice time.

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Abstract

The purposes of this study were to develop a notational analysis system to evaluate volleyball setting performance independent of the actions of the hitter and to use the data to develop a Markovian transitional matrix that would make known the probabilities of specific outcomes from each setting scenario. Setting performance was analyzed based on the sets distance from the net, height of the set, and position of the set in relation to the hitter as viewed from 13 filmed competitions of a Division I intercollegiate women's volleyball team. Data from the notation of 1353 sets were used to develop a Markovian transitional matrix. The data indicated that 25 different setting scenarios occurred. Overall, sets within 3-5 feet from the net resulted in the highest probability of a point and the lowest probability of a point for the opponent. Low sets, whether inside or outside in relation to the hitter also resulted in a high probability of winning a point. High sets, whether inside or outside in relation to the hitter, resulted in the lowest probability of success and the highest probability of a point for the opponent. A notational analysis system such as described in this study can effectively be used by coaches to evaluate setting performance, provide effective feedback, develop team strategies and style of play, and allocate practice time.

Introduction

Methods of analyzing athletic skills are valuable in helping coaches improve their team's performance and increase the likelihood of success. Information obtained through notational analysis systems provides valuable insight into the strengths and weaknesses of a team. Correct interpretation of the results of notational analysis allows coaches to provide appropriate feedback, motivate athletes, monitor improvements throughout the entire season (Byra & Scott, 1983) and allocate practice time effectively. Extensive research on volleyball performance is lacking (Daniel & Hughes, 2003). Notational analysis systems have been developed to analyze various volleyball skills, including passing, serving, and hitting (Coleman, 1975; Coleman, Neville, & Gordon, 1971; Eom & Schutz, 1992; Lirdla, 1980; Rose, 1983; Sawula, 1977; Vojik, 1980). A notational analysis system that solely focuses on setting performance and produces valuable information regarding the precision of a setter has yet to be developed.

When using notational analysis, skills are usually analyzed based on the result of an action. The outcomes of certain volleyball skills are inversely related to the actions of the opposing team. For example, if a serve results in a bad pass from the opposing team, the serving team receives a high rating for the good serve while the opposing team receives a low rating for a poor pass (Rose, 1983). Similarly, an attack is frequently evaluated in terms of how the defense responded to the attack (Lirdla, 1980).

Setting, however, is a skill that is not directly related to the opponent's performance (Coleman, 1975) and eventual outcome. Thus, a setter's performance is difficult to analyze. Most sets performed by the designated setter occur as the second of three contacts on the same side of the net. A setter is awarded an assist for sets which lead to a positive outcome from the third and final contact. Currently, evaluation of a setter's performance is based on assists, even though they are not directly related to the outcome.

The current methods of evaluating a setter's performance do not accurately reflect the quality or precision of the set. Ideally, the setter's performance should be evaluated independent of any other contact within the possession. This is confounded by the fact that setting and hitting are related in a possession's sequence of events; yet, it is possible for a hitter to obtain a kill off a poor set, and likewise possible to execute a good set in which the hitter is unable to terminate the rally. Consequently, setting and hitting should be evaluated as individual actions. If a notational analysis system were developed to specifically evaluate setting performance, then coaches, teams, and athletic conferences might be more confident in their recognition of the best setters. In addition, coaches could use this information to offer more constructive feedback to their players and allocate practice time to the development and improvement of necessary skills.

The purposes of this study were to develop a notational analysis system to evaluate setting performance and to use these data in the development of a Markovian transitional matrix to determine the probability of specific outcomes from different setting scenarios.

Methods

An expert committee comprised of four NCAA Division I volleyball coaches and a statistician established three criteria as an effective evaluation of setting performance.

The criteria included the distance the ball is to the net, the height of the set, and the position of the set relative to the hitter. Based on these three criteria, setting performance was evaluated by analyzing game films of a collegiate women's volleyball team. Analysis of setting required coding each set according to pre-determined criteria. Data entry of codes was performed using the Data Volley software program (Data Project, Salerno, Italy, release 2.1.9).

The Data Volley software program is limited in the number of possible scenarios that can exist. Coding actions for specific digits is limited to five or six digits. Although this slightly influenced how setting was evaluated, the three major criteria of evaluating setting performance established by the expert committee could be accounted for. The first two digits of the code (for example: 15EH+) represented the player's number. The third digit represented the setting action. The set was automatically coded with an E. We coded the fourth digit to represent the distance to the net, which was limited to five possible scenarios. We coded the fifth and last digit to represent the height and position of the set, which was limited to six possible scenarios.

Game films from the 2005 Brigham Young University women's volleyball season were viewed to develop codes for the notational analysis system that matched the data entry limitations of the Data Volley software program. These games were filmed from a camera positioned behind the end line which provided a view of the entire court. The expert committee derived the codes shown in Table 1 to describe the height of the set and the position of the set relative to the hitter.

The position of the set referred to whether the ball was too far inside or outside in relation to the hitter. A set was classified as inside when the ball was set more towards the center of the court. A set was classified as outside when the ball was set more towards the side lines of the court. The height of the set referred to the maximum height of the ball. A set was classified as high when the maximum height of the ball was above the desired set location. When the maximum height of the ball was below the desired set location the set was considered too low. Using height and position criteria, a set was classified as "perfect" when it was neither too high, nor too low, nor too far inside, nor too far outside. A setting error was classified as any setting violation called by the first referee (e.g., lift, or double contact).

This study assumed that the height and position of the set could be analyzed together and were represented by a single coded variable. Therefore, when a set was too low or too high, it was also either too far inside or too far outside for the hitter. Likewise, when a set was inside or outside in relation to the hitter, it was also either too high or too low. Since the principle investigator was a member of the Brigham Young University women's volleyball coaching staff, she had a good knowledge of the team's offensive systems and desired set locations.

The expert committee also derived the codes shown in Table 2 to describe the distance the set was from the net. It was anticipated that a set 0-1 feet from the net would rarely be executed for any hitting position and was therefore described as "too close" to the net. A set >3-5 feet from the net was expected to be quite common, given that this distance is the instruction given to the setters, and was therefore described as the "goal" set. Therefore, a set >1-3 feet from the net was described as “close” to the net while a set >5-8 feet from the net was described as “far.” Finally, in terms of a front-row hitter, any set that was >8 feet from the net was described as “too far” from the expected or desired location. Scrimmages between players of the 2006 Brigham Young University women’s volleyball team were used to determine the placement of the camera that would provide the best side view of the court. The side view camera was placed along a line parallel to the net and five feet from it. This camera only viewed actions on one side of the net. Athletic tape was placed upon the floor within the camera’s view to mark the five categorical distances from the net during the scrimmages. By viewing films from the scrimmages the principle investigator became proficient in evaluating the distance of each set from the net.

The codes (Tables 1 and 2) used to describe the three criteria for evaluating setting performance were used to analyze filmed volleyball competitions of the 13 home matches between the Brigham Young University women’s volleyball team and opponents during the 2006 season. Each home match was filmed using two cameras in the positions described above. Evaluating the set from two different views made it possible to accurately analyze the setter’s performance.

During actual competitions, a co-investigator trained to interpret volleyball skills keyed a detailed code of the match into the Data Volley software program. This co-investigator coded all volleyball actions, including serving, passing, setting, hitting, blocking, and defense. The co-investigator coded each set with a default code (15EH+) where the only variable the co-investigator changed was the player number. Only sets from eligible designated setters were evaluated from each game film. Consequently, sets performed from other players who were occasionally in a position to set during competitions were not evaluated. It was simply noted that a set occurred during the particular sequence of events.

Although several different actions (i.e., a setter dump, a pass set, a one-handed set, the two-handed overhead set) can be performed by the setter, the only setting action that was not evaluated was the setter dump. A setter dump was considered an attack and therefore did not qualify as a variable in this study. Since this study focused on the precision of the setter's ball location rather than the technique used, the evaluation did not differentiate between the pass set, one-handed set, and the two-handed overhead set.

Coding Protocol

Analysis for the matches was completed after films from both camera angles had been captured and saved into a computer. The principle investigator then synchronized both camera views to the co-investigator's initial code within the Data Volley software program. The first three digits of the code were used to access each set performed by the setter within the match. Each set was then evaluated for its distance from the net (Table 2) and the height of the set and position of the set relative to the hitter (Table 1). Each sets distance from the net was determined from the sideline view camera at the point at which the hitter contacted the ball. The height and position of the set was determined from the end line view camera.

Statistical Analysis

Every time the ball was on Brigham Young University's side of the net, there was a sequence of events that followed one of the following patterns: serve-outcome, pass-set-attack-outcome, or block-dig-set-attack-outcome. It was assumed that these sequences were Markov chains where the quality of each contact depends on the quality of the previous contact but not on contacts further removed in the sequence.

The probabilities for the sequences were represented in an extensive matrix of transition probabilities with 127 rows and columns. The rows of the matrix represented the coded serve, pass, set, attack, dig, block, or outcome in the sequence, and the columns represented the next event. Thus, the elements of the matrix were the probabilities of moving from one state to another. Impossible sequences, such as a serve to another serve, were constrained to have zero probability. Other sequences known to always occur (e.g., service error to opponent scoring) were assigned a probability of one. A Bayesian paradigm was used to model the unknown transition probabilities. A multinomial likelihood was used for each row of the transition matrix. Prior probability densities for transition probabilities were assumed to be distributed as Dirichlet variables. Markov chain Monte Carlo methods were then used to produce posterior distributions of the transition probabilities. It was proposed that the median of the posterior distribution be used as the point estimate to be inserted into the transition matrix.

There were four attack-outcome scenarios: a kill which resulted in a point, a continuation of play/dig by the opponent, a block by the opponent, or a hitting error. Blocks by the opponent and hitting errors were pooled since they both resulted in a point for the opponent. Thus, the transition matrix was used to determine the probabilities of the 25 setting scenarios ending in each of three possible outcomes, a point for BYU, a point for the opponent, or continuation of play. The transitional matrix was then used to answer questions about relative skill importance of setting.

To establish reliability of the setting evaluation, three randomly selected matches were analyzed a second time. The same principle investigator performed all analyses of game films. The second analysis of the three matches occurred at least two weeks following the first analysis.

Results

In the films of the 13 home matches, there were a total of 1353 sets from the setter that were included in the analysis. An additional 159 sets were performed by players other than the designated setter. There were five different height and position possibilities (Table 1) at each of the five distance from the net categories (Table 2). All setting errors were pooled into one category. Thus, using the coding for distance to the net and height and position of the set, 26 different setting scenarios from the setter were possible. While only 24 setting scenarios from the setter actually occurred in the data set, when sets performed by non-designated setters were included, there were 25 total scenarios included in the analysis.

There were several different analyses made from the transition matrix that determined the estimated probability outcomes. The estimated probabilities of every possible setting scenario leading to a point, continued play, or point for the opponent are listed in Table 3. These data are further collapsed to analyze the height and position of the set (Table 4) and the distance of the set from the net (Table 5).

Of the 1353 sets, there were 629 (46.5%) sets within the goal distance of >3-5 feet from the net. The majority of these (292; 46.6% of sets at this distance; 21.6% of all sets) were perfect sets. Overall, perfect sets had the highest probability of resulting in a point, followed by sets that were low and either inside or outside (Table 4). Overall, perfect sets also resulted in the lowest probabilities of a point for the opponent, followed by sets that were low and either inside or outside. Overall, high sets, whether inside or outside resulted in lower probabilities of wining a point and higher probabilities of a point for the opponent. Overall, sets within >3-5 feet of the net resulted in the highest probability of winning a point and the lowest probability of a point for the opponent (Table 5). The probability of winning a point decreased and the probability of a point for the opponent increased as the distance of the set from the net moved further from the goal distance of >3-5 feet from the net.

In the three matches analyzed twice to determine reliability, there were a total of 272 sets performed. Of these, 235 sets (86.4%) were coded the same for the height and position of the set. Of the 272 sets, 249 sets (91.5%) were coded the same for the distance from the net. Of the 272 sets, 88.97% were coded the same for the height and position of the set and the distance from the net.

