CORDELL, LYNN VIRGINIA. The Effect of the Straight Approach and the Angular Approach Upon Accuracy of the Volleyball Spike. (1974) Directed by: Dr. Gail Hennis. Pp. 63.

The purpose of this study was to determine if there was a significant difference in volleyball spiking accuracy between two methods of spike approach. Ten right-handed subjects were tested performing both the straight approach and the angular approach from the left side of the court. Subjects were instructed to aim at one of two targets located in the opposite backcourt. A mechanical apparatus was constructed to project the ball to the spikers in order to produce a consistent set-up. Forty trials divided between two testing sessions were administered to each subject. Data were analyzed on four participants whose scores exhibited a sufficiently high degree of consistency between trials. Through the use of a one-way analysis of variance, no significant difference was found between the straight approach and the angular approach in terms of accuracy.

THE EFFECT OF THE STRAIGHT APPROACH AND THE ANGULAR APPROACH UPON ACCURACY OF THE VOLLEYBALL SPIKE

by

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APPROVAL PAGE

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CHAPTER I

INTRODUCTION AND STATEMENT OF PURPOSE

Most Americans today have, at sometime, played volleyball. According to Egstrom and Schaafsma (1966:1), volleyball is the number one participant sport in the United States. The popularity which the sport enjoys is a result of its inherent appeal to all ages and all levels of ability. From backyards and beaches to high school and college gymnasiums, volleyball has grown from a recreational pastime requiring little or no skill to a fast, highly invigorating team sport. Today's scientific method of play has transformed team members from multipurpose players to specialists. Complicated offensive and defensive systems which characterize current high level competition have come a long way since the turn of the century. To become skillful and successful, a player must be willing to devote both time and energy to the development of speed, endurance, timing, and coordination.

Volleyball, as we know it today, bears little resemblance to the game as it was originally conceived. In 1895, William G. Morgan, YMCA director of Holyoke, Massachusetts, saw the need for an indoor game which was not as strenuous as basketball yet provided sufficient exercise, fun, and relaxation for the middle aged businessmen who engaged in noon hour athletics. According to Thigpen (1967:3), the rubber bladder of a basketball was volleyed back and forth across a tennis net elevated to a height of six feet six inches. The object of the game was to keep

the ball inbounds and not allow it to touch the floor. Morgan originally christened his game mintonette; but, at the suggestion of a Springfield College faculty member, the name was changed to volleyball.

Thigpen (1967:4) also notes that volleyball, though an American invention, is enjoyed more in other parts of the world. Europe and Asia dominated world play even before the International Olympic Committee officially approved volleyball as an Olympic sport in 1957. The Japanese women's team, in 1964, added a new dimension to the game with their spectacular defense. This defense with its increased forward and lateral mobility has become an integral part of both men's and women's teams throughout the world.

As the game has developed in recent years, emphasis has shifted to power. The basic power attack play is the spike which, curiously enough, is not an American invention. According to Welch (1969:66)

> Something new was added to volleyball by a backwoods team of the Philippines . . . by 'hoisting the ball high into the air near the net' and having a big rangy bushman run from center court and 'slug the ball.' No one could stop such an attack nor could they find anything in the rules to prevent this method of scoring. So back to America came news of 'punching, slugging, whacking, thumping,' or, if you like, 'spiking' the ball.

Thus the spike became an important part of the game. The culmination of offensive play usually results in the execution of this skill which demands coordination, finesse, and expert timing. To realize fully the effects of a well performed spike, one needs only to look at the eyes of a beginning student as she views the spike for the first time (Trotter, 1963:72). Keller (1968:27) acknowledges the fact that spikes

have been clocked at speeds in excess of one hundred miles per hour. A properly executed spike is one of the most dynamic yet aesthetic skills in the realm of sport.

Presently the trend in volleyball is toward the development of multiple offensive systems. The basic four-two formation places two spikers and one setter in each row. The five-one allows the setter, when in the back row, to come forward to play the ball. This leaves three spikers in the front row who may legally participate in play at the net. Regardless of which system is used, placement in spiking is of paramount importance in today's game.

Studies have been conducted that are concerned with velocity (Brechtelsbauer, 1965; Rogers, 1969; Webster, 1970) and angle of projection (Brechtelsbauer, 1965; Rogers, 1969) of the spike. Though this information appears to be of interest, the inherent value is overshadowed by the fact that today's defenses can adapt to most of the power and force that teams can generate. The introduction of the dink and the off-speed spike has primed the defense to expect the ball in any area of the court and to react accordingly. With today's increasingly complex offensive systems and their highly developed defensive counterparts, accurate placement of the ball is a necessity for points to be scored. Thus, placement becomes acutely important. The force of the ball coming over the net is wasted effort if an opponent is there to make the reception. A study concerning the effect of the straight approach and the angular approach upon the accuracy of a spike might yield information that would be beneficial for teachers and coaches. If one approach could be found to be more accurate than the other in

placing the ball, there could be implications for directing skill learning and performance. A concentrated effort could be spent in perfecting one approach.

Research relating to spiking accuracy, outside the skill testing area, is virtually nonexistent. Rogers (1969:16) has stated that there are three components of spiking: velocity, angle of projection, and accuracy. In order to investigate possible accuracy discrepancies in approach variation, it was the purpose of this study to test the effect of two different approaches to the spike upon accuracy of the results.

STATEMENT OF THE PROBLEM

The purpose of this study was to examine the effect of the straight approach and the angular approach upon the accuracy of the volleyball spike. The basic hypothesis to be tested was that there is no difference in the accuracy of the spike when performed from a straight approach or an angular approach. The alpha level was set at .05.

DEFINITION OF TERMS

1. Accuracy. The exact and precise placement of the ball in a court area which affords the least amount of defensive resistance.
2. Angular approach. An approach to the spike which begins approximately eight to ten feet away from the net on or outside the sideline at about a forty-five degree angle to the net.
3. Dink. A maneuver which incorporates the same body movement as the spike but which places the ball softly over and behind the block.

4. Highly skilled. Exceptional ability to perform well consistently.
5. Off-speed spike. A maneuver which involves the same body preparation as the spike but one in which power is curtailed at the last moment, causing the ball to lose its angle of projection and fall to the middle of the court. Similar to a drop shot in badminton or tennis, the object of the off-speed spike is to catch the defense off guard.
6. On-side spike. A spike which is performed as the ball is set on the dominate side of the body.
7. Spike. "A ball (other than a serve) which is hit forcibly from a height greater than the top of the net." (1973-75 DGWS Volleyball Guide, p. 138)
8. Straight approach. An approach to the spike which begins as the player stands shoulders parallel to and eight to ten feet away from the net.
9. Trial. A given opportunity to attempt to spike the ball into the designated target area.

UNDERLYING ASSUMPTIONS

1. The selected sample used in the study were highly skilled women volleyball players in view of their present or past participation on collegiate volleyball teams.
2. The subjects were a representative sample of all highly skilled women volleyball players.
3. The instrument used for stabilizing the set was valid and reliable according to the specifications set forth.

4. All players were motivated to perform to the best of their ability.
5. Because the testing was conducted indoors, air resistance was negligible.
6. The targets simulated two of the weak defensive areas of the court.
7. The scorer was unbiased in the recording of scores.
8. Highly skilled players exhibit a stable skill execution.

SCOPE OF THE STUDY

Delimitations

1. The population of the study included all highly skilled women players in the United States who were present or past members of collegiate varsity volleyball teams.
2. The sample was composed of ten right-handed spikers.
3. Two testing sessions were held for each subject.
4. The testing period took place during the 1973 volleyball season.
5. Each subject was given five trials using each approach while being instructed to aim at one of the two target areas for a total of twenty trials per session.
6. Four practice trials were allowed prior to each testing session to familiarize the subjects with the testing procedures.
7. A total of forty trials was administered to each subject. Scores on these actual trials were used for data analysis.
8. The investigation was concerned only with whether or not subjects perform more accurately using the straight approach or the angular approach. Distinct consideration of velocity and angle of projection as components of accuracy (West, 1970) were not included in this study.

Limitations

1. The study was limited to the four subjects whose scores exhibited a high degree of consistency between trials.
2. The use of a small sample definitely influenced the long range effects the findings might have had if a larger sample could have been used.
3. The subject group does not represent a sample large enough to allow generalizations to be made to all right-handed women volleyball spikers.
4. Results were recorded for spikes from the left front court position only.
5. Due to the time factor involved in testing, only forty trials were administered to each subject.
6. The angle of projection provided by the setting device was not indicative of an optimum set flight.

CHAPTER II

REVIEW OF THE LITERATURE

In examining the paucity of available research on spiking, the need for a study such as the present one was noted. Current volleyball literature evidences an absence of information concerning comparative methodology, performance maturation, and investigation of the highly skilled performer. Even the research on skill testing is outdated. In the current study, five primary concerns were decided upon in selecting material for review. The first section presents several methods of determining accuracy. The following section surveys the effect of the emphasis of speed and/or accuracy upon the learning of motor skills. The third section presents the disparity between the two accepted approaches to the spike. The next section reports various methods for determining the point of hand contact with the ball in spiking in order to determine if one method was feasible for inclusion in the present study. The final section surveys various mechanical devices used to aid in the teaching and refinement of sports skills.

