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A STUDY OF FOUR-MALLET GRIPS USED IN PLAYING  
KEYBOARD PERCUSSION INSTRUMENTS

THESIS

Presented to the Graduate Council of the  
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By

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Glasscock, Lynn D., A Study of Four-Mallet Grips Used in Playing Keyboard Percussion Instruments. Master of Music (Orchestral Instrument: Percussion), August, 1971, 74 pp., 20 tables, bibliography, 14 titles.

The purpose of this study was to evaluate the efficiency of three common grips used in four-mallet playing. The three grips were referred to as (a) the Musser grip, (b) the cross stick grip No. 1, and (c) the cross stick grip No. 2. A thorough description (including illustrations) was given for each grip.

The evaluation of efficiency was made through research testing, which was conducted by the author. Forty individuals participated in the research testing. Four tests were conducted, and each test had ten participants. The individuals who participated in Tests I, II and III had no previous four-mallet experience. The individuals who participated in Test IV had previous four-mallet experience. The evaluation of the efficiency covered by the four tests was limited to (a) horizontal movement of the outside mallet(s), (b) horizontal movement of the inside mallet(s), and (c) horizontal movement of the hand(s).

According to Tests I, II and III, the majority of beginning four-mallet players will find the cross stick grip No. 2 the easiest and most efficient (as far as the three movements which were tested are concerned) of the three grips. However,

some individuals (a much smaller percentage) will prefer either the Musser grip or the cross stick grip No. 1. Many beginners will find the Musser grip extremely difficult. A very small percentage of beginning four-mallet students will have poor efficiency using cross stick grip No. 2.

According to the results of Test IV, the efficiency of the Musser grip and the cross stick grip No. 2 improve at a faster rate than does the efficiency of the cross stick grip No. 1.

The movements tested in this study are extremely important when playing with four mallets. However, this study was limited to the testing of three types of horizontal movements and, therefore, did not cover all the aspects of four-mallet playing. Because all factors were not included in this study, no one grip was proven to be ultimately the "best."

Each individual four-mallet player must decide for himself which grip is best suited for his particular needs. The findings of this study should aid in making that decision.

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## CHAPTER I

### INTRODUCTION

#### The Purpose

The purpose of this study is to evaluate the efficiency of three common grips used in four-mallet playing.

#### Need for the Study

The majority of percussion instruments (excluding Latin American instruments) require sticks, mallets or beaters to produce their characteristic sounds. A suitable method of holding the implements is necessary in order for the performer to have a maximum degree of control, dexterity and flexibility. The fact that two mallets must be held in each hand for four-mallet playing requires that a grip be employed which is unlike any other grip used to play percussion instruments.

Because of the scarcity of available material, there is a definite need for a more detailed, organized source of information on four-mallet grips.

#### Definition of Terms

For the purpose of this study, the following terms are defined:

Outside (or outer) mallet(s): the right mallet in the right hand and the left mallet in the left hand. (See Figure 1.)

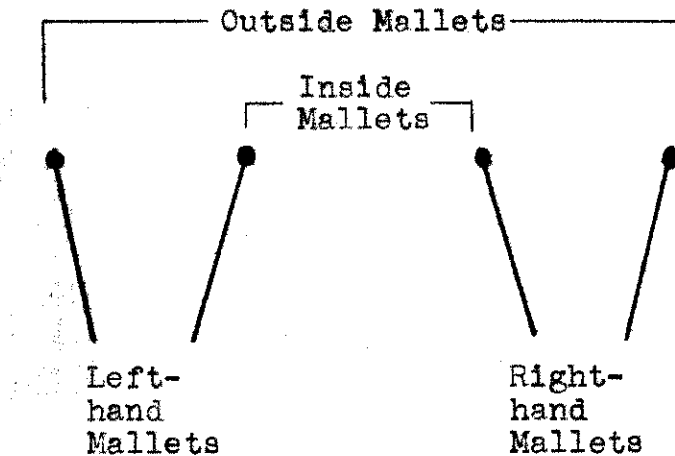


Fig. 1--Position of outside and inside mallets

Inside (or inner) mallet(s): the left mallet in the right hand and the right mallet in the left hand.

Musser grip: a four-mallet grip in which the outer and inner mallets of each hand do not cross.

Cross stick grip No. 1: a four-mallet grip in which the outer and inner mallets of each hand cross, and the outer mallet is closest to the palm of the hand.

Cross stick grip No. 2: a four-mallet grip in which the outer and inner mallets of each hand cross, and the inner mallet is closest to the palm of the hand.

"Opening" the mallets: when the inside and outside mallets of the same hand move away from each other.

"Closing" the mallets: when the inside and outside mallets of the same hand move toward each other.

Small interval: when the distance between any two bars of the keyboard is seven inches or less.

Large interval: when the distance between any two bars is more than seven inches but less than seventeen inches.

Extremely large interval: when the distance between any two bars of the keyboard is seventeen inches or more.

"Open" position: position of the mallets when playing a large or extremely large interval.

"Close" position: position of the mallets when playing a small interval.

"Movement of the outside mallet": refers to the motions necessary for the outside mallet to strike a different note while the inside mallet repeats the same note. (See Figure 2.)

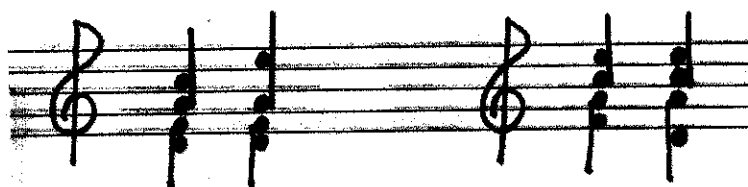


Fig. 2--Examples of "movement of outside mallet"

The playing of Figure 2 may require movement of both mallets and also a slight movement of the hand; however, only the outside mallet "moves" to a new pitch. All the motions necessary to allow the outside stick to strike the new note should be understood in the phrase "movement of the outside mallet."

"Movement of the inside mallet": all motions necessary for the inside mallet to strike a different note while the outside mallet repeats the same note. (See Figure 3.)

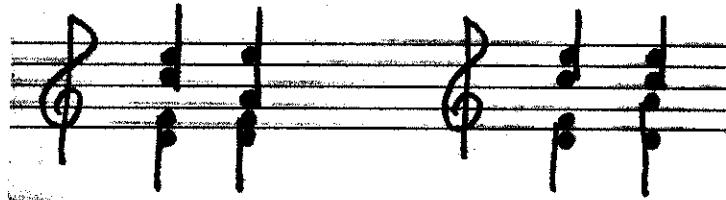


Fig. 3--Examples of "movement of inside mallet"

"Movement of the hand": refers to all the motions necessary when both the inside and outside mallets change pitches, but the intervals are such that there is little or no "opening" or "closing" of the mallets. (See Figure 4.)



Fig. 4--Examples of "movement of the hand"

Keyboard percussion instruments: those instruments with a horizontal, piano-type keyboard arrangement of bars which are struck with mallets held by the performer.

#### Delimitations

The evaluation was limited to research testing only, and opinions given in publications were not used.