Discussion

The importance or value of a player’s performance may be a product of how performance is being assessed. Value is given to those aspects of performance that are measured even though the measurement may not be a true indicator of performance. Ideally, evaluations must be true measures of performance. Evaluating and ranking a setter based on assists does not accurately measure the precision and accuracy of a setters setting performance. For example, if a hitter does not convert a perfect set into a point, the setter is not recognized for his/her perfect set. On the contrary, if a hitter converts a poor set into a point, the setter is awarded an assist. In addition, awarding an assist to the setter fails to describe the quality of his/her set. This leads us to believe that setters are undervalued in their role and contribution to the team. The notational analysis system described in this study evaluates a setter's performance in a more objective manner.

This study presents, for the first time, a notational analysis system that quantitatively analyzes setting performance based on the sets distance from the net, height of the set and position of the set in relation to the hitter. To the best of our knowledge, the data and methods presented in this study, represents one of the most comprehensive and growing data sets used in evaluating setting performance**.** Also unique to this study is the analysis of each set performed by viewing competitive game films recorded from two different views of the court. Using the notational analysis system described in this study, 26 possible setting scenarios existed, thus providing an analysis in far more detail than has previously been reported.

This study analyzed setting performance of a women's collegiate volleyball team during the 2006 season. The notational analysis system used in this study was specific to the team being evaluated. For example, setters are instructed that the ideal or "goal" set (Table 2) is within >3-5 feet from the net, neither too high nor too low and neither too far inside or outside. Although other teams may have different setting strategies, we believe that the coding derived by the expert committee to analyze a set based on the set's distance from the net and the height and position of the set are sound practices that can be used by any team.

A Sets Distance from the Net

We hypothesized that a perfect set presented in the goal position provides the greatest advantage to the hitter by offering the largest number of attacking options with the least likelihood of losing a point to the opposing team. The data gathered from this study demonstrate that nearly 47% of all sets were placed in the goal location and 19% and 22% of all sets were placed >1-3 feet from the net or >5-8 feet from the net (Table 5), respectively. This indicates that the setters are performing as instructed. Overall, when compared to other distances, setting the ball at the goal distance resulted in the highest probability of winning a point and the lowest probability of losing a point. Setting the ball closer to or further from the net than the goal distance decreased the probability of winning a point and increased the probability of losing a point to the opponent. Sets that are too far from the net (i.e., >8 feet) offer the highest probability (29.1%) of a point for the opponent. This probability is higher than the probability (28%) of a set made by a non-designated setter resulting in a point for the opponent. A set placed too far from the net is not the primary choice for an offensive attack, but is usually the result of setting from a less than ideal position created from the pass. The results of this study lend support to providing setters with a specific goal distance from the net to set the ball and allocating time to practice setting to the goal distance.

Even though sets placed too close (i.e., 0-1 feet) to the net occurred infrequently, they usually resulted in an error, or an automatic point for the opponent. Sets to this distance were most often performed when attempting a quick attack. Such attacks increase the probability of errors due to the faster speed of play. Sets to this distance should be avoided.

Height and Position of the Set

We hypothesized that perfect sets, regardless of the distance from the net, would result in better outcomes than any other height and position of the set. When the data were collapsed on the height and position of the set (Table 5), perfect sets resulted in the highest probability of winning a point and the lowest probability of losing a point to the opponent. At any given distance from the net (Table 3), perfect sets generally resulted in the highest probability of a point. Sets which were low and either inside or outside also resulted in high probabilities, and sometimes greater probabilities of a point than a perfect set. This may be explained by the fact that the nature of the Brigham Young University's offense is to be quick and fast. Thus, the setters tend to set low, specifically low and inside rather than outside (Table 4). It appears that hitters are able to adjust to the lower and faster inside set and are surprisingly successful with their efforts. This faster paced game may catch the opponent's defense off guard and ensure some success in winning a point. While a low and inside set has previously not been a considered set of choice, the results of this study supports the re-evaluation of the definition of a perfect set.

In contrast, sets which were high and either inside or outside resulted in the lowest probabilities for a point and the highest probability of a point for the opponent. In fact, high sets resulted in the lowest probability of a point in almost every distance from the net category (Table 3). We propose that in a fast paced offense, hitters would generally begin their hitting approach at an earlier moment than when playing a slow paced offense. Consequently, when the hitter is given a high set, their hitting approach is slowed down and interrupted. A high set also allows more time for the opposing team to set up in its most desired and effective defensive option. For a fast paced offense, the hitting approach would be less interrupted when given a low set.

Sets by Nondesignated Setters

Compared to other players, designated setters have had more practice setting the ball and therefore are more consistent in their setting performance. Sets performed by nondesignated setters result in nearly the lowest probability of winning a point and the highest probability of losing a point to the opponent. Although this would be expected, the number of sets performed by nondesignated setters should be minimal. The data from this study indicates that 10.5% of all sets were performed by nondesignated setters. These sets occur when the setter is forced to take the first contact or when the setter is unable to be in position to set the second contact due to the quality of the first contact. To reduce the number of sets by nondesignated setters, additional practice time should be allocated to receiving the serve and making successful passes to the desired location of the designated setter.

Reliability

A second analysis of three matches indicated acceptable reliability of coding 272 sets similarly. After comparing the second analysis to the first, any discrepancies were reviewed to determine the source of the error. Four of the codings for distance to the net and 6 codings for height and position of the set were mistakes that could have been avoided. The majority of discrepancies in coding a sets distance from the net occurred when the set was placed between categories (Table 2). Most errors occurred when coding sets placed between the distances of >1-3 feet from the net and >3-5 feet from the net because sets in these two distance categories combined accounted for 65.7% of the total number of sets. Marking distances from the net on the computer screen when viewing films would facilitate accurate and consistent coding of a sets distance from the net. Such practices help make the coding of volleyball actions systematic, consistent, and accurate. The discrepancies in coding the height and position of the set appear more random. A greater number of inconsistencies occurred when differentiating between a perfect set and a low and inside set. Many of the height and position discrepancies occurred when the pass pulled the setter away from setting at the net. In some of these situations, the view of the set, as recorded from the camera on the end line was uncertain. It should also be noted that most of the inconsistencies between the first and second analysis occurred in the match that had been coded the earliest among the three. Even though the principle investigator is an experienced volleyball player and coach and was trained in viewing films and coding actions, mistakes still occurred. Therefore, it would be prudent for the coaching staff to develop a systematic method of training those who are assigned to view and code game films. For example, the coaching staff may have a set of “practice” films to view and code actions. Proficiency would be established when one’s codes entered for the game matched those written by a trained individual who had viewed the game multiple times and corrected any errors in coding.

Conclusion

With consistent use of this notational analysis system, setters can now receive beneficial feedback regarding their performance and placement of a set. Coaches can be objectively informed about the probabilities of success with each setting scenario. Coaches could use this information to establish team strategies specific to the style of play and better define the team’s “goal” set. Furthermore, coaches can show their setters where and how their sets are being distributed and how their choices affect the outcome of the rally. Coaches can also make informed choices on how to allocate practice time.

Future research using the notational analysis system described in this paper could analyze the performance of different setters on the same team to determine the best combination of players on the court. Setting performance of various teams can be analyzed to develop a better overall evaluation of setting performance. In addition, setting performance of teams competing at different levels can be analyzed and compared. It may also be useful to derive a more detailed analysis of where sets are being distributed while also evaluating the probability of a positive or negative outcome for each choice. In light of technological advances, and with practice, an efficient managerial assistant could code a match in real time, allowing the coaching staff to evaluate a team’s performance and make necessary adjustments during the match. Last of all, a notational analysis as described in this paper can also be used to analyze the remaining volleyball skills in determining a quantitative analysis of a sequence of events beginning with a serve and ending with a point. If all volleyball actions within a match are coded, as with the Data Volley software program, the transitional probability matrix that was created in this study can be used to provide a detailed analysis of the sequence of events.

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Table 1

Code used to describe the height and position of the set

Description	Code
Perfect Set	#
Low and Inside	+
High and Outside	!
Low and Outside	-
High and Inside	/
Setting Error: (Lift/Double)	=

Table 2

Code used to describe the distance of the set from the net

Approximate Distance	Description	Code
0-1 feet from net	Too Close	Q
>1-3 feet from net	Close	H
>3-5 feet from net	Goal	T
>5-8 feet from net	Far	M
>8-10+ feet from net	Too Far	L

Table 3

Estimated probability outcomes of all possible setting scenarios

Set Distance From the Net	Set Height and Position	Point	Continued Play	Point for Opponent
0-1 feet from net	Perfect Set	54.89%	21.70%	23.41%
	Low and Inside	55.32%	20.58%	24.09%
	High and Outside	32.71%	35.18%	32.11%
>1-3 feet from net	Perfect Set	53.77%	24.54%	21.69%
	Low and Inside	52.56%	24.48%	22.96%
	High and Outside	49.99%	26.19%	23.81%
	Low and Outside	53.27%	24.72%	22.01%
	High and Inside	50.50%	29.39%	20.11%
	Setting Error	0.00%	0.00%	100.00%
>3-5 feet from net	Perfect Set	53.56%	24.94%	21.50%
	Low and Inside	53.57%	24.26%	22.17%
	High and Outside	50.69%	25.97%	23.34%
	Low and Outside	51.98%	25.86%	22.16%
	High and Inside	49.45%	27.13%	23.42%
	Setting Error	0.00%	0.00%	100.00%

Table 3 Continued

>5-8 feet from net	Perfect Set	52.67%	25.83%	21.50%
	Low and Inside	52.81%	25.04%	22.14%
	High and Outside	47.54%	28.69%	23.78%
	Low and Outside	50.05%	24.79%	25.17%
	High and Inside	48.15%	28.17%	23.67%
	Setting Error	0.00%	0.00%	100.00%
>8 feet from net	Perfect Set	45.02%	27.54%	27.45%
	Low and Inside	39.75%	31.03%	29.22%
	High and Outside	41.83%	29.03%	29.14%
	Low and Outside	40.25%	32.09%	27.66%
	High and Inside	38.84%	31.22%	29.95%
	Setting Error	0.00%	0.00%	100.00%
Set not by Setter		39.24%	32.68%	28.08%

Table 4

Estimated probability outcomes and distribution for height and position sets

Set Height and Position	Point	Continued Play	Point for Opponent	Raw Count	Percent Distribution
Perfect Set	52.88%	25.17%	21.95%	524	38.73%
Low and Inside	52.25%	24.91%	22.84%	415	30.67%
High and Outside	47.20%	27.67%	25.14%	120	8.87%
Low and Outside	50.60%	26.00%	23.39%	80	5.91%
High and Inside	45.66%	29.00%	25.34%	198	14.63%
Setting Error	0.00%	0.00%	100.00%	16	1.18%

Table 5

Estimated probability outcomes and distribution for distance from the net sets

Set Distance From the Net	Point	Continued Play	Point for Opponent	Raw Count	Percent Distribution
0-1 feet from net	49.92%	24.38%	25.70%	4	0.30%
>1-3 feet from net	51.05%	23.97%	24.99%	261	19.29%
>3-5 feet from net	52.69%	24.97%	22.34%	629	46.49%
>5-8 feet from net	50.59%	26.40%	23.02%	297	21.95%
>8-10 feet from net	40.92%	29.98%	29.11%	162	11.97%

Appendix A

Prospectus

Chapter 1

Introduction

Analysis of athletic skills is a valuable resource to coaches when deciding how to help his/her team make improvements to be successful. Information obtained through notational analysis systems provides valuable insight to the strength and weaknesses of a team. With this information, coaches can provide appropriate feedback, motivate athletes, monitor improvements throughout the entire season (Byra & Scott, 1983) and allocate practice time. In the sport of volleyball, little detailed research in volleyball performance is available (Daniel & Hughes, 2003). While some notational analysis systems have been developed to analyze various volleyball skills, including passing, serving, and hitting (Coleman, 1975; Coleman, Neville, & Gordon, 1971; Eom & Schutz, 1992; Lirdla, 1980; Rose, 1983; Sawula, 1977; Vojik, 1980), a notational analysis system that produces valuable information regarding the precision of a setter and solely focuses on setting performance has yet to be developed.