Measurement of accuracy

Lawther (1972:153) defines accuracy as precision and exactness of movement through the control of force. Both distance and direction must be taken into account in the prediction of results. Accuracy is relative to the event; it varies from aiming a basketball toward a hoop

eighteen inches in diameter to aiming a golf ball toward a four and one quarter inch cup. Therefore, accuracy is considered an elusive criterion to standardize in all activities.

Aside from the studies conducted in the combined areas of speed and accuracy and their effects on the teaching of skills, very little research was found on accuracy alone. In view of the purpose of this study, several methods of measurement were investigated. In an attempt to measure the velocity of a spiked volleyball, Rogers (1969) and Webster (1970) instructed subjects to aim at targets on the court. Both studies incorporated the use of the subjective accuracy ratings of linesmen. Gelner (1965) utilized cinematography to analyze the accuracy of a tennis forehand drive. Overhead and sideview films were taken of such analyses as ball distance from the target, stroke path, angle of incidence, and angle of rebound, as well as observations of body and selected segmental displacements, velocities, and accelerations of an accurate forehand drive. Del Rey (1972) designed a target used in measuring speed and accuracy by means of an electric relay system. The target consisted of three concentric metal overlays connected together with contact screws. The screws were electrically wired to a relay which was able to measure where a projected object landed in relation to the center of the target. Haley (1966) used radar in measuring the velocity of a volleyball spike. The use of such a tracking system to measure the velocity of projected objects implies the feasibility of constructing such a system for the measurement of accuracy.

Speed and accuracy

There has been an abundance of research conducted in the relationship of speed to accuracy and the most advantageous order of teaching these two elements of movement. In 1922, Garrett, while studying the relationship of accuracy and speed, concluded that the two elements are inversely related; and, in the learning stages of a skill, one increases as the other decreases. Fulton (1942) investigated the placing of emphasis on speed or accuracy in the developmental stages of a ballistic skill. Verbal instruction was given in each instance to direct primary concentration on either the speed of the movement or the accuracy of its results. In the expansion of this study (1945), she substantiated her results in finding that early emphasis on speed is more advantageous because of its high degree of transfer to higher speeds. Accuracy was found to be a very unstable variable which is fairly specific to the speeds at which it is practiced. Attempts to improve in speed caused a loss in accuracy of the subjects tested. Attempts to regain accuracy caused a consequent loss in speed. In movements where accumulation of momentum is essential (tennis and golf), results would be adversely affected by early emphasis on accuracy (1945:51). Fulton also stated that the relationship between speed and accuracy varies with the skill and may be a function of the task and type of training given (1945:50).

Solley (1952) and Woods (1967) confirmed several of Fulton's findings such as the discovery that accuracy was lost when emphasis was placed on speed or a change in speed. Woods concluded that equal emphasis on speed and accuracy during the initial development of a

motor skill produced the most effective results. Singer (1968:219) supported simultaneous consideration of speed and accuracy with the elaboration that accuracy is lost when the speed of a movement increases because the change is tantamount to learning an entirely new movement. Singer (1968:219) also stated that most motor skills emphasize accuracy first, but Fulton and others concur that the transfer to accuracy is easier when the early emphasis is on speed.

The approach to the spike

There are two generally accepted methods of approaching the ball prior to the actual jump to attack. The first is the straight approach which begins with the spiker facing the net squarely (Egstrom and Schaafsma, 1966:16; Keller, 1969:29; McManama and Shondell, 1969:48). The second, the angular approach, is usually initiated at a forty-five degree angle, though this point is arbitrary (Bailey, 1964:57; Cherebetiu, 1969:85; Neal, 1969:268; Scates and Ward, 1969:23-24; Thigpen, 1967:24; Ward, 1966:95). The latter approach should begin with the spiker's feet on or outside the sideline. Some authors explain the positioning for each approach yet refrain from advocating either (Cherebetiu, 1969: 85; Poindexter and Mushier, 1973). Both approaches employ a short run of two or three steps before the spiker plants her feet to curtail horizontal momentum.

There are various descriptions in the literature concerning how far the spiker should position herself from the net prior to the approach. Scates and Ward (1969:23) proposed an angular approach beginning eight to twelve feet from the net. In an earlier account, Ward (1966:95) proposed a distance of six to eight feet as a starting

point. Neal (1969:268) also suggested that the angular approach be started from nine to ten feet from the net.

When using the straight approach, McManama and Shondell (1969: 48) suggested beginning eight to ten feet from the net. Trotter (1963:73) used a six to eight feet positioning point. Ten to twelve feet were proposed by Egstrom and Schaafsma (1966:16) for beginning a straight running approach, and Keller (1969:29) suggested a distance of up to fifteen feet. The inconsistencies in the literature implied a definite need for investigation concerning the approach to the spike. Webster (1970) compared the effects of both approaches on the velocity of the spike.

Determination of the exact point of contact

While surveying the literature, the concept of a volleyball projection device was formulated. Studies utilizing such a device were nonexistant, but several studies reported the use of a human setter. Naturally, once a human element was introduced, obvious deviations in sets would occur. Therefore, consistency of the spike was established for measurement purposes by determining what should be the exact point of hand contact with the ball. From this initial determinant, data concerning the velocity of the spike and its angle of projection could be determined.

Blackman (1968) stretched ropes at various heights and noted which ropes the spiked ball passed over. Brechtelsbauer (1965) asked each subject to simulate the approach and spiking action against a wall while a record was made of three trials on each of two days. The average of the combined six trials was used as the height of

contact for each individual. In 1969, Rogers used a similar method of instrumentation to measure jumping height. The wall was marked in increments of one-half foot from six and one-half feet to eight and one-half feet. Several practice trials were permitted. Three trials were recorded independently by two observers. The most frequently reached height was used.

Swinyard (1957) used an assumed point of contact which was eight feet. This assumption was based on the distance needed for the ball to clear a net seven and one-half feet high. Webster (1970) constructed a device to suspend the volleyball at a set height. These "volleyball tongs" stabilized the set so that a predetermined point of hand contact could be established for each trial. Webster's study provided the inspiration for the current endeavor and prompted this investigation into various other methods for determining points of contact.

The need to determine the exact point of hand contact in the present study on accuracy of the spike was not necessary. The investigator was only concerned with results after the ball landed. The consistency needed in ball trajectory to equalize the set for all subjects would appear to be concomitant with the use of a mechanical setter. There were too many possible differences in accepting such arbitrary points as were noted in the above studies. For example, the use of ropes to determine acceptable spikes presents a variance in the distance between the ropes as to what exact point the ball passed through. It may have grazed either the top or bottom rope but nevertheless would be standardized for all participants through the

use of such a measuring device.. In order to determine if a volleyball projection device could eliminate such differences, research on various projection devices in other activities was examined.

Projection devices

Various machines and teaching aids have been constructed to facilitate the learning of skills in physical education. Several of these devices which deserve mention here are those which involve the projection or stabilization of balls or other objects for contact by the hand or a striking implement. Singer (1968:242) cited the use of ball throwing machines for use in tennis and baseball. Solley and Borders (1965) utilized the Ball Boy machine, a device which projects tennis balls at timed intervals. Use of the Ball Boy, preceded by the traditional teaching of the forehand drive in tennis, produced a significant learning increase over use of the traditional approach alone. According to Singer (1968:242) the Ball Boy Company, Bronxville, New York, also manufactures a device which suspends a ball at a predetermined height and releases it at the moment of racket contact. This apparatus is similar to that used by Webster (1970) in stabilizing a volleyball for the spike. As cited previously, these "volleyball tongs" consisted of two pieces of wood mounted on a frame and held in place by springs. Contact with the ball forced its release.

Lee (1967) used a battery powered badminton shuttlecock projection device to investigate the effect of an aid of this type on playing ability of beginning badminton players. The most recently publicized machine of this type appeared to be one of multipurpose usage for badminton, tennis, and volleyball. Johnson (1973) constructed a

practical and inexpensive "Set-Up" machine manually operated through the use of pulleys, a conveyor belt, and cups which hold the projectiles. Through the adaptation of a small motor, object release becomes automatic. The device has proven helpful in the practice of such skills as spiking and other overhead smash type shots.

CHAPTER III

PROCEDURES

This study was conducted to determine the differences, if any, upon spiking accuracy between the straight and angular approaches. The hypothesis tested was that there is no difference in the resulting accuracy of spiking a volleyball between the two approaches. The length of the testing period was approximately one month from the start of the pilot study to the conclusion of the last subject's session. Various mechanical difficulties involving the projecting instrument intervened causing several delays in the collection of data. Of the number of subjects tested, only scores from those subjects exhibiting a consistency between trials were analyzed for inclusion in the study.

CONSTRUCTION OF THE INSTRUMENT

Rationale for the instrument

In the course of developing the procedures of testing subjects on different approaches to a spiking position, it was determined that the development of a device to project a volleyball at a pre-determined height over a pre-determined distance consistently would be of significant value. Several possibilities were considered. One idea involved a chute on which the ball could roll downward toward the subject from a height high enough to permit a spike to be executed. Another possibility consisted of a ball projected from a device operating on the same

principle as a pinball machine. The theory which gave rise to the final product was based on the catapult principle.

Design of the instrument

Initial consideration consisted of a ball flight of approximately thirty feet, which produced a set with an arc height of approximately twenty to twenty-four feet. These consideration were based on the necessity of having the ball travel twelve to fifteen feet above the net and land on or near the sideline.

With these conditions in mind, design work was initiated at Memco Manufacturing Inc., Commack, New York, on a launching apparatus patterned after the ancient Roman catapult principle. Both internal and external factors were taken into consideration in order to insure accuracy and consistency of operation. Of prime consideration was the maximum efficiency of the catapult in delivering the greatest possible force to the volleyball rather than having the energy dissipated throughout the apparatus itself. Because the propelling action was initiated by a high powered spring incorporated around a rigid shaft and loaded by a strong cocking arm, consideration of friction components and force requirements within the mechanism parts was of most importance. See Table 1, page 18; and Figure 1, numbers 2 and 7, page 19. In order to elicit the necessary projection characteristics to produce the desired effect, the exact spring characteristics were determined through trial and error. Varied flight distances and trajectory heights were provided for by means of an adjustment at the front end of the machine. See Figure 3, page 21. Number 13 shows the adjustable bolts used to raise and lower the machine and thus vary the arc of flight and angle of projection. Length,

TABLE 1

LEGEND TO ACCOMPANY DRAWINGS OF PROJECTION DEVICE

Item	Quantity	Description
1	1	Frame assembly
2	1	Arm assembly
3	1	Height adjustment arm assembly
4	3	Suction cup
5	1	Trigger
6	1	Trip cord
7	1	Spring assembly
8	1	Spring snubber
9	2	Pivot bolt
10	1	Pivot block
11	1	Spring rod assembly
12	3	Butt hinge
13	2	Height adjustment bolts

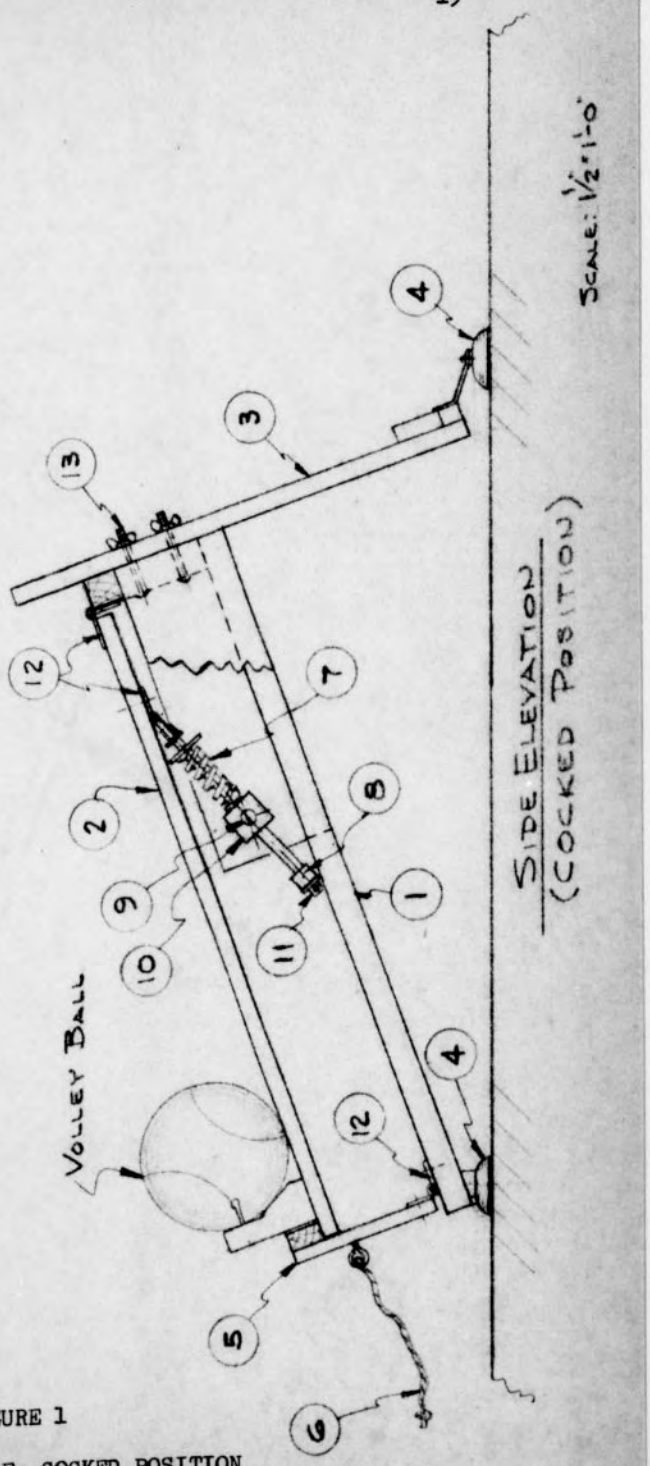

FIGURE 1

PROJECTION DEVICE--COCKED POSITION

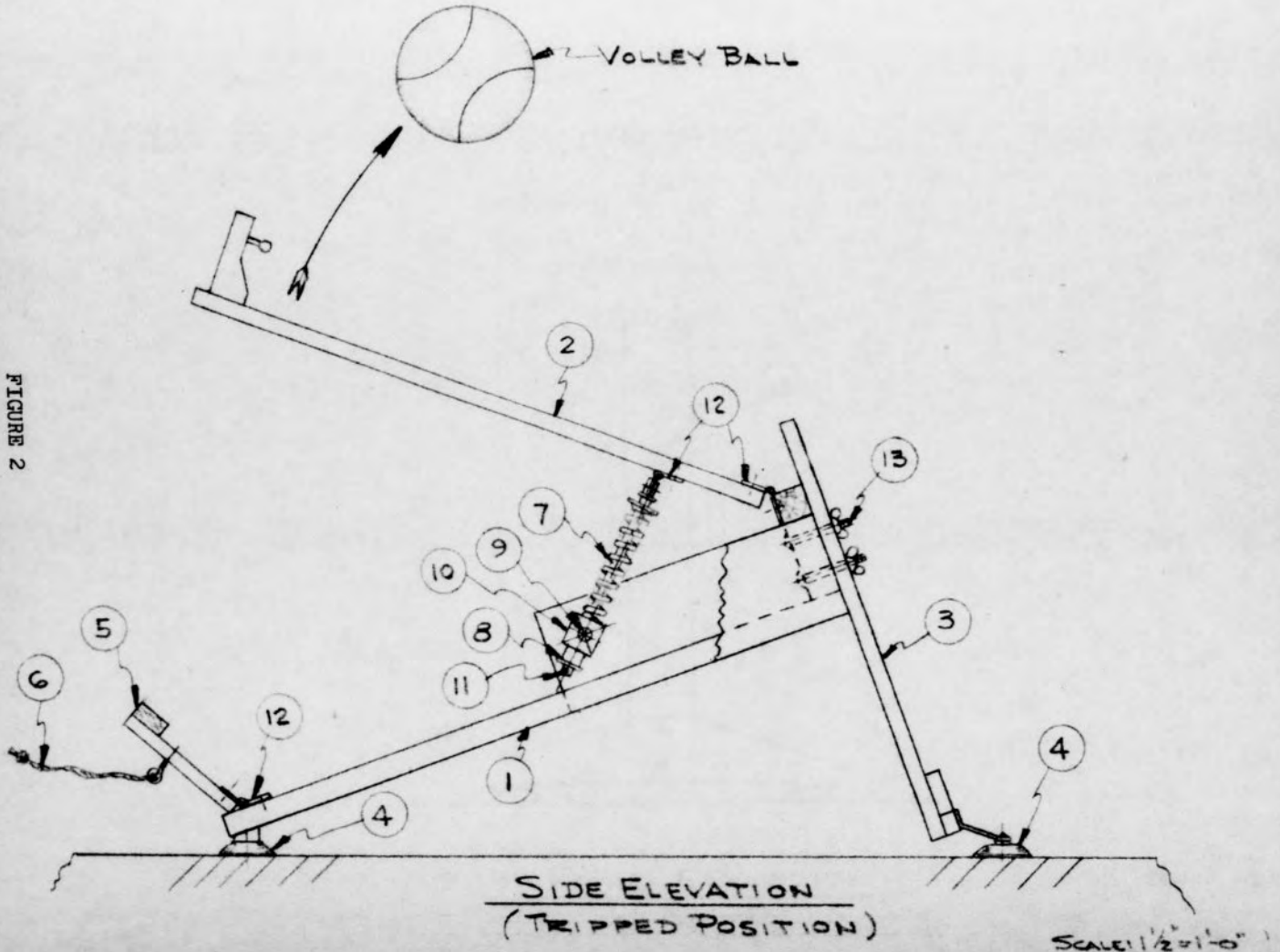

FIGURE 2

PROJECTION DEVICE--TRIPPED POSITION

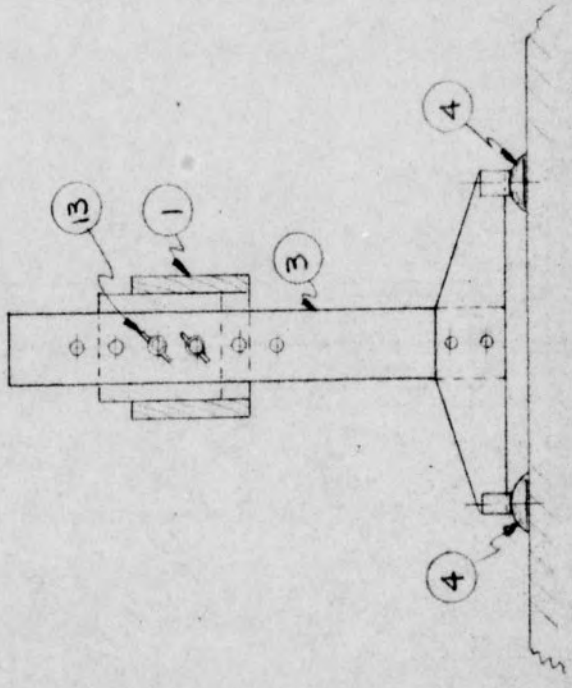

FIGURE 3

PROJECTION DEVICE--FRONT ELEVATION

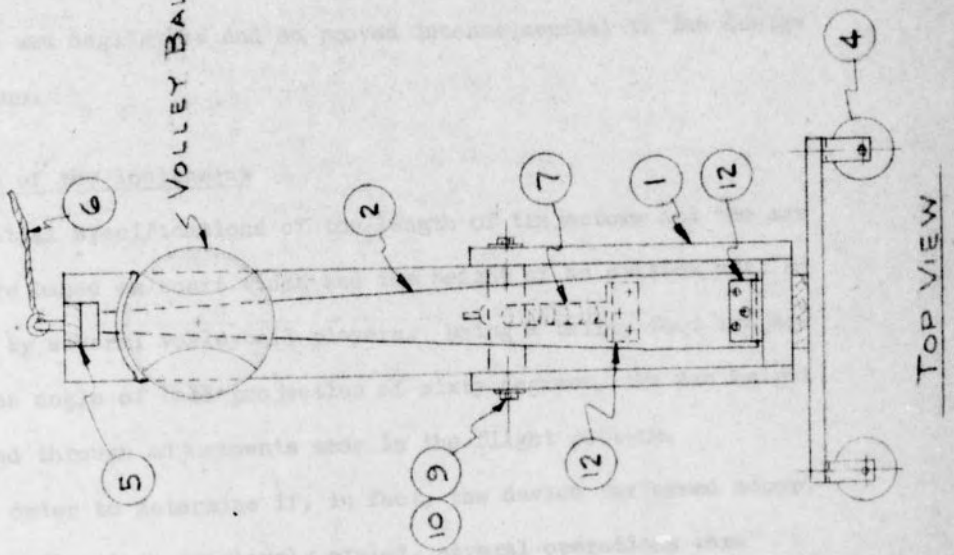

FIGURE 4

PROJECTION DEVICE--TOP VIEW

thickness, width, and weight of members were considered with ease of transportation and storage in mind. See Figures 1-4, pages 19-22. The original apparatus was constructed entirely of soft pine. After completion of the pilot study, it became necessary to rebuild the cocking arm and the frame assembly of oak.

The prime external factor which had to be considered was the weight of the volleyball itself (eight ounces). The component of air resistance was negligible and so proved inconsequential in the design calculations.

Validation of the instrument

Initial specifications of the length of trajectory and the arc height were based on court width and the height of an optimum set, as suggested by several volleyball players. Using a thirty foot trajectory and an angle of ball projection of sixty degrees, the arc height was reached through adjustments made in the flight pattern.

In order to determine if, in fact, the device performed according to specifications previously stated, several operations were observed and subjectively evaluated. Conclusions were reached that the device did project the ball as planned the entire width of the court and at the desired height.

Testing for reliability

In testing for consistency, the means of fifteen trials were obtained both prior to the pilot study and following the actual study. Results are indicated in Table 2, page 24. Scores were rounded to the nearest half foot. The pretest mean was 30.9 feet, and the posttest

TABLE 2

PRETEST AND POSTTEST SCORES
FOR PROJECTION DEVICE

	Number of Trials	Total	Mean	Standard Deviation	t
Pretest	15	464	30.9	.4577	1.0721
Posttest	15	450	30	.7037	

mean equaled 30 feet. The standard deviation for the pretest was .4577, and the posttest standard deviation was .7037. A t test for small, correlated groups was used to determine if any significant difference existed between the pretest and posttest examinations of the projection device. The alpha level was set at .05 for a two-tailed test. The obtained t equaled 1.0721, which indicated that there was no significant difference between the pretest and posttest distances. See data in Appendix C.

Empirical observation of the original scores before rounding showed a high degree of consistency between trials. Scores deviated only as much as one-fourth foot on the pretest and two and one-sixth feet on the posttest. Some lateral deviation was observed which appeared to be minimal. This could possibly have been due to failure to position the ball with its valve in the same direction for each trial.

PILOT STUDY

A preliminary investigation was conducted in October of 1973 at the Appalachian State Invitational Volleyball Tournament at Appalachian State University, Boone, North Carolina. Two members of the Appalachian State University women's varsity volleyball team were the subjects for this portion of the study. The investigator was primarily interested in checking the mechanics of the testing procedures, the reliability of the testing device under actual testing conditions, and the amount of time necessary to test each subject. Although scores were recorded, the data were not analyzed.

The testing consisted of two sessions of forty trials each. Each subject randomly selected the approach order. Basic procedures concerning the target, instructions given to the subjects and the scorer, and the method of scoring were the same as were later used in the actual study. These are explained in detail in the subsequent sections of this chapter.

Both subjects completed the two testing sessions on the same day due to the fact that the tournament was a one day affair. Because the randomly assigned approaches were taken from both the right and the left, the projecting instrument had to be shifted from one side of the court to the other depending upon the target at which each subject was aiming. At one point during the testing, it was discovered that the two pivot bolts in the frame assembly were slipping. See Figure 1, page 19, number 9. To prevent this from happening in subsequent testing and to assure correct replacement of the bolts, pencil notches were placed on the frame assembly to mark the spot to which the bolts were tightened. After each block of five trials, the bolts were examined and, if necessary, returned to their original position. Due to this repetitive delay and the necessary moving of the instrument, it was concluded that the time factor was definitely a hindrance because a total of eighty trials involved over an hour per subject. In the actual study the number of trials was reduced to twenty per session (a total of forty), and all trials were taken from the left side of the court. These two adjustments reduced the actual testing time for one session to approximately fifteen minutes.

THE STUDY

Selection of subjects

The study called for highly skilled women volleyball players. In an attempt to obtain such subjects, letters were sent to tournament directors requesting the opportunity to test at two Southeastern invitational tournaments. See Appendix A for a copy of the letter. As previously indicated, two participants in the Appalachian State tournament were used for the pilot investigation, and the West Georgia Invitational Tournament at West Georgia College, Carrollton, Georgia, in early November 1973 provided two of the subjects for the actual study. These latter players were from Eastern Kentucky University, Richmond, Kentucky. Although arrangements had been made to test other players, space conflicts and unforeseen tournament delays made additional testing impossible. The remainder of the subjects were three graduate students and five varsity team members from the University of North Carolina at Greensboro. All subjects were current or former members of a varsity intercollegiate team. All were right-handed.

Court and equipment

The courts used were regulation sixty feet by thirty feet volleyball courts bounded by lines two inches in width. Two targets were constructed of clear plastic. Each target consisted of three strips of plastic 15' by 6' by .006 mm. connected together with two strips of Scotch brand double-stick tape. Scoring areas were marked on the targets by one and one-half inch green cloth Mystic tape. Each successive area encompassed one additional foot on the top and the side. Assigned

scoring values were five, four, three, and two from the corner of the target toward midcourt. See Figure 5, page 29. A score of one was recorded for a spike landing anywhere on the court other than the target of the designated attempt. The scoring values were placed on the target with neutral colored masking tape. The two targets were positioned at the outer edges of the sidelines and the endline of the backcourt. A six inch overlap existed between each section of connected plastic. An overlap of two feet was created in midcourt between the two targets. Masking tape was used at the corners and the bottom of the targets to provide stability.

The device used to set the ball to the spikers was positioned on the opposite side of the net from the target and on the right side of the court. See Figure 5, page 29. Only on-side spikes were used in the investigation. The machine was positioned three feet from the net and six feet into the court from the outside of the right sideline. The distance away from the net was utilized to allow a ball exhibiting any form of lateral flight deviation to descend on the same side of the net as the spiker. Tape marks were placed around the supporting members of the machine to assure exact replacement following the recoil of the device after each operation.

A regulation SV-5 twelve panel volleyball was used during all testing sessions. All volleyballs were inflated with approximately six pounds of air pressure.

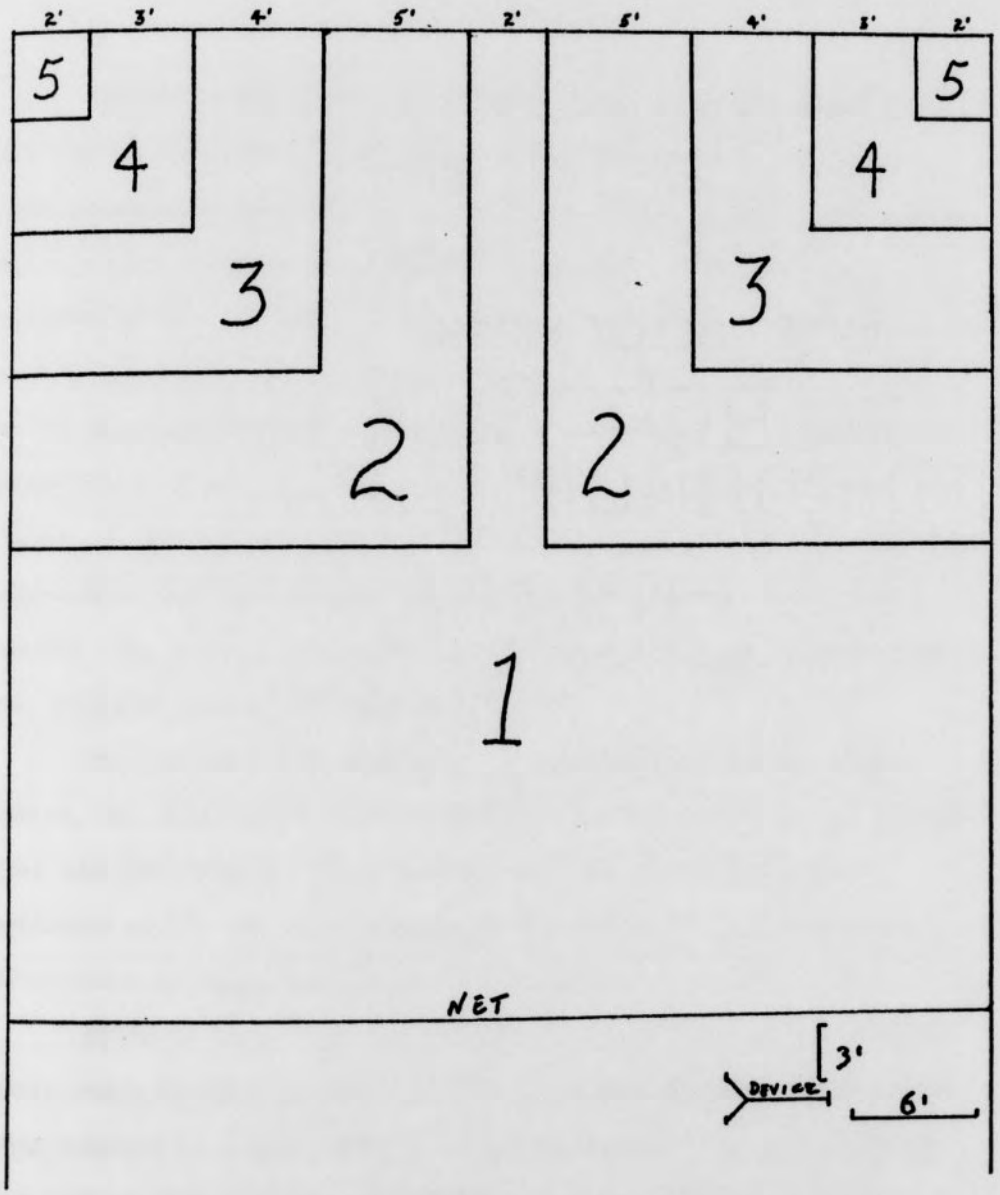

FIGURE 5

POSITIONING OF PROJECTION DEVICE IN
RELATION TO FLOOR TARGETS

ADMINISTRATION

Subjects were given instructions as to the nature of the study and its delimitations. See Appendix B for a list of instructions. Each participant was asked to spike at one of two targets using either the straight approach or the angular approach. Five trials were allowed for each approach while aiming at each target. This equaled a total of twenty spikes during each of two testing sessions. Prior to the sessions, subjects randomly selected the approach order which consisted of these four choices: 1) left angular approach to the left target, 2) left angular approach to the right target, 3) left straight approach to the left target, 4) left straight approach to the right target. The scorer recorded the chosen order which was replicated by the player at the second testing session.

The subjects were then given an explanation of the setting device, and they were allowed to become acquainted with its use through four practice trials. These trials could be taken using either approach; or, if the subject desired, they could be used solely for observation to gauge ball flight and distance.

Subjects could begin any desired distance from the net provided their shoulders were parallel to the net in the straight approach, and they remained in a line running obliquely through the intersection of the spiking line and the left sideline during the angular approach. To more nearly simulate a game situation, the approach distances were permitted to be altered during the testing.

The target and the method of scoring were explained in detail. The scores of five, four, three, and two were plainly visible, and it

was added that a score of one would be recorded for any ball landing in bounds but outside the designated target. Any illegal spike, net foul, center line violation, or ball which failed to go over the net or landed outside the court was scored as zero. Repetition of trials was allowed only for a mechanical failure of the instrument.

Each trial was preceded by a question of "Ready?" Upon hearing no negative response, the catapult was activated. The investigator loaded and released the device for each trial as well as watched for net and center line violations during each spike. The machine was replaced on the floor tape marks following each release of the ball.

One scorer assisted in the recording of data, and this individual aided in this capacity throughout the entire study. The scorer was instructed to position herself in an area affording the best view of both targets. Balls which landed on the lines between two target values received the higher score. See Appendix B for a list of instructions given to the scorer.

COLLECTION OF DATA

Scores were recorded on a reproduction of the actual target area. See Appendix D. The number of the trial was recorded and circled. A record was also kept of the target to which each group of trials was designated. A spike with an accompanying violation was marked "v." A ball which was hit legally yet landed on the wrong target was marked "wt." A separate scoresheet was used for each session so that there were two sheets for each subject. Data were grouped by approach and target (left or right). Totals were obtained for each session, and a final total was obtained from the addition of both trials.

TREATMENT OF DATA

Data for ten subjects were gathered, but inclusion in the study was precipitated by achieving a correlation of at least .70 between both testing sessions. According to Weber and Lamb (1970:63), .70 and above is considered a high correlation. Subjects whose first session total and second session total differed by more than five were eliminated from the study. Only the four subjects whose scores exhibited a seemingly high consistency between trials were selected for further analysis.

The Pearson Product-Moment Method of correlation was used to determine the coefficient between the two sets of trials for the four subjects. Cell totals for each approach to each target were obtained, and a one-way analysis of variance was used to determine if a significant F could be obtained. The alpha level was set at .05 for a two-tailed test.

CHAPTER IV

PRESENTATION AND INTERPRETATION OF DATA

Several statistical methods were utilized in the analysis of the obtained data. This chapter contains an explanation of those data and an interpretation of the results.

Analysis of data

In determining the reliability of the projection instrument, the means of the pretest and the posttest, 30.9 feet and 30 feet respectively, were consistent within a foot. Refer to Appendix C for scores. Obtained standard deviations, .4577 and .7037, show a close grouping of all scores around the two means. A t test yielded no significant difference between the two sets of data. Analysis of both the pretest and the posttest confirms the desired consistency of instrument operation.

Of the ten subjects selected for the study, only four reached scores of which the totals on sessions one and two were comparable enough to obtain a correlation of over .70 which, as previously stated, was selected as the cut-off point. All subjects whose session totals differed by more than five were deleted. The Pearson Product-Moment Method of correlation was used in determining the relationship between the two sets of trials of the four subjects selected for inclusion in the study. Each subject's total scores for session one were added together and compared with the summed totals for session two. This procedure yielded a coefficient of .75 which indicated a high degree

of consistency in performance. See Table 3, page 34.

TABLE 3

RELIABILITY COEFFICIENT FOR THE TWO TESTING SESSIONS

Sessions	Number of Subjects	Reliability Coefficient
I and II	4	.75

The scores on the five trials for each approach to each target were then totaled and a composite score was determined for each of four cells. From these totals the means and the standard deviations for each approach to each target were obtained. Table 4, page 35 shows the results. A one-way analysis of variance was performed using the obtained cell totals. The alpha level was set at .05. The obtained F was .26 which was not sufficiently large enough to indicate a significant difference. Therefore, the null hypothesis that there is no difference in the effect of the straight approach and the angular approach upon accuracy of the volleyball spike was found tenable for these subjects.

Interpretation of results

Failure to obtain a significant F ratio in the investigation of accuracy variances between the straight approach and the angular approach to the spike presents several explanatory possibilities. Because of the necessity of obtaining subjects possessing an extremely high level of spiking ability, the study could have been adversely affected from the outset due to an apparent lack of the necessary

TABLE 4

ANALYSIS OF VARIANCE AMONG TOTAL SCORES OF ALL APPROACHES
N = 4

Approaches	Means	Standard Deviation	F
Straight approach, right target	9.75	3.3040	.26
Straight approach, left target	9.00	2.9439	
Angular approach, right target	8.75	4.9917	
Angular approach, left target	7.50	3.1091	

amount of skill among the subjects available for testing. In order to determine if there is a difference in accuracy scores using the straight or the angular approach, the subjects would have to possess the ability to perform each approach equally well. An exceedingly high level of skill is necessary to comply with this stipulation. Most players appear to discover a preferred approach and seem to abandon the other at the expense of dexterity. As a result of subjective observation, it appeared that the subjects tested in this study did not possess the necessary level of skill.

Inability to obtain a larger sample also may have influenced the results to the extent that the power efficiency of the analysis of variance was weakened considerably. Though ten subjects were tested, only the four who achieved a correlation of .70 or higher between the first and second testing sessions were included in the study. Certain variables, which were unable to be controlled, may have also adversely affected the obtained scores. Two players were tested the night before and the first night after tournament play. The other eight participated in sessions which were a week apart due to inability to secure the gymnasium to set up testing conditions.

The launching device itself seemed to produce an unnatural set; one that appeared to move too quickly at its outset and to approach the subjects with a lower than normal arc of trajectory. The set, which traversed a distance of approximately the width of the court, resembled a "shoot set." This tactic is frequently used in high level competition to force the center blocker to one side so she will be unable to reach the actual spiking area as the ball is set from the

right forward to the left forward or vice versa. The low, flat arc moves the ball quickly from the setter to the spiker thus leaving the latter to contend with a one-man block only. Though the shoot set can be helpful for variation or if the situation warrants its use, the more common set is one that originates from a distance of less than fifteen feet from the spiker.

Because of the necessity of constructing an immediate prototype, materials were selected for the instrument on the basis of their ready availability. Redesign of this instrument is now in process incorporating more sophisticated materials of lighter weight, primarily aluminum. A more refined adjustment method for varying trajectory height and length of travel has also been developed. The improved version will be able to accomodate changes in arc height from between fifteen and thirty feet. In addition, a slight revision in the method of cocking the arm and loading the spring mechanism will afford greater safety to the operator and will permit folding the machine to a completely flat position for greater ease in transportation and storage. The possibility of developing an optional electrically operated solenoid which will permit the release of the cocking arm from a remote position is also under consideration.

Precise timing between setter and spiker is of paramount importance in order to complete the play, and the allowance of only four practice trials (standardized for all subjects) may have prevented the occurrence of the timing aspect. Although the instrument was validated and was equal and reliable for all participants, even a slight lack of consistency coupled with the unfamiliarity of the device may have

been enough to alter the performance pattern of the subjects. The speed at which the ball left the launching apparatus seemed to force some subjects to alter their approach distance and cause them to begin closer to the net. Taller spikers also seemed to have an advantage, but whether this was due in any part to the use of the machine or the fact that taller players are known to adapt well to spiking could only be speculation on the part of the investigator.

Most of the literature on the teaching of the spike instructs players to be aware of the position of their blockers and the open areas of the court even before they leave the floor to make contact with the ball. As the approach is made, defensive weaknesses should be carefully observed and analyzed. To be able to survey all this, keep the ball in perspective, and formulate an open line of attack, the player must possess keen powers of kinesthetic and perceptual awareness. She must be conscious of a variety of relationships involving people, objects, and the areas around her. On examining the data, the question has been raised concerning a possible lack of concentration on this aspect of spiking. The ball may be contacted and result in a spike exhibiting superb form and tremendous velocity; but due to lack of foresight by the spiker or ability to perceive an open area in time, the ball is blocked or an agile defense picks it up and returns it. Spatial awareness is a necessity to develop along with skill in performing the movement.

Lastly, in examining the research on speed and accuracy in order to determine an explanation for such an exceedingly low analysis of variance, the literature concerning the teaching order of these two

skill components was consulted. All studies seemed to concur that, during the initial stages of skill learning, speed and accuracy are inversely proportional. Fulton's early research (1942, 1945) seemed to summarize most of the conclusions reached until that time. She conducted studies in which early emphasis on speed was advocated because of its feasibility for transfer to higher speeds. She concluded that momentum skills in particular would be adversely affected by initial emphasis on accuracy. Indication was made that the task and the type of training involved might also affect the order of emphasis of these two elements. Later research by Solley (1952), Woods (1967), and Singer (1968) indicated that equal emphasis on both speed and accuracy yields the most desirable results.

It is the contention of the researcher that, though equal emphasis should be given to both aspects, not enough consideration is given to accuracy from the initial learning stages of the spike. Most beginners are taught to contact the ball with as much force as possible; and, consequently, the result is a beautifully driven ball with no intent or purpose. The player assumes she has a command of the mechanics and can execute a dynamic spike, but this same player loses all sense of aim when she faces a pair of blockers. Accuracy is not given major consideration until after force and velocity are well a part of a player's spike. Consequently, the spiker has to introduce various arm and wrist rotation in order to hit around the block, or she must employ deceptive movements such as an off-speed spike or a quick spike following a "Jap set." The latter skill is performed by jumping prior to the set and contacting the ball as it leaves the setter's hands. Both

tactics are employed to confuse the defense. These skills are useful, especially with today's trained and highly adaptable defenses, but there still seems to be a lack of attention to the major role which accuracy places in spiking. In the level of skill observed in the study, it appeared that accuracy was a function of fate. Also, there could plausibly be no one approach that is more accurate than the other. Thus, the explanation that there is no difference between the approaches could be veritable. There appears to be a need for further investigation of the assumptions stated here which have surfaced as a result of the analysis of the data gathered in the present study.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

The purpose of this study was to investigate the effect of the straight approach and the angular approach upon accuracy of the volleyball spike. Participants were tested performing both approaches from the left forward position while aiming at one of two targets located in the opposite court. Data were correlated to determine consistency and were further analyzed using a one-way analysis of variance.

A device was constructed to project the ball consistently for all subjects prior to each trial. Based on the principle of a catapult, this apparatus eliminated the need for a human setter and thus provided the participants with an aerial ball which simulated an actual set.

A pilot study was conducted which permitted the amount of testing time per subject to be investigated and the proposed number of trials to be resolved. Data were not analyzed for the two subjects who took part; but, in preparation for the actual study, the administrative mechanics were altered slightly as a result of the information gathered.

Four right-handed spikers, who met the criterion of a .70 correlation between two testing sessions, were finally selected for inclusion in the actual study. Each subject randomly selected the order of trials. The choices were: 1) angular approach to the left target, 2) angular approach to the right target, 3) straight approach to the left target, 4) straight approach to the right target. The two targets, which were

constructed from clear plastic, covered an area of the court fifteen feet by thirty feet. Subjects participated in two sessions each consisting of twenty trials (five for each of the four choices) for a total of forty trials. Cell totals were analyzed using a one-way analysis of variance. Results indicated that there was no difference in accuracy resulting from emphasis on the straight approach or the angular approach for the subjects tested.

It was theorized that, though current research proposes a simultaneous emphasis on speed and accuracy, not enough emphasis is placed on accuracy during the developmental learning stages of the spike. Though generalizations cannot be made as a result of the information gathered, it is the belief of the researcher that uncontrolled variables, such as testing during a tournament and the problems encountered with the projection apparatus, tended to interfere with the administration of the testing. This, in turn, may have prevented the collection of pure data.

Conclusions

On the basis of this study it can only be concluded that the testing instrument provided a reliable set and that a difference in accuracy between the two approaches cannot be determined, if in reality it does exist, unless highly skilled players who perform consistently are secured for testing. As a result there is a definite need for further research on the question of accuracy differences in spike approach.

SUGGESTIONS FOR FURTHER RESEARCH

The present study could serve as a pilot investigation for any of the following ideas in which successive research is needed:

1. Calculation of velocity and angle of projection using both approaches.
2. Utilization of the improved launching device in the replication of the present study.
3. Replication of the study using a different skill level such as AAU, USVBA, or international players.
4. Investigation of the effect of a volleyball projection device on the learning of the spike.
5. Replication and/or elaboration of the present endeavor using a group of subjects previously accustomed to using a volleyball projection device for practice.
6. Testing the perceptual awareness of spikers as measured by accuracy using targets of various geometrical shapes.

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APPENDIXES

APPENDIX A

Correspondence

,1973

Dear Ms. ,

This letter is a request for obtaining permission to engage in research at the Invitational Volleyball Tournament (date) . The study is entitled: The Effect of the Straight Approach and the Angular Approach Upon Accuracy of the Volleyball Spike. If possible, I would like to secure right-handed spikers as subjects. The study, as I envision it, requires highly skilled participants in order that both approaches be performed as well as possible. Thus, this is my reason for choosing this tournament, one I know to be of such high caliber.

There will be two sessions of testing which will involve spiking at two targets on the court. A diagram is included depicting the approaches and the target areas. Each subject will perform twenty trials from the left side of the court for a total of forty trials per subject per session. A breakdown of this arrangement is included on the diagram sheet. Practice trials will be allowed to familiarize the subjects with the testing conditions and the projection device. An apparatus will project the volleyball twelve to fifteen feet above the net to simulate a game set.

If possible, I would like to conduct the testing sessions on the night before the tournament begins and on the first night of play. If coaches desiring to participate would select their two best right-handed spikers, this would complete the selection process.

I realize that my study may not have far reaching implications, but the possibility exists that a study concerning the effect of the two approaches upon the accuracy of a spike might yield information that is beneficial to teachers and coaches. If one approach could be found to be more accurate in placing the ball, there could be implications for directing skill learning and performance.

Results will be tabulated by April 1, 1974 and a copy will be mailed to the teams. If the coaches could enclose an indication of their willingness to respond with the information they return to you, I would greatly appreciate it.

Most sincerely,

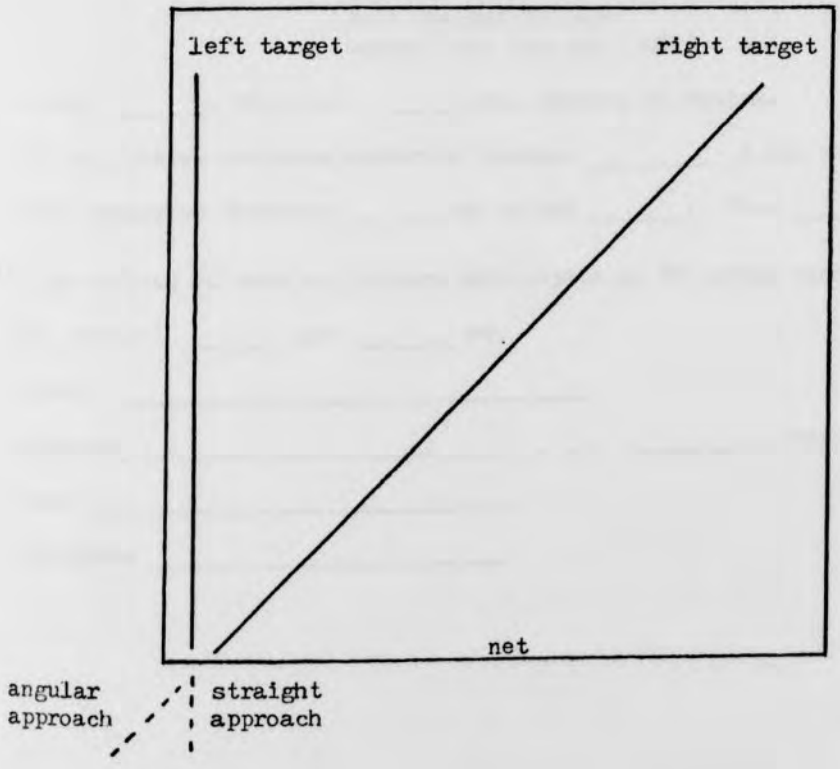
Lynn Cordell
University of North Carolina

FLYER SENT TO TEAMS PARTICIPATING
IN WEST GEORGIA TOURNAMENT

Ms. Lynn Cordell, graduate student at the University of North Carolina at Greensboro, has requested permission to conduct tests regarding a study entitled: "The Effect of the Straight Approach and the Angular Approach Upon Accuracy of the Volleyball Spike." She would like to have skilled spikers from the teams participating in the West Georgia Tournament. All participants must be right-handed. Therefore, at Ms. Cordell's request, I am asking the coaches if they would be willing to assist her in conducting these tests. She would like to do this on Thursday evening prior to tournament matches and after the matches Friday night. I am enclosing a copy of the block design and information regarding techniques to be used in conducting the study. Your cooperation will be greatly appreciated, I am sure.

Sincerely,

Dorothy McNabb
Tournament Director



BLOCK DESIGN FOR TRIALS

	1st day	2nd day	Total
Angular approach to the left target	5	5	10
Angular approach to the right target	5	5	10
Straight approach to the left target	5	5	10
Straight approach to the right target	5	5	10
			40

There will be two sessions of testing which will involve spiking at two targets on the court. A diagram is included depicting the approaches and the target areas. Each subject will perform twenty trials from the left side of the court during each of two testing sessions for a total of forty trials. A breakdown of this arrangement is located above. Practice trials will be allowed to familiarize the subjects with the testing conditions and the projection device. An apparatus will project the volleyball twelve to fifteen feet above the net to simulate a game set.

Please return this to: Dorothy McNabb
Physical Education Department
West Georgia College
Carrollton, Georgia 30117

I will _____, will not _____ need housing on campus.

If yes, please indicate number of persons _____; how many nights.

Plan to arrive Thursday _____ or Friday _____. Time _____.

I am willing to have my players participate in the study conducted by

Ms. Cordell _____ yes _____ no.

School _____

Address _____ zip _____

Coach _____

Telephone _____

APPENDIX B

Instructions

INSTRUCTIONS GIVEN TO SUBJECTS

--Using both the straight approach and the angular approach, you will be asked to spike at one of two targets. Five trials will be allowed for each approach while aiming at each target. The following is a breakdown of the total number of spikes (twenty during each of two sessions for a total of forty):

left angular approach to the left target
left angular approach to the right target
left straight approach to the left target
left straight approach to the right target

--You will be allowed to randomly draw the sequence prior to the session itself. The scorer will record the order of choice.

--The device used to set the ball is a mechanically operated, spring driven instrument which will provide a consistent set. The angle of projection may not appear optimal, but adjust to the ball as you would any set in an actual game situation.

--You will be allowed four practice trials. These may be taken using either of the two approaches. Any of the practice trials may also be used to observe the ball flight and to gauge distance.

--You may begin any desired distance from the net using the straight approach provided your shoulders are parallel to the net.

--You may begin any desired distance from the net using the angular approach provided you remain in a line which runs obliquely to the net through the intersection of the spiking line and the left sideline.

--Approach distances may be altered at any time during the testing.

--The target covers an area of the backcourt fifteen feet by thirty

feet. The highest score obtainable is five; the lowest is zero.

--Lines are good and will be scored as the highest possibility on that particular trial.

--A score of one will be recorded for any ball which is good but which lands outside the desugnated target.

--Any illegal spike, net foul, center line violation, or ball which fails to go over the net or lands outside the court will be scored as zero.

--A trial may only be repeated due to mechanical failure of the instrument.

--A command of "Ready?" will be issued prior to each trial. Upon hearing no response to the contrary, the machine will be activated and the ball will be released.

--Try to be as accurate as possible.

INSTRUCTIONS GIVEN TO THE SCORER

--Station yourself along the sideline or endline in an area affording the best view of the target court.

--Mark the number of the trial in the appropriate spot on the scoresheet.

--Use only one scoresheet per person for each of the two sessions.

--Balls landing on lines between target areas receive the higher score.

--Any ball landing out of bounds is scored as zero.

--Any illegal spike is scored as zero.

--Balls landing in bounds but outside the designated target area receive a score of one.

--Boundary lines are valid and the score is recorded accordingly.

APPENDIX C

Raw Scores

PROJECTION DISTANCES FOR CATAPULT

PRETEST		POSTTEST	
Rounded to Nearest half-foot	Actual Scores	Rounded to Nearest half-foot	Actual Scores
31.0'	31' 1"	29.5'	29' 5"
31.0'	31' 2"	30.0'	30' 0"
31.0'	31' 2"	29.5'	29' 8"
31.5'	31' 8"	29.5'	29' 4"
31.0'	30' 9"	30.0'	29'10"
31.0'	31' 0"	29.5'	29' 8"
30.5'	30' 6"	30.0'	30' 3"
31.5'	31' 5"	30.0'	30' 1"
31.5'	31' 6"	31.0'	30' 9"
30.5'	30' 6"	29.0'	29' 3"
30.5'	30' 5"	30.5'	30' 4"
31.0'	31' 0"	29.0'	29' 2"
30.5'	30' 6"	31.5'	31' 4"
31.0'	31' 3"	31.0'	30'11"
30.5'	30' 8"	30.0'	29'11"

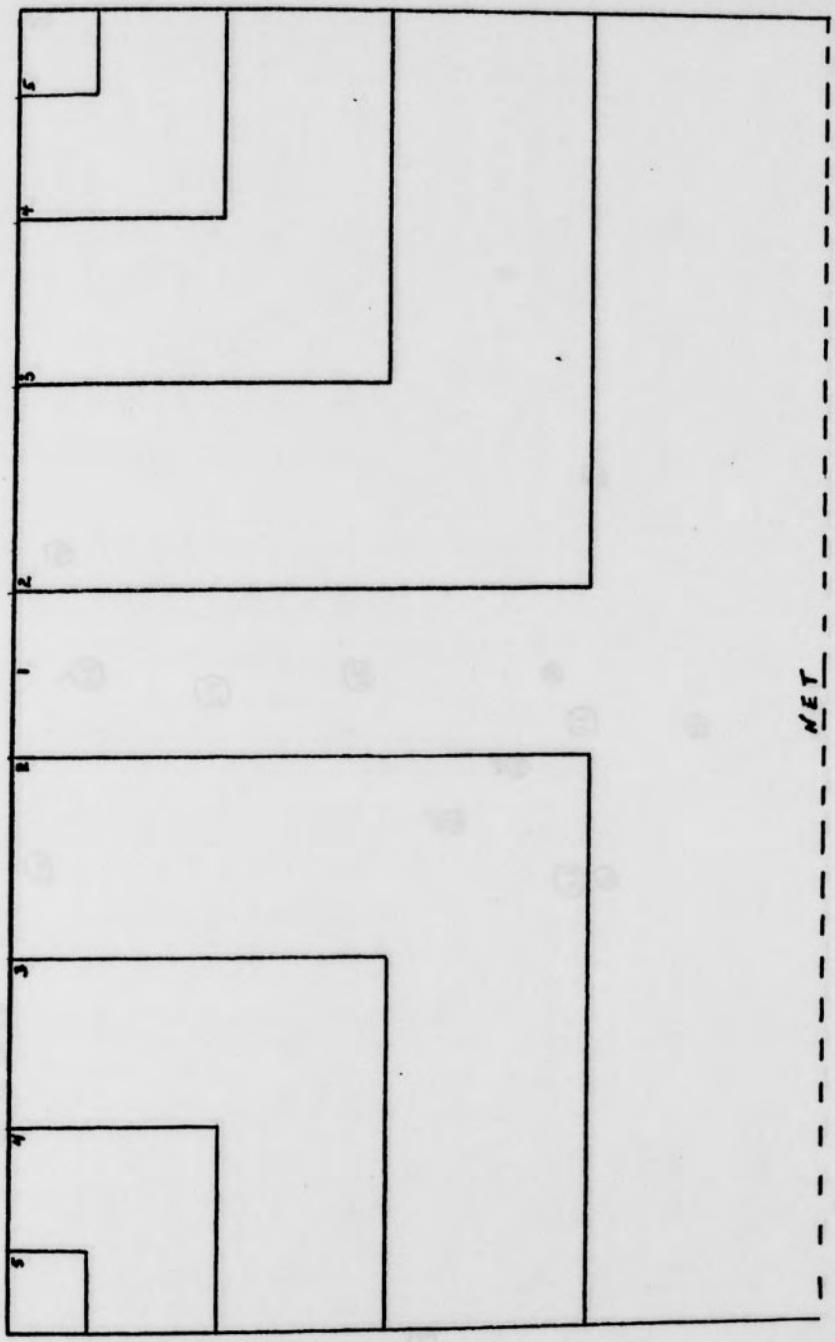
TESTING SESSION SCORES FOR SUBJECTS

	Trial	I	II		I	II		I	II		I	II		I	II		I	II		I	II		I	II		I	II	
	1	0	1	1	0	0	0	0	1	1	0	1	1	1	3	4	0	3	3	0	0	0	0	1	1	0	2	2	1	1	2
Straight approach right target	2	2	1	3	0	2	2	0	1	1	0	0	0	0	2	2	1	1	2	2	0	2	1	1	2	0	0	0	0	1	1
	3	1	0	1	0	1	1	0	0	0	2	1	3	0	0	0	3	2	5	2	0	2	0	3	3	2	1	3	2	1	3
	4	1	2	3	1	1	2	1	2	3	1	1	2	0	3	3	1	1	2	0	2	2	0	1	1	0	1	1	1	1	2
	5	1	2	3	0	1	1	1	2	3	2	0	2	0	0	0	1	0	1	3	3	6	0	2	2	0	0	1	1	0	1
	6	0	4	4	2	0	2	3	0	3	0	3	3	0	0	0	1	4	5	1	0	1	0	4	4	0	0	0	0	2	2
Straight approach left target	7	0	4	4	0	4	4	0	0	0	0	0	0	4	3	7	1	0	1	2	0	2	2	2	4	2	0	2	1	0	1
	8	0	0	0	2	4	6	3	0	3	0	5	5	1	0	1	0	1	1	0	0	0	0	5	5	0	1	1	0	0	0
	9	2	0	2	0	0	0	0	1	1	0	0	0	0	2	2	0	2	2	0	0	0	1	0	1	2	2	4	0	0	0
	10	1	2	3	2	1	3	0	0	0	2	4	6	2	3	5	3	0	3	0	3	3	2	2	4	2	2	4	3	1	4
	11	1	0	1	0	4	4	0	0	0	0	1	1	0	2	2	0	1	1	3	2	5	1	1	2	1	1	2	1	0	1
Angular approach right target	12	1	1	2	2	0	2	0	2	2	0	1	1	0	0	0	2	2	4	1	0	1	1	1	2	1	1	2	1	0	1
	13	1	1	2	1	1	2	0	0	0	0	0	0	4	0	4	2	0	2	0	0	0	4	2	6	3	0	3	2	1	3
	14	2	0	2	1	1	2	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	2	2	2	3	2	5	1	1	2
	15	0	1	1	2	2	4	0	0	0	1	2	3	2	0	2	1	0	1	1	1	2	0	4	4	0	1	1	4	2	6
	16	1	0	1	1	1	2	0	0	0	1	0	1	3	0	3	1	0	1	2	3	5	0	3	3	0	1	1	0	0	0
Angular approach left target	17	0	0	0	0	3	3	0	2	2	0	2	2	3	0	3	3	0	3	1	0	1	0	0	0	0	0	0	2	4	6
	18	0	2	2	2	0	2	1	0	1	0	1	1	0	4	4	1	0	1	1	2	3	0	2	2	1	1	2	0	0	0
	19	1	2	3	0	0	0	2	0	2	0	1	1	2	1	3	0	0	0	0	2	2	3	0	3	0	2	2	0	0	0
	20	2	0	2	2	0	2	0	1	1	0	0	0	0	3	3	0	0	0	1	0	1	1	1	2	0	2	2	0	0	0
	Total	17/23		40	18/26		44	11/12		23	9/24		33	22/26		48	21/17		38	20/19		39	18/37		55	17/20		37	20/15		35

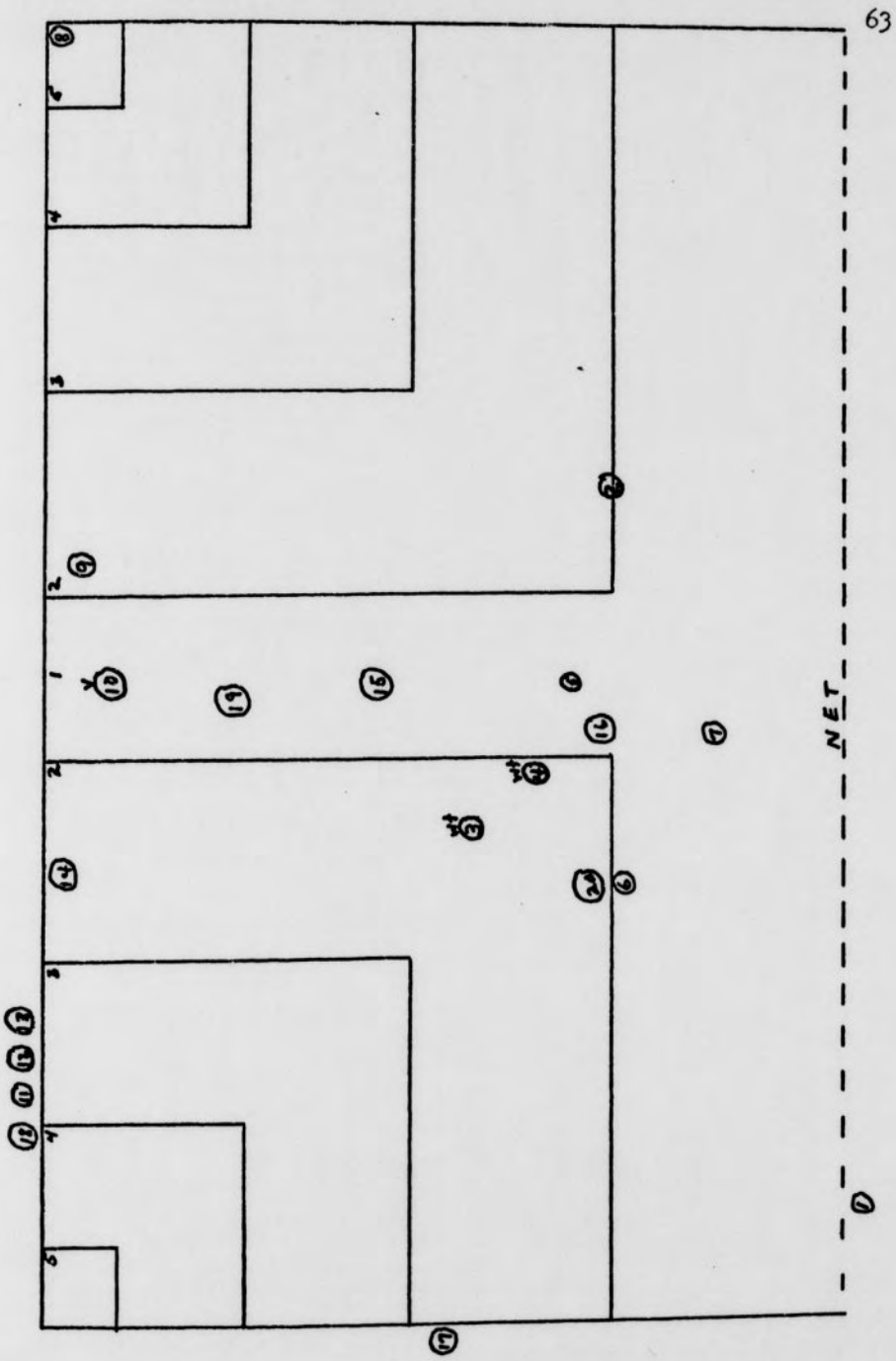
Underlined totals indicate four subjects selected for inclusion in the study.

APPENDIX D

Score Sheets



SAMPLE SCORE SHEET



SAMPLE SCORE SHEET WITH MARKINGS