The evaluation of efficiency was limited to the following movements:

- (a) horizontal movement of the outside mallet(s),
- (b) horizontal movement of the inside mallet(s),
- (c) horizontal movement of the hand(s).

## CHAPTER II

### THE THREE BASIC METHODS OF HOLDING FOUR MALLETS

There are three basic methods of holding and playing four mallets in common use today.<sup>1</sup> The purpose of this chapter is to give a thorough description of each of the three methods. Figure 5 identifies the parts of the hand used in the following discussion.

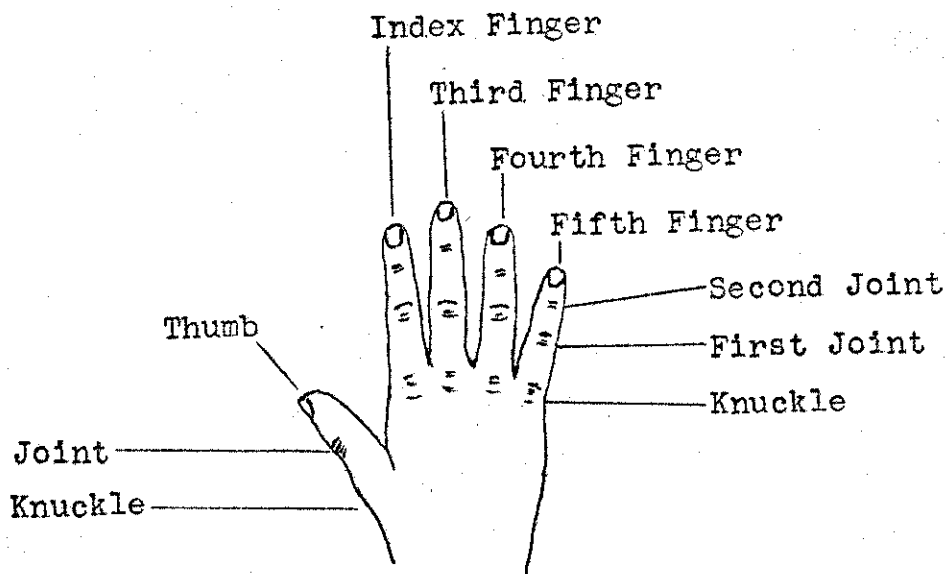


Fig. 5--Terms used in identifying parts of the hand

The manner in which the mallets are held is the same for both the right and left hand for each of the three grips.

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<sup>1</sup>Gary Burton, Four Mallet Studies (Glenview, Illinois, 1968), p. 3.

All illustrations of the grips are of the right hand to facilitate comparisons.

#### Musser Grip

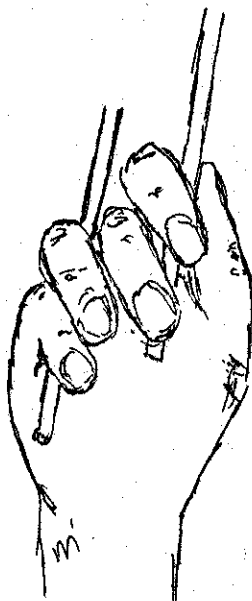


Fig. 6--View of the Musser grip in "close" position (for small intervals).

The name "Musser" grip has evolved from a method of holding four mallets which was developed and used by the late marimba manufacturer and performer, Clair Omar Musser.<sup>2</sup> In this grip the inner mallet is held between the thumb and the second joint of the index finger.<sup>3</sup> It is necessary for the inner mallet to be held very close to the end of the shaft so

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<sup>2</sup>James Moore, "Use Four Mallets!," Percussionist, IV (December, 1965), 5.

<sup>3</sup>Vida Chenoweth, "Four-Mallet Technique," Percussionist, I (December, 1963), 5.



that the sticks will not touch or cross when it (the inner mallet) is maneuvered for large intervals. The inner mallet is also partially held by the third finger, which is curved around the shaft just below the index finger.<sup>4</sup>

The outer mallet is held independently of the inner mallet. The shaft of the outer mallet extends between the third and fourth fingers and passes between the knuckle and first joint of these fingers. The fourth and fifth fingers are curled around the outer stick, which extends slightly (approximately one and one-half inches) past the fifth finger.<sup>5</sup> In Figure 6 the grip is shown in a "close" position from a view facing the palm of the hand.

Because the outer mallet is not held as near to the end of the shaft as the inner mallet, the ball of the inner mallet is further from the hand than the ball of the outer mallet. This will cause the inner mallet to be "longer" than the outer mallet.<sup>6</sup>

When changing from small to large intervals, or vice versa, the motion of the mallets is controlled independently. "Theoretically, the outer mallet is stationary while the inner one pivots toward or away from it in adjustment to various intervals."<sup>7</sup> After some facility has been obtained, however,

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<sup>4</sup>Moore, p. 5.

<sup>5</sup>Ibid.

<sup>6</sup>Ibid.

<sup>7</sup>Chenoweth, p. 5.

the outer mallet may also be maneuvered to aid in the "opening" and "closing" of the mallets.<sup>8</sup>

When playing large intervals, the inner mallet is usually held between the thumb and index finger in the same manner that is used for playing small intervals. Figure 7 shows the Musser grip in an "open" position.

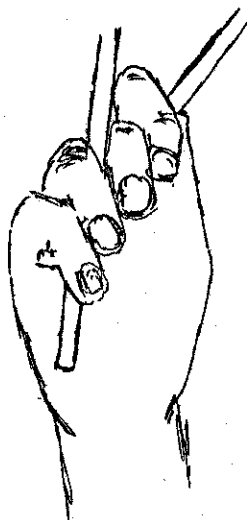


Fig. 7--View of Musser grip in "open" position (for large intervals).

However, when playing extremely large intervals the index and third fingers curve around the shaft and the thumb "slides" to the top of the shaft. (See Figure 8.) Less strain is involved in playing extremely large intervals in this manner.<sup>9</sup>

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<sup>8</sup>Ibid.

<sup>9</sup>Lionel Hampton, Method for Vibraharp, Xylophone and Marimba, edited by David Gornston (New York, 1939), p. 19.

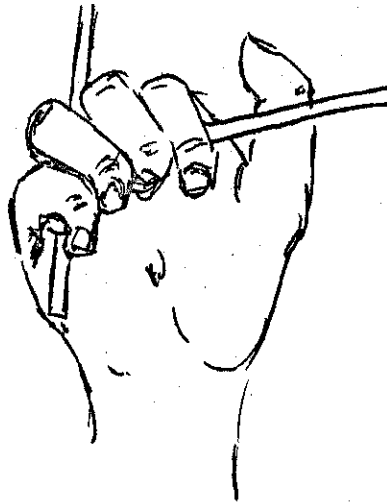


Fig. 8--View of Musser grip used in playing extremely large intervals.

When using the Musser grip, the palms of the hands will be almost perpendicular to the floor.<sup>10</sup> (See Figure 9.)