When using notational analysis, skills are usually analyzed based on the result of an action. The outcomes of certain volleyball skills are inversely related to the actions of the opposing team. For example, if a serve results in a bad pass from the opposing team, the serving team receives a high rating for the good serve while the opposing team receives a low rating for the poor pass. Similarly, if an attack hit is defended and controlled by the opposing team, whether by the block or defense, the hitter receives a low rating while the defense receives a high rating.

Setting, on the other hand, is most often the only skill that is not directly related to the opponent's performance (Coleman, 1975). Most sets occur as the second of three contacts on the same side of the net. It is a skill performed after a teammate first contacts the ball and is completed before another teammate attempts to terminate the rally. The outcome of an offensive rally is usually related to the third and final hit. This makes the set difficult to analyze because setting performance is a skill unrelated to the opponent's performance or only indirectly related to an outcome.

In order to appropriately evaluate the skill of a setter, the set should be analyzed independent of the rally's outcome. Currently, the only indicators of a setter's skill on the official NCAA statistic sheet for intercollegiate volleyball games are setting errors and the number of assists. Evaluating a setter's skill in this manner is problematic because ball handling errors are indistinguishable from timing errors and the setter is only rewarded when the hitter obtains a "kill." We recognize that it is still possible for a hitter to obtain a kill off a poor set. Likewise, it is possible to execute a good set in which the hitter is unable to terminate the rally. Consequently, current notational analysis systems do not accurately reflect the quality or precision of the set. If a notational analysis system were developed to specifically evaluate setting performance, then coaches, teams, and athletic conferences might be more confident in their recognition of the best setters. Coaches might also use this information to offer more constructive feedback to their players and allocate practice time to the development and improvement of necessary skills.

To assign an evaluation to setting performance, three variables will be considered. These are the distance the ball is from the net, the height of the set, and the position of the set in relation to the hitter.

Statement of Purpose

The twofold purposes of this study are to develop a notational analysis system to evaluate setting performance and to use these data as part of the development of a Markovian transitional matrix.

Hypothesis

The null hypothesis assumes that there is no relationship between setting performance and the success of the attack hit in thirteen intercollegiate NCAA Division I women's volleyball games.

The alternative hypothesis assumes that there is a relationship between setting performance and the success of the attack hit in thirteen intercollegiate NCAA Division I women's volleyball games.

Definition of Terms

Antennae- "An antenna is a flexible rod, 1.8 m long and 10mm in diameter, made of fiberglass or similar material. An antenna is fastened at the outer edge of each side band. The antennae are placed at opposite sides of the net . . . the antennae are considered as part of the net and laterally delimit the crossing space (Rule 2.4)." (FIVB, 2005).

Attack Hit- "All actions which direct the ball towards the opponent, with the exception of service and block are considered attack hits (13.1.1) . . . An attack hit is completed at the moment the ball completely crosses the vertical plane of the net or is touched by an opponent (13.1.3).” (FIVB, 2005).

Attack Line- “An attack line, whose rear edge is drawn 3 meters (10 feet) back from the axis of the center line, marks the front zone (1.3.4).” (FIVB, 2005).

Back-row hitter- “A back-row player may complete an attack hit at any height from behind the front zone: at his/her take-off the player’s foot (feet) must neither have touched nor crossed over the attack line; after his/her hit, the player may land within the front zone (13.2.2). A back-row player may also complete an attack hit from the front zone, if at the moment of contact the ball is not entirely higher than the top of the net. (13.2.3).” (FIVB, 2005).

Block- “Blocking is the action of players close to the net to intercept the ball coming from the opponents by reaching higher than the top of the net. Only front-row players are permitted to complete a block (14.1.1).” (FIVB, 2005).

Defense- “The action by a team when the ball is controlled by its opponents.” (Coleman & Liskevych as cited by Coleman, 1975, p. 6).

Dig- “Recovery of an opponent’s (attack hit).” (Coleman & Liskevych as cited by Coleman, 1975, p. 6).

Double Contact- “A player hits the ball twice in succession or the ball contacts various parts of his/her body in succession (9.3.4).” (FIVB, 2005).

Dump- An attack hit most often performed by the setter on the second of three allowed contacts.

Front-row hitter- "A front row player may complete an attack hit at any height, provided that the contact with the ball has been made within the player's own playing space (except Rule 13.2.4.—can't attack opponents serve) (13.2.1.)." (FIVB, 2005).

Front zone- "On each court the front zone is limited by the axis of the centre line and the rear edge of the attack line (1.4.1)." (FIVB, 2005).

Kill- "An attack (hit) that cannot be returned and thus directly results in a point or side out for the attacking team." (Coleman, 1975, p. 6).

Left side hitter- When facing the net, the front-row player positioned closest to the left antennae when the ball is in play.

Lift/Catch- "The ball is caught and/or thrown; it does not rebound from a hit (9.3.3)." (FIVB, 2005).

NCAA- The National Collegiate Athletic Association

Offense- "The techniques and tactics of the team controlling the ball." (Coleman & Liskevych as cited by Coleman, 1975, p. 7).

P*ass*- "The controlled movement of the ball from one player to another on the same team." (Coleman & Liskevych as cited by Coleman, 1975, p. 8).

Right side hitter- When facing the net, the front-row player positioned closest to the right antennae when the ball is in play.

Service- "The act of putting the ball into play, from the back right player, placed in the service zone (12)." (FIVB, 2005).

Set- “A pass made overhand or underhand, hit into the air for the purpose of placing the ball in position for the attack (hit).” (Coleman & Liskevych as cited by Coleman, 1975, p. 8).

Setting performance- For the purpose of this study, setting performance will be defined as the ball placement from a set that describes the distance the ball is from the net, the height of the set, and the position of the ball in relation to the hitter.

Delimitations

1. This study delimits the sample size specific to Brigham Young University’s women’s volleyball team, and even more specifically those athletes designated as a setter by position who are eligible to compete. For the 2006 volleyball season, the Brigham Young University roster has two athletes that meet these criteria which therefore qualifies them as potential setters for the analysis. Consequently, sets performed by other players who are in a position to set for a single possession during competition will not be evaluated.

2. All data will be collected by the investigator. Since the investigator is a member of the Brigham Young University women’s volleyball coaching staff, she is familiar with the offensive systems and has a good knowledge of desired set location.

Assumptions

This study assumes that the skill of setting can be analyzed as a quantitative statistic which coaches can reference when making decisions. In addition, this study assumes that the height and position of the set can be analyzed together. For example, it assumes that when a set is low, it is also either too far inside or too far outside.

Limitations

1. Analysis of game films may be limited to the position of the cameras. One camera will be positioned to view the entire court from behind the end line. The second camera will be aimed along a line 5 feet from the net and parallel to it. Consequently, this sideline view will not be exactly parallel to where every set leaves the setters hands. Therefore, the accuracy is slightly skewed.

2. The Data Volley software program (Data Project, Salerno, Italy, release 2.1.9) will be used to evaluate the setting data. This program does limit the number of possibilities that can be analyzed within its codes. However, all three independent variables used in this study can be accounted for within the limits of the software program.

3. Only films of home matches will be evaluated to control for the positioning of cameras and views of the games.

Chapter 2

Review of Literature

Athletic notational systems were initially created to use hand recorded information to provide a statistical analysis of a given event (Hughes, 1988). These statistics provide numerous benefits for coaches and athletes. The data from these kinds of statistics can provide evidence that a change in training routine or performance technique is needed (Byra & Scott, 1983). Other uses for sports statistics include identifying individual strengths and/or weaknesses, offering feedback about an individual or team's performance, motivating athletes, and evaluating performances throughout the entire season (Byra & Scott, 1983). Perhaps the largest benefit to players and teams is the ability to evaluate performance during competition (Ejem, 1980). Changes in strategy can be made to better prepare for future matches against the same opponent.

The literature will be discussed in three different categories: (1) the history of notational analysis, (2) notational analysis in other sports, and (3) notational analysis in volleyball.

History of Notational Analysis

Notational analysis is a concept that has evolved from a hand notation system used by Messersmith and Bucher in 1939 to a video analysis system aided by computers. Messersmith and Bucher (1939) studied basketball players with the question of how far one player travels during the course of one basketball game. Their results indicate that college players in the Big Ten Conference traveled anywhere from 3.46 to 3.97 miles per game. The comparison to secondary colleges showed similar averages while that of high school basketball players was significantly less.

Downey is credited with starting the notational analysis of racket sports in 1973 (Hughes, 1998). However, his system was so complicated that many simply took from him the idea of recording sport actions. For example, Sanderson and Way (1977) created a hand notational analysis system for squash. Their system incorporated symbols to denote racket strokes and proved to be incredibly useful in analyzing the game. However, it was a labor intensive process requiring 40 hours of work to obtain a full analysis of one match (Hughes, 1988). Since that time, notational analysis has been aided by film recording, video analysis, and computers that are capable of processing an immediate analysis of desired data.

Computers facilitate analysis of sport action by being able to record, analyze, and recall the action or event (Franks & Nagelkerke, 1988). The data stored in computers is useful as either feedback for athletes or information for the coach and investigator (Franks & Nagelkerke, 1988). Analysis of sport actions prior to that time was performed by either video analysis or even more traditionally, hand notational analysis. Franks, Wilson, and Goodman (1987) demonstrate how useful computers have become in offering analysis to coaches by applying a computer program to a field hockey team. This system offers a detailed and quantifiable analysis of performance that coaches can use to encourage a change in athlete technique and performance.

Notational analysis was developed as a way to objectively record, store, and recall data collected from a sports performance. Franks and Miller (1986) determined that attempting to recall information after a match cannot be totally reliable. Their results determined that the probability of novice soccer coaches recalling events correctly after a match was 42%. Their study also found that certain memorable events within the match were recalled more easily than others. That is not to say, however, that using a notational analysis system during the match would prove to be unreliable. In fact, coaches who choose to use a subjective and qualitative analysis of their team can receive great accuracy by recording the performance in some type of coded form (Franks & Goodman, 1986). That performance applies to both the individual athlete as well as the team since they "produce observable behavior that can be objectively quantified" (Franks & Goodman, 1986). Coaches should base their planning on objective measurements (Hughes and Franks, 1997). Coding of athletic performance provides an objective method of analyzing subjective material, thereby offering sports teams useful information. The current study will use a type of computer software coding program that has been specifically designed for volleyball.

Notational Analysis in Other Sports

Notational analysis has proven to be such a valuable source of feedback that most sports are using some form of it to evaluate their teams. Research indicates a heavy analytical focus placed upon the sports of soccer (Castellano, Mendo, de Segura, Fontetxa, & Bueno, 2000; Grehaigne, Bouthier, & David, 1997; Luhtanen, Korhonen, & Ilkka, 1995; Taylor, James, & Mellalieu, 2004) and squash (Hong, Robinson, & Chan, 1998; Hong, Robinson, Chan, Clark, & Choi, 1996; Sanderson, 1983; Sanderson & Way, 1977). However, tennis, badminton, field hockey, and Australian football are only a few of the other specific examples that benefit from their own game analysis.

Several studies have analyzed various aspects of the game of soccer. Luhtanen et al. (1995) created a video-based notational analysis system for the 1994 World Cup that analyzes such traits as "different time, space and maneuver characteristics per player with the ball." They explain that this type of analysis is effective because it objectively evaluates one's own team and can also be useful when scouting opposing teams. A new way of analyzing attacking moves was created by Grehaigne et al. (1997) while Castellano et al. (2000) describes a new coding system that fully describes and analyzes all actions that occur in soccer. In recent research, Taylor et al. (2004) used notational analysis to evaluate corner kicks in soccer. His findings offer advice to coaches for corner kick routines and also support previous research indicating that corner kicks present a good scoring opportunity due to the frequent number of kicks attempted.

Squash also receives a great deal of attention and benefit from using notational analysis. In 1977, Sanderson and Way first began to develop a hand notation system to evaluate 17 different squash strokes. By 1983, Sanderson fully described his notation system for squash by using symbols in its coding sequence to denote stroke types. From this system, match summary information, such as length of rallies and number of winners or errors, became quickly and easily accessible. In another study, two different scoring methods for squash were analyzed (Hughes & Knight, 1995) with the conclusion that there is no significant difference in the length of a rally. Hong et al. (1996, 1998) used a video notation to analyze the world's top male and female squash players. Their results demonstrate that for the high level female athletes, winning a game depends on winning shots rather than relying on opponents mistakes (1998). For the men, the results demonstrate that the most important strategy is focus on the “pressure and attack game” (1996). The researchers offer this method as a means for analyzing squash in all levels of competition.

Early research for tennis evaluated serving and match-play strategies (King & Baker, 1979) using mathematical-statistical methods. Recent research has adopted an advanced computerized notational analysis system to demonstrate that singles tennis is greatly influenced by both the gender of the player and the court surface they compete on at the Grand Slam tournaments (O’Donoghue & Ingram, 2001).

Appleby & Dawson (2002) began analyzing the 1997 inaugural season of the Australian Football League by means of video analysis. They evaluated the aspects of marking opportunities, ruck contests, and kick ins from which coaches obtained valuable information useful in creating applicable, game-like training drills.

In baseball, a qualitative method of analyzing 24 kinematic variables for pitching technique was recently published by Nicholls, Fleisig, Elliott, Lyman, and Osinski (2003). However, they concluded that their current protocol did not produce an accurate profile analysis.

Blomqvist, Luhtanen, and Laakso (1998) determined the validity of a notational analysis system for badminton. The system was found to be valid and reliable when evaluating playing time, player position, and the type of shot, but less reliable for the decision of the shot.

It is apparent from these examples that notational analysis has advanced throughout the previous decades and is useful in most if not all sports in providing information beneficial to coaches and athletes.

Notational Analysis of Volleyball Skills

Volleyball is one sport that has not been well researched from a performance analysis (Daniel & Hughes, 2003). This is unfortunate due to the fact that in 1980 there was an estimated 65 million volleyball players throughout the world (Vojik, 1980). This number has undoubtedly increased over a period of twenty years, and as Vojik argues, is in and of itself enough incentive to gather as much knowledge about the game as possible. Data accumulation from notational analysis may be just as beneficial to the game of volleyball as it is in other sports.

Notational analysis for volleyball became more prominent during the early 1970s and proved to provide a valuable evaluation. Notational analysis was used to evaluate various skills and provide information valuable to volleyball coaches. Coleman et al. (1971) published a 5-point scoring system, ranging from 0 to 4, that is inversely related for serving and passing. Using this system it becomes apparent that if the server scores a 4, the passer inversely scores a 0. The only exception to this occurs when the server scores a 0 for missing the serve; the passer receives no score because there was no pass attempted. Rose (1983) analyzed a variety of volleyball skills during the 1983 men's NCAA National Championship. He analyzed serving and passing using Coleman et al. (1971) scoring system. His scoring system for backcourt defense used a 4-point scale, ranging from 0-3, while hitting and blocking used a 5-point scale, ranging from 0-4.

Nothing is established to analyze setting in this study. Coleman (1992) also used a 5-point notational system for blocking.

Several publications regarding volleyball analysis and statistics appeared in *Volleyball Technical Journal* during the early 1980s. They provided useful information and added to the knowledge of strategy and analysis of team performance. Unfortunately, publication of the V*olleyball Technical Journal* was discontinued in 1986. Since that time, research pertaining to volleyball analysis has not been as available.

Several different aspects of volleyball have been analyzed using notational analysis. Buck and Harrison (1990) used video analysis in a beginning volleyball class to describe game play patterns. Successful and unsuccessful trials for four volleyball skills were tallied. The authors concluded that game play alone does not yield an improvement in performance; rather instruction is needed with game-like drills to see improvement. Daniel and Hughes (2003) created a hand notation system that would effectively evaluate elite and non-elite volleyball players. Their results demonstrated a clear difference in the execution and quality of skills between elite and non-elite players. Further analysis revealed that for the elite teams, the quality of the attack hit depends upon the quality of the set, which depends upon the quality of the pass or defense. A recent study evaluated setting with aspects of attention and decision making (Sibley & Etnier, 2004). Their results demonstrate that attention in setting increased both during the last segment of the ball's flight and due to the decision-making process.

Katsikadelli has published numerous studies analyzing the jump serve in volleyball. His most recent study (Katsikadelli, 1998) analyzes the scoring percentages to compare serve reception and the jump serve of the 1994 World Volleyball Championship final and the 1995 European Volleyball Championship final. He reported that although the jump serve is still the primary serve to hinder the opponent's serve receive, teams are now better prepared to receive a jump serve. Agelonidis (2004) adds his analysis to the jump serve to explain its effectiveness and recent dominance in the sport of volleyball. Over a ten-year period (1992-2002) the percentage of high level athletes competing with a jump serve increased from 20.8% to 99.2%, which proved to be statistically significant through a binomial test.

Among the most recently published studies to compare hitting and setting is that of Palao, Santos, and Urena (2005). They evaluated Sydney, Australia's 2000 Olympic volleyball games to determine if the setter's position on the court influenced the hitter's success. Their results indicate that for men, it did not matter whether the setter's position was in the front or back row. However, for women, hitting performance was enhanced when the setter was positioned in the back row. Our current study may be useful in providing additional input by analyzing the precision of the set when the setter is positioned in the front row or the back row.

In order to analyze volleyball skills, a valid and reliable system needs to be in place. Bartlett, Smith, Davis, and Peel (1991) describe a valid skills test as one that is game-like and one that is administered by the instructor rather than student peers. Since serving, passing, and setting are basic volleyball skills, they claim these skills tests already have content validity. They created a setting skills test of their own to try and incorporate these ideas. They gave a subject ten underhand tosses to attempt to set the ball over a string to an outside hitter target area. This target area is given a 5-point scale. If the set is the appropriate height and distance to the sideline it is awarded 5 or 4 points. If the set is too close to the net or is too close to the center of the court, it is awarded 3, 2, or 1 point. The retest was given after two days. This system is only used for the outside set and is somewhat controlled due to the fact that the initial ball the subject receives comes from a controlled toss. Our current study will analyze the quality of the set from data collected during actual competition.

Downs and Wood (1996) modeled their Special Olympics volleyball skills assessment test after the assessment used by Bartlett et al. (1991) at North Carolina State University to evaluate serving and passing skills. Their test for setting, on the other hand, was done differently to accommodate the Special Olympics participants. Their goal was to alternate forearm passing and setting to a maximum of 25 actions of each skill for a total of 50 points. To test for reliability the test and retest period was four days apart and analyzed by canonical correlation analysis which confirmed moderately high reliability. To test for validity, they evaluated criterion-related evidence and predictive validity. Criterion-related validity was proven by the strong relationship between the judges' ratings of performance and each subtest. Predictive validity was never proven to absolutely determine placement of teams into groups of equal ability.

Unlike any other volleyball skill, setting is most often the only one that is performed without being directly influenced by the opposing team (Coleman, 1975). Setting is the only skill which follows a pass or dig from one's own side of the net and is completed before the attacker attempts to end the rally. Even so, several studies have evaluated setting based on the result of the hit or play. We recognize, however, that it is possible for a hitter to make an error even when given an excellent set. In this situation, the excellent set does not get rewarded. The reverse scenario is also possible. A hitter could possibly make an excellent play from a poor set. If the hitter obtains a kill, then the set is incorrectly rewarded.

The following studies have all used some type of notational analysis system for evaluating volleyball skills. Only the portions dedicated to setting analysis within each study will be discussed here. Lirdla (1980) placed the set into one of three categories: good, average, and poor. A good set basically guarantees success, while a poor set does not. An average set score is awarded when "the attack is performed in strained circumstances" (Lirdla, 1980). In this system, the setting score is quite vague and is awarded based upon the result of the attack it creates, rather than awarding a score to the set itself.

Eom and Schutz (1992) use a similar rating system but with a 5-point (0-4) performance scale that applies to all six skills analyzed, including setting. A score of 0 is awarded when there is an error that results in loosing the rally. A score of 1 is awarded when there is a poor execution, but does not directly loose the rally. A score of 2 is awarded for an average execution where neither team has a good opportunity to win the rally. A score of 3 is awarded for a good execution that does not directly win the rally. A score of 4 is awarded for an excellent execution. Although this study is more specific than Lirdla's study (1980), the individual skills evaluated also depend on the result and do not evaluate the skill itself.

Eom and Schutz (1992) used their rating system to evaluate volleyball skills involved in the Attack Process and the Counterattack Process. The Attack Process includes the initial sequence of skills starting with the serve reception, to the set, and the attack hit. The Counterattack Process, therefore, includes the sequence of skills from the block, to the dig, to the set, and the attack hit. The analysis was performed on eight men's volleyball teams that were competing in the Third Federation of International Volleyball Cup. The results suggest that setting for the Attack Process is essentially the same for strong and weak teams. On the other hand, the top four teams outperformed the bottom four teams on all skills involved in the Counterattack Process. Therefore, they conclude that the quality of performance in volleyball skills (setting) for the Counterattack Process appeared to be a factor in the team's success.

Unlike other analyses, Coleman's (1975) analysis attempts to evaluate the set without the defensive influence on the play. He evaluates the set with a four point (0-3) performance scale by comparing the suggested relationship between the effect of the set and the score given for the set. A zero is awarded if the result of the set loses the point and the rally. A one is awarded if the set is unhittable and a free ball is donated to the opponents. A two is awarded if the set is not perfect, but is still hittable. A three is awarded if the set is in the perfect position for the hitter. This system, however, still evaluates setting from the result of the play.

Almost the same four point (0-3) performance scale used by Coleman (1975) was used to analyze the set during an Olympiad by Sawula (1977). However, Sawula more clearly defines losing the rally (score 0) as a ball handling error, the ball set too close to the net, or a ball that is set over the net. Sawula also specifies that an excellent set (score 3) provides every chance for the hitter to score, regardless of whether or not he does score. His rationale for an excellent set describes the set as a good distance from the net, good placement, and good height. This rationale is correct in idea; however, the descriptions are still vague and open to interpretation. Using similar rationale, the current study attempts to objectively quantify the term "good."

The most detailed notational analysis system that evaluates setting actually uses three different indices to describe the set (Vojik, 1980). The 1st index is the type of set with 12 possibilities that physically describe the set. The 2nd index is the place at the net from sideline to sideline where the ball is contacted and is given five possibilities. This index examines where the set location is across the width of the court and appears to be similar to the 1st index which details the type of set. It is similar in the fact that generally a type of set has a designated position on the court to which it is executed to. The 3rd index is labeled the quality of set and has seven possibilities. The scoring system for this index awards the set by reflecting on the actions of the opponents block. While this was a beneficial analysis during its time, none of these indices indicate whether the placement of the set is what the coach's desire. What appears to be missing is a system of analysis that examines the specific location of the set from the distance to the net and whether the intended set was precisely executed.

The computer program developed by Doug Penner (1985) to code a volleyball match requires entry of a 3-point rating system for the set. A zero is awarded if there is an error, hitter error, or an over-set. A one is awarded if the hitter is blocked or the play continues. A two is awarded if the hitter kills the ball. This system again, evaluates setting based upon the hitter's performance. We, for the purpose of this study, plan to use a computer software program, similar in idea to the one Penner developed, to analyze setting performance. However, the current setting analysis will be much more detailed.

The Canadian Volleyball Association (1985) published the statistical system used to evaluate men's volleyball during the 1984 Olympics held in Los Angeles. Their statistical report for every match offers information regarding the attack, block, serve reception, serve, and errors. Again, there was no analysis of setting. A similar type of statistical report is currently being used in NCAA Division I women's volleyball matches. However, now there is an assist category, which is the only statistic available to evaluate setting performance during a match. A set is credited as an assist only if the intended hitter is credited with a kill and is therefore a reflection of the hitter's ability to terminate the rally, rather than the setter's execution of the set.

The goal of any set is to achieve a high level of accuracy (Tant, Lamack, & Greene, 1993). Therefore, it is a skill requiring a great deal of precision in order to create the ideal attacking opportunity. Ironically, setting is the most subjective skill in volleyball which makes it the hardest to evaluate (Lirdla, 1980). Therefore, the interactions of the pass, set, and hit are hard to interpret (Coleman, 1975). This might explain why no study has solely devoted its focus to the evaluation of the set. Nearly all the publications cited in this review include setting as only a portion of the study, and many evaluate setting based on the result of the play.

However, setting is a skill that should be analyzed independent of what the opponents do to defend the offensive attack (Coleman, 1975). With this in mind, the set is then evaluated based on the quality of the set itself, rather than the performance of the hitter or the defense. Consequently, there exists a need to develop a notational analysis system to solely evaluate the volleyball set, independent of everything else. Doing so could potentially aid coaches and conferences around the nation in confidently evaluating setting performance and precision. Conferences might then be more confident in recognizing the best setters by independently evaluating their performance.

Chapter 3

Methods

This study develops a notational analysis system that evaluates setting performance through three variables, the distance the ball is to the net, the height of the set, and the position of the set in relation to the hitter. An expert committee comprised of four NCAA Division I coaches have established these criteria as an effective evaluation of setting performance. These three variables will be evaluated from filmed volleyball games. Two cameras will be set up to film each competition to be analyzed. One camera will be set up behind the end line to view the entire court. The second camera will be set up along a line parallel to the net and five feet from it. This camera will hence only view Brigham Young University's side of the net. The investigator will synchronize both views of the match to a detailed code of all volleyball skills performed within the match. A coworker trained to interpret volleyball skills will input the detailed code into the Data Volley software program (Data Project, Salerno, Italy, release 2.1.9). As a result, evaluating two different views of the same set becomes possible and aids the study in achieving an accurate evaluation.

The filmed games will include all home matches between the Brigham Young University women's volleyball team and opponents during the 2006 season. Only sets from eligible designated setters will be analyzed from each of the game films. Consequently, sets from other players who are in a position to set for a single possession during competition will not be evaluated.

Although several different actions can be performed by the setter (a dump, a pass set, a one-handed set, the two-handed overhead set), the only setting action that will not be evaluated is the dump. A dump is considered an attack hit and therefore does not qualify as a variable in this study. Since this study will focus on the precision of the setter's ball location rather than the technique used, the evaluation will not differentiate between the pass set, one-handed set, and the two-handed overhead set.

Notational Analysis Coding

Data entry will be performed using the Data Volley software program. Certain limitations regarding the number of possible scenarios exist for the coding that can be performed within this program. Although this slightly influences how setting can be evaluated, the three major variables involved in a set will be accounted for and thus included in the analysis. The coding is set up to record five digits (for example: 15EH+). The first two digits represent the player's number. The third digit represents the action of the set (automatically coded with an E). The fourth digit represents the distance to the net, and is only allotted five possible scenarios (Q, H, T, M, L) from the software. The fifth and last digit represents the final placement of the set and is only allotted six possible scenarios (#, +, !, -, /, =) from the software. Our interpretations of these scenarios are outlined as follows.

Distance from the Net. Five different codes are used to describe the distance of the set from the net (Table 1). This distance will be determined from the sideline view camera. From this coding, all hitting positions can be evaluated. However, due to a hitter's specific position, certain distance to the net codes will most likely not be utilized.

A middle blockers' set code will most often fall within >1-3 feet from the net (coded as H) and >3-5 feet from the net (coded as T) due to the quickness of the set. It is anticipated that >5-8 feet from the net (coded as M) will be set much less frequently while >8-10+ feet from the net (coded as L) will almost never be set for a middle hitter. For a back-row hitter, >8-10+ feet from the net (coded as L) will most often be used because these players are limited to jumping from behind the ten-foot line. All codes will apply to both left and right-side hitters.

Descriptions of the various distances are outlined in Table 1. It is anticipated that a set approximately 0-1 feet from the net will almost never be used for all hitting positions and is therefore described as "too close" to the net. A set that is approximately >3-5 feet from the net is expected to be quite common and is therefore described as "goal." Therefore, a set that is approximately >1-3 feet from the net is described as "close" to the net while a set that is approximately >5-8 feet from the net is described as "far." Finally, in terms of a front-row hitter, any set that is approximately >8-10 feet from the net is described as "too far" from the expected location.

Table 1 Fourth digit position in coding sequence for distance from the net

Approximate distance	Description	Code
0-1 feet from net	too close	Q
>1-3 feet from net	close	H
>3-5 feet from net	goal	T
>5-8 feet from net	far	M
>8-10+ feet from net	too far	L

Height and Position of the Set. The final digit representing the placement of the set will be subcategorized into six coded possibilities (Table 2). A setting error will be categorized as any setting violation called by the first referee (lift, or double contact). The height of the set and the position of the set will be represented by a single coded variable. The position of the set refers to whether the ball is too far inside or outside in relation to the hitter. A set will be classified as inside when the ball is set more towards the center of the court. A set will be classified as outside when the ball is set more towards the side lines of the court. A set will be classified as high when the maximum height of the ball is above the desired set location. When the maximum height of the ball is below the desired set location the set will be considered too low. This study assumes that the height and position of the set can be analyzed together. Therefore, when a set is too low or too high, it is also either too far inside or too far outside the hitter. Likewise, when a set is inside or outside in relation to the hitter, it is also either too high or too low. Since the investigator is a member of the Brigham Young University women's volleyball coaching staff, she is very familiar with the offensive systems and is familiar with the desired set location.

Any timing related errors between the hitter and the setter will be analyzed in terms of the set. If a poor set causes a timing related error between the hitter and setter, the poor set will be reflected within the evaluation. Likewise, if a good set was performed and the hitter causes poor timing, the good set will be reflected within the evaluation. Therefore, the setting evaluation will be performed independent of the hitter's performance and will not be classified as a setting error.

This coding system will in essence provide 26 possible scenarios, thus providing analysis in far more detail regarding the placement of the set than has been previously performed.

Table 2 Fifth digit position in coding sequence for height and position of the set

Meaning	Code
Perfect Set	#
Low and Inside	+
High and Outside	!
Outside and Low	-
Inside and High	/
Setting Error: (Lift/Double)	=

Game Analysis

Pilot studies were performed to become familiar with the Data Volley software program, determine where camera setup should be placed**,** and determine the best way to interpret the Data Volley setting codes. Initial pilot work was performed on the 2005 Brigham Young University women's volleyball season using the Data Volley software program to decode the height and position of the set from actual competitions. From this pilot work and with the help of an expert committee, Table 2 was created to describe the height and position of the set. Additional pilot work was performed on a scrimmage between players of the 2006 Brigham Young University women's volleyball team. This scrimmage was recorded to determine the placement of the camera that would show the side view of the court. Prior to the scrimmage, athletic tape was placed upon the floor within this camera's view to separate each of the five categorical distances from the net, as outlined in Table 1. From this scrimmage, the investigator became comfortable in viewing these five separate distances from the net.

Once the game films of the 2006 volleyball season matches are captured and copied into the Data Volley software program, it will be saved and recorded into the computer. A trained coworker will break down the film to code for all volleyball actions, including serving, passing, setting, hitting, blocking, and defense. This coworker was trained to use the Data Volley software program under the supervision of Brigham Young University head women's volleyball coach, Jason Watson. This coworker will code any set with a default code (15EH+) in which the only variable the coworker might change is the player number. The investigator will then use the first three digits of the code to access the designated setter of the game and begin analyzing the final two digits of the code.

Using the Data Volley software program, the same trained coworker will record the pass and dig based on a six scenario system. A perfect pass/dig (coded as #) generates no movement by the setter and all offensive options. A good pass/dig (coded as +) produces a pass within five feet of perfect and still possesses all offensive options. A level two pass/dig (coded as!) is one that produces only two offensive options. A level one pass/dig (coded as -) is one that produces only one offensive option. A level zero pass/dig is awarded when a player gets aced (coded as =) or creates an overpass yielding in an immediate point for the opponent (coded as /). From this data, the investigator can examine the probability of obtaining any set outlined within this study from the quality of passing performance.

Although the timing between the hitter and setter is important and is normally a factor within many setting analyses, the only relationship tying the hitter to the setter for the evaluation portion of this study occurs at the point in which the hitter contacts the ball and in the statistical analysis. Since the set is performed along the pathway of the pass, it is impossible to obtain a parallel view of every set seen in the sideline view camera. Therefore, in order to determine the distance from the net in the evaluation, the exact distance to be evaluated occurs at the point in which the hitter contacts the ball.

Analysis for the matches will be completed after both camera angles have been copied into the computer and then synchronized to the coworker's codes. To establish reliability of the evaluation of the set, an additional evaluation of three randomly selected matches will be performed. The same investigator will perform all volleyball game setting evaluations.

Statistical Analysis

Every time the ball is on Brigham Young University's side of the net, there is a sequence of events that follows one of the following patterns: serve-outcome, pass-set-attack-outcome, or block-dig-set-attack-outcome. The outcome is a point for BYU, a point for the opponent, or continuation of play. It is assumed that these sequences are Markov chains where the quality of each contact depends on the quality of the previous contact but not on contacts further removed in the sequence. The probabilities for the sequences are represented in an extensive matrix of transition probabilities with over 100 rows and columns. The rows of the matrix represent the first graded serve, pass, set, attack, dig, block, or outcome in the sequence, and the columns represent the next event.

Thus, the elements of the matrix are the probabilities of moving from one state to another. Impossible sequences, such as a serve to another serve, are constrained to have zero probability. Other sequences known to always occur (e.g., service error to opponent scoring) are assigned a probability of one. A Bayesian paradigm will be used to model the unknown transition probabilities. A multinomial likelihood and prior probability densities for transition probabilities are assumed to be distributed as Dirichlet variables. Markov chain Monte Carlo methods will then be used to produce posterior distributions of the transition probabilities. It is proposed that the maximum of the posterior distribution be used as the point estimate to be inserted into the transition matrix. The transition matrix will then be used to answer questions about relative skill importance of setting.

Independent Variables

The independent variables include the setting distance from the net, the height of the set, and the position of the set in relation to the hitter.

Dependent Variables

Although setting will be analyzed independent of an outcome, the outcome of the rally will be determined for the statistical analysis through the Data Volley program. The dependent variable in this study is the outcome of the attack hit, which includes four possible outcomes. The attack hit will be evaluated as either a kill (coded as #), as dug by the opponent and kept in play (coded as +), as an error (coded as =), or as blocked by the opponent (coded as /).

Anticipated Results

From the analysis of the data, we hope to determine the importance of the set relative to an outcome. Conclusions regarding the effect of a good set will be made by analyzing the probabilities of certain sets leading to positive or negative outcomes. The statistical analysis will provide information estimating the transitional probabilities of moving from one skill at a certain level to another skill at certain level. We anticipate that a better set will lead to a better hitting performance.

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Appendix A1

Excerpt from Data Volley Text File

[Match]
10/21/2006;;;;;;;1;1;;;DVSW Release 3.7.5;
[Team]
BYU;BYU;3;Watson Jason;Huebner Aldridge;
SDSU;San Diego State;0;Warner Mark;;
[Oders]
;;;;;;;15;6;
[MatchComments]
;;;;
[Set]
True;10-6;20-15;25-16;30-20;23;
True;10-4;20-19;25-20;30-22;31;
True;6 -10;17-20;26-25;30-27;29;
True;;;;;
True;;;;;
[Player1]
0;1;10;1;1;1;;;GOO-CHE;Goodman;;;
0;2;11;*;*;*;;;BEA-JAN;Beaumont;L;;
0;3;12;;;;;;EVA-LIN;Evans;L;;
0;4;13;2;2;;;;HAN-ASH;Hansen;;;
0;5;14;;;;;;RIC-LAU;Richards;C;;
0;6;15;;;;;;STI-TES;Stimpson;;;
0;7;16;4;4;4;;;WIL-KIM;Wilson;;;
0;8;17;;;2;;;VAN-MAR;Vandersteen;;;
0;9;18;;;;;;BRO-LEX;Brown;;;
0;10;19;3;3;3;;;LOT-ERI;Lott;;;
0;11;20;*;*;*;;;KEM-ANI;Kemp;L;;
0;12;21;;;;;;PAR-CAT;Parker;;;
0;13;22;;;;;;POR-BRY;Porter;;;
0;14;23;5;5;5;;;HAR-LIN;Hartsock;C;;
0;15;24;6;6;6;;;SCH-AMY;Schlauder;;;
0;16;25;;;;;;LAU-STE;Lau;;;
0;20;26;;;;;;JUD-JEN;Judkins;;;
0;24;27;;;;;;DYE-RAC;Dyer;;;
[Player2]
1;1;1;;;;;;VER-ANG;Verdenacci;;;
1;2;2;;;;;;MOR-KAR;Moriarty;;;
1;3;3;3;5;5;;;BOW-ASH;Bowker;;;
1;9;4;;6;6;;;STA-MEL;Stapley;;;
1;10;5;4;4;4;;;DEN-AUD;Dent;;;
1;12;6;;;;;;DYK-KAR;Dykema;;;
1;17;7;;;;;;XAV-LUC;Xavier;;;
1;19;8;;;;;;LOU-BAR;Louie;;;
1;20;9;;;;;;PIE-JEN;Pierson;;;
[Scout]
*P15;;;;;;;19.09.56;1;1;1;;;;
aP6;;;;;;;19.09.56;1;1;1;;;;
*z6;;;;;;;19.09.56;1;6;1;;;;
az1;;;;;;;19.09.56;1;6;1;;;;
01SQ+;;;;;;;19.09.52;1;6;1;1;20;;
65RQ+;;;;;;;19.09.52;1;6;1;1;20;;
65AM#PM;s;r;;;;;19.09.56;1;6;1;1;25;;
49&H=;s;;;;;;19.09.56;1;6;1;1;25;;
ap00:01;;;;;;;19.10.01;1;6;1;1;30;;
az6;;;;;;;19.10.01;1;6;6;1;30;;
61SH+;;;;;;;19.10.14;1;6;6;1;43;;
11RH!;;;;;;;19.10.14;1;6;6;1;43;;
15EL/;;;;;;;19.10.18;1;6;6;1;47;;
07AM#PM;s;r;;;;;19.10.19;1;6;6;1;48;;
99&H=;s;;;;;;19.10.19;1;6;6;1;48;;
*p01:01;;;;;;;19.10.21;1;6;6;1;50;;
*z5;;;;;;;19.10.21;1;5;6;1;50;;
11SQ+;;;;;;;19.10.37;1;5;6;1;66;;
65RQ+;;;;;;;19.10.37;1;5;6;1;66;;
65AT+PW;;r;;;;;19.10.40;1;5;6;1;69;;
11DH+;;;;;;;19.10.44;1;5;6;1;73;;
15ET#;;;;;;;19.10.45;1;5;6;1;74;;
14AQ#P2;p;p;;;;;19.10.45;1;5;6;1;74;;
99&H=;p;;;;;;19.10.45;1;5;6;1;74;;
*p02:01;;;;;;;19.10.52;1;5;6;1;81;;
11SQ+;;;;;;;19.10.59;1;5;6;1;88;;
65RQ!;;;;;;;19.10.59;1;5;6;1;88;;
65AM=PH;p;r;;;;;19.11.03;1;5;6;1;92;;
49&H#;p;;;;;;19.11.03;1;5;6;1;92;;
*p03:01;;;;;;;19.11.08;1;5;6;1;97;;
11SQ=;s;;;;;;19.11.20;1;5;6;1;109;;
99&H#;s;;;;;;19.11.20;1;5;6;1;109;;
ap03:02;;;;;;;19.11.24;1;5;6;1;113;;
az5;;;;;;;19.11.24;1;5;5;1;113;;
55SH-;;;;;;;19.11.47;1;5;5;1;136;;
01RH#;;;;;;;19.11.47;1;5;5;1;136;;
15EH-;;;;;;;19.11.50;1;5;5;1;139;;
14AQ+P3;;r;;;;;19.11.51;1;5;5;1;140;;
65AH+PS;;p;;;;;19.11.53;1;5;5;1;142;;
15DH=;p;;;;;;19.11.55;1;5;5;1;144;;
99&H#;p;;;;;;19.11.55;1;5;5;1;144;;
ap03:03;;;;;;;19.11.59;1;5;5;1;148;;
55SH-;;;;;;;19.12.09;1;5;5;1;158;;
11RH#;;;;;;;19.12.09;1;5;5;1;158;;
15ET#;;;;;;;19.12.12;1;5;5;1;161;;
07AM+PH;;r;;;;;19.12.12;1;5;5;1;161;;
65AM+PM;;p;;;;;19.12.16;1;5;5;1;165;;
07DH+;;;;;;;19.12.18;1;5;5;1;167;;
15ET#;;;;;;;19.12.19;1;5;5;1;168;;
14AQ=P2;p;s;;;;;19.12.21;1;5;5;1;170;;
99&H#;p;;;;;;19.12.21;1;5;5;1;170;;
ap03:04;;;;;;;19.12.26;1;5;5;1;175;;

Appendix B

Additional Result

Matrix Raw Counts		Set not by Setter	Attack Front 2				Attack Gap Set				Attack High Set to RS		Attack Back 1		
		E	P2#	P2+	P2=	P2/	P3#	P3+	P3=	P3/	P5#	P5+	P6#	P6+	P6/
Set 0-1 Feet from Net	EQ#	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EQ+	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EQ!	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Set 1-3 feet from Net	EH#	0	37	19	4	1	2	1	0	0	0	0	6	0	1
	EH+	0	18	25	5	8	3	5	1	1	0	0	2	2	0
	EH!	0	0	1	0	2	0	0	0	0	0	0	0	0	0
	EH-	0	2	1	0	0	1	2	1	0	0	0	0	1	0
	EH/	0	0		0	0	1	0	0	0	0	0	0	0	0
	EH=	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Set 3-5 feet from Net	ET#	0	17	17	2	0	4	2	0	0	0	0	4	0	0
	ET+	1	9	13	4	1	0	4	0	0	0	0	1	0	0
	ET!	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ET-	0	2	2	0	0	2	1	0	0	0	0	0	0	0
	ET/	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	ET=	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Set 5-8 feet from Net	EM#	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EM+	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EM!	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EM-	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EM/	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EM=	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Set 8-10+ feet from Net	EL#	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	EL+	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EL!	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EL-	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	EL/	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EL=	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Set not by Setter	E	0	0	0	0	0	0	0	0	0	2	3	0	0	0

Attack Fast Slide				Attack Out of System Front Row Attack			Attack Back Row B Set				Attack Back Row Right Side "D"			
P8#	P8+	P8=	P8/	PA#	PA+	PA=	PB#	PB+	PB=	PB/	PD#	PD+	PD=	PD/
0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	2	2	0	0	0	0	0	0	0	0	0	0	0	0
9	7	1	2	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	4	2	0	0	0	0	0	0	0	0	0	0	0	0
14	11	3	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	1	0	0	0	1	1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1	6	6	2	0
0	0	0	0	0	0	0	0	2	1	0	5	2	2	1
0	0	0	0	0	0	0	0	4	1	0	0	2	1	0
0	0	0	0	0	1	0	0	0	0	0	1	1	0	0
0	0	0	0	0	1	0	3	10	2	0	2	6	2	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	2	6	1	3	12	5	0	0	2	0	0

Attack Go				Attack Hut				Attack Right Side "Red"				Attack Highball "4"			
PG#	PG+	PG=	PG/	PH#	PH+	PH=	PH/	PK#	PK+	PK=	PK/	PM#	PM+	PM=	PM/
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
4	0	0	2	3	2	1	0	4	1	1	1	0	0	0	0
3	0	2	0	2	1	0	0	2	1	0	1	1	2	0	0
0	0	0	0	1	1	0	0	0	1	0	0	1	0	0	0
0	1	0	1	3	0	0	0	2	0	1	0	0	0	0	0
0	0	1	0	1	1	1	0	2	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	24	2	8	51	22	3	1	25	9	7	3	1	1	0	0
25	12	4	4	21	15	0	6	19	10	5	2	2	2	0	0
6	3	1	2	6	8	2	0	4	6	0	0	3	3	0	1
6	5	0	0	5	5	0	1	2	2	1	0	1	1	0	0
7	2	0	0	5	9	0	3	4	5	2	0	2	3	1	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	13	2	0	15	21	3	2	11	2	3	0	1	3	0	1
7	13	4	2	8	8	4	5	6	12	1	2	1	5	0	0
0	6	2	0	4	8	1	2	0	1	1	0	0	8	2	1
3	5	0	0	1	0	1	1	1	3	1	0	0	2	1	0
6	6	0	2	14	13	1	1	4	2	1	1	6	10	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	2	1	0	1	4	0	0	0	0	0	0
0	1	0	0	0	0	1	0	0	2	0	0	1	3	0	0
0	3	0	0	2	1	0	0	1	1	0	0	3	5	1	0
0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0
2	2	0	0	0	3	1	0	0	1	0	0	4	13	1	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	3	0	0	3	8	0	1	13	13	5	6	11	36	7	4

Attack Pipe or BIC			Attack Inside Left Side Set "Rip"		Attack Slide				Attack "X"-Series or Combo				Outcomes		
PP#	PP+	PP=	PR#	PR+	PW#	PW+	PW=	PW/	PX#	PX+	PX=	PX/	Good	Continue	Bad
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	1	4	0	1	1	0	0	0	0	0	0	0
0	0	0	0	0	5	1	0	1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
0	0	0	2	2	8	4	2	0	2	1	0	1	0	0	0
0	0	0	0	0	4	6	0	1	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
7	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0
0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0
2	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	5	2	0	0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	2	1	0	0	0	0	0	0	0	0	0	0	1	5	2

Total Row Sum	Total Category Sum	Total Sets
1	4	
2		
1		
105		
111	249	
7		
16		
10		
12		
292	627	
200		
46		
37		
52		
2		
90	296	
79		
36		
20		
71		
1		
36	161	
23		
30		
7		
65		
1		1353
159		1512

Matrix Transition Probabilities		Set not by Setter	Attack Front 2				Attack Gap Set				Attack High Set to RS		Attack Back 1		
		E	P2#	P2+	P2=	P2/	P3#	P3+	P3=	P3/	P5#	P5+	P6#	P6+	P6/
Set 0-1 Feet from Net	EQ#	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EQ+	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EQ!	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Set 1-3 feet from Net	EH#	0	0.2790473	0.1500484	0.0338416	0.012175	0.0408532	0.01931201	0	0	0	0	0.0556275	0	0.0123265
	EH+	0	0.1436182	0.1981987	0.0430046	0.067176	0.0363655	0.04424666	0.0132868	0.0128135	0	0	0.0208597	0.0202529	0
	EH!	0	0	0.1467874	0	0.242869	0	0	0	0	0	0	0	0	0
	EH-	0	0.1169953	0.0718916	0	0	0.0718516	0.1164901	0.0699243	0	0	0	0	0.0709783	0
	EH/	0	0	0	0	0	0.1002826	0	0	0	0	0	0	0	0
	EH=	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Set 3-5 feet from Net	ET#	0	0.055435	0.0491181	0.0075925	0	0.0326753	0.01013655	0	0	0	0	0.0186077	0	0
	ET+	0.0029884	0.0472006	0.0626473	0.0215816	0.007637	0	0.02070717	0	0	0	0	0.0077997	0	0
	ET!	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ET-	0	0.0563242	0.0570269	0	0	0.0565906	0.03580844	0	0	0	0	0	0	0
	ET/	0	0	0	0	0	0	0	0	0	0	0	0	0.025843	0
	ET=	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Set 5-8 feet from Net	EM#	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EM+	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EM!	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EM-	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EM/	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EM=	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Set 8-10+ feet from Net	EL#	0.0152467	0	0	0	0	0	0	0	0	0	0	0	0	0
	EL+	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EL!	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EL-	0.0647206	0	0	0	0	0	0	0	0	0	0	0	0	0
	EL/	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EL=	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Set not by Setter	E	0	0	0	0	0	0	0	0	0	0.0154	0.020798	0	0	0

Attack Fast Slide				Attack Out of System Front Row Attack			Attack Back Row B Set				Attack Back Row Right Side "D"			
P8#	P8+	P8=	P8/	PA#	PA+	PA=	PB#	PB+	PB=	PB/	PD#	PD+	PD=	PD/
0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
0	0.4962812	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.0408362	0.0270402	0.0199035	0	0	0	0	0	0	0	0	0	0	0	0
0.0751272	0.0595551	0.01306	0.0205834	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.0295579	0.0185816	0.0074729	0	0	0	0	0	0	0	0	0	0	0	0
0.0711032	0.0525733	0.0166454	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.0404918	0.0254847	0	0	0	0.0254121	0.0255068	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0.0197426	0	0	0	0	0	0	0	0.0205974	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0.0375901	0.167101	0.1455177	0.0579547	0
0	0	0	0	0	0	0	0	0.0878076	0.0545065	0	0.1845331	0.0850239	0.0870485	0.0540149
0	0	0	0	0	0	0	0	0.1144989	0.040652	0	0	0.0664709	0.0413691	0
0	0	0	0	0	0.1575189	0	0	0	0	0	0.1577277	0.1524188	0	0
0	0	0	0	0	0.0212029	0	0.0466428	0.1352053	0.0338405	0	0.034707	0.0848196	0.0338807	0.0225162
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0.015015	0.0379885	0.0097412	0.0207238	0.0719114	0.0322564	0	0	0.0150337	0	0

Attack Go				Attack Hut				Attack Right Side "Red"				Attack Highball "4"			
PG#	PG+	PG=	PG/	PH#	PH+	PH=	PH/	PK#	PK+	PK=	PK/	PM#	PM+	PM=	PM/
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0.5037188	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
0.0483176	0	0	0.0193412	0.0340808	0.0193387	0.0116767	0	0.0483355	0.0125187	0.0122072	0.0121585	0	0	0	0
0.028268	0	0.0207104	0	0.0206301	0.0130046	0	0	0.0205803	0.0132228	0	0.0129913	0.0131655	0.020034	0	0
0	0	0	0	0.1504226	0.15536	0	0	0	0.1521406	0	0	0.152421	0	0	0
0	0.0715689	0	0.0701425	0.1539774	0	0	0	0.1152004	0	0.0709795	0	0	0	0	0
0	0	0.1063306	0	0.1063914	0.1052442	0.1053461	0	0.1632858	0	0	0	0.1020687	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.1723022	0.0715946	0.007254	0.0239416	0.1523834	0.0664128	0.010299	0.004628	0.0863152	0.0297184	0.0217396	0.0102816	0.0046773	0.004754	0	0
0.1209655	0.0564178	0.0215781	0.0209515	0.0972925	0.0698878	0	0.0298665	0.0928857	0.047427	0.0258122	0.0118094	0.0121445	0.0119585	0	0
0.133391	0.0644121	0.0303098	0.0481559	0.1170111	0.1539127	0.0466011	0	0.1002398	0.1175751	0	0	0.0652783	0.0657153	0	0.0287057
0.1423832	0.1204122	0	0	0.1197897	0.1205717	0	0.0352054	0.056173	0.0558717	0.0356594	0	0.0359334	0.0369808	0	0
0.1197874	0.0429746	0	0	0.0876534	0.1467963	0	0.0578656	0.0708105	0.0876455	0.0410265	0	0.0415205	0.0564595	0.026376	0.0264638
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.1389184	0.1369526	0.0273369	0	0.1588779	0.2193537	0.0371463	0.0272259	0.1187648	0.026884	0.0373603	0	0.0169263	0.0371596	0	0.0170933
0.0870109	0.1534201	0.0526217	0.0299519	0.0966566	0.097362	0.05226	0.0646489	0.0754245	0.140277	0.0187068	0.0301759	0.0191394	0.0632816	0	0
0	0.1526809	0.0614462	0	0.1082	0.2005114	0.0403614	0.0614226	0	0.0391969	0.0390861	0	0	0.1966909	0.062279	0.0381245
0.1353322	0.2152541	0	0	0.0638619	0	0.0640314	0.0633112	0.0653696	0.1409069	0.0638258	0	0	0.0998571	0.0619169	0
0.0802269	0.0808241	0	0.0320736	0.1786347	0.1663232	0.0204306	0.0201752	0.0560116	0.032249	0.0204396	0.020262	0.0809447	0.1305304	0.020086	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0377939	0	0	0	0.0592484	0.0371927	0	0.0366503	0.1018202	0	0	0	0	0	0
0	0.0551357	0	0	0	0	0.0543629	0	0	0.0865391	0	0	0.0534905	0.1201117	0	0
0	0.0894457	0	0	0.067722	0.0432182	0	0	0.0423647	0.0416139	0	0	0.0920688	0.1410602	0.0425454	0
0	0	0.1548209	0	0	0.1590841	0	0	0	0	0	0	0	0.153709	0	0
0.0332653	0.0346948	0	0	0	0.0466407	0.0220231	0	0	0.0218699	0	0	0.0608775	0.176006	0.0214498	0.0206689
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.0148911	0.0203777	0	0	0.0203878	0.0494165	0	0.009445	0.077623	0.0774284	0.0320948	0.0371937	0.0653861	0.2054175	0.0433164	0.026214

Attack Pipe or BIC			Attack Inside Left Side Set "Rip"		Attack Slide				Attack "X"-Series or Combo				Outcomes		
PP#	PP+	PP=	PR#	PR+	PW#	PW+	PW=	PW/	PX#	PX+	PX=	PX/	Good	Continue	Bad
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0.0128007	0.0123961	0.0419409	0	0.0117941	0.0120819	0	0	0	0	0	0	0
0	0	0	0	0	0.0436703	0.0126223	0	0.012952	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0.1057111	0	0	0	0	0.1053396	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	0	0.0101247	0.0074418	0.0353662	0.0160051	0.0075718	0	0.0159667	0.0073753	0	0.0046696	0	0	0
0	0	0	0	0	0.0255805	0.0297693	0	0.0073633	0.0074059	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0.0286921	0	0	0	0	0	0
0	0	0	0	0	0	0.0352693	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0.0257181	0.0261638	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0190628	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0263329
0	0	0	0	0	0	0.0204482	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0.1885435	0.0805361	0	0	0	0	0	0	0	0	0.0348047	0	0	0	0	0
0	0	0.0537497	0	0	0	0	0	0	0	0	0	0	0	0.023676	0
0.0682469	0.0667397	0	0	0	0	0	0	0	0	0	0.0419838	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.0343778	0.0726635	0.0336378	0	0	0	0	0	0	0	0	0	0	0	0.0090099	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	0.0154753	0.0095827	0	0	0	0	0	0	0	0	0	0	0.009626	0.0322258	0.0150311

Collapsed Matrix-Sets Separated Raw Counts		Set not by Setter	Attack Front 2	Attack Gap Set	Attack High Inside	Attack Back 1	Attack Fast Slide	Attack Out of System Front Row Attack	Attack Back Row B Set	Attack Back Row Right Side "D"	Attack Go	Attack Hut
		E	P2	P3	P5	P6	P8	PA	PB	PD	PG	PH
Set 0-1 Feet from Net	EQ#	0	0	0	0	0	1	0	0	0	0	0
	EQ+	0	0	0	0	0	1	0	0	0	0	0
	EQ!	0	0	0	0	0	0	0	0	0	0	0
Set 1-3 feet from Net	EH#	0	61	3	0	7	7	0	0	0	6	6
	EH+	0	56	10	0	4	19	0	0	0	5	3
	EH!	0	3	0	0	0	0	0	0	0	0	2
	EH-	0	3	4	0	1	0	0	0	0	2	3
	EH/	0	0	1	0	0	0	0	0	0	1	3
	EH=	0	0	0	0	0	0	0	0	0	0	0
Set 3-5 feet from Net	ET#	0	36	6	0	4	11	0	0	0	90	77
	ET+	1	27	4	0	1	28	0	0	0	45	42
	ET!	0	0	0	0	0	0	0	0	0	12	16
	ET-	0	4	3	0	0	0	0	0	0	11	11
	ET/	0	0	0	0	1	3	2	0	0	9	17
	ET=	0	0	0	0	0	0	0	0	0	0	0
Set 5-8 feet from Net	EM#	0	0	0	0	0	0	0	0	0	28	41
	EM+	0	0	0	0	0	0	0	0	0	26	25
	EM!	0	0	0	0	0	0	0	0	0	8	15
	EM-	0	0	0	0	0	0	0	0	0	8	3
	EM/	0	0	0	0	0	0	1	0	1	14	29
	EM=	0	0	0	0	0	0	0	0	0	0	0
Set 8-10+ feet from Net	EL#	1	0	0	0	0	0	0	1	14	1	3
	EL+	0	0	0	0	0	0	0	3	10	1	1
	EL!	0	0	0	0	0	0	0	5	3	3	3
	EL-	1	0	0	0	0	0	1	0	2	1	1
	EL/	0	0	0	0	0	0	1	15	11	4	4
	EL=	0	0	0	0	0	0	0	0	0	0	0
Set not by Setter	E	0	0	0	5	0	0	9	20	2	5	12

Attack Right Side "Red"	Attack Highball "4"	Attack Pipe or BIC	Attack Inside Left Side Set "Rip"	Attack Slide	Attack "X"-Series or Combo	Outcomes			Total Row Sum	Total Sets
PK	PM	PP	PR	PW	PX	Good	Continue	Bad		
0	0	0	0	0	0	0	0	0	1	
1	0	0	0	0	0	0	0	0	2	
0	1	0	0	0	0	0	0	0	1	
7	0	0	2	6	0	0	0	0	105	
4	3	0	0	7	0	0	0	0	111	
1	1	0	0	0	0	0	0	0	7	
3	0	0	0	0	0	0	0	0	16	
2	1	0	1	1	0	0	0	0	10	
0	0	0	0	0	0	0	0	12	12	
44	2	0	4	14	4	0	0	0	292	
36	4	0	0	11	1	0	0	0	200	
10	7	0	0	0	1	0	0	0	46	
5	2	0	0	1	0	0	0	0	37	
11	7	0	0	2	0	0	0	0	52	
0	0	0	0	0	0	0	0	2	2	
16	5	0	0	0	0	0	0	0	90	
21	6	1	0	0	0	0	0	0	79	
2	11	0	0	0	0	0	0	0	36	
5	3	0	0	0	0	0	0	1	20	
8	17	0	0	1	0	0	0	0	71	
0	0	0	0	0	0	0	0	1	1	
5	0	10	0	0	1	0	0	0	36	
2	4	1	0	0	0	0	1	0	23	
2	9	4	0	0	1	0	0	0	30	
0	1	0	0	0	0	0	0	0	7	
1	19	9	0	0	0	0	1	0	65	
0	0	0	0	0	0	0	0	1	1	1353
37	58	3	0	0	0	1	5	2	159	1512

Collapsed Matrix-Sets Separated Transition Probabilities		Set not by Setter	Attack Front 2	Attack Gap Set	Attack High Inside	Attack Back 1	Attack Fast Slide	Attack Out of System Front Row Attack	Attack Back Row B Set	Attack Back Row Right Side "D"
		E	P2	P3	P5	P6	P8	PA	PB	PD
Set 0-1 Feet from Net	EQ#	0	0	0	0	0	1	0	0	0
	EQ+	0	0	0	0	0	0.497293	0	0	0
	EQ!	0	0	0	0	0	0	0	0	0
Set 1-3 feet from Net	EH#	0	0.465482	0.060543	0	0.067377	0.087936	0	0	0
	EH+	0	0.441905	0.108482	0	0.041802	0.168072	0	0	0
	EH!	0	0.396566	0	0	0	0	0	0	0
	EH-	0	0.187296	0.26616	0	0.067839	0	0	0	0
	EH/	0	0	0.101784	0	0	0	0	0	0
	EH=	0	0	0	0	0	0	0	0	0
Set 3-5 feet from Net	ET#	0	0.111399	0.042886	0	0.018434	0.056904	0	0	0
	ET+	0.003132	0.140045	0.020778	0	0.007237	0.139529	0	0	0
	ET!	0	0	0	0	0	0	0	0	0
	ET-	0	0.114317	0.092791	0	0	0	0	0	0
	ET/	0	0	0	0	0.024744	0.069123	0.05307076	0	0
	ET=	0	0	0	0	0	0	0	0	0
Set 5-8 feet from Net	EM#	0	0	0	0	0	0	0	0	0
	EM+	0	0	0	0	0	0	0	0	0
	EM!	0	0	0	0	0	0	0	0	0
	EM-	0	0	0	0	0	0	0	0	0
	EM/	0	0	0	0	0	0	0.01962427	0	0.01949924
	EM=	0	0	0	0	0	0	0	0	0
Set 8-10+ feet from Net	EL#	0.015015	0	0	0	0	0	0	0.03579348	0.3738123
	EL+	0	0	0	0	0	0	0	0.1422803	0.4227249
	EL!	0	0	0	0	0	0	0	0.157316	0.1075918
	EL-	0.06135	0	0	0	0	0	0.1503807	0	0.3344268
	EL/	0	0	0	0	0	0	0.02032079	0.2158902	0.1799536
	EL=	0	0	0	0	0	0	0	0	0
Set not by Setter	E	0	0	0	0.036655	0	0	0.06433	0.1249863	0.01466235

Attack Go	Attack Hut	Attack Right Side "Red"	Attack Highball "4"	Attack Pipe or BIC	Attack Inside Left Side Set "Rip"	Attack Slide	Attack "X"-Series or Combo	Outcomes		
PG	PH	PK	PM	PP	PR	PW	PX	Good	Continue	Bad
0	0	0	0	0	0	0	0	0	0	0
0	0	0.5027066	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0	0	0
0.068449	0.067317	0.0885654	0	0	0.02607992	0.068252	0	0	0	0
0.04942	0.034843	0.0497856	0.034434	0	0	0.071257	0	0	0	0
0	0.314302	0.1452365	0.143895	0	0	0	0	0	0	0
0.146776	0.142937	0.1889912	0	0	0	0	0	0	0	0
0.103108	0.338394	0.159929	0.100151	0	0.09707244	0.099563	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1
0.273052	0.232709	0.1472183	0.010088	0	0.01804372	0.059674	0.02959243	0	0	0
0.217771	0.196102	0.1779967	0.024988	0	0	0.064871	0.00754975	0	0	0
0.280012	0.314708	0.2150766	0.162447	0	0	0	0.02775666	0	0	0
0.255556	0.275941	0.1538003	0.074669	0	0	0.032925	0	0	0	0
0.156479	0.286764	0.1996519	0.156485	0	0	0.053682	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1
0.300103	0.441767	0.182517	0.075614	0	0	0	0	0	0	0
0.321843	0.309537	0.2675347	0.082452	0.018633	0	0	0	0	0	0
0.21285	0.406273	0.0800483	0.300829	0	0	0	0	0	0	0
0.339426	0.197967	0.2703001	0.166775	0	0	0	0	0	0	0.025531
0.194708	0.37822	0.1361637	0.231638	0	0	0.020147	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1
0.035391	0.097841	0.139652	0	0.266755	0	0	0.0357405	0	0	0
0.051618	0.051496	0.0828771	0.175864	0.051325	0	0	0	0	0.021816	0
0.087921	0.109893	0.0868777	0.275943	0.133935	0	0	0.04052305	0	0	0
0.154562	0.148245	0	0.151036	0	0	0	0	0	0	0
0.069098	0.066875	0.0207019	0.276233	0.142481	0	0	0	0	0.008446	0
0	0	0	0	0	0	0	0	0	0	1
0.03678	0.080396	0.2242847	0.337765	0.025654	0	0	0	0.009294	0.030667	0.014527

Collapsed Matrix Distance - Raw Counts		Set not by Setter	Attack Front 2	Attack Gap Set	Attack High Inside	Attack Back 1	Attack Fast Slide	Attack Out of System Front Row Attack	Attack Back Row B Set	Attack Back Row Right Side "D"	Attack Go
		E	P2	P3	P5	P6	P8	PA	PB	PD	PG
Set 0-1 Feet from Net	EQ	0	0	0	0	0	2	0	0	0	0
Set 1-3 feet from Net	EH	0	123	18	0	12	26	0	0	0	14
Set 3-5 feet from Net	ET	1	67	13	0	6	42	2	0	0	167
Set 5-8 feet from Net	EM	0	0	0	0	0	0	1	0	1	84
Set 8-10+ feet from Net	EL	2	0	0	0	0	0	2	24	40	10
Set not by Setter	E	0	0	0	5	0	0	9	20	2	5

Attack Hut	Attack Right Side "Red"	Attack Highball "4"	Attack Pipe or BIC	Attack Inside Left Side Set "Rip"	Attack Slide	Attack "X"-Series or Combo	Outcomes			Total Row Sum	Total Sets
PH	PK	PM	PP	PR	PW	PX	Good	Continue	Bad		
0	1	1	0	0	0	0	0	0	0	4	
17	17	5	0	3	14	0	0	0	12	261	
163	106	22	0	4	28	6	0	0	2	629	
113	52	42	1	0	1	0	0	0	2	297	
12	10	33	24	0	0	2	0	2	1	162	1353
12	37	58	3	0	0	0	1	5	2	159	1512

Collapsed Matrix Distance Transition Probabilities		Set not by Setter	Attack Front 2	Attack Gap Set	Attack High Inside	Attack Back 1	Attack Fast Slide	Attack Out of System Front Row Attack	Attack Back Row B Set	Attack Back Row Right Side "D"
		E	P2	P3	P5	P6	P8	PA	PB	PD
Set 0-1 Feet from Net	EQ	0	0	0	0	0	0.529647	0	0	0
Set 1-3 feet from Net	EH	0	0.387514	0.093094	0	0.050286	0.100384	0	0	0
Set 3-5 feet from Net	ET	0.000865	0.10065	0.0327	0	0.013694	0.073819	0.004702567	0	0
Set 5-8 feet from Net	EM	0	0	0	0	0	0	0.004623108	0	0.004560491
Set 8-10+ feet from Net	EL	0.007487	0	0	0	0	0	0.01647861	0.1410574	0.2472669
Set not by Setter	E	0	0	0	0.036478	0	0	0.06371164	0.1238751	0.01500954

Attack Go	Attack Hut	Attack Right Side "Red"	Attack Highball "4"	Attack Pipe or BIC	Attack Inside Left Side Set "Rip"	Attack Slide	Attack "X" Series or Combo	Outcomes		
PG	PH	PK	PM	PP	PR	PW	PX	Good	Continue	Bad
0	0	0.2370856	0.233267	0	0	0	0	0	0	0
0.064798	0.080651	0.0843987	0.024541	0	0.01629594	0.061485	0	0	0	0.036553
0.244105	0.23401	0.1656572	0.044287	0	0.008525684	0.054949	0.0186623	0	0	0.003373
0.27143	0.366098	0.1884217	0.150728	0.004664	0	0.00468	0	0	0	0.004795
0.068735	0.087435	0.06941176	0.189397	0.146023	0	0	0.0162741	0	0.007507	0.002926
0.037227	0.081024	0.2245029	0.338523	0.025454	0	0	0	0.008774	0.031088	0.014331

Collapsed Matrix - Position Raw Counts		Set not by Setter	Attack Front 2	Attack Gap Set	Attack High Inside	Attack Back 1	Attack Fast Slide	Attack Out of System Front Row Attack	Attack Back Row B Set	Attack Back Row Right Side "D"	Attack Go
		E	P2	P3	P5	P6	P8	PA	PB	PD	PG
Perfect Set	E#	1	97	9	0	11	19	0	1	14	125
Low and Inside	E+	1	83	14	0	5	48	0	3	10	77
High and Outside	E!	0	3	0	0	0	0	0	5	3	23
Outside and Low	E-	1	7	7	0	1	0	1	0	2	22
Inside and High	E/	0	0	1	0	1	3	4	15	12	28
Setting Error	E=	0	0	0	0	0	0	0	0	0	0
Set not by Setter	E	0	0	0	5	0	0	9	20	2	5

Attack Hut	Attack Right Side "Red"	Attack Highball "4"	Attack Pipe or BIC	Attack Inside Left Side Set "Rip"	Attack Slide	Attack "X"-Series or Combo	Outcomes			Total Row Sum	Total Sets
PH	PK	PM	PP	PR	PW	PX	Good	Continue	Bad		
127	72	7	10	6	20	5	0	0	0	524	
71	64	17	2	0	18	1	0	1	0	415	
36	15	29	4	0	0	2	0	0	0	120	
18	13	6	0	0	1	0	0	0	1	80	
53	22	44	9	1	4	0	0	1	0	198	1337
0	0	0	0	0	0	0	0	0	16	16	1353
12	37	58	3	0	0	0	1	5	2	159	1512

Collapsed Matrix-Position Transition Probabilities		Set not by Setter	Attack Front 2	Attack Gap Set	Attack High Inside	Attack Back 1	Attack Fast Slide	Attack Out of System Front Row Attack	Attack Back Row B Set	Attack Back Row Right Side "D"
		E	P2	P3	P5	P6	P8	PA	PB	PD
Perfect Set	E#	0.001044	0.16209	0.037	0	0.0249	0.0534	0	0.00251618	0.02662472
Low and Inside	E+	0.001407	0.18417	0.039	0	0.0152	0.114	0	0.00937531	0.02763998
High and Outside	E!	0	0.02846	0	0	0	0	0	0.04061871	0.02817931
Outside and Low	E-	0.005948	0.08918	0.099	0	0.014	0	0.01395052	0	0.03149251
Inside and High	E/	0	0	0.007	0	0.0065	0.0183	0.0297058	0.06834456	0.06462166
Setting Error	E=	0	0	0	0	0	0	0	0	0
Set not by Setter	E	0	0	0	0.03633	0	0	0.06378024	0.1242672	0.01429107

Attack Go	Attack Hut	Attack Right Side "Red"	Attack Highball "4"	Attack Pipe or BIC	Attack Inside Left Side Set "Rip"	Attack Slide	Attack "X"-Series or Combo	Outcomes		
PG	PH	PK	PM	PP	PR	PW	PX	Good	Continue	Bad
0.215286	0.217884	0.1394584	0.017465	0.019249	0.01602617	0.047802	0.01894658	0	0	0
0.17857	0.16206	0.1565059	0.049642	0.007294	0	0.049965	0.003311101	0	0.001405	0
0.18606	0.282931	0.136839	0.240154	0.034362	0	0	0.0223962	0	0	0
0.242461	0.216863	0.1753609	0.091299	0	0	0.014353	0	0	0	0.006073
0.138133	0.249866	0.1187082	0.214966	0.045082	0.006567169	0.029948	0	0	0.002648	0
0	0	0	0	0	0	0	0	0	0	1
0.036296	0.080608	0.2233268	0.340155	0.025578	0	0	0	0.009211	0.03122	0.014931