THREE FORWARD FALLS IN DANCE:
A CINEMATOGRAPHIC ANALYSIS

A THESIS

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We hereby recommend that the thesis prepared under our supervision by SARAH JANE MANGELSDORF

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DEDICATION

To my parents, Mr. and Mrs. George Edward Mangelsdorf, whose love and guidance has given me encouragement throughout the years of my education

and

Jane Perry

A master teacher who first introduced me to the art of modern dance.

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CHAPTER I

ORIENTATION TO THE STUDY

Introduction

The unyielding law of gravity has long been a source of interest to man in movement. Doris Humphrey based a part of her theory concerning dance upon the principle of balance and unbalance, or fall and recovery. John Martin states of Humphrey's experiments:

> All motion, she concluded, was 'an arc between two deaths;' there was the 'death' of complete inactivity in which there was no contest with gravity, and at the other extreme was the 'death' of destruction in which gravity defeated all efforts at resistence. Obviously, the movements that were most interesting to watch were those in the sphere of danger, where destruction was being defied and at the crucial moment avoided.[1]

The collapse, or fall, has been termed a quality of movement by some authorities. Lockhart and Pease describe the collapse as:

> The release of tension in any part of the body caused it to collapse; gravity is permitted to take over. The collapse may be gradual and controlled, as in a slow fall, or it may be sudden, as in fainting.[2]

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[1]John Martin, Book of the Dance (New York: Tudor Publishing Company, 1963), p. 149.

[2]Aileene Lockhart and Esther Pease, Modern Dance (Dubuque, Iowa: Wm. C. Brown Company Publishers, 1966), p. 85.

The fall, or collapse, is used frequently in dance compositions; however, available literature on the performance of the technical aspects of this skill is incomplete and limited.

The use of film records for the analysis of physical movement has become popular in recent years, but has been oriented particularly toward sport skills. McMillan stated in her film study of the pirouette en dehor that no previous cinematographic research in the area of dance was available and that her research appeared to be a pioneer study.[1]

The need for research in dance is apparent and is summarized by Hawkins who states:

> I believe that the serious study of dance requires a continuous blending of two phases of study. One phase has to do with moving to create, and the other has to do with acquiring insight about movement and dance as art.
>
> . . . . . .
>
> . . . We should have research that gives greater insight into the effective ways of developing movement potential . . .[2]

The Committee on Research in Dance states another reason for contextual dance research which is "to establish dance as a recognized and respected academic discipline."[3]

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[1]MargeAnne Hume McMillan, "A Cinematographical Analysis of Characteristic Likenesses and Differences between Skilled, Semi-Skilled, and Non-Skilled Performances of Pirouettes," (unpublished M.A. thesis, Texas Woman's University, 1972), pp. 3-4.

[2]Alma M. Hawkins, "Dance as a Discipline," Focus on Dance IV, ed. by Nancy W. Smith (Washington, D. C.: American Association for Health, Physical Education, and Recreation, 1967), pp. 11-13.

[3]Committee on Research in Dance, Preceedings of the Preliminary Conference on Research in Dance (New York: 1968), p. 84.

Dougherty agrees with these statements concerning the expansion of research by dancers. She specifically mentions the use of cinematography as a valuable method of improving dance technique in an article appearing in Designs for Dance.[1]

It appeared that cinematographic research in the discipline of dance is limited, and that such research, as it involves dance falls, is non-existent. The investigator pursued a study of three forward falls in dance: the Swedish fall, the front slide fall, and the forward straight fall. The purpose of the study was to study the technique of these falls and through a comparative analysis suggest ideas for better methodology.

Statement of the Problem

The investigation entailed a comparative cinematographic analysis of three forward falls: the Swedish fall, the front slide fall, and the forward straight fall. The study employed an individual who was an expert (a professional dancer) in the field of dance and three female dancers who, through audition, were selected as members of the Modern Dance Tour Group of the Texas Woman's University, Denton, Texas, during the summer months of 1973.

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[1]M. Frances Dougherty, "Implications for Dance: In Research," Designs for Dance, ed. by Ruth L. Murray (Washington, D. C.: American Association for Health, Physical Education, and Recreation, 1968), pp. 24-35.

Definitions and/or Explanation of Terms

For the purpose of clarification, the following definitions and/or terms were established for use in the study:

Cinematography.--"Cinematography involves the use of the camera to record motion for subsequent kinesiologic analysis."[1]

Swedish Fall.--

The Swedish fall begins in a standing position. The dancer falls forward landing on the hands with extended elbows, then flexion of the elbows lowers the chest toward the floor. As the fall is executed one hip is hyperextended.[2]

Front Slide Fall.--

The front slide fall begins with a plié and a forward reach of the arms toward the floor. After the hands contact the floor, the flexion of the elbows lowers the diaphragm to the floor. The hands pull to the rear causing the body to slide forward on the floor.[3]

Forward Straight Fall.--

The forward straight fall begins in a standing position. The dancer falls forward, keeping the body in a straight line, and lands on the hands with extended elbows. The elbows flex to lower the body in a straight line to the floor.[4]

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[1]Gene A. Logan and Wayne C. McKinney, Kinesiology (Dubuque, Iowa: Wm. C. Brown Company, 1970), p. 195.

[2]Newton C. Loken and Robert J. Willoughby, Complete Book of Gymnastics (New Jersey: Prentice-Hall, Inc., 1967), p. 188.

[3]Elizabeth Sherbon, On the Count of One (Palo Alto, California: National Press Books, 1968), p. 102.

[4]Jack Cole, Class Notes for Dance Workshop, Texas Woman's University, June 28, 1971-July 7, 1971.

Expert.--An expert dancer is an individual who is currently, and has performed as a member of a professional dance company for three years.

Skilled dancers.--Skilled dancers are individuals who, through auditions, were selected as members of the Modern Dance Tour Group of the Texas Woman's University, Denton, Texas.

Purpose of the Study

The purpose of this investigation was to contribute to dance research by completing a comparative analysis of three forward falls from cinematographic data. Specifically, the investigator examined: (1) the body alignment from head to ankle during the falls, (2) the angle of the body at impact, (3) the placement of the hands on the ground, and (4) the action of the arms before and after contact with the ground.

Delimitations of the Study

The present study was subject to the following limitations:

1. Ability of the expert dancer to execute the skills in an expert manner.
2. Participation of three skilled female dancers from the Modern Dance Tour Group of the Texas Woman's University, Denton, Texas.

3. Filming simultaneous front and side views of the Swedish fall, the front slide fall, and the forward straight fall.
4. The equipment used in filming and analysis of the film.
5. Validity and reliability of the analysis of tracings and point and line drawings of selected frames from the films of each subject.

CHAPTER II

RELATED LITERATURE

A survey of the literature disclosed that the present study did not duplicate any previous investigation with respect to scope and content. A review of the studies which were related to the present study are presented.

McMillan[1] undertook a study to determine through cinematography, the similarities and the differences among skilled, semi-skilled, and non-skilled performances of the *pirouette en dehors*. The execution of this technique was divided into three phases: (1) the preparation, (2) the turn, and (3) the conclusion.

The subjects selected were nine individuals residing in the Dallas-Fort Worth metropolitan area. The non-skilled group consisted of three members of a beginning ballet class with no previous formal ballet training. The three subjects in the semi-skilled group were members of the Texas Woman's University Modern Dance Group with no formal ballet training during the past ten years. Three members of the Fort Worth Ballet Company formed the skilled group.

The subjects were filmed with a 16mm Bell and Howell HR 70 movie camera. Both a frontal and a sagittal view were

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[1]McMillan, "A Cinematographic Analysis of the *Pirouette*."

made with a normal one inch lens at a distance of ten feet. Each subject performed three *pirouettes en dehors* from fourth position in each of the two views. A large electric clock and a yard stick were included in the filmed area.

A Dagmar Super Microfilm reader was used to view the film frame by frame. Tracings and point-and-line drawings were made and analyzed to determine further similarities and differences of the subjects.

After examining the tracings and drawings the investigator found that in Phase I, movements by all the subjects were more similar than different. The skill levels did display a difference in the size of the movements and in the amount of time elapsed. Phase II indicated more different movements than similar ones. The differences were visible in "spotting," arm positioning, right foot placement, and acceleration during the turn. Phase III revealed more differences than similarities between the skill levels. The skilled group differed with respect to the placement of the right foot on the floor following the *passé* movement, the arm positions, and the ending stance. It was concluded that while most of the subjects moved to the right side on the floor the skilled group moved more to the left side on the floor.

Beck[1] undertook a study to determine through cinematography, foot action during the performance of a vertical jump. The sub-problem of this study was to determine the relationship of length of toes to the elevation obtained from the vertical jump. Sixty semi-skilled dancers from the Texas Woman's University, Denton, Texas, were used to form a normal curve for the selection of nine subjects to be filmed.

A Redlake Locam camera set at 170 frames per second and placed at ground level approximately ten feet from the subjects was used to record the jump. A one foot ruler was visible in the film to provide the known measurement for subsequent scaling. Front and side views were photographed of each subject. Each subject performed a vertical jump by standing with the feet parallel, about five inches apart, the hands placed on the hips, and at a designated signal performed a demi-plié and jumped as high as possible.

In regard to the sub-problem, a Lange skinfold caliper was used to collect the data on the length of the toes. The measurements were made twice with a two day interval. The test-retest reliability for each toe was: first toe, .916, second toe, .926, third toe, .940, fourth toe, .940, and fifth toe, .922.

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[1]Virginia Beck, "A Film Analysis of Foot Action in Relation to Elevation Obtained in a Vertical Jump as Performed by Semi-Skilled Dancers" (Unpublished M. A. thesis, Texas Woman's University, 1973).

The nine subjects were divided into three groups classified as: low performers of the vertical jump, average performers of the vertical jump, and high performers of the vertical jump. A Recordak MPE-1 film reader was used to view the film frame by frame from the initial upward movement of the heel until there was complete loss of ground contact. A Pearson Product Moment Correlation was calculated between toe length and obtained elevation in the performance of the vertical jump.

In conclusion, Beck determined that 67 per cent of the subjects filmed utilized the second toe for final impetus in the preparation to leave the ground for the vertical jump. There was a difference in time in seconds during the preparation. The low performers took a longer amount of time for the preparation than the average and high performers, while there appeared to be no difference in time for the preparation between the high and average performers of the vertical jump. All nine subjects increased the velocities of the vertical jump during the final stages of take-off, and had a progressive foot action from heel, to malleolus, to the toes. All subjects had a steady increased acceleration in the foot throughout the jump, and accelerated the foot as the toes gave the final impetus for the vertical jump. The results of the Pearson Product Moment Correlation on the sub-problem

showed no significant correlation ($r < .21$) between the length of any toe and obtained elevation in the performance of the vertical jump.

Buckman[1] conducted a study to determine through cinematography, the performance of the tour jeté by skilled, semi-skilled, and non-skilled subjects. The investigator divided the execution of this technique into seven phases: (1) the preparation, (2) the take-off position, (3) the initiation of take-off, (4) the take-off, (5) the apex of the jump, (6) the descent, and (7) the landing.

The nine subjects were selected individuals attending the Texas Woman's University, Denton, Texas, or residing in the Dallas metropolitan area. The skilled subjects were members of the Dallas Civic Ballet. The semi-skilled subjects were members of the Modern Dance Tour Group of the Texas Woman's University and enrolled in the intermediate ballet course at the University. The non-skilled group were individuals attending the Texas Woman's University, with no previous dance experience, and enrolled in the beginning ballet course during the 1972-1973 academic year. The subjects were chosen on the basis of six judges' ratings.

A sixteen millimeter Bell and Howell HR 70 movie camera with Kodak Black and White Tri X reversal film was

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[1]Susan Donna Buckman, "A Cinematographic Analysis of the Tour Jeté" (Unpublished M. A. thesis, Texas Woman's University, 1974).

used to film the performances of the subjects. The camera was placed at twenty feet from the subjects to view a nine foot wide area with a known measurement and a clock exposed in the filmed area. The camera was set at a speed of sixty frames per second with a ten millimeter lens.

A Recordak MPE-1 Film Reader was used to view the film frame by frame. The best side view was selected upon the basis of the criteria established for the rating scale. Tracings of the entire body were made from seven selected frames. Each of the tracings for the three members of each level of skill was superimposed to make three groups of data.

Based upon the results of the tracings the investigator drew several conclusions with respect to the performance of the tour jeté. In Phase one, the skilled performers showed straight leg extensions and plantar flexed ankle extensions. The semi-skilled group displayed relaxed leg extensions with dorsi flexed ankle extensions, and the non-skilled performers exhibited bent leg extensions and dorsi flexed ankle extensions. All three groups held their arms in second position. Phase two showed the angle of the plié for the skilled group to be greater than the back leg, while the semi-skilled had equal angles and the non-skilled performers displayed a greater front leg angle. The body angles differed also between the groups with the skilled group leaning toward the back, the semi-skilled in an erect position, and the non-skilled subjects

leaning forward. The arms displayed an extension of less than ninety degrees for the skilled performers, but greater than a ninety degree extension in the semi-skilled and non-skilled groups. In Phase three, the angle of plié was slight for the skilled and semi-skilled but deep for the non-skilled subjects. All performers held an erect body angle while the angle between the thrusting leg and the supporting leg for the skilled group was approximately ninety degrees, the other groups showed less than ninety degrees. Rotation of the body had started for the skilled and semi-skilled participants. The arms were en avant for the skilled, at the side for the semi-skilled, and varied for the non-skilled. In Phase four, the body angle and the angle between the thrusted leg and the supporting leg remained the same as in Phase three. The skilled and semi-skilled subjects had completed a quarter turn in rotation while the non-skilled group was beginning to rotate. The arms for the skilled group had moved to en haute while the other groups had varied arm positions, Phase five showed an approximate forty-five degree angle for the skilled group in spinal extension as the other displayed less than a forty-five degree angle. The skilled group held the legs in first position, the body erect, and completed the rotation. The semi-skilled and the non-skilled had a forward body angle, the legs spread, and the rotations were incomplete. All three groups had the arms in en haute

position. The skilled performers in Phase six, the descent, displayed the angle between the legs at less than ninety degrees, and erect body position, and the arms in arabesque position. The other two groups had less than a seventy degree angle between the legs, a forward body angle, and varied arm positions. Phase seven, the landing, showed a slight angle of plié for all of the groups. The angle between the legs was approximately ninety degrees for the skilled and semi-skilled, but less for the non-skilled group. The body angle was erect for the skilled performers and forward for the other two groups. Arabesque position of the arms remained for the skilled group as the others varied.

Youle[1] conducted a study of the toe-heel action during ground contact for women runners. Specifically, the investigator sought to determine the relationship between the toe-heel action and each of the following events: (1) the mile run, (2) the 880 yard run, (3) the 440 yard dash, (4) the 200 yard dash, and (5) the 100 yard dash. The investigator collected film data of fifteen national level women runners competing in each of the events during the actual competition.

Youle collected the film data by means of a 16mm Bell and Howell HR 70 movie camera. The camera was placed on the

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[1]Tyann Youle, "A Film Analysis of Toe-Heel Action During Ground Contact of Women Runners" (Unpublished M.A. thesis, Texas Woman's University, 1971).

ground at a right angle to the runners and nine feet from the track edge. After the films were developed, they were projected for initial viewing by means of a 16mm analyzer projector. The film image of the runners' feet was projected onto paper and plotted frame by frame beginning with the frame of the foot's initial contact with the ground and ending when the foot left the ground.

Youle found that the type of initial ground contact varied with the type of running event. In the 100 and 200 yard dashes the majority of the runners established initial ground contact with the ball of the foot. Initial contact in the 440 yard dash was almost evenly divided between the ball of the foot and the flat-footed contact. In the 880 yard and the mile runs, the majority of the runners made initial contact with the ground with the heel of the foot. Youle found also that the number of frames and time of ground contact varied with the event, being greatest in the mile run and shortest in the 100 and 200 yard dashes.

Youle concluded that a relationship exists between toe-heel action during ground contact and running speed in women runners. This relationship is that as the distance increases the duration of ground contact increases. The initial ground contact progresses from the ball of the foot in the sprints to the back of the foot as the length of the race increases.

Heusner[1] undertook a study of the racing dive in swimming in terms of basic mechanical principles involved. He developed a mathematical expression to describe the time required to dive, glide, and swim the first length of any race, and he determined also the optimum angles of take-off for various personal characteristics and for specific race conditions.

Seventeen highly skilled college swimmers were subjects in this cinematographic study. All pictures were taken from the side at sixty-four frames per second. The camera was placed over one end of the starting line at the height of the starting block from the water and at a constant distance of thirty feet from the subject. Each subject was instructed to grasp the gutter with one hand and to tuck the body for a front push-off. At a predetermined signal, the subject pushed off as hard as possible, and remained in a prone glide position on the surface of the water for a ten second time period. Five trials were given to reach the average distance and was measured to the nearest one-quarter of a foot. The subjects than swam one length of a standard seventy-five foot pool using their normal racing stroke. Cinematographic

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[1]William W. Heusner, "Theoretical Specifications for the Racing Dive: Optimum Angle of Take-Off," The Research Quarterly, Vol. XXX, No. 1 (1959), pp. 25-37.

recordings of each start were taken in addition to official stopwatch times for each seventy-five foot race.

Eleven variables resulted from the data collected and were arranged in a mathematical expression. Additional data were collected on each subject to permit evaluation of these same variables. He then compared the times computed from the equation and the times measured with the stopwatches. In addition, a coefficient of validity was computed between the measured times and the computed times. He found a validity of .975 which represented a high degree of relationship between the two methods of estimating the true time of a twenty-five yard race.

In order to put the results of this study into a useable form for any individual, reasonable minimum, average, the maximum values were determined for each of the factors used in the equation. This yielded a means of determining the optimum angle of take-off. All of the variables except the constant acceleration caused by gravity affected the optimum angle. The optimum angle of take-off for the average competitor under normal conditions was found to be thirteen degrees.

Heusner attempted to determine the effect that diving at other than the optimum angle would have upon a swimmer's time. He substituted all the variables which would increase the angle of take-off and similarly,

substituting the values which would decrease the angle of take-off. The angles of twenty-one degrees and six degrees were chosen as maximum limits because they represented the range of take-off angles observed previously in motion pictures. The results showed that by varying the angle from thirteen degrees the swimmer could lose between one-tenth and two-tenths of a second over the twenty-five yard course.

Giradin and Hanson[1] undertook a study to determine the relationship between the ability to perform eleven tumbling skills and the ability to diagnose errors of execution in the performance of the same skills. Thirty-two male junior and senior physical education majors enrolled at the University of Maryland volunteered to serve as subjects. The subjects had completed an upper-divisional course in kinesiology and an eight week course in gymnastics.

An information test of tumbling skills was employed to determine whether an understanding of the mechanics of the skills was important to the ability to diagnose errors in performance. The reliability of the sixty-four item true-false test was established by the test-retest method upon completion of the course in gymnastics. Content validity was established

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[1]Yvan Giradin and Dale Hanson, "Relationship Between Abilities to Perform Tumbling Skills and Ability to Diagnose Performance Errors," The Research Quarterly, XXXVIII, (1967), pp. 556-561.

through consultation with the instructor of the gymnastics class and through documentary analysis of textbooks.

A 16mm camera was used to film the subjects performing the eleven skills at a speed of twenty-four frames per second. The film was viewed by three judges selected according to the following criteria: (1) individual skill in performance, (2) experience in teaching tumbling skills, and (3) experience as a judge for gymnastic meets. Each judge rated the performance of each skill on a ten-point rating scale. The total score for each subject was the average of the judges's ratings. Intercorrelations on the judges' ratings were computed.

Thirty-two subjects diagnosed the errors of the execution of tumbling skills as performed by selected tumblers. The three judges evaluated the performances of the same tumblers until they reached agreement upon the errors of the performance. The subjects viewed each skill five times and listed all the errors they recognized. Their ability to diagnose the errors in the performance was evaluated by the following: (1) agreement with the judges, (2) errors not listed by the judges, and (3) incorrect errors which were listed.

Giradin and Hanson were able to draw the following conclusions:

The ability to diagnose performance errors in eleven specific tumbling skills is related to the ability to perform these same skills.

Knowledge of the mechanics of execution for eleven tumbling skills is related to the ability to diagnose performance errors in these same skills, but, knowledge does not relate significantly with the ability to perform.

CHAPTER III

METHODS AND PROCEDURES

The general purpose of the investigation was to study, through cinematography, the technique of the performance of the Swedish fall, the front slide fall, and the forward straight fall. The study entailed a comparative cinematographic analysis of an expert performance and three skilled performances of the three forward falls. Specifically, the investigator examined: (1) the body alignment from head to ankle during the falls, (2) the angle of the body at impact, (3) the placement of the hands on the ground, and (4) the action of the arms before and after contact with the ground.

This chapter contains the methods and procedures used to attain the purpose of this study. Included are preliminary procedures, selection and description of the subjects, procedures followed in filming the skills, procedures followed in analyzing the skills, and preparation of the final written report.

PRELIMINARY PROCEDURES

A pilot study was conducted using available equipment at the Texas Woman's University, to determine the procedures

to be followed during the filming of the subjects. It was decided, upon the basis of the results, to use a sixteen millimeter Bell and Howell HR 70 movie camera. This camera produced a picture with sufficient detail for analysis. Seven anatomical reference points were chosen to be marked: the coracoid process, the olecranon, the ulnar styloid process, the malleolus, the knee axis, the greater trochanter, and the xiphoid process.

Permission to use the equipment and facilities required by the study was secured from the Dean of the College of Health, Physical Education, and Recreation at the Texas Woman's University, Denton, Texas. The outline of the proposed study was developed and approved by the members of the thesis committee. In August, 1973, the completed Tentative Outline was presented at a Graduate Seminar. A prospectus of the approved study was filed in the office of the Dean of Graduate Studies at the Texas Woman's University, Denton, Texas.

SELECTION OF THE SUBJECTS

The subjects selected for the study were four individuals residing in Denton, Texas. Three of the subjects were enrolled in the Texas Woman's University and were members of the Modern Dance Tour Group. The fourth subject was a member of the dance faculty in the College of Health, Physical Education, and Recreation.

Criteria were established for the selection of the subjects by the investigator based upon the definitions of the Swedish fall, the front slide fall, and the straight forward fall. Three judges who were faculty members of the Texas Woman's University Dance Department selected the skilled subjects and the thesis committee selected the expert on the basis of her professional career.

The investigator prepared, in conjunction with the judges, a ten point rating scale for the judges to use during the selection of the subjects. The subjects were rated from one to ten on this scale, with ten equalling excellence. The scale included five points for each of the falls. The Swedish fall included: (1) a fall forward landing with the arms straight, then flexing to lower the body, (2) a hyperextension of the hip as the fall begins, (3) smooth and controlled movement during the fall, (4) a well arched back, (5) extension of the leg as high as possible with the chest close to the floor. The front slide fall included: (1) a plié as the body bends forward reaching with the arms, (2) a landing on the hands with the elbows extended then flexing to bring diaphragm to the floor, (3) smooth and controlled movement during the fall, (4) a well arched back, (5) a pulling back with the arms to slide the torso on the floor. The forward straight fall included the following items: (1) a straight body alignment during the fall, (2) a landing

on the hands with extended elbows then flexing to lower the body, (3) smooth and controlled movement during the fall, (4) a straight body close to the floor at the conclusion of the fall, (5) a landing with the feet parallel and the toes flexed. An example of the scale may be found in the appendix. Face validity of the scale was assumed.

The scores of the subjects given by each judge were treated by averaging the scores for each subject. The three dancers obtaining the highest scores for all three falls were selected and served as subjects for the study.

PROCEDURES FOLLOWED IN FILMING THE SKILL

Two sixteen millimeter Bell and Howell HR 70 movie cameras were employed for the study and placed at right angles to each other. The front camera was placed at a distance of fifteen feet from the starting point of the subject, while the lateral camera was set at thirty feet away from the subject. The cameras were powered by a hand wound clock-work motor which was wound after the performance of each fall.

Kodak Black and White Tri-X reversal Film which was perforated on both edges was used in the cameras. This type of film was a high speed film that could be used successfully in low-level illumination. The film was run at sixty-four frames per second. Producers' Services, Incorporated, Dallas, Texas, developed the film.

The subjects were filmed in Dance Studio 21 of the College of Health, Physical Education, and Recreation Building at the Texas Woman's University, Denton, Texas. The studio was selected for its convenience, adequate lighting and large wall space for suitable background. Regular classroom light used in conjunction with two auxilliary flood lights supplied the illumination. The flood lights were elevated to a height of five feet by tripods and situated on either side of the filming area at a distance of ten feet in front of the dancers.

The dancers wore black leotards and tights. Pres-a-Ply Permanent Labels cut in 1/2 inch squares were used to mark the seven anatomical reference points. The labels were easy to apply and reflected the light sufficiently.

Each subject was allowed sufficient time to warm-up and then perform two practice trials for each fall to insure that each fall could be completed in the viewing area of both cameras. The Swedish fall, the front slide fall, and the forward straight fall were performed three times by each dancer in random order to prevent tiring on the part of the subjects.

The lateral and front views of each dancer were filmed through twenty-five millimeter lenses on the cameras. The aperature of both lenses was set at an F-stop between 1.9 and 2.0 for all performances of the three falls. An

electric clock with a one second sweep hand was included in the viewing area of both cameras to aid in the analysis of the film. The standing heights of the subjects were used as the known measurements.

PROCEDURES FOLLOWED IN ANALYZING THE SKILL

The film was viewed frame by frame by means of a Recordak MPE-1 Film Reader and the best combined front and lateral view of each subject was selected on the basis of the criteria established for the rating scale used to select the subjects, (refer to page 23). The frontal view was chosen to yield the data of the angle of the arms at impact and the placement of the hands.

The investigator employed a Vanguard Motion Analyzer on the lateral view of each subject. The data were key punched and serted into an IBM 320/50 computer. The program used was the "Bates C" Program for Film Data. This program yielded the angles of selected body parts during the falls and the velocities of these parts. Analysis of the data involved the transference of the data onto graphs for ease of interpretation. From the graphs a comparison of the four subjects was made also and is described in Chapter IV.

PREPARATION OF THE FINAL WRITTEN REPORT

The investigator organized and presented the data in appropriate tables and illustrations. The data were

summarized and a conclusion was drawn. A final written report of the study was developed and included implications of the findings and recommendations for further studies. A bibliography and an appendix were added in order to complete the written report.

CHAPTER IV

ANALYSIS OF DATA AND RESULTS

Introduction

In Chapter IV, the results of the study are presented. The purpose of the investigation was to contribute to dance research by completing a comparative analysis of three forward falls from cinematographic data. From the filmed performance of an expert and three skilled dancers executing the Swedish fall, the front slide fall, and the forward straight fall, data were collected.

Two sixteen millimeter Bell and Howell HR 70 movie cameras were used to film the subjects. Studio 21 of the College of Health, Physical Education, and Recreation at the Texas Woman's University was the location chosen for the filming because the studio afforded sufficient illumination and background space.

The film was viewed frame-by-frame on a Recordak MPE-1 and the front and lateral views meeting the criteria were selected for analysis. A Vanguard Motion Analyzer was employed in analyzing the data of the lateral view. Every tenth frame was selected for analysis. This information was computed on an IBM 320/50 computer utilizing the "Bates C"

Program for Film Data. Point and line drawings were made from selected frames to depict the lateral view of body alignment during the falls.

The results of the analysis are organized according to the specific fall and under each fall the following topics are discussed: (1) the body alignment during the fall, (2) the angle of the body at impact, (3) the placement of the hands on the ground, and (4) the action of the arms before and after contact with the ground.

Presentation of the Data

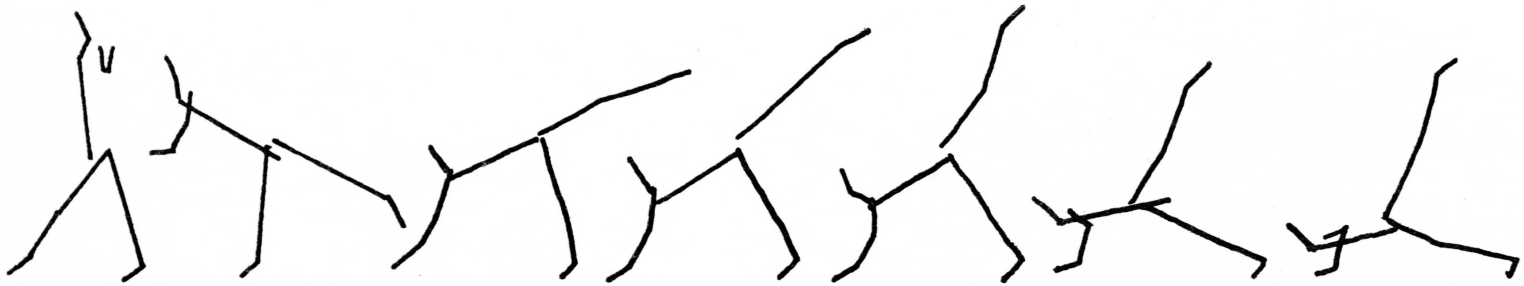
Swedish Fall

In Illustrations 1 and 2 the point and line drawings of the selected frames depicting the body alignment for the Swedish fall are presented. The frames chosen from which the stick figures were drawn were selected arbitrarily in order to show the clearest profile of the trunk during the fall.

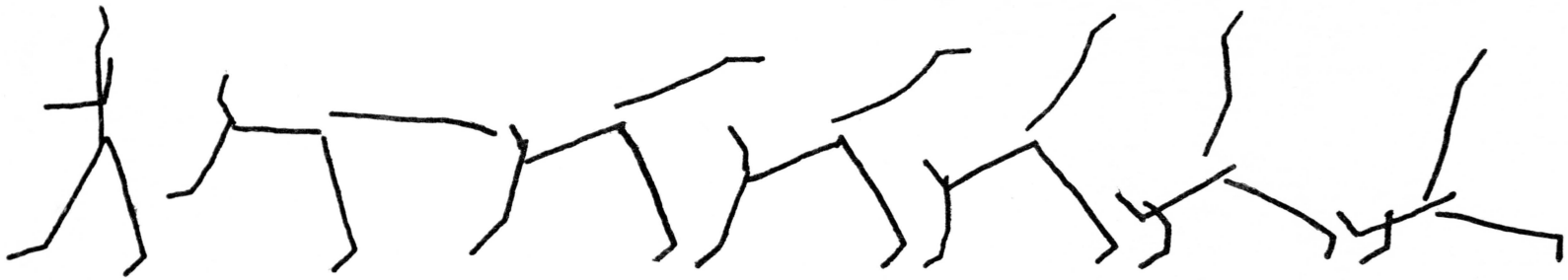
The body alignment for the four subjects was similar throughout the duration of the Swedish fall. All of the subjects began in an upright position and, as the trunk of the body leaned forward, the hyperextension of the hip began. The arms reached forward in a straight manner toward the floor as the trunk continued to increase its angulation. At impact, the elbows were relatively straight from the

ILLUSTRATION I

BODY ALIGNMENT DURING THE SWEDISH FALL



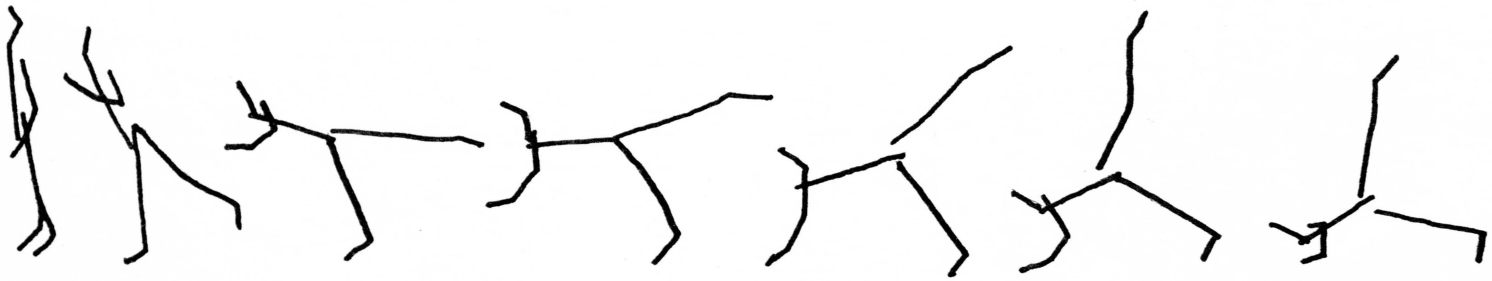
Subject I



Subject II

ILLUSTRATION II

BODY ALIGNMENT DURING THE SWEDISH FALL



Subject III

Subject IV

lateral view and increased in flexion as the body lowered to the floor. The rearward leg remained lifted and continued to increase in height until the conclusion of the fall.

Graphs one, two, three, and four display the angle of the trunk, the left lower arm, the left upper arm, the left hand, and the left thigh for each subject performing the Swedish fall. The left side of the body was chosen because of its proximity to the camera. The body alignment of subject one progressed from an angle of 93.15 degrees down to an angle of 190.00 degrees at impact. Subject two had a body angle from 91.35 degrees to 185.80 degrees at impact while the alignment for subject three moved from an angle of 92.00 degrees to an angle of 177.25 degrees, and the body alignment for subject four progressed from an angle of 96.75 degrees down to an angle of 206.95 degrees.

In Table I, the angles of inclination of the five anatomical parts at the point of impact in the Swedish fall are presented. The angles were measured in a counter clockwise direction from horizontal.

As the data showed, subject four, the expert, had the greatest trunk angle at impact, 206.95 degrees. Subject three had the least angle of 177.25 degrees, while subject one displayed an angle of 190.00 degrees and subject two had a trunk angle of 185.80 degrees at impact. The data disclosed also that the greater trunk angle the subjects

ILLUSTRATION 3

ANGLE OF INCLINATION OF SWEDISH FALL

Subject I

Key:

Trunk _ _ _ _ _
Left Thigh ___.____.____.____
Left Upper Arm _____

Left Lower Arm____ __ ____ __
Left Hand .....

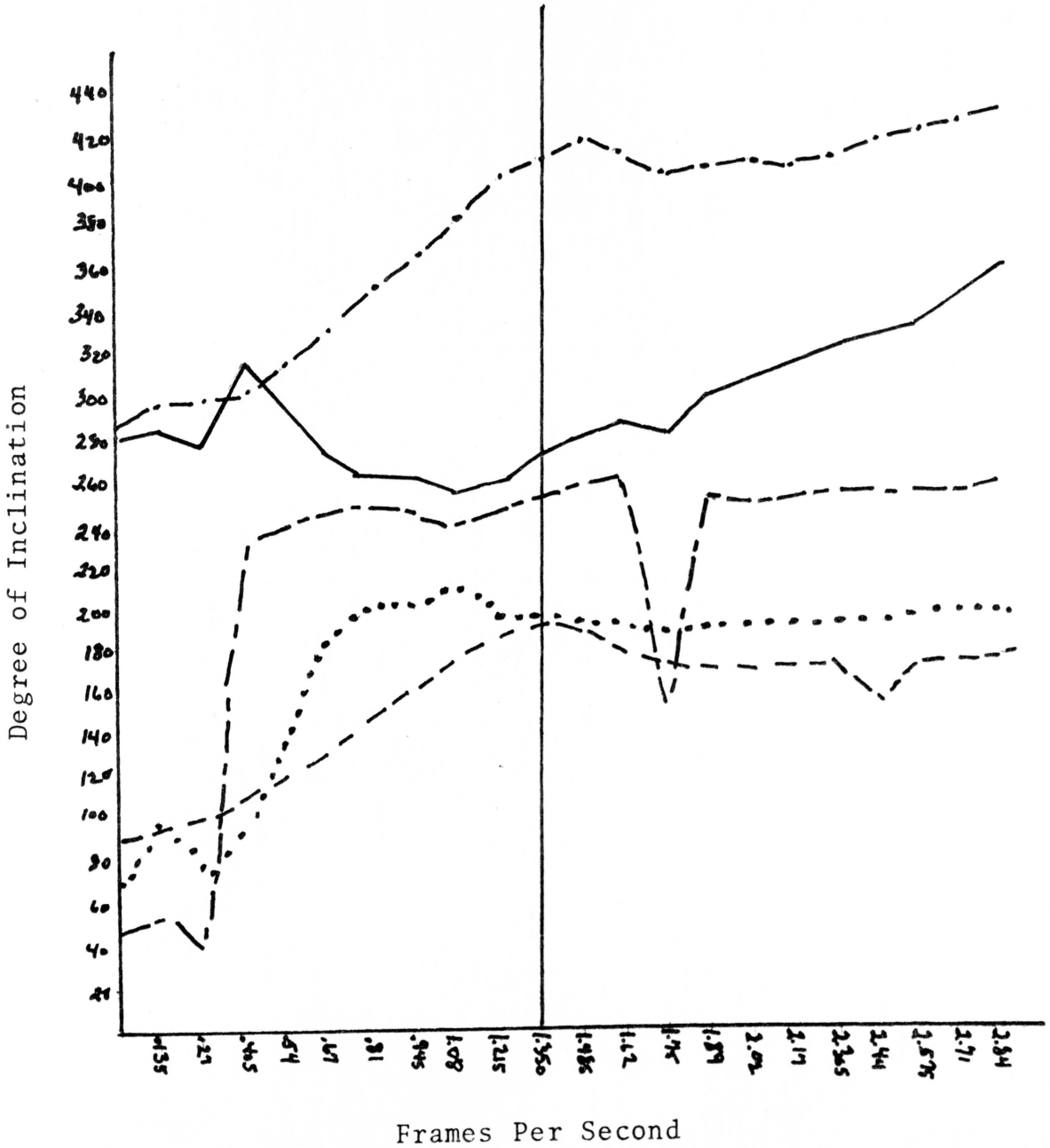


ILLUSTRATION 4

ANGLE OF INCLINATION OF SWEDISH FALL

Subject 2

Key:

Trunk _ _ _ _ _
Left Thigh ____.____.____.____
Left Upper Arm _____

Left Lower Arm ____ _ ____ _ ____
Left Hand.....

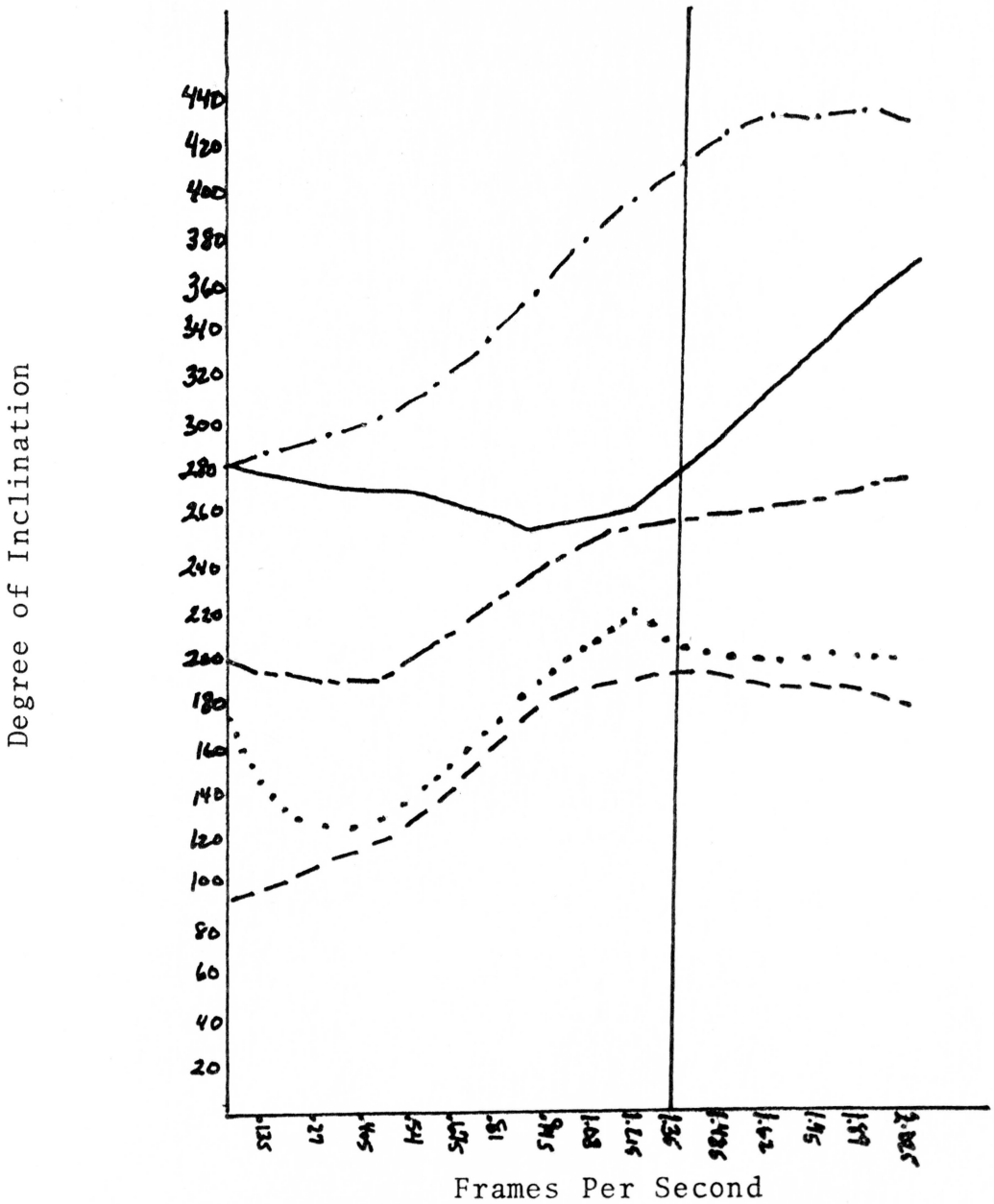


ILLUSTRATION 5

ANGLE OF INCLINATION OF SWEDISH FALL

Subject 3

Key:
Trunk _ _ _ _ _
Left Thigh___.___.___.___
Left Upper Arm_____
Left Lower Arm___ _ ___ _ ___
Left Hand.....

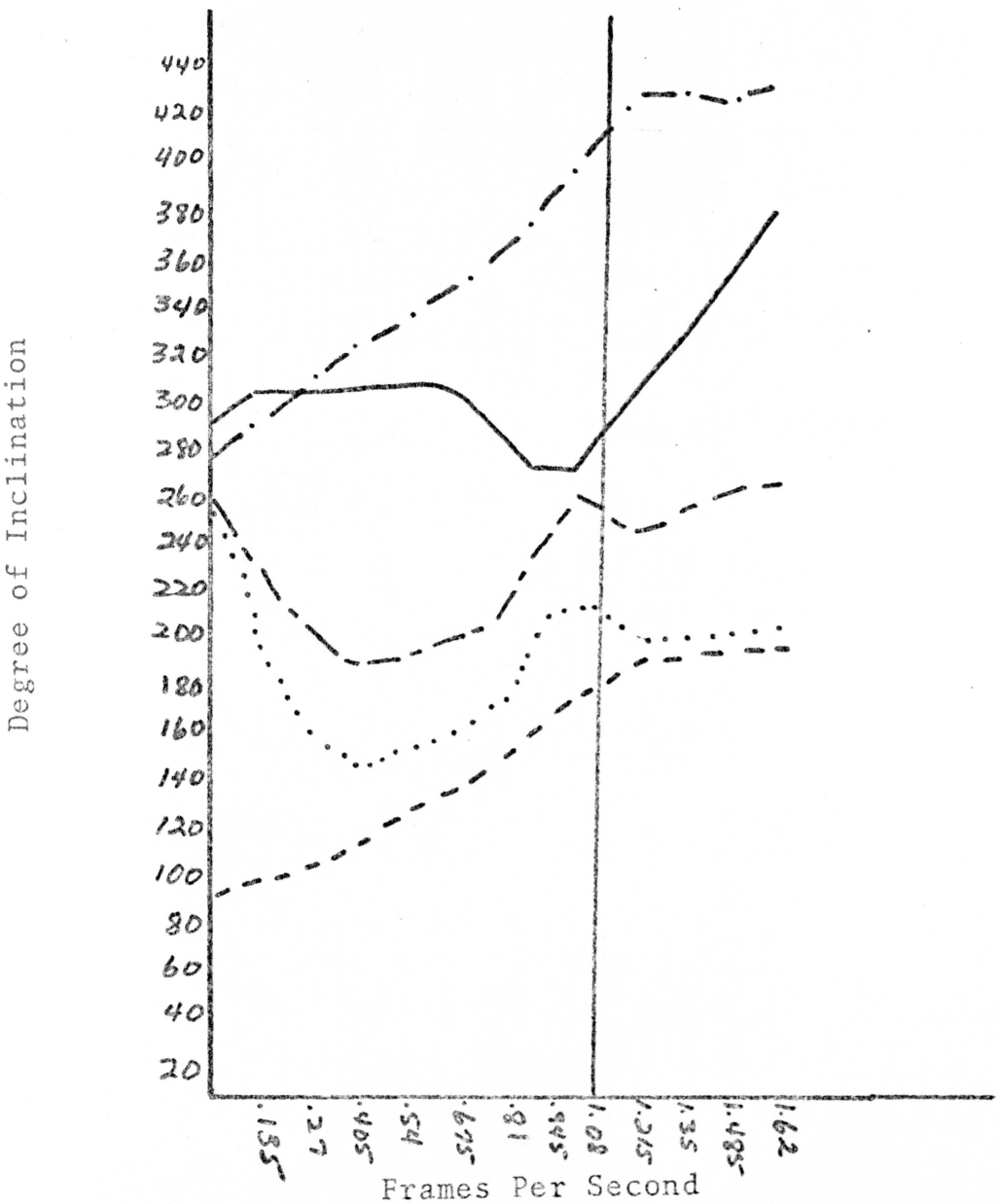


ILLUSTRATION 6

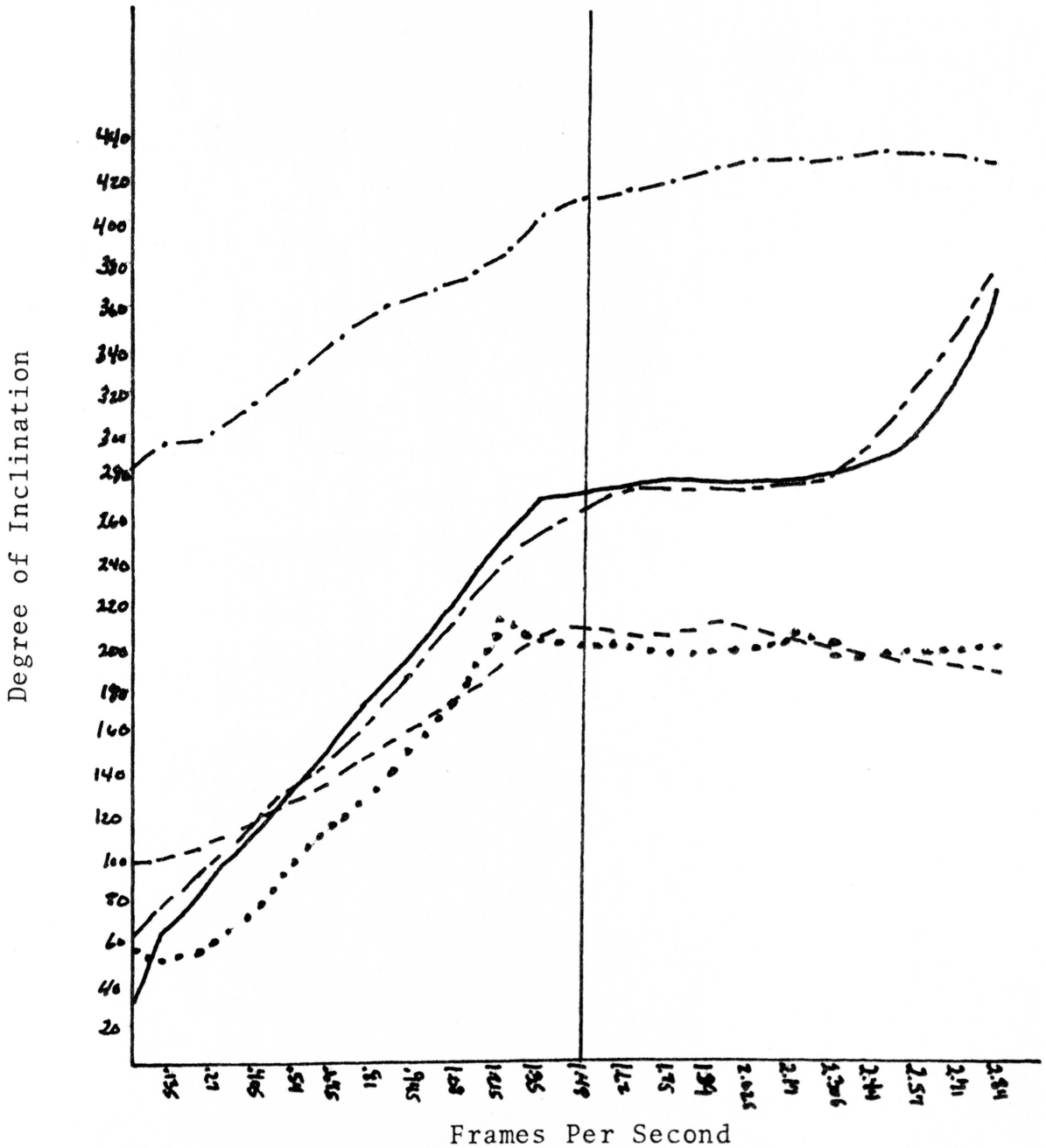
ANGLE OF INCLINATION OF SWEDISH FALL

Subject 4

Key:

Trunk _ _ _ _
Left Thigh ___.___.___.___
Left Upper Arm _____

Left Lower Arm ____ _ ____ _ ____
Left Hand .....



maintained at impact the greater hyperextension of the hip of the elevated leg resulted.

TABLE I

ANGLES OF INCLINATION AT IMPACT IN THE SWEDISH FALL

Subjects	1	2	3	4
Angles of				
Trunk	190.00	185.80	177.25	206.95
Left Thigh	59.49	48.65	42.34	54.16
Left Lower Arm	250.00	249.27	251.08	264.92
Left Upper Arm	273.01	270.00	266.19	264.56
Left Hand	191.31	196.19	209.25	197.88

The following illustration shows the placement of the hands on the floor at impact for the four subjects executing the Swedish fall. The hands were placed directly forward with the fingers slightly spread and the arms at an outward angle from the shoulders. The hands retained this position during the completion of the fall. The illustration depicts the front view of the arms at impact. The data are summarized in Table II.

The angles of the arms were measured by a protractor. These data disclose that the arms were spread outwardly from the shoulders at approximate angles between twenty and twenty-five degrees to the floor, and displayed elbow flexion between 145 and 160 degrees.

ILLUSTRATION 7

FRONT VIEW OF ARMS AT IMPACT OF SWEDISH FALL

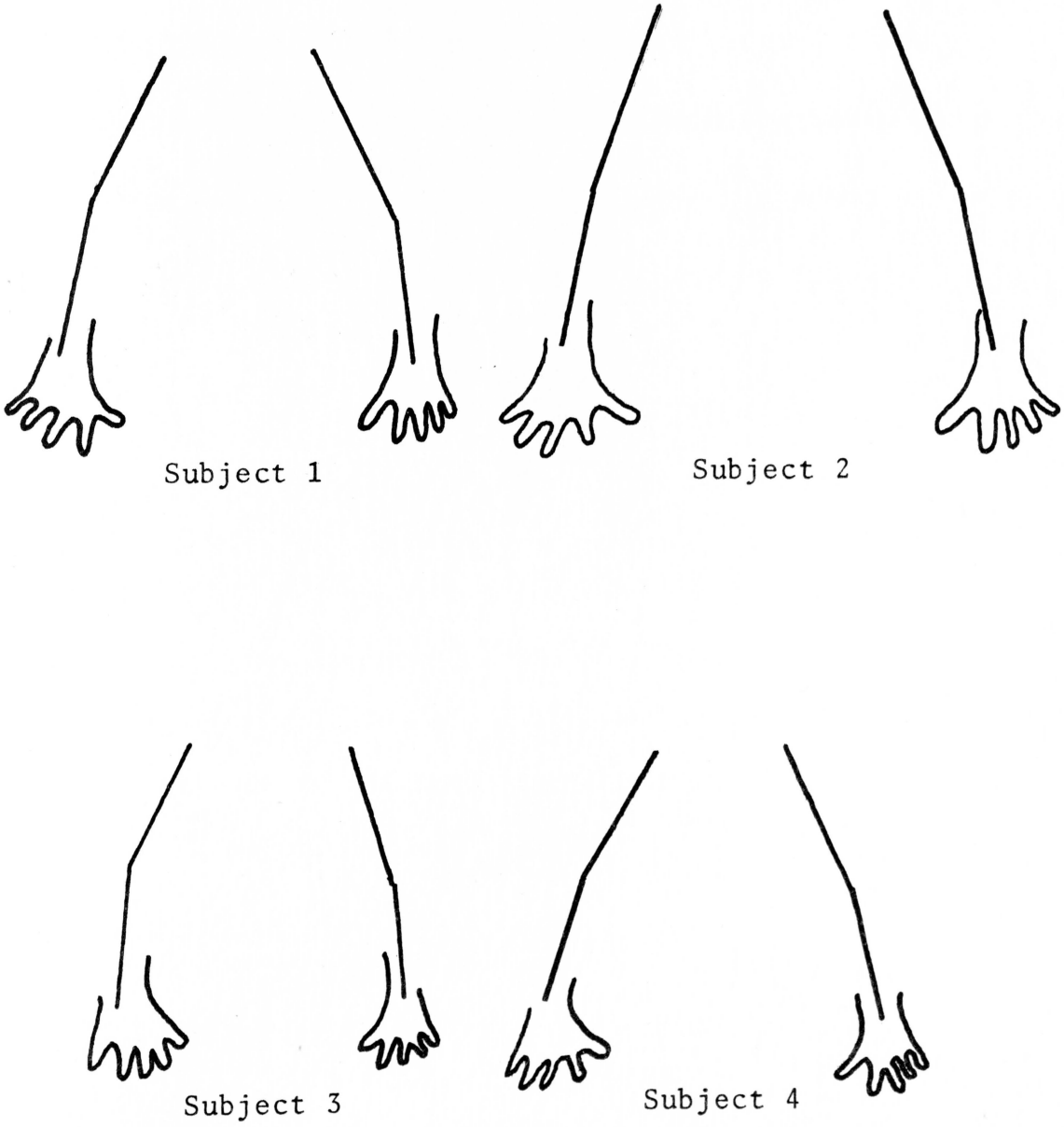


TABLE II

ANGLES OF THE ARMS AT IMPACT

Subjects	1	2	3	4
Angle at elbow				
Right	150	160	150	160
Left	145	160	150	150
Angle at shoulder				
Right	23	20	25	25
Left	25	25	20	25

The following graph indicates the linear velocity of the trunk of the body during the Swedish fall. The linear velocity was calculated frame by frame for all subjects. Impact occured at the 100th frame (1.35 seconds) selected for subjects one and two. Subject three met the floor at frame ninety (1.22 seconds) and subject four, the expert, reached the floor at frame 110th (1.49 seconds). At impact, the linear velocity of the trunk of the body was 3.7 feet per second for subject one. Subjects two and three reached a velocity of 5.3 feet per second and subject four had a velocity of 2.4 feet per second.

The action of the arms of the four subjects may be seen from the lateral view of the point and line drawings presented earlier in the text. The initial position of the arms varied for the four subjects. The positions were:

subject one, the elbows were flexed with the hands directed upward and pulled behind the shoulders; subject two, the elbows were flexed with the hands parallel to the floor and the forearm in front of the body; subject three, the elbows were hanging along the side of the body and subject four, the elbows were extended behind the body with the hands reaching upward above the shoulders.

The elbows were flexed with the hands near the shoulders for three of the subjects as the Swedish fall continued. The exception was subject two who held the elbows flexed but well in front of the body. As the fall progressed, the arms became similar with the four participants; the elbows extended reaching for the floor and initiated flexion after impact. The flexion of the elbows increased until the upper torso was near the floor. Although the initial arm action of the four subjects varied, the movement after impact was similar for all of the participants.

Front Slide Fall

Selected frames of the front slide fall are presented in the following illustrations by point and line drawings. These drawings depict the body alignment during the fall.

Subjects one, two, and four initiated the fall with the upward thrust of a hop, and upon landing, the plié and the forward reach with the arms began. Subject three began

with the plié and the forward reach of the arms. The four dancers had a crouched body position with one leg extended rearward and the other leg flexed, close to the torso, as the arms and torsos reached toward the floor to impact. After impact the flexion of the elbows lowered the torso, and then the arms and flexed leg pushed to the rear thrusting the body forward on the floor. The front slide fall ended with the elbows extended in back, the head lifted, an arched back, and the legs lifted slightly above the ground.

In the graphs on the following pages, the angles of five anatomical reference points through the fall are presented. The reference points are: the trunk, the left thigh, the left lower arm, the left upper arm, and the left hand.

The body alignment of subject one progressed with a trunk angle of 86.94 degrees down to an angle of 157.38 degrees at impact. Subject two started with a trunk angle of 85.69 degrees and moved to an angle of 179.43 degrees at impact. The body alignment of subject three progressed from an angle of 100.01 degrees to 162.94 degrees at impact, and subject four had a body angle of 86.49 degrees and moved to 156.16 degrees at impact.

The angles of the five reference points at the moment of impact of the front slide fall are presented in Table III.

ILLUSTRATION 8

LINEAR VELOCITY OF THE TRUNK OF THE BODY
DURING THE SWEDISH FALL

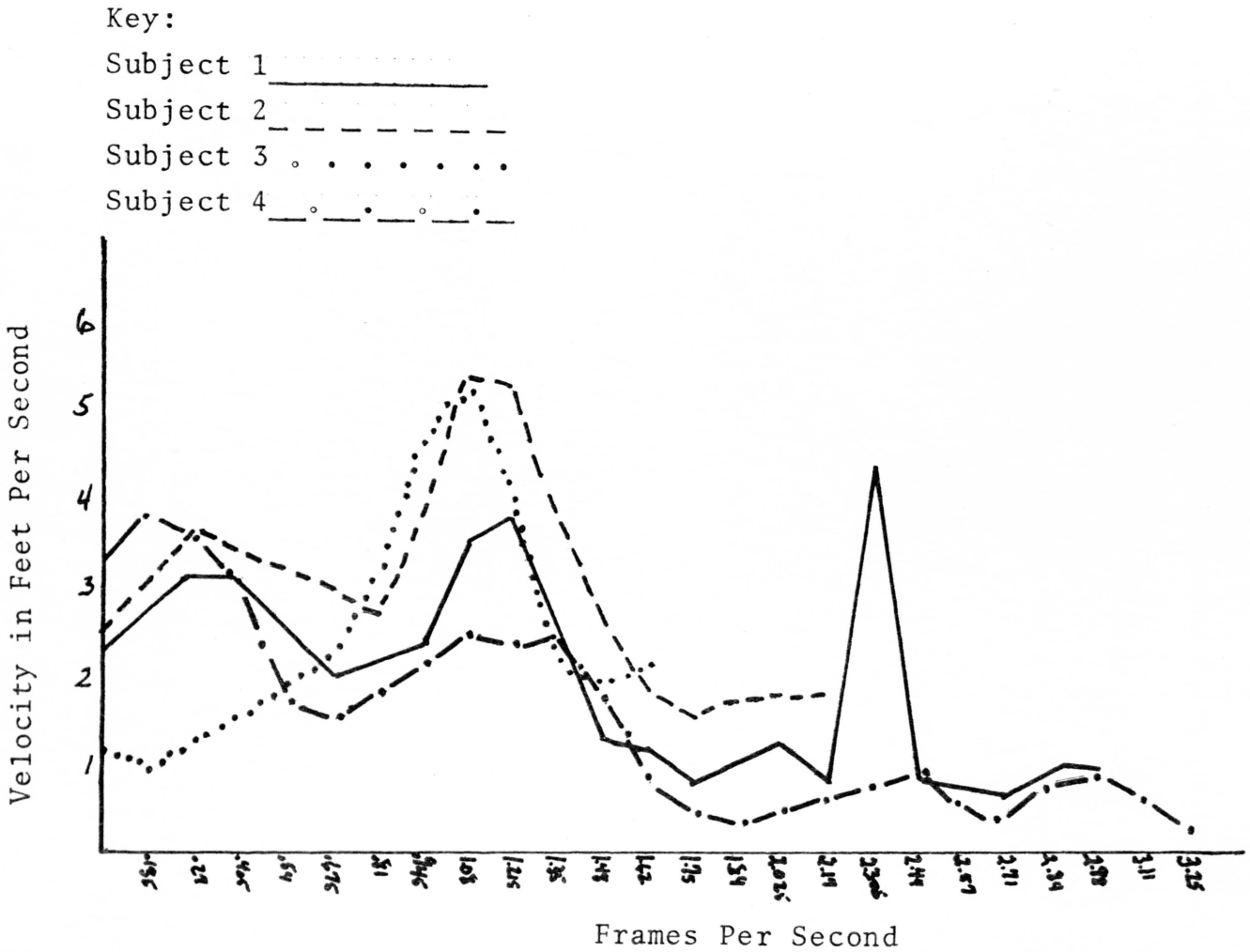
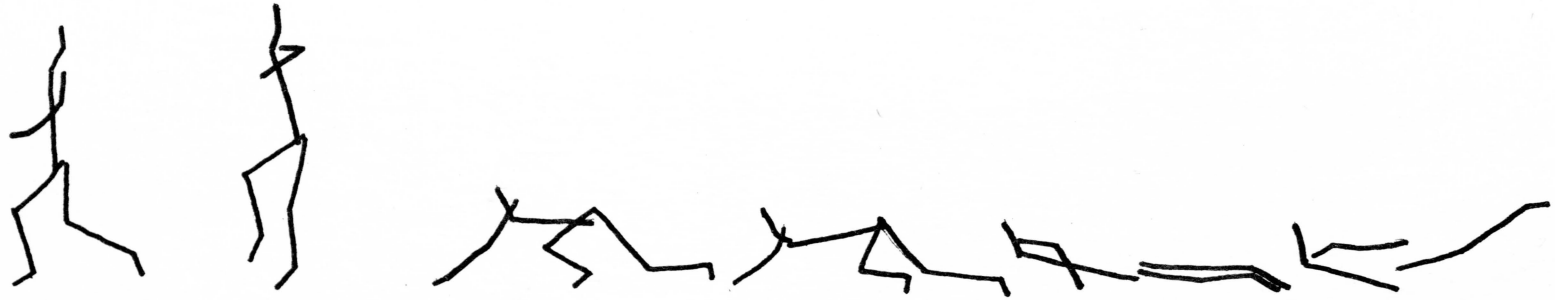
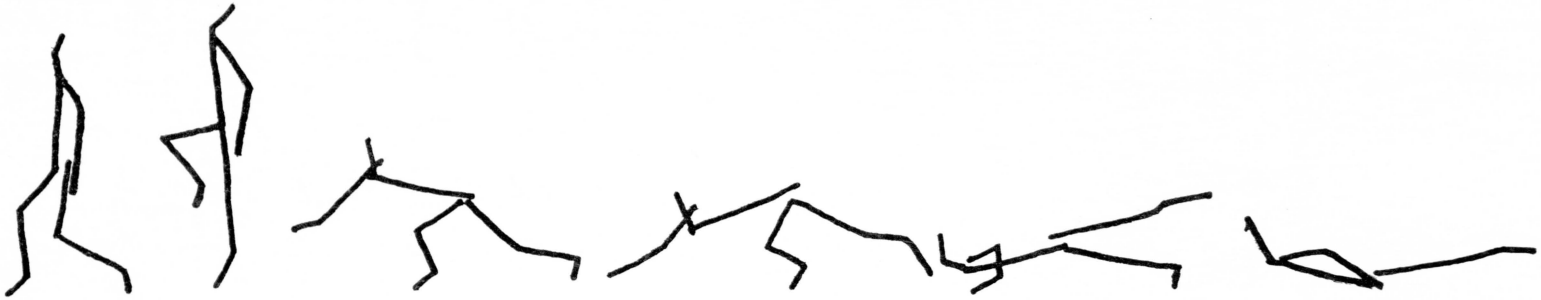


ILLUSTRATION 9

BODY ALIGNMENT DURING FRONT SLIDE FALL



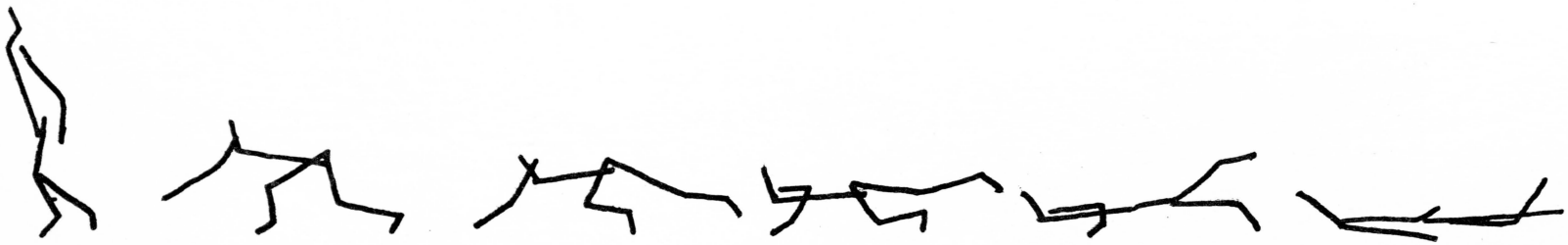
Subject 1



Subject 2

ILLUSTRATION 10

BODY ALIGNMENT DURING FRONT SLIDE FALL



Subject 3

Subject 4

ILLUSTRATION 11

ANGLE OF INCLINATION OF FRONT SLIDE FALL

Subject 1

Key:

Trunk_ _ _ _ _

Left Thigh__._.__._.__.

Left Upper Arm_____

Left Lower Arm___ _ ___ _ ___

Left Hand . . . . . .

ILLUSTRATION 12

ANGLE OF INCLINATION OF FRONT SLIDE FALL

Subject 2

Key:

Trunk_ _ _ _ _

Left Thigh__._.__._.__.

Left Upper Arm_____

Left Lower Arm___ _ ___ _ ___ _

Left Hand . . . . . .

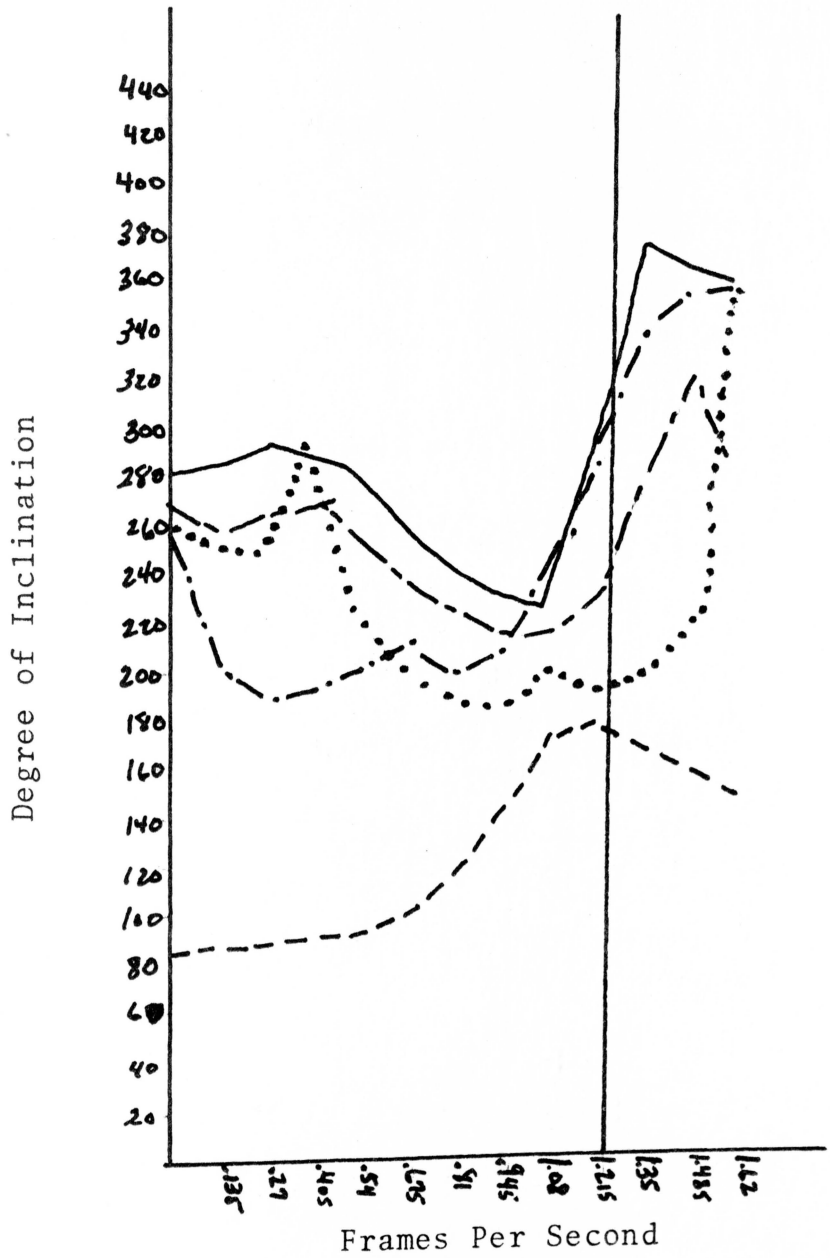


ILLUSTRATION 13

ANGLE OF INCLINATION OF FRONT SLIDE FALL

Subject 3

Key:

Trunk_ _ _ _ _

Left Thigh__._.__._.__.

Left Upper Arm_____

Left Lower Arm___ _ ___ _ ___

Left Hand . . . . . .

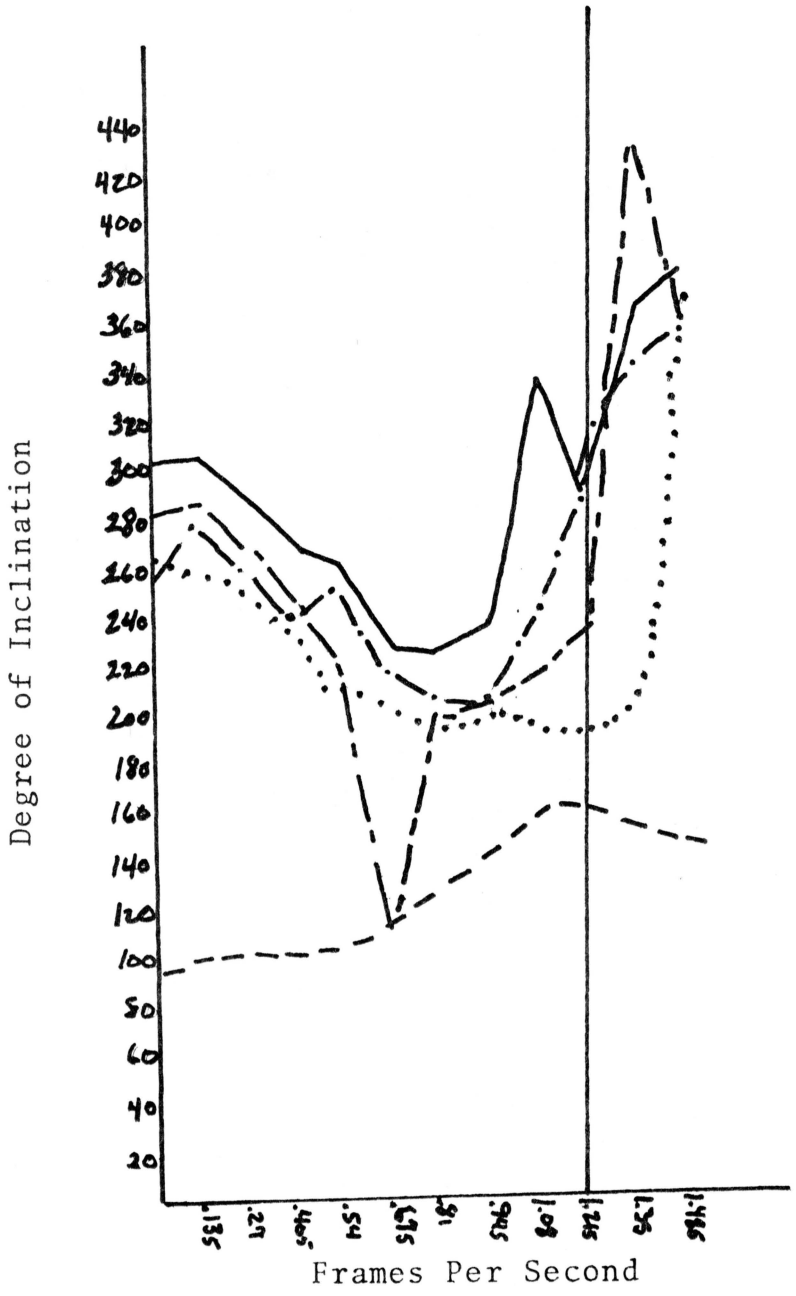


ILLUSTRATION 14

ANGLE OF INCLINATION OF FRONT SLIDE FALL

Subject 4

Key:

Trunk _ _ _ _ _

Left Thigh __.__.__.__.

Left Upper Arm _____

Left Lower Arm ___ _ ___ _ ___

Left Hand . . . . . .

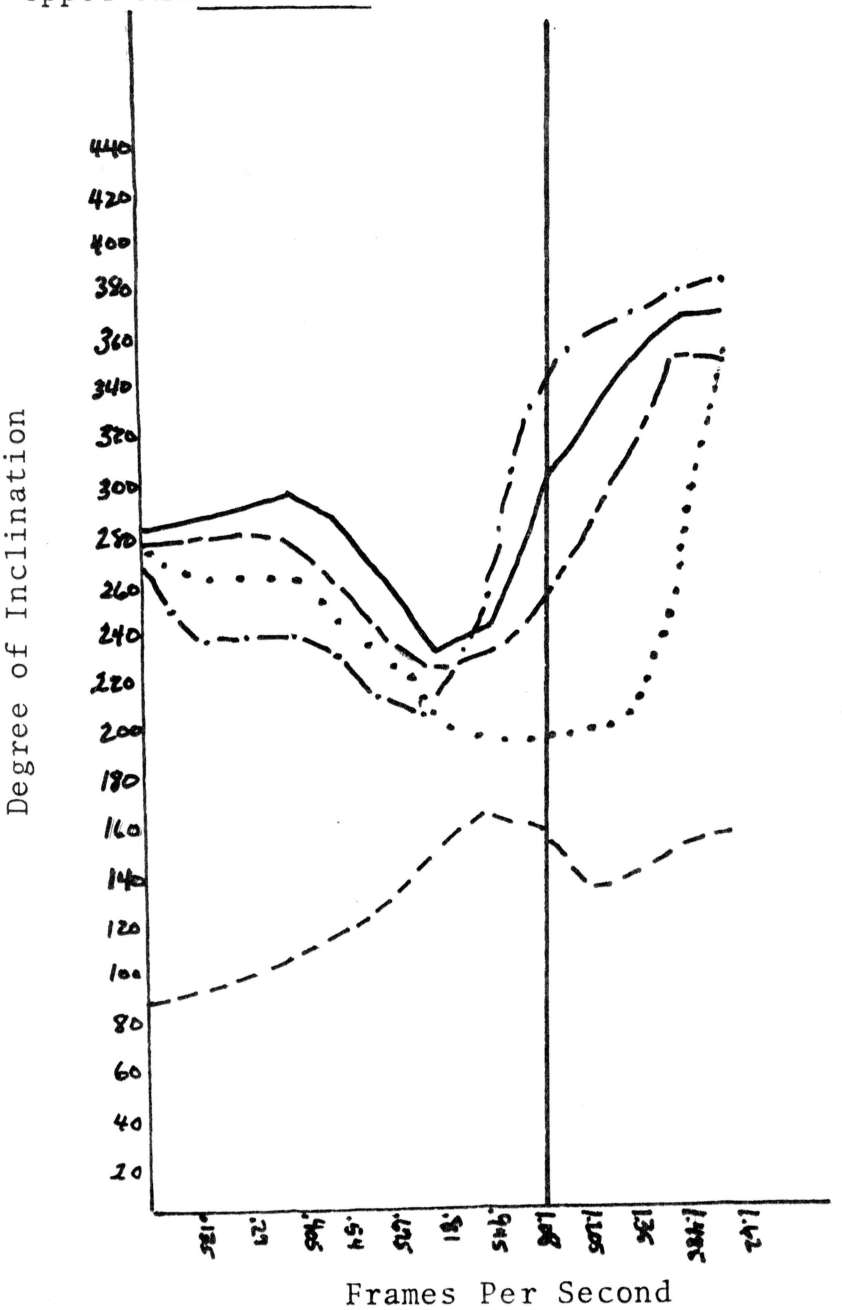


TABLE III

ANGLES OF INCLINATION AT IMPACT IN THE FRONT SLIDE FALL

Subjects	1	2	3	4
Angles of				
Trunk	157.38	179.43	162.94	156.16
Left Thigh	212.95	294.74	299.36	326.98
Left Lower Arm	144.66	228.42	233.13	244.13
Left Upper Arm	306.11	288.92	341.56	293.63
Left Hand	199.65	193.30	194.53	195.42

As indicated in the data, subjects two and three had greater angles of the trunk of the body at impact than subjects one and four. The angle of the trunk continued to increase in the front slide fall for subjects two and three until the diaphragm touched the floor and the body slid forward. Subjects one and four increased the angle of the trunk after impact but landed on the hip and thigh area. This action indicated that the greater angle the trunk of the body had at impact facilitated the placement of the diaphragm on the floor for a smooth forward slide. This action can be viewed in the point and line drawings on pages 43 and 44.

Diagram 15 presents the angles of the arms at impact from a front view of the four dancers executing the front slide fall. The results are seen in Table IV.

TABLE IV

ANGLES OF THE ARMS AT IMPACT

Subjects	1	2	3	4
Angle at elbow				
Right	150	160	150	155
Left	135	135	125	135
Angle at shoulder				
Right	36	45	55	25
Left	48	53	45	35

These data disclose that the arms were spread outwardly from the shoulder at approximate angles between twenty-five and fifty-five degrees to the floor and displayed elbow flexion between 125 and 160 degrees. The placement of the hands of the four subjects on the ground showed the hands faced directly forward with the fingers slightly spread and on the outside to the shoulders.

The following graph presents the linear velocity of the trunk, the left hand, and the left foot of each subject. Impact occured at the eightieth frame (1.08 seconds) for subjects one and four, and at the ninetieth frame (1.215 seconds) for subjects two and three. The linear velocities of the trunk of the body at impact were: subject one, 6.4 feet per second; subject two, 9.0 feet per second; subject three, 9.3 feet per second and subject four, 8.7 feet per

ILLUSTRATION 15

FRONT VIEW OF ARMS AT IMPACT OF FRONT SLIDE FALL

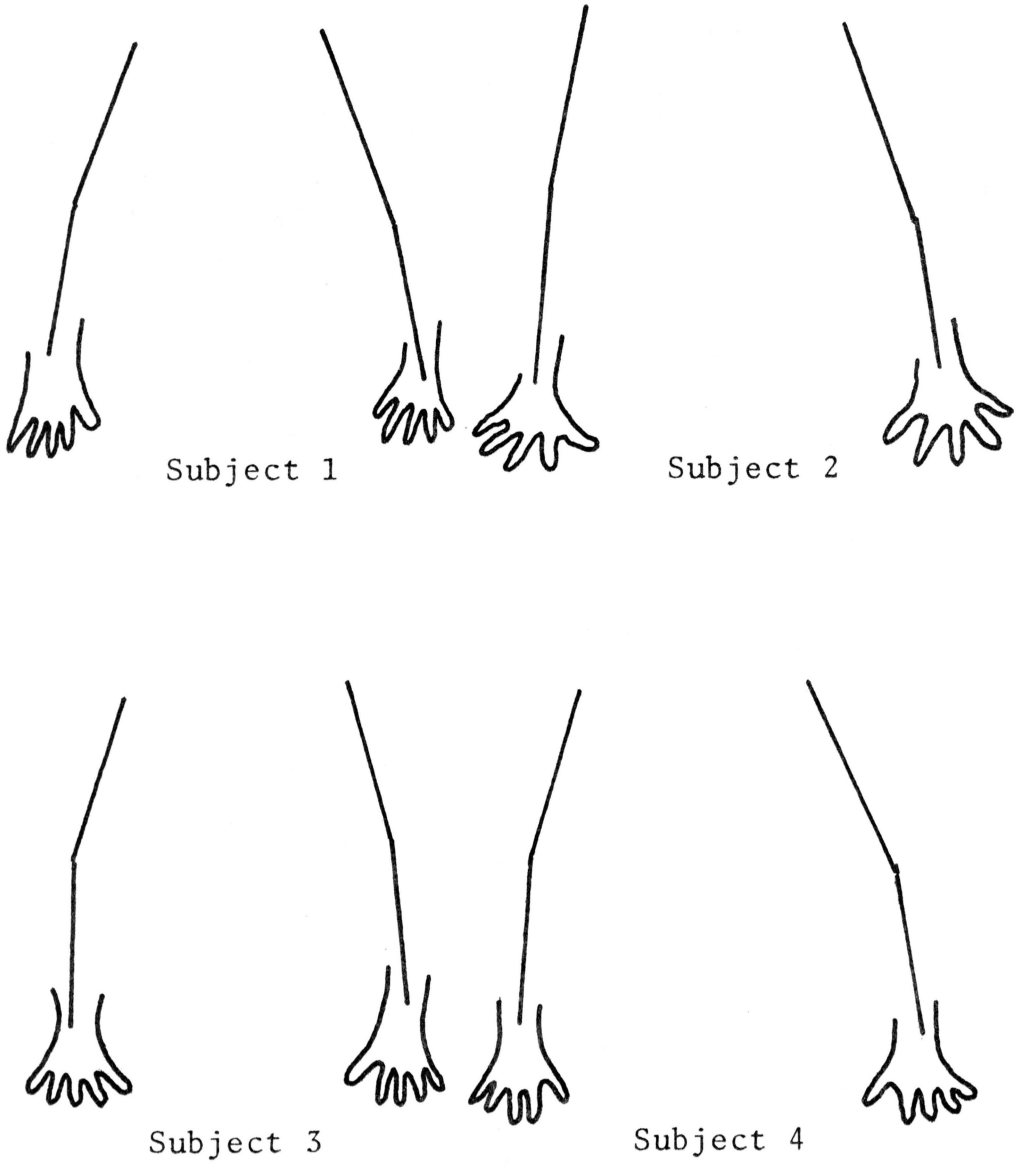


ILLUSTRATION 16

LINEAR VELOCITY OF THE TRUNK OF THE BODY
OF THE FRONT SLIDE FALL

Key:

Subject 1 _____

Subject 2 _ _ _ _ _

Subject 3 . . . . .

Subject 4 __ . __ . __

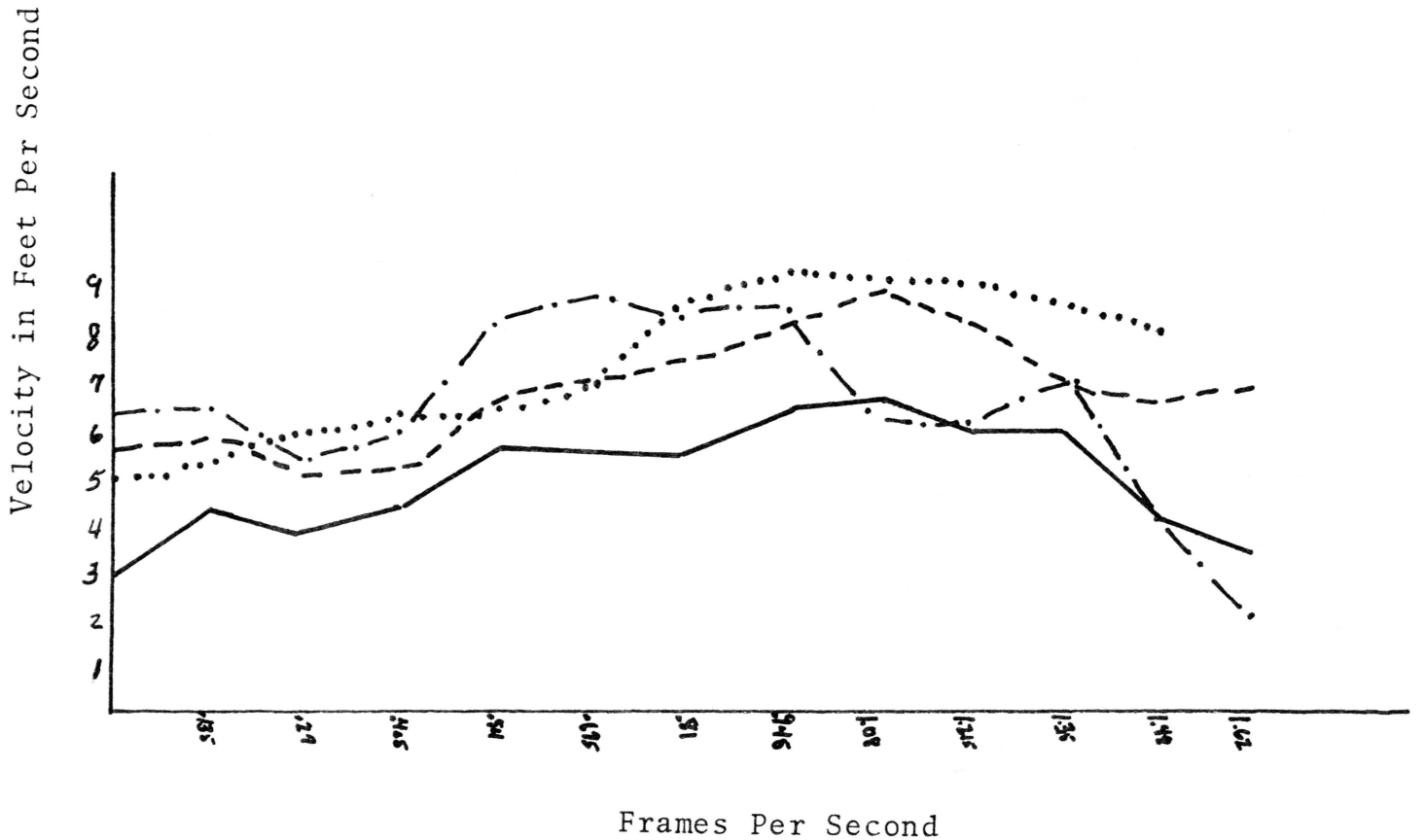


ILLUSTRATION 17

VELOCITY OF HAND AND FOOT OF FRONT SLIDE FALL

Key:

Hand _____

Foot _ _ _ _ _ _ _

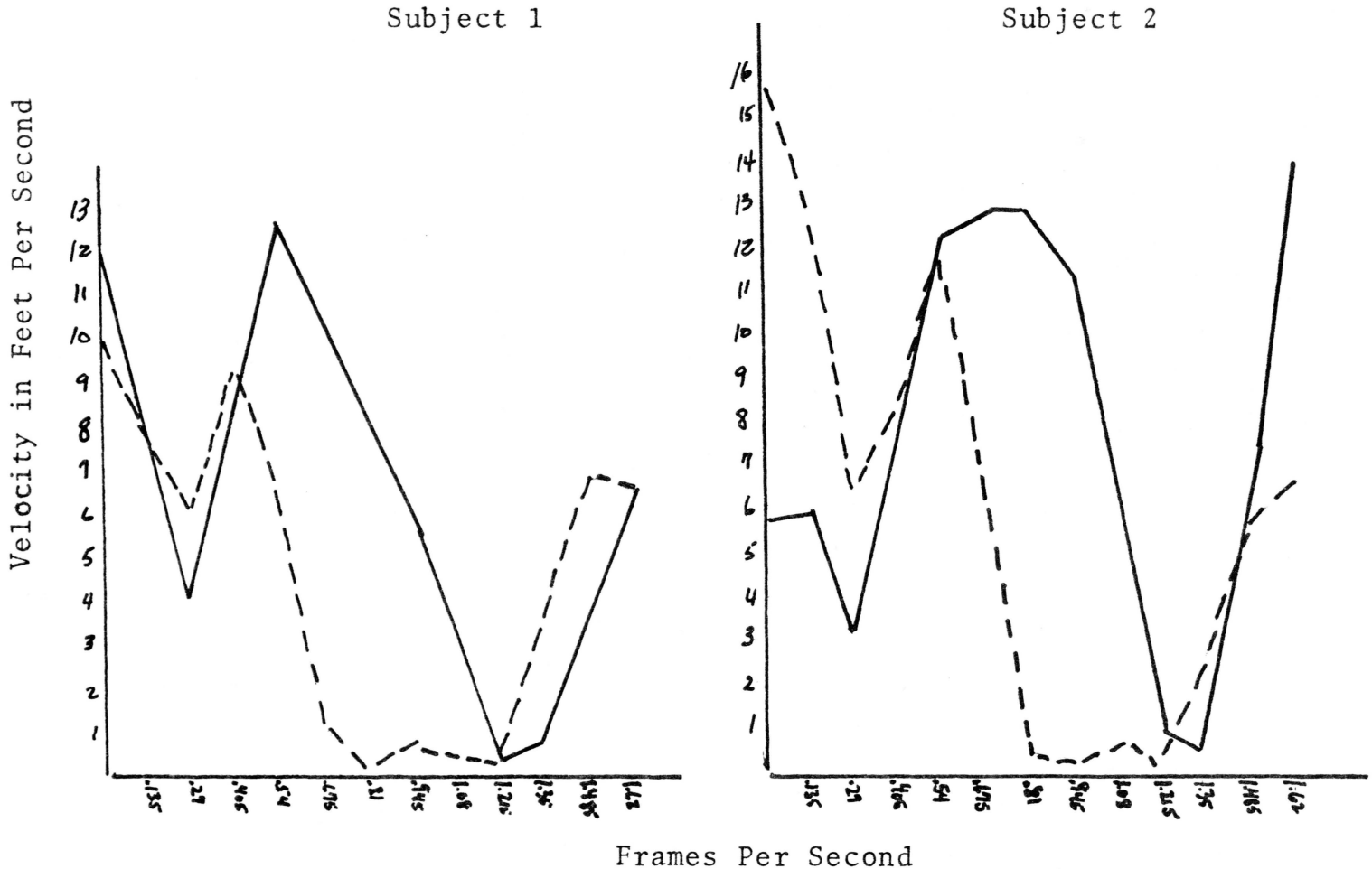


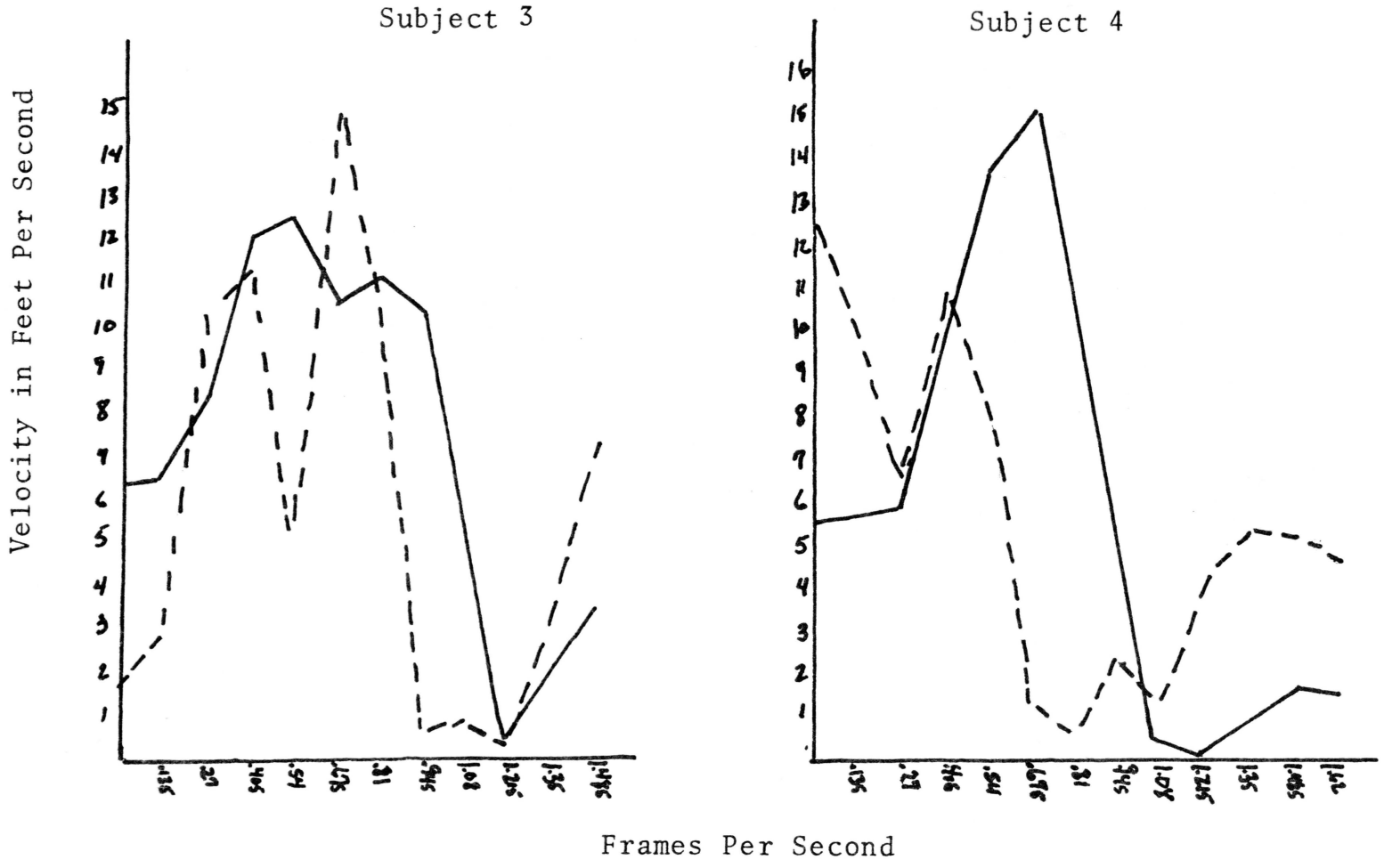
ILLUSTRATION 18

VELOCITY OF HAND AND FOOT OF FRONT SLIDE FALL

Key:

Hand _____

Foot - - - - - - - - -



second. The linear velocities of the left hand and foot showed that after impact subjects one and three increased velocity of these parts of the body simultaneously to thrust the body forward on the floor. Subjects two and four increased the linear velocity first in the left foot and then the hand to slide the body forward.

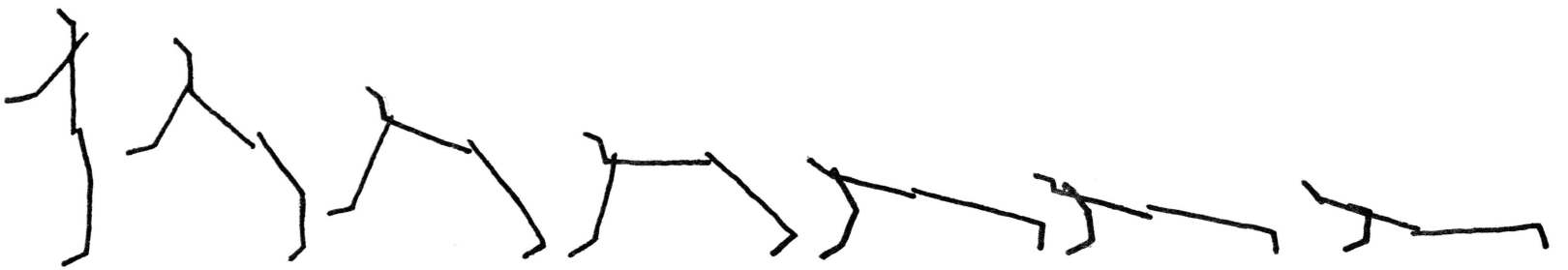
The initial action of the arms varied with the four participants executing the front slide fall. With the placement of the forward foot on the floor all subjects held the arms in front of the body with elbows extended and the hands toward the floor. All subjects had flexion of the elbows at impact. The flexion of the elbows progressed lowering the body to the floor. As the body reached the floor the elbows pulled rearward to extend along the torso of the body.

Forward Straight Fall

The body alignment of the four dancers executing the forward straight fall are presented by the stick figures on the following pages. The starting position varied between the subjects. Subject one remained flat footed with the arms extended forward while, subject two stood in *relevé* with the elbows flexed and the hands close to the shoulders. Subject three stood in *relevé* with the arms extended rearward, and subject four was flat footed with the arms aligned with the side of the body. As the forward straight fall progressed, the

ILLUSTRATION 19

BODY ALIGNMENT DURING THE FORWARD STRAIGHT FALL



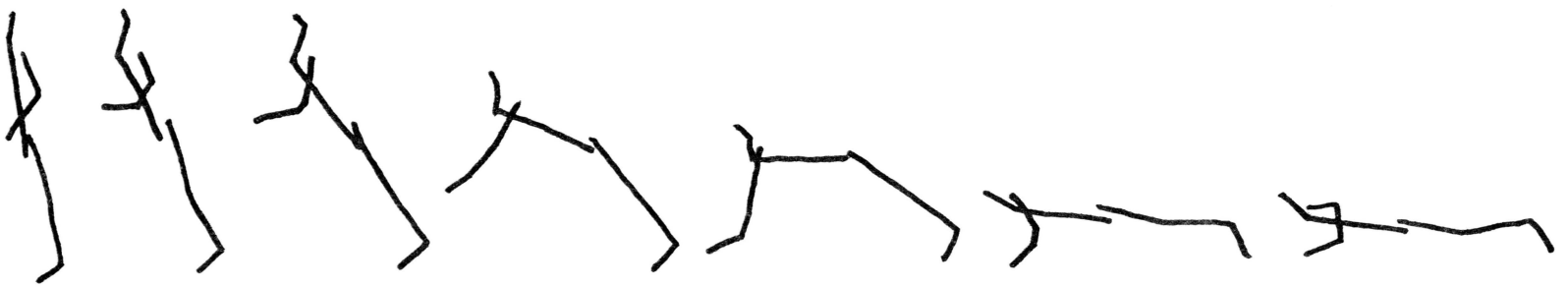
Subject 1

Subject 2

ILLUSTRATION 20

BODY ALIGNMENT DURING THE FORWARD STRAIGHT FALL

Subject 3



Subject 4

body position became straight with the arms extended toward the floor for all subjects. At impact, the lateral view disclosed straight arms and body flexion at the hip area. Subjects one and four displayed greater flexion in this area as compared with subjects two and three. The body was re-aligned as the elbows flexed to lower the body to a position near the floor. All subjects maintained flexed toes and parallel feet at the conclusion of the fall.

Graphs 21, 22, 23, and 24 indicate the angles of five anatomical reference points of the four participants performing the forward straight fall. The five reference points include: the trunk of the body, the left thigh, the left lower arm, the left upper arm, and the left hand.

The body alignment depicted by the angle of the trunk progressed from an angle of 91.54 degrees down to an angle of 162.83 degrees at impact for subject one. Subject two had an angle of 93.15 degrees and moved to an angle of 154.17 degrees at impact. Subject three moved from an angle of 76.01 degrees to 147.53 degrees at impact while subject four progressed from 94.00 degrees to an angle of 162.55 degrees at impact.

Table V discloses the angles of the parts of the body at impact for the expert, subject four, and the skilled dancers, subjects one, two, and three.

ILLUSTRATION 21

ANGLE OF INCLINATION OF THE FORWARD STRAIGHT FALL

Subject 1

Key:

Trunk _ _ _ _ _ _ _ _ _

Left Thigh ___, ___. ___. ___

Left Upper Arm _____

Left Lower Arm ___ _ ___ _ ___

Left Hand . . . . . .

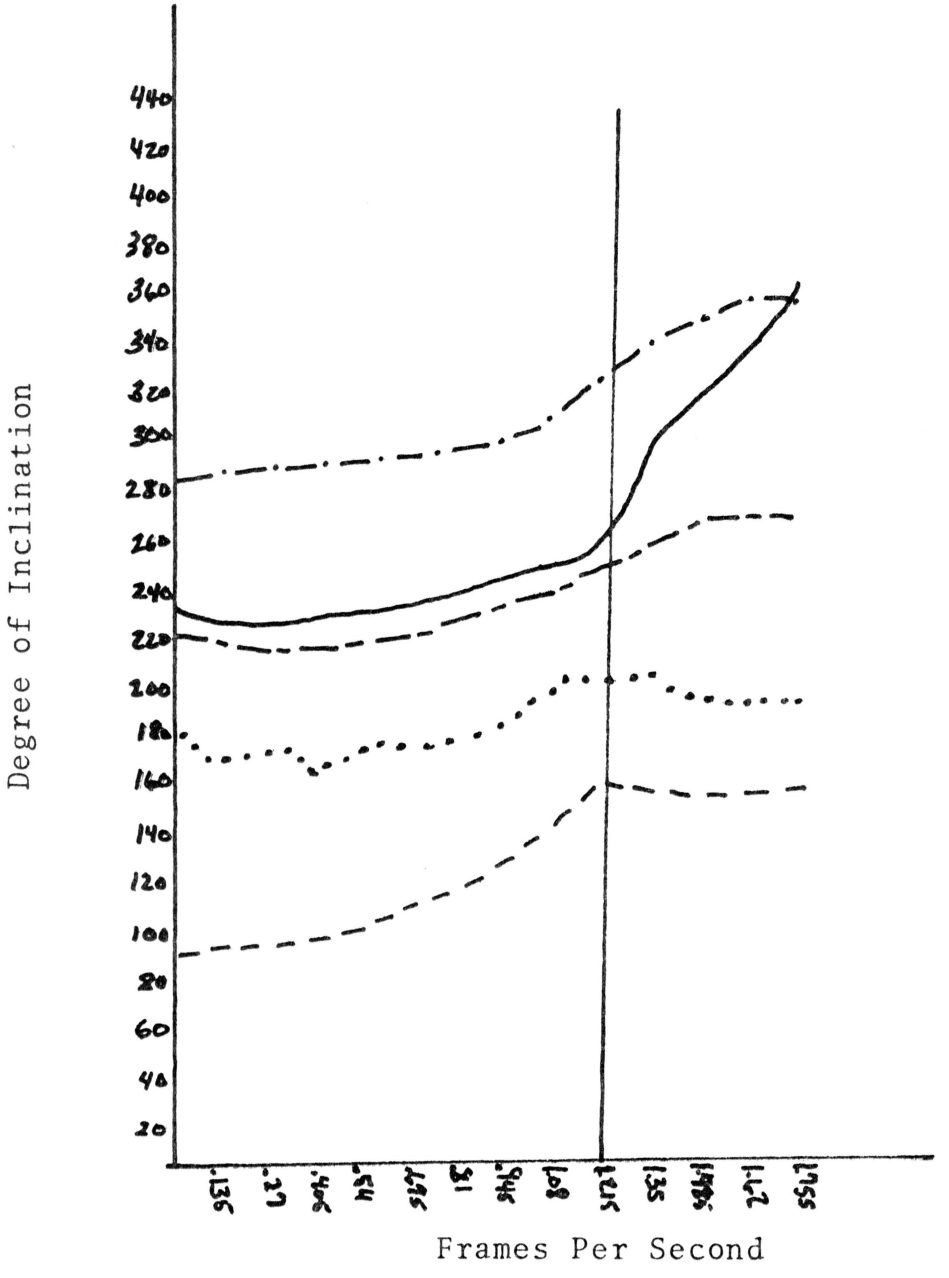


ILLUSTRATION 22

ANGLE OF INCLINATION OF THE FORWARD STRAIGHT FALL

Subject 2

Key:

Trunk _ _ _ _ _ _

Left Thigh __.__.__.

Left Upper Arm_____

Left Lower Arm ___ _ ___ _ ___

Left Hand . . . . . .

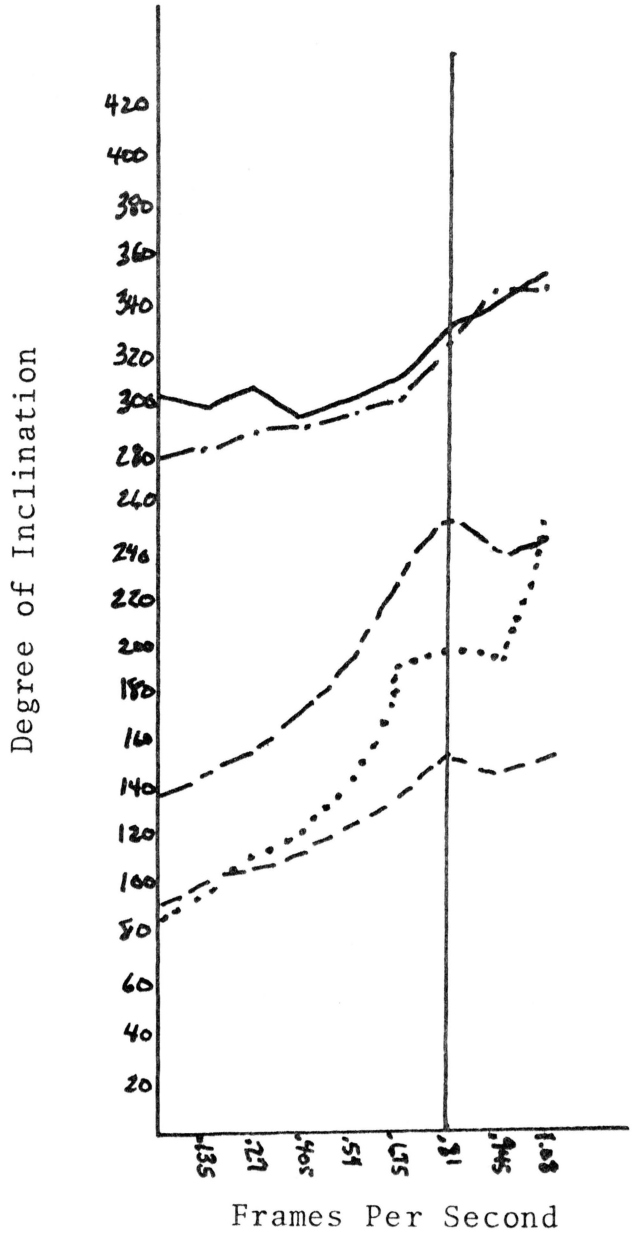


ILLUSTRATION 23

ANGLE OF INCLINATION OF THE FORWARD STRAIGHT FALL

Subject 3

Key:

Trunk _ _ _ _ _ _ _ _ _

Left Thigh __.__.__.__.

Left Upper Arm _____

Left Lower Arm __ _ __ _ __

Left Hand .'. . . . .'. . ..

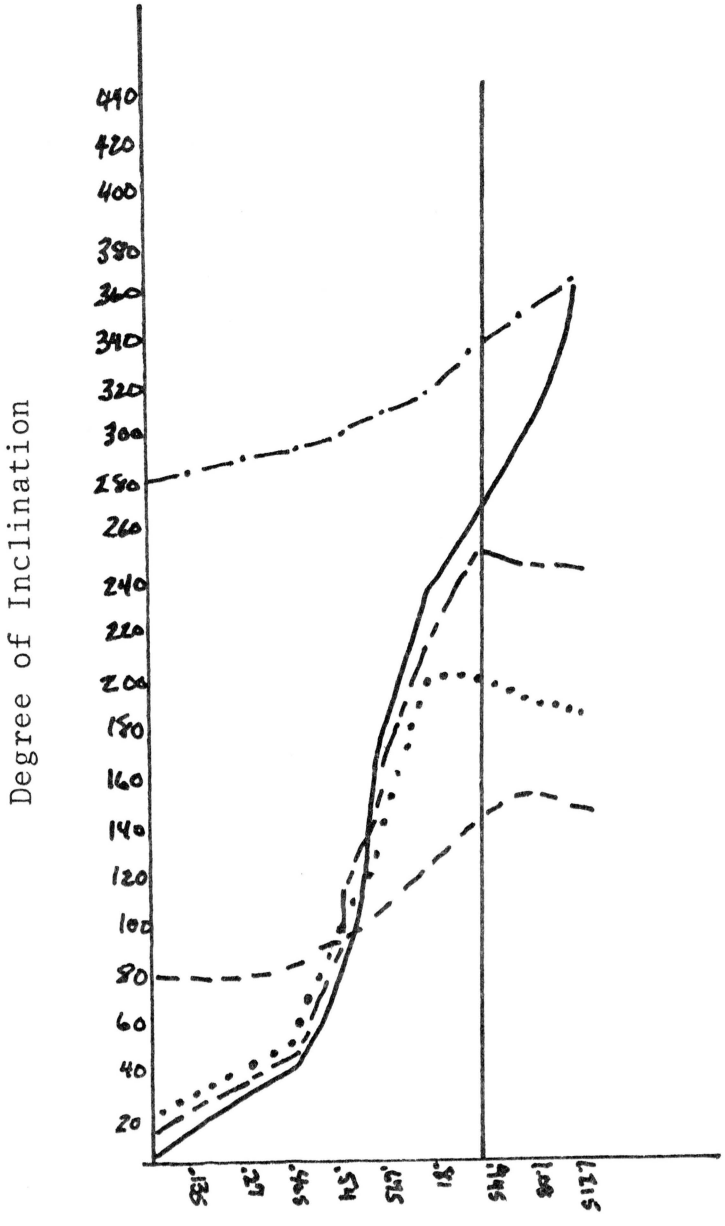


ILLUSTRATION 24

ANGLE OF INCLINATION OF THE FORWARD STRAIGHT FALL

Subject 4

Key:

Trunk _ _ _ _ _ _

Left Thigh __.__.____.__

Left Upper Arm_____

Left Lower Arm___ __ ___ __

Left Hand . . . . . .

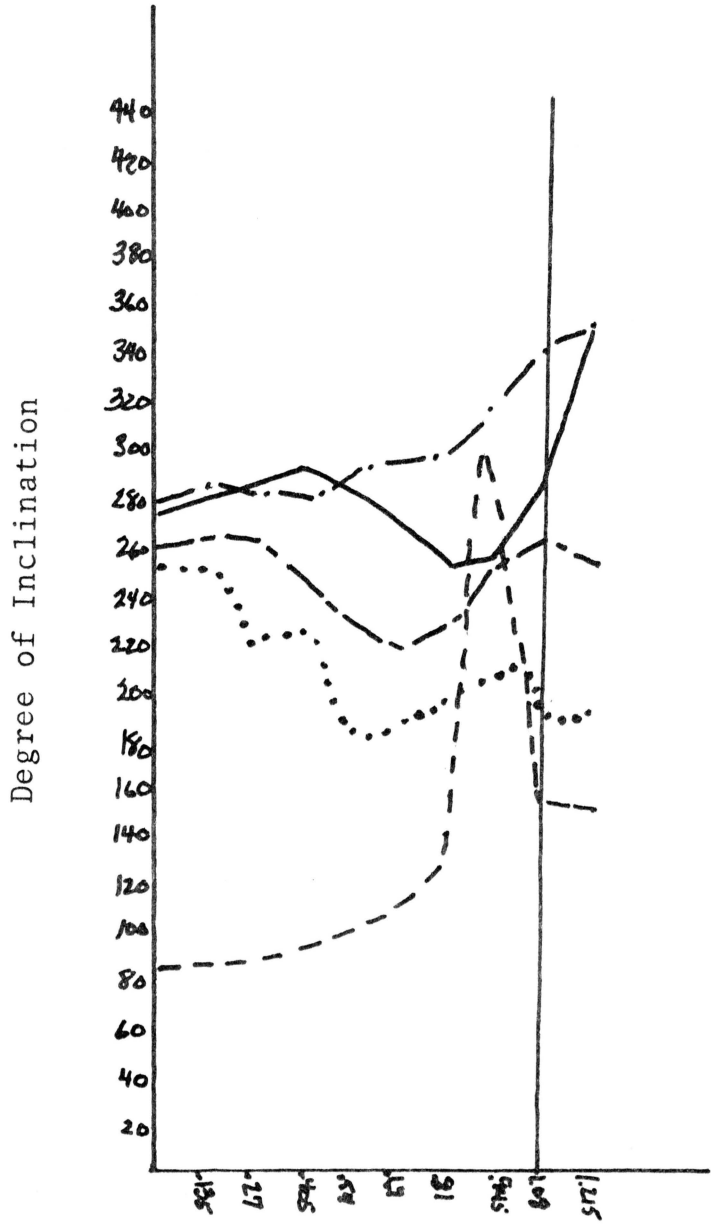


TABLE V

ANGLES OF INCLINATION AT IMPACT IN THE FORWARD STRAIGHT FALL

Subjects	1	2	3	4
Angles of				
Trunk	162.83	154.17	147.53	162.55
Left Thigh	324.38	331.36	337.04	346.53
Left Lower Arm	247.20	253.59	252.47	263.41
Left Upper Arm	259.44	260.70	264.69	295.36
Left Hand	201.64	198.62	201.80	193.11

Illustration 25 displays the placement of the hands on the ground and the angles of the arms at impact. In the forward straight fall, the hands were placed directly forward with the fingers spread slightly. The arms were extended outwardly at a slight angle from the shoulders. Table VI presents the angle between the upper arm and the lower arm of each subject and the angles of the arms from the shoulders for each dancer.

These data disclosed that the arms were spread outwardly from the shoulder at approximate angles between ten and twenty-five degrees to the floor and displayed elbow flexion between 150 degrees and 160 degrees.

Graph 26 displays the linear velocity of the trunk of the body for each subject executing the forward straight fall. Impact occurred at the 100th frame (1.350 seconds)

TALBE VI

ANGLES OF THE ARMS AT IMPACT

Subjects	1	2	3	4
Angle at elbow				
Right	20	10	15	15
Left	25	25	15	25
Angle at shoulder				
Right	165	170	155	155
Left	155	155	160	150

selected for analysis for subject one; the seventieth frame (.945 seconds) for subject two and the eightieth frame (1.08 seconds) for subjects three and four. The highest linear velocity of the trunk was reached at impact for subjects one, two, and three. Subject four had a lower linear velocity at impact than in the frame preceding and the frame following impact. The linear velocity of the trunk of the body at impact was 5.65 feet per second for subject one. Subject two reached a velocity of 8.7 feet per second. Subject three had a velocity of 8.75 feet per second and the linear velocity at impact for subject four was 8.1 feet per second.

The action of the arms before contact with the ground varied between the four subjects in the forward straight fall. The first subject extended the arms forward at the initiation of the forward straight fall and continued to do

ILLUSTRATION 25

FRONT VIEW OF THE ARMS AT IMPACT OF
THE FORWARD STRAIGHT FALL

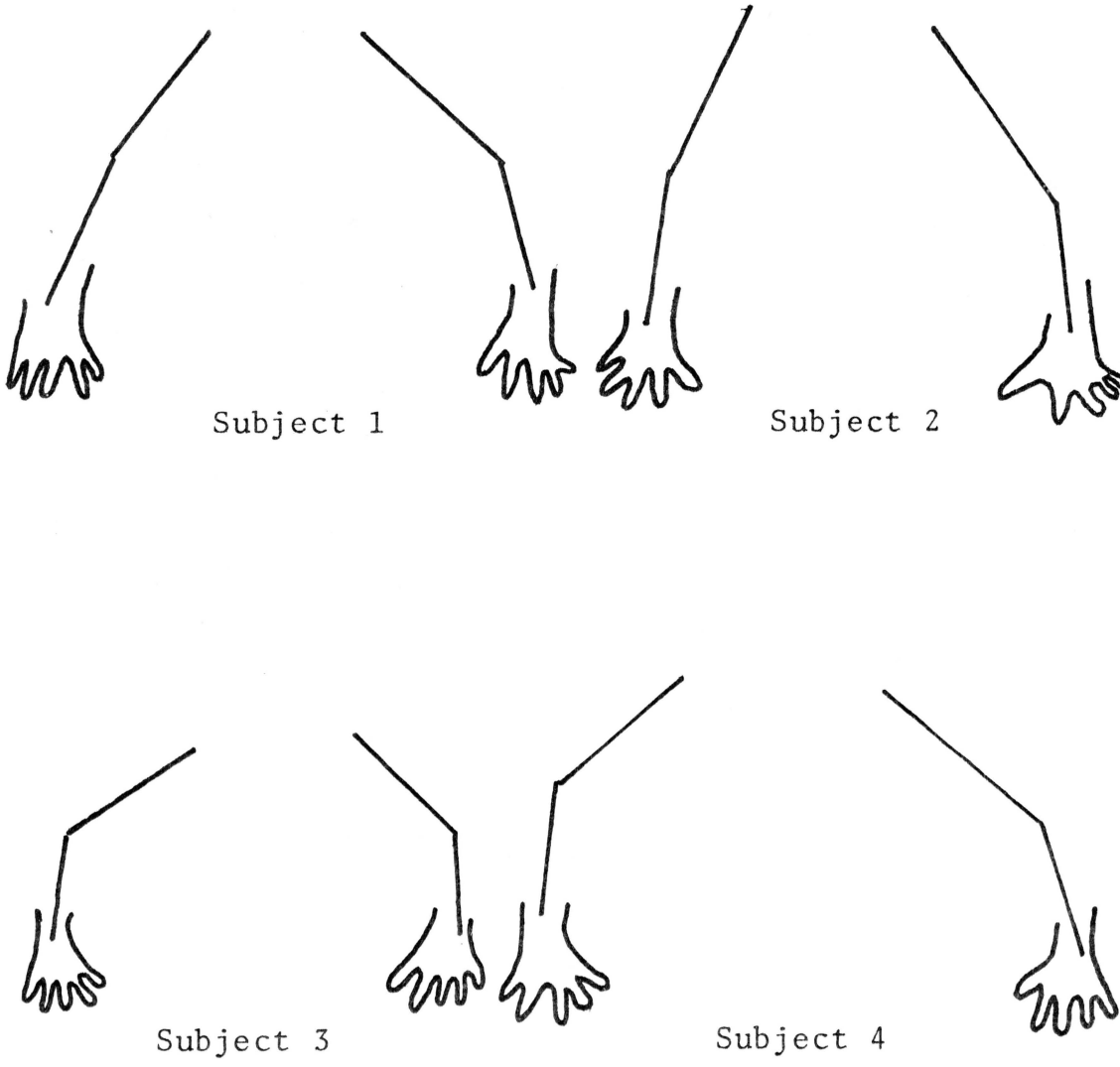
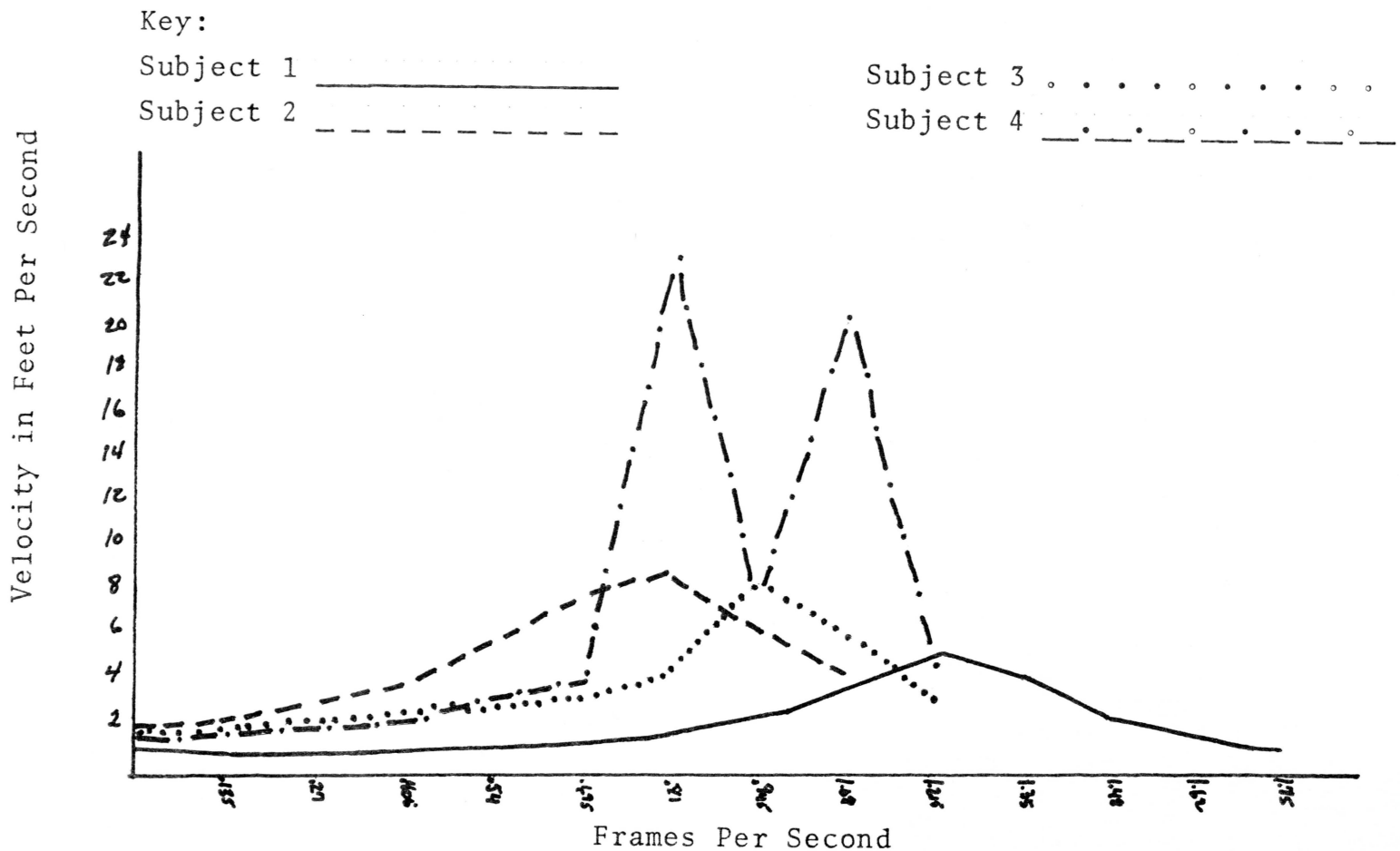


ILLUSTRATION 26

LINEAR VELOCITY OF THE TRUNK OF THE BODY
OF THE FORWARD STRAIGHT FALL



so until impact. Subject two held the elbows flexed with the hands close to the shoulders. The elbows extended when the body was approximately mid-way to the floor and remained extended until impact. The arms of subject three were extended to the rear of the body higher than shoulder level. Progression of the arms continued overhead and as the body increased in angle, the arms reached toward the floor in a straight manner to impact. Subject four placed the arms along the side of the body and brought the arms upward and in a straight manner toward the floor to impact. After contact with the ground, the four subjects displayed similar arm action. The flexion of the elbows increased to lower the body to the floor at the end of the fall. The movement of the arms can be followed by the point and line drawings presented on pages 56 and 57.

Summary

In Chapter IV, the results of the film analysis were presented in narrative, illustrative, and tabular form. The findings were organized under three major categories: the Swedish fall, the front slide fall, and the forward straight fall. Discussion followed each fall under these specific topics: (1) the body alignment during the fall, (2) the angle of the body at impact, (3) the placement of the hands on the ground, and (4) the action of the arms before and after contact with the ground.

Selected frames of the lateral view of each subject were presented to describe the body alignment during the fall and were represented by point and line drawings. Graphs disclosing the angles of five anatomical parts of the body and linear velocities of the trunk of the body were included. The front slide fall contained also linear velocities of the left hand and foot for discussion. The placement of the hands on the ground at impact were shown from the front view in illustrations.

Similarities which were found among the expert and the three skilled performers of the Swedish fall included the following:

1. The body alignment for all subjects during the fall
2. The placement of the hands on the ground at impact
3. Slight flexion of the elbows at impact
4. The action of the arms after impact
5. The action of the hyperextended leg during the fall

Differences which were found among the subjects were:

1. The initial arm action of the fall
2. The degree of inclination of the body parts
3. The velocities of the trunk for all subjects

Similarities which were noted during the front slide fall included the following:

1. The flexion of the elbows at impact
2. The placement of the hands on the ground at impact

3. The action of the arms after impact
4. The final position of the body

The differences disclosed among the subjects were:

1. The initial arm action and body position of the subjects
2. The degree of inclination of the trunk of the body at impact
3. The degree in inclination of other body parts during the fall
4. The use of the arms and left leg to thrust the body forward
5. The velocities of the trunk of the body of the four subjects

The forward straight fall showed the subjects had the following similarities:

1. The body alignment after impact
2. Slight flexion of the elbows at impact
3. The placement of the hands on the ground

Differences which were found among the four subjects performing the forward straight fall included:

1. The initial body position
2. The degree of inclination of the trunk of the body at impact
3. The degree of inclination of other parts of the body at impact

4. The linear velocities of the trunk at impact

5. The action of the arms before impact

In Chapter V of this study, the investigator will draw a conclusion and offer recommendations for further studies.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSION, AND RECOMMENDATIONS FOR FUTURE STUDIES

Introduction

This chapter presents a summary of the study, and includes the purpose for the study, a conclusion, and recommendations for future studies.

Summary

Little cinematographic research was found in the area of dance. The research did reveal that dance educators are interested in promoting the study of kinesiology in the professional preparation of dancers.

The purpose of this investigation was to contribute to dance research by completing a comparative analysis of three forward fall from cinematographic data. Specifically, the investigator examined: (1) the body alignment during the falls, (2) the angle of the body at impact, (3) the placement of the hands of the ground, and (4) the action of the arms before and after contact with the ground.

Documentary analysis revealed that no previous study of the Swedish fall, the front slide fall, and the forward straight fall had been conducted. Reviews of studies pertinent to this investigation were presented. These studies

included a cinematographic analysis of the pirouette en dehors conducted by McMillan, a cinematographic study of foot action during the vertical jump conducted by Beck, a comparative film analysis of the tour jeté undertaken by Buckman, a cinematographic investigation of toe-heel action during ground contact and running speed conducted by Youle, a cinematographic study of the racing dive in swimming conducted by Heusner, and a study of the relationship of the ability to perform and the ability to diagnose errors of eleven tumbling skills conducted by Giradin and Hanson.

The present investigation entailed the use of four subjects, an expert and three skilled dancers. The expert was a member of the Texas Woman's University Dance Department faculty and had danced with a professional dance company. The three skilled participants were enrolled in the Texas Woman's University, Denton, Texas, and were members of the Modern Dance Tour Group during the academic year of 1973.

Film data were collected by means of two sixteen millimeter Bell and Howell movie cameras placed at right angles to each other. The dancers were viewed through twenty-five millimeter lenses set at an F-stop between 1.9 and 2.0 for all performances of the three falls. The cameras were set at sixty-four frames per second and Kodak Black and White Tri-X Reversal Film was used.

The subjects were filmed in Studio 21 of the College of Health, Physical Education, and Recreation at the Texas Woman's University, Denton, Texas. Auxillary lighting was supplied by two portable flood lights elevated by tripods. The subjects wore black leotards and tights and had selected anatomical reference points marked with white Pres-a-Ply labels. Each dancer performed three trials of the Swedish fall, the front slide fall, and the forward straight fall in random order. The front and lateral views were filmed simultaneously and an electric clock was visible in both viewing areas.

The film was viewed frame by frame by a Recordak MPE-1 Film Reader and the best combined front and lateral view of each subject was selected. The front view yielded the data of the angle of the arms at impact and the placement of the hands on the ground. The angles were measured by a protractor.

A Vanguard Motion Analyzer was employed on the lateral view. Every tenth frame was selected for analysis. This information was computed by an IBM 320/50 computer using the "Bates C" Program for Film Data. The results of the computation were converted into point and line drawings, graphs, and tables for discussion. Similarities and differences were noted from the analysis of these data.

Findings of the Study

The following findings were based on the data obtained from the present study:

Swedish Fall

1. The body alignment of the four subjects was similar during the fall
2. The angle of the trunk of the body for the four subjects varied within a range of 206.95-177.25 degrees at impact
3. The velocity of the trunk of the body had a range of 5.3-2.4 feet per second at impact
4. The placement of the hands on the ground was directly forward with the fingers spread and placed at slight angles outward to the shoulders for all subjects at impact
5. The action of the arms varied at the early phases of the Swedish fall but became similar before and after contact with the floor.

Front Slide Fall

1. The preparation at the beginning of the fall was the same for three of the subjects.
2. The body alignment was similar for all subjects after the *plié* and the forward reach began.
3. The angle of the trunk of the body at impact varied within a range of 179.43-156.16 degrees.

4. The linear velocity of the trunk of the body at impact fell in a range of 9.3-6.4 feet per second.
5. The arms and the left leg of two subjects increased in linear velocity simultaneously to slide the body forward, while the other two subjects increased with the left leg and then with the arms.
6. The hands were placed on the ground in a forward direction with the fingers spread and at a slight outward angle to the shoulders for all subjects.
7. The elbows were flexed at impact for the four subjects.
8. The action of the arms before contact with the ground varied with the four subjects but followed similar patterns after impact.

Forward Straight Fall

1. The initial positions varied for the four subjects.
2. The body alignment followed a similar pattern after the bodies were approximately mid-way to the floor for the participants.
3. The angle of the trunk of the body at impact was in a range of 162.55-147.53 degrees.
4. The linear velocity of the trunk of the body at impact disclosed a range of 8.75-5.65 feet per second.
5. The hands were placed on the ground in a forward direction with the fingers slightly spread and outward at slight angles to the shoulders at impact.

6. The elbows were slightly flexed at impact for all subjects.
7. The action of the arms varied with the four subjects before impact but followed a similar pattern after contact with the floor.

Conclusion

The investigator drew the following conclusion with respect to the comparative analysis of the Swedish fall, the front slide fall, and the forward straight fall: this cinematographic analysis of an expert and three skilled dancers executing three forward falls has contributed to the area of dance research by presenting knowledges obtained from the analysis of these falls.

The investigator drew the following sub-conclusions with respect to the performance of the Swedish fall, the front slide fall, and the forward straight fall:

1. Whereas the initial body positions may vary with the subjects, the final body position is similar for all subjects.
2. The hands are placed similarly on the floor during the three forward falls for all four subjects.
3. Larger angles of the trunk of the body at impact of the Swedish fall facilitate greater hyperextension of the hip of the elevated leg.

4. Larger angles of the trunk of the body at impact during the front slide fall facilitate the placement of the diaphragm on the floor for a smooth forward slide.
5. The action of the flexion of the elbows after contact with the ground was similar in the Swedish fall and the straight forward fall. The front slide fall disclosed the same action until the forward thrust of the body occurred.

Recommendations for Future Studies

The following recommendations are suggestions for additional investigations.

1. A replication of this study be conducted employing subjects with a higher level of skill in the front falls.
2. Further cinematographic research in the area of dance skills be conducted to broaden knowledge and promote better methodology.

APPENDIX

CHECK LIST

NAME_____ JUDGE_____

Rate each item on a 10-1 scale

SWEDISH FALL

_____1. Fall forward landing with the elbows straight then flexing to lower the body

_____2. One leg lifts as the fall begins

_____3. Movement smooth and controlled during the fall

_____4. The back is well arched

_____5. Leg extended as high as possible, chest close to the floor

FRONT SLIDE FALL

_____1. Plié and bend forward reaching with the arms

_____2. Land on the hands, elbows flexing to bring the diaphragm to the floor

_____3. Movement smooth and controlled during the fall

_____4. The back is well arched

_____5. Pull back with the arms to slide the torso on the floor

FORWARD STRAIGHT FALL

_____1. Body alignment straight during the fall

_____2. Land on hands with the elbows straight then flexing to lower the body

_____3. Movement smooth and controlled during the fall

_____4. Body ends close to the floor in a straight line parallel to the floor

_____5. Feet parallel and toes flexed on landing

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