In most instances the playing of a major or minor second does not require an altered positioning of the hand or fingers. However, because the inner mallet is "longer" than the outer mallet, the playing of a minor second with the outer mallet striking an "accidental" bar and the inner mallet striking a "natural" bar will result in the need for a large hand turn. (See Figure 10.)

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<sup>10</sup>Hope Stoddard, "Xylophone, Marimba, Glockenspiel, Vibe," International Musician, LI (October, 1952), 24.

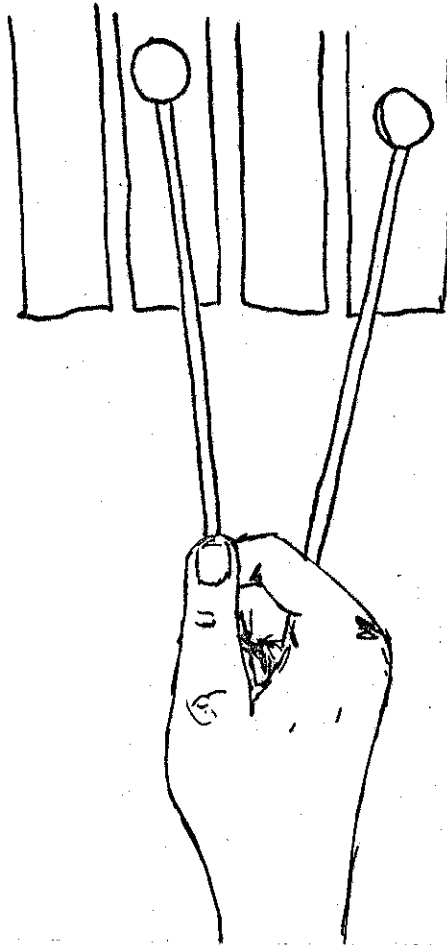


Fig. 9--Top View of Musser grip

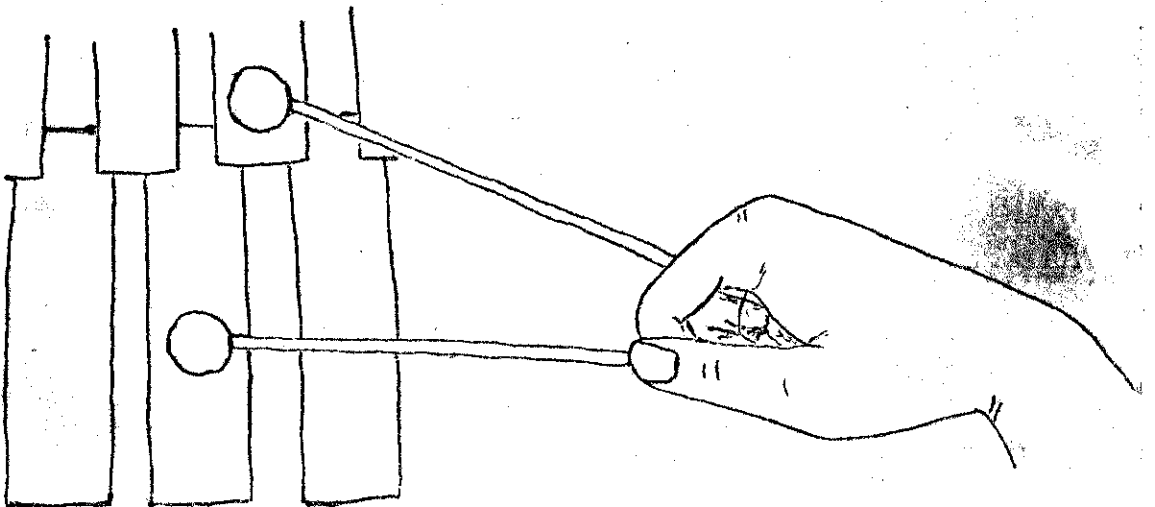


Fig. 10--View of Musser grip showing a large hand turn

## Cross Stick Grip No. 1

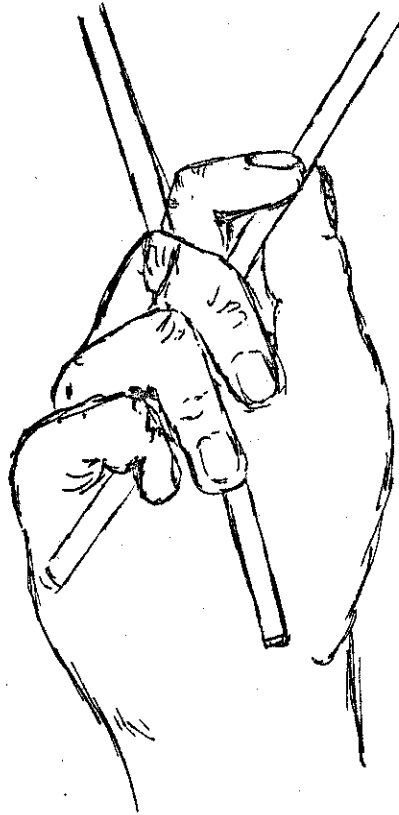


Fig. 11--View of cross stick grip No. 1 in "close" position

The "cross stick" method of holding four mallets is quite different from that of the Musser grip. Unlike the Musser grip the mallets cross, and, instead of two, only one finger is between the mallets.

When using cross stick grip No. 1, the shaft of the outer mallet extends between the index and third fingers and passes between the knuckle and the first joint of these two fingers.<sup>11</sup> This outer mallet is the closer of the two mallets to the palm of the hand at the point where the sticks cross. The mallets

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<sup>11</sup>Burton, p. 4.

normally cross approximately three inches from the ends of the sticks; however, this location may vary.

Although the outer mallet is held basically in the same position for both small and large intervals, this is not the case with the inner mallet. The position of individual fingers changes somewhat with the size of interval to be played. When playing small intervals the inside mallet comes between the thumb and index finger. (See Figure 11.)

When playing large or extremely large intervals, the index finger is curled around the shaft slightly closer to the end, and the inside mallet is below and on the side of the thumb.<sup>12</sup> (See Figure 12.)

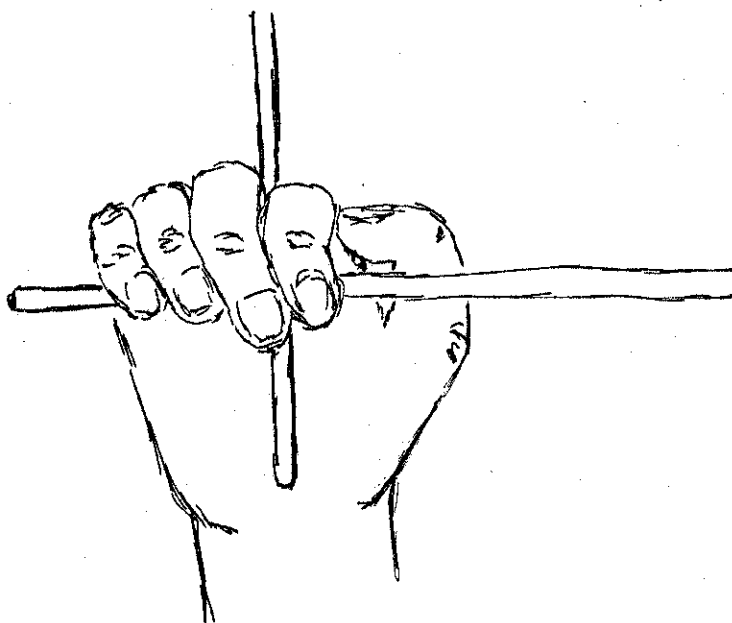


Fig. 12--View of cross stick grip No. 1 in "open" position

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<sup>12</sup>Ibid., pp. 4-5.

When playing a small interval, the third finger is curled around the point where the sticks cross, but is curled only over the inside mallet and touches the outside mallet with the tip when playing large intervals.<sup>13</sup>

The position of the fourth finger also changes in that it is curled over the inside mallet and touches the outside mallet with the tip when playing small intervals, and is curled around only the inside mallet when playing large intervals. The fifth finger will always remain curled around the inside mallet.<sup>14</sup>

In cross stick grip No. 1 the fourth and fifth fingers play an important part in moving the mallets from an "open" to "close" position.

Instead of the task of opening and closing the mallets falling solely upon the index finger and thumb, the fourth and fifth fingers should be used. The third finger is to stabilize the outer mallet. The fourth and fifth fingers then can pull or push the inner mallet along with the index finger and thumb to facilitate the desired opening and closing of the mallets. [It should be stressed] how important it is to put these two fingers to work. Their use will mean the difference between a minimum of mallet control, and a maximum of mallet control. One might even say that the secret to four mallet control is in using the fourth and fifth fingers.<sup>15</sup>

When playing a major or minor second, either (a) the index finger must be extended or removed from between the mallets, or (b) the mallets must be at an angle which will permit the playing of the interval with the index finger

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<sup>13</sup>Ibid.

<sup>14</sup>Ibid.

<sup>15</sup>Ibid., p. 5.

remaining between the mallets. (See Figures 13 and 14.) It is possible (and may sometimes be necessary) to use a combination of these two procedures.

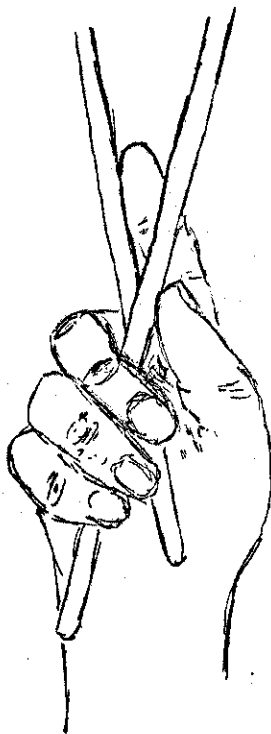


Fig. 13--View of cross stick grip No. 1 with extended index finger for the playing of a major or minor second.

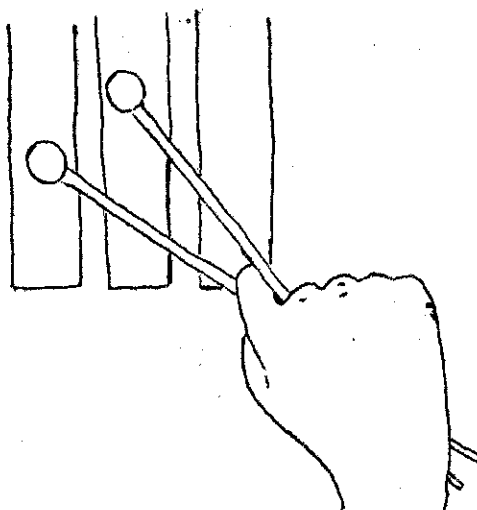


Fig. 14--View of cross stick grip No. 1 with mallets angled for the playing of a major or minor second.



## Cross Stick Grip No. 2

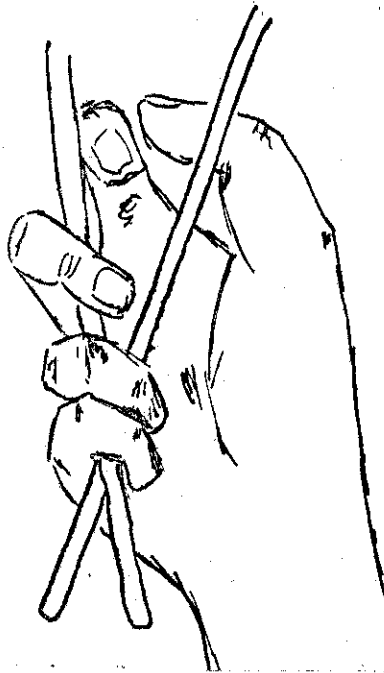


Fig. 15--View of cross stick grip No. 2 in "close" position

Cross stick grip No. 2 may look and, at first, seem to be very similar to the previous grip described (cross stick grip No. 1). However, a more detailed evaluation will show substantial differences.

The mallets are crossed approximately three inches from the ends of the sticks as in the previous method, but with this grip the outside mallet is on the bottom and the inside mallet is closest to the palm. The outer mallet extends between the index and third fingers, which are both curved but not curled around the stick. The shaft passes between the first and second joints of the index finger and crosses the third finger at the first joint.<sup>16</sup> (See Figure 15.)

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<sup>16</sup>Howard M. Peterson, The Mallet Instrumental Fundamental Series--Book One (New York, 1966), pp. 2-3.

The fourth and fifth fingers are curled around the point where the sticks cross and, except for extremely large intervals, never change their basic position.<sup>17</sup> (See Figure 16.)

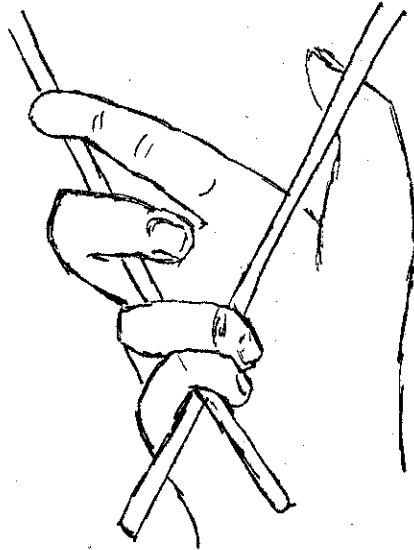


Fig. 16--View of cross stick grip No. 2 in "open" position

In the case of an extremely large interval, the fourth finger may release its grip and, therefore, leave only the fifth finger to be curled around the point where the sticks cross. (See Figure 17.) Thus, the outer mallet is held between the index and third fingers, and also by the fourth and fifth fingers (only the fifth finger in extremely large intervals) where the sticks cross.

The inside mallet is also held by the fourth and fifth fingers at the crossing point and is aided by the thumb, which

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<sup>17</sup>Phil Kraus, Modern Mallet Method, edited by Doug Allan (New York, 1960), pp. VIII, X.

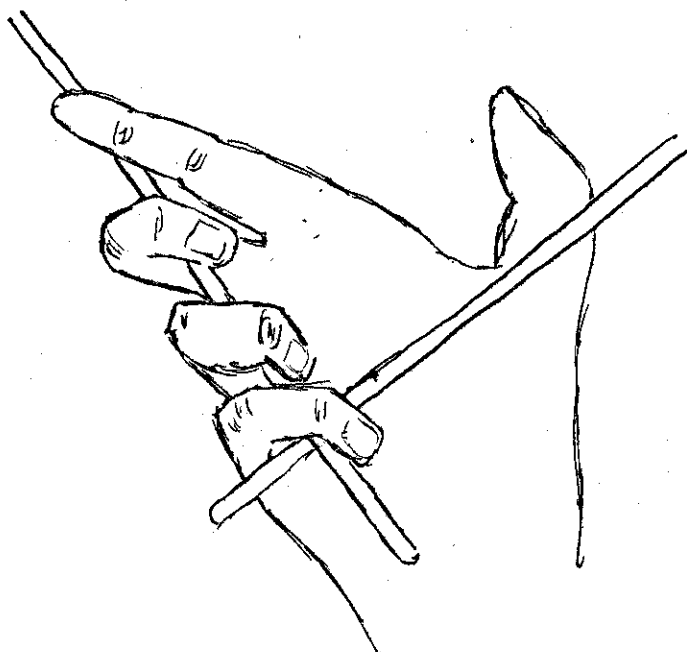


Fig. 17--View of cross stick grip No. 2 used in playing extremely large intervals.

exerts pressure on the top of the shaft when playing small intervals and on the inside (side nearest the index finger) of the shaft when playing large intervals.<sup>18</sup> The shaft passes between the joint and tip of the thumb when playing both large and small intervals. However, when playing exceptionally large intervals, the shaft usually passes between the joint and the knuckle of the thumb. (See Figures 15, 16 and 17.)

The "opening" and "closing" of the mallets that is necessary for the playing of large and small intervals is done by (a) the thumb, plus some assistance from the fourth and fifth fingers, for the inside mallet, and (b) the index and

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<sup>18</sup>Jacques Delécluse, Méthode Complète de Vibraphone (Paris, 1963), pp. 59-61.

third fingers, plus some assistance from the fourth and fifth fingers, for the outside mallet.<sup>19</sup>

The procedures for playing major and minor seconds are the same as those listed under 'Cross Stick Grip No. 1.

Figure 18 shows the grip when the index finger is extended.

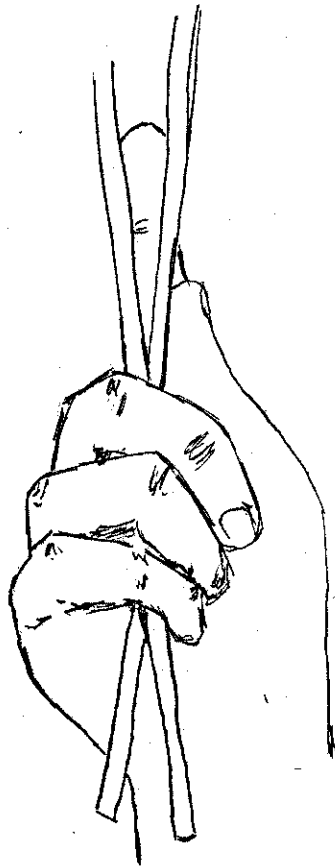


Fig. 18--View of cross stick grip No. 2 with extended index finger for the playing of a major or minor second.

When playing a major or minor second using the hand turn method, the view looks identical to Figure 14.

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<sup>19</sup>Kraus, p. VIII.

## CHAPTER III

### DESCRIPTION OF RESEARCH TEST PROCEDURES

The following is an explanation and description of the research testing which was conducted by the author.

#### Purpose of Research Test

The purpose of this test was to see if any conclusive evidence could be obtained concerning the efficiency of the three grips.

#### Selection of Test Material

When playing a keyboard percussion instrument, both vertical and horizontal movements are necessary. Because vertical movements are an inherent part of any aspect of playing, it was decided to concentrate the testing on the horizontal movements. Also, due to the nature of the grips and the type of playing involved, the horizontal movements are the primary factors influencing the efficiency of the grip.

The following horizontal movements are possible when playing with four mallets: (a) movement of the outside mallet(s), (b) movement of the inside mallet(s), (c) movement of the hands(s), and (d) any combination of the above movements.

Figures 19 through 27 are excerpts from the solo keyboard percussion literature. They show examples of each of the first three types of horizontal movements.

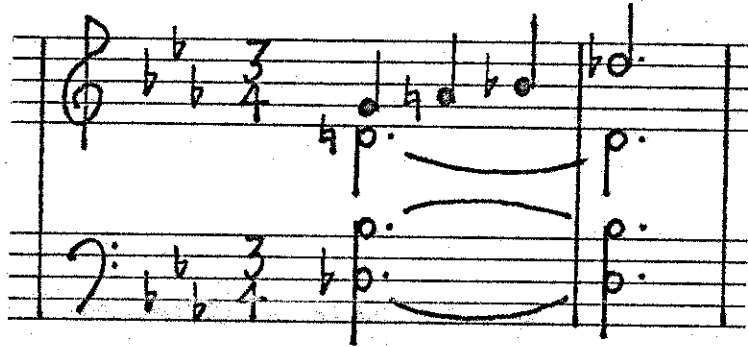


Fig. 19--Movement of the right-hand outside mallet (from the second movement of Concerto for Marimba and Orchestra by Robert Kurka).

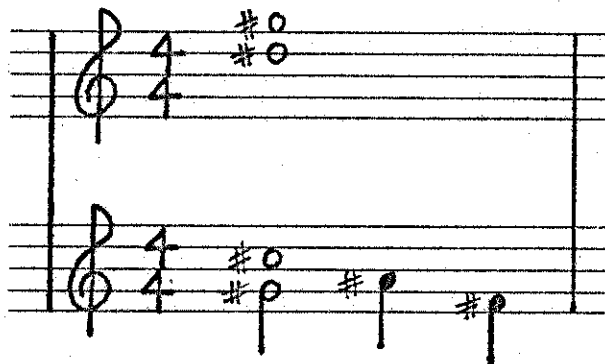


Fig. 20--Movement of the left-hand outside mallet (from the first movement of Suite for Marimba by Alfred Fissinger).

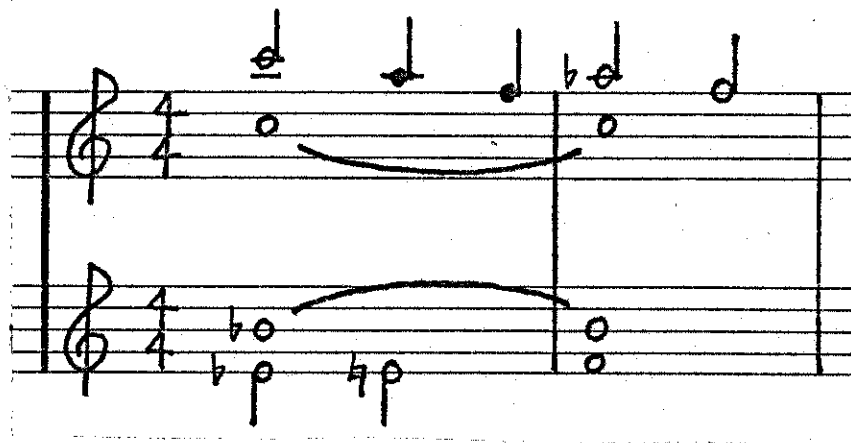


Fig. 21--Movement of both right- and left-hand outside mallets (from the first movement of Concerto for Marimba and Orchestra by Robert Kurka).

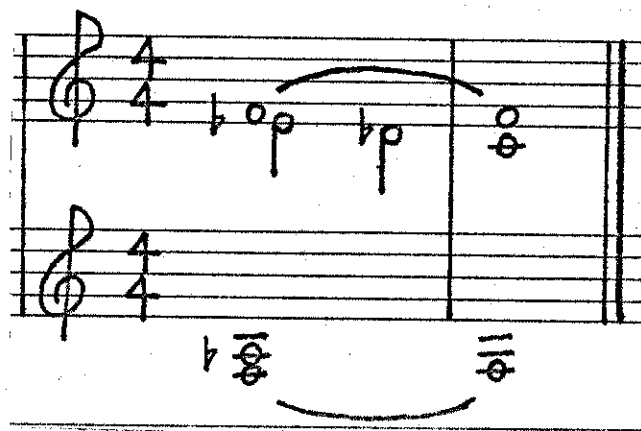


Fig. 22--Movement of right-hand inside mallet (from the second movement of Suite for Marimba by Alfred Fissinger).

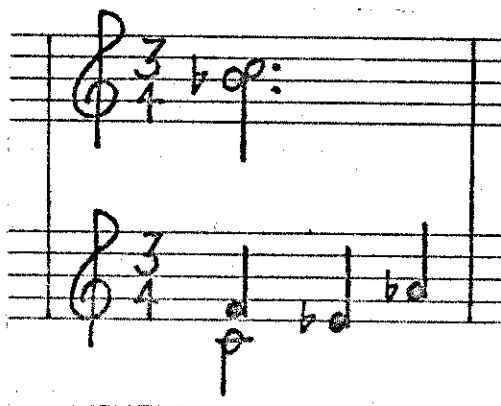


Fig. 23--Movement of left-hand inside mallet (from the second movement of Concerto pour Marimba et Vibraphone by Darius Milhaud).

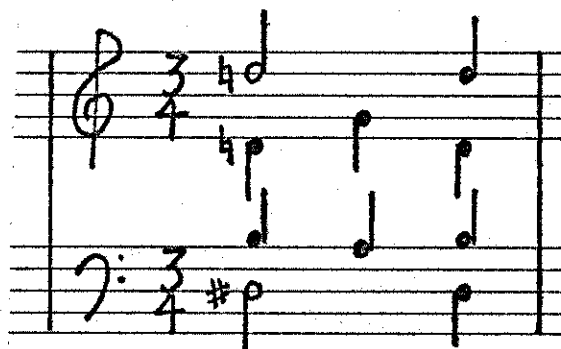


Fig. 24--Movement of both right- and left-hand inside mallets (from the second movement of Suite No. 1 for Marimba by E. J. Ulrich).

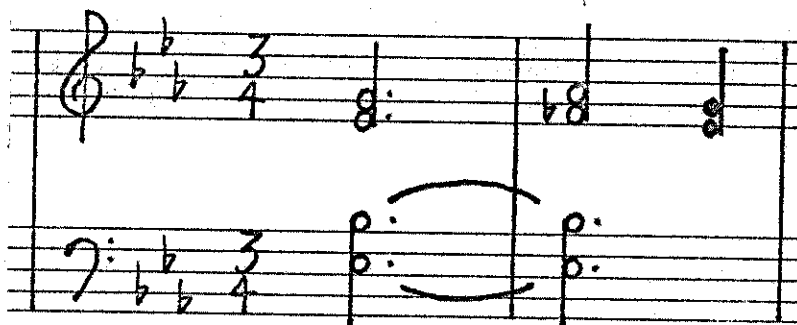


Fig. 25--Movement of the right hand (from the second movement of Concerto for Marimba and Orchestra by Robert Kurka).





Fig. 26--Movement of the left hand (from the second movement of Concerto pour Marimba et Vibraphone by Darius Milhaud).

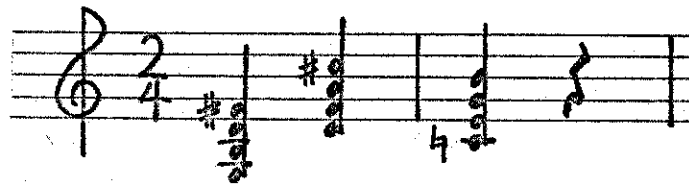


Fig. 27--Movement of both hands (from the second movement of Concerto for Marimba and Orchestra by Paul Creston).

Figure 28 is part of the "Chorale" movement from Suite No. 1 for Marimba by E. J. Ulrich. It provides an excellent example of combinations of the preceding three types of movements.

#### Procedure of Testing

Forty individuals participated in the research testing. Four tests were conducted, and each test had ten participants. The individuals who participated in Tests I, II and III had no previous four-mallet experience. The individuals who participated in Test IV had previous four-mallet experience.

The image displays a musical score for Marimba No. 1, consisting of three systems of music. Each system is written on two staves: a treble clef staff on top and a bass clef staff on the bottom. The music is in 3/4 time and features a key signature of one sharp (F#). The notation includes various rhythmic values such as quarter, eighth, and sixteenth notes, as well as rests. Brackets and curved lines are used to group notes across staves, indicating specific mallet and hand movements. The first system shows a complex rhythmic pattern with many beamed notes. The second system features a more melodic line with some rests. The third system continues the melodic and rhythmic development, ending with a final note on each staff.

Fig. 28--Combination of mallet and hand movements (from the second movement of Suite No. 1 for Marimba by E. J. Ulrich).

The testing was divided in the following manner:

- (a) Test I--movement of the outside mallet(s)
- (b) Test II--movement of the inside mallet(s)
- (c) Test III--movement of the hand(s)
- (d) Test IV--movement of the outside mallet(s)

Because complete isolation of each problem was desired, special procedures were employed. First, only one hand (the right hand) was used, thus eliminating the problem of coordinating both hands together. The right hand was chosen arbitrarily. Because the method of holding the mallets is identical for either hand, results should be proportionately the same. Second, the intervals were simple, repetitious, and could be remembered easily. Third, the intervals were given orally, thus eliminating the problem of "reading."

The following precautions were taken to ensure a fair test:

- (a) All tests were conducted on the same instrument (marimba) and in the same room.
- (b) All tests were conducted by the same person (the author).
- (c) The times taken on the test were made with the use of a stop watch.
- (d) Each subject was tested individually.
- (e) Each subject played the same intervals with each of the three grips.

(f) The order in which the grips were shown was varied so that no one grip was always first, or always second, or always last.

(g) Each grip was shown and then tested before another grip was shown.

(h) Each grip was given approximately the same initial amount of time for its explanation. More explanation was given any grip upon the request of the subject.

(i) Immediately after the test was completed, it was given again to the same subject, and thus an average of the two tests could be taken.

#### Test I--Movement of Outside Mallet

Test I was conducted in the following manner.

Step 1: The test procedure was briefly explained to the subject.

Step 2: One of the three grips was shown to the subject. This included instruction on how to make interval changes.

Step 3: The subject was requested to play the following interval.

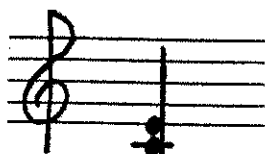


Fig. 29--First interval

Step 4: The subject was then requested to play the following interval.



Fig. 30--Second interval

Step 5: The subject was requested to practice alternating from the first interval to the second interval several times. (See Figure 31.)



Fig. 31--First set of interval changes of Test I

Step 6: The subject was stopped and then asked to play the two intervals in alternation for a total of ten times as fast as possible while still maintaining a high degree of accuracy. The playing of both intervals was considered to be "one time." He was not responsible for counting the intervals.

Step 7: The command was given to begin. A stop watch was started with the striking of the first interval and stopped after the ten alternating intervals (a total of twenty individual intervals) had been completed. The time was recorded.

A recording of the accuracy was also made. When the subject's accuracy was considered "good" (less than four mistakes), no marks were given. When the accuracy was considered "fair" (from four to seven mistakes), one mark (x) was given. When the accuracy was considered "poor" (eight or more mistakes), two marks (xx) were given. A mistake consisted of playing an incorrect note (by either mallet) or allowing the inside mallet to strike before the outside mallet (or vice versa) when playing an interval.

When the subject (a) started before the command was given, (b) was not ready to begin when the command was given, (c) dropped the sticks, or (d) lost all control of the sticks, the time was not taken. No penalty of time or accuracy was charged for this type of occurrence. A new testing of the same interval change was made.

Step 8: After the completion of testing the first set of intervals, the subject was instructed to use the same grip and play the following combination of intervals.



Fig. 32--Second set of interval changes of Test I

Step 9: He was requested to practice making the interval change several times.

Step 10: Same as Step 6.

Step 11: Same as Step 7.

Step 12: The subject was instructed to use the same grip and play the following combination of intervals.



Fig. 33--Third set of interval changes of Test I

Step 13: Same as Step 9.

Step 14: Same as Step 6.

Step 15: Same as Step 7.

Step 16: Using the same grip, the subject was instructed to play the following combination of intervals.

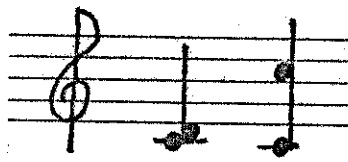


Fig. 34--Fourth set of interval changes of Test I

Step 17: Same as Step 9.

Step 18: Same as Step 6.

Step 19: Same as Step 7.

Step 20: A new grip was demonstrated to the subject (which again included instruction on how to make interval changes).

Step 21: Using this new grip, he was requested to play the first set of interval changes. (See Figure 31.)

Step 22: Same as Step 9.

Step 23: Same as Step 6.

Step 24: Same as Step 7.

Steps 25-37: The same process was continued for the next three sets of interval changes. (See Figures 32, 33 and 34.)

Steps 38-55: The remaining grip was demonstrated, and all the procedures (practicing, etc.) were followed in playing the same four sets of interval changes.

Steps 56-95: After all four sets of interval changes had been completed with all three grips, the entire process of playing all the interval changes with each of the three grips was repeated. However, for the second testing the subject was requested not to practice making the interval changes before timing the test (an exclusion of Step 9).

Step 96: After the test was completed the second time, the subject was asked which of the three grips he preferred. His answer was recorded on the test sheet.

Step 97: The subject was then requested to read a statement and sign it if he agreed with its contents. The statement was as follows:

To the best of my knowledge, the tester showed no prejudice either for or against any of the three grips which I was shown. The choosing of the grip which I liked best was completely my own.

SIGNED: \_\_\_\_\_

Each of the ten subjects agreed that the statement was true and signed as requested.



Test II--Movement of Inside Mallet

The procedure for Test II was exactly the same as for Test I, except different sets of intervals were tested.

The following four interval changes were given.

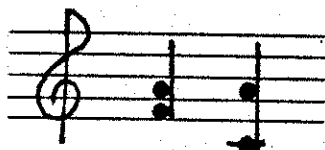


Fig. 35--First set of interval changes of Test II



Fig. 36--Second set of interval changes of Test II

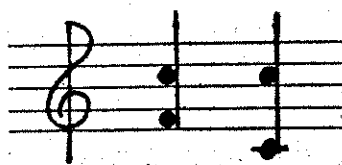


Fig. 37--Third set of interval changes of Test II

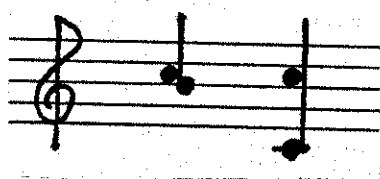


Fig. 38--Fourth set of interval changes of Test II

Test III--Movement of the Hand

The procedure for Test III was exactly the same as for Test I and Test II, except different sets of intervals were tested.

The following four interval changes were given.



Fig. 39--First set of interval changes of Test III



Fig. 40--Second set of interval changes of Test III

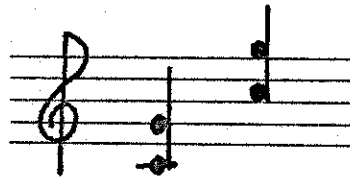


Fig. 41--Third set of interval changes of Test III



Fig. 42--Fourth set of interval changes of Test III

Although the distances from the centers of the bars are different in the third and fourth sets of intervals, it is still possible to play them without "opening" or "closing" the mallets. For example, Figure 43 shows the distances between the bars for the fourth set of intervals. As shown by the illustration, the mallets could be approximately fifteen inches apart and easily strike both intervals.

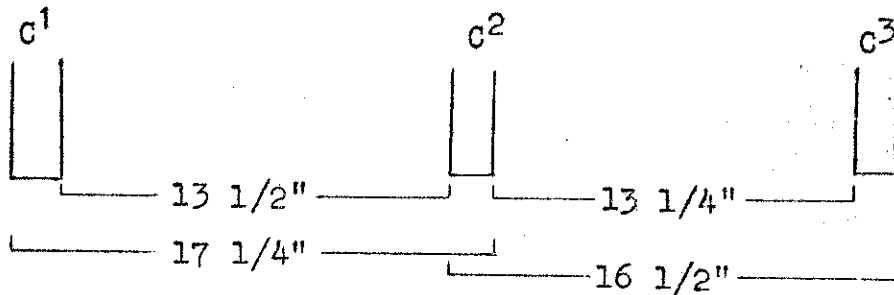


Fig. 43--Distances between the bars for the fourth set of intervals.

#### Test IV--Movement of the Outside Mallet

The procedure for Test IV was similar to Test I in that the same sets of interval changes were used for both tests. However, because the subjects for Test IV had previous experience playing with four mallets, the following procedural changes were made.

(a) The grip that the subject used for his four-mallet playing was always tested first.

(b) No attempt was made to demonstrate the grip that the subject already used.

(c) The subject was not asked to comment on which grip he preferred, and, therefore, was not requested to sign the statement shown on page 31.

## CHAPTER IV

### PRESENTATION OF RESEARCH DATA

The results of the forty subjects who participated in the testing are given in this chapter. The results of each test are given separately.

#### Test I--Movement of Outside Mallet

Five tables showing different analyses of Test I are given so that a clear understanding of the results can be obtained.

Each of the ten subjects who participated in Test I had two sets of time ratings and two sets of accuracy marks. For convenience of analysis, the average of the two time ratings was taken. However, to avoid fractions, the total number of accuracy marks was recorded. Therefore, each set of interval changes received an accuracy rating from zero (good) to four (poor) and one time rating.

#### Table I

Table I shows the following for each grip: (a) the subject's average time for each set of interval changes, and (b) the subject's total accuracy marks recorded against each set of interval changes. The grip which each subject liked best is also given. A dash (--) appearing in a column means

TABLE I  
TEST I (MOVEMENT OF OUTSIDE MALLET) RESULTS

Player	Interval Changes	Musser Grip	
		Avg. Time	Accuracy
No. 1	CE to CA	10.5	xxx
	CD to CG	8.7	xxx
	CG to CC	--	
	CD to CC	--	
No. 2	CE to CA	14.0	x
	CD to CG	14.7	x
	CG to CC	16.7	xx
	CD to CC	22.3	xxx
No. 3	CE to CA	18.0	
	CD to CG	22.0	
	CG to CC	19.5	xx
	CD to CC	--	
No. 4	CE to CA	13.5	
	CD to CG	10.9	x
	CG to CC	11.6	xxxx
	CD to CC	--	
No. 5	CE to CA	8.1	
	CD to CG	9.5	
	CG to CC	8.5	x
	CD to CC	10.5	xx
No. 6	CE to CA	10.8	
	CD to CG	11.2	x
	CG to CC	12.2	xx
	CD to CC	15.6	xxx
No. 7	CE to CA	10.3	
	CD to CG	10.5	
	CG to CC	12.7	xx
	CD to CC	18.2	xxx
No. 8	CE to CA	8.5	xxx
	CD to CG	7.9	xxx
	CG to CC	--	
	CD to CC	--	
No. 9	CE to CA	8.1	x
	CD to CG	7.2	
	CG to CC	10.0	xx
	CD to CC	12.0	xxxx
No. 10	CE to CA	10.8	xxx
	CD to CG	10.0	xxx
	CG to CC	--	
	CD to CC	--	

TABLE I--Continued

Cross Stick Grip No. 1		Cross Stick Grip No. 2		Grip Preferred
Avg. Time	Accuracy	Avg. Time	Accuracy	
9.7	xxx	8.9	xx	Cross Stick No. 2
8.7	xxx	9.9	xx	
11.4	xx	8.5	xx	
11.1	xxx	9.6	xxx	
14.4		12.2		Cross Stick No. 2
12.3	xx	10.8		
16.9	xxx	13.5	x	
18.8	xxx	15.2	x	
13.6		14.0		Cross Stick No. 2
14.7	x	14.9		
13.5		11.9		
22.4	x	20.5	xx	
9.5		7.7		Cross Stick No. 2
9.8		9.3		
13.2	xx	9.6	x	
15.1	xxx	14.9	xx	
9.0		8.4		Cross Stick No. 1
9.0		7.8		
9.1	xx	7.8	x	
13.0	xx	9.8	x	
13.0		10.2		Cross Stick No. 2
16.6	x	12.0		
17.2	xx	10.8	x	
24.2	xxx	14.6	xx	
9.4		9.7		Cross Stick No. 1
12.1		10.1		
12.0	xx	11.3	x	
18.5	xx	14.6	xx	
9.6	xx	8.4	xx	Musser
9.8	xx	9.0	xxx	
11.3	xx	8.6	xx	
13.2	xxxx	9.6	xxx	
10.2		9.4		Cross Stick No. 2
9.5		6.5		
10.6	xx	10.8	xx	
12.9	xxxx	12.1	xxxx	
10.3	x	7.3		Cross Stick No. 2
9.1	x	6.5		
10.9	xxx	7.2	xx	
14.0	xxxx	8.5	xx	

that the subject was unable to make the interval change. This occurred with the Musser grip only.

Table I shows that the cross stick grip No. 2 was the preferred grip seven times as compared to two times for the cross stick grip No. 1 and only one time for the Musser grip.

#### Table II

Table II shows the following for each grip: (a) a total of the average times of the four sets of interval changes made by each subject, (b) the total number of accuracy marks for all four sets of interval changes made by each subject, (c) the total of all the average times made by the ten subjects, and (d) the total of all the accuracy marks made by the ten subjects.

In Table II the results of cross stick grip No. 1 and cross stick grip No. 2 can be compared easily and exactly. However, when comparing the time and accuracy marks of the Musser grip to the other two grips, allowances must be made for the unsuccessful attempts which occurred.

Both the total time and the total number of accuracy marks for the cross stick grip No. 2 are substantially better than the cross stick grip No. 1. Although not as clearly shown, the totals of the cross stick grip No. 1 are also substantially better than the totals of the Musser grip.

Because the judging of the accuracy was not exact, small differences in accuracy totals between grips should be disregarded. However, when there is a large difference in



TABLE II  
TIME AND ACCURACY TOTALS FOR MOVEMENT OF OUTSIDE MALLETS

Player	Musser Grip		Cross Stick Grip No. 1		Cross Stick Grip No. 2	
	Total Avg. Time	Total Accuracy	Total Avg. Time	Total Accuracy	Total Avg. Time	Total Accuracy
No. 1	19.2 (-2)*	6	40.9	11	36.9	9
No. 2	67.7	7	62.4	8	51.7	2
No. 3	59.5 (-1)**	2	64.2	2	61.3	2
No. 4	36.0 (-1)**	5	47.6	5	41.5	3
No. 5	36.6	3	40.1	4	33.8	2
No. 6	49.8	6	71.0	6	47.6	3
No. 7	51.7	5	52.0	4	45.7	3
No. 8	16.4 (-2)*	6	43.9	10	35.6	10
No. 9	37.3	7	43.2	6	38.8	6
No. 10	20.8 (-2)*	6	44.3	9	29.5	4
Total	395.0 (-8)***	54	509.6	65	422.4	44

\*Indicates that two of the four sets of interval changes were not successfully completed.

\*\*Indicates that one of the four sets of interval changes was not successfully completed.

\*\*\*Indicates that eight of the forty sets of interval changes were not successfully completed.

accuracy totals between the grips (as in Table II), a comparison can be made.

Table III

Using the computations in Table II, Table III shows the number of times each grip had the first, second and third (fastest, second fastest and slowest respectively) time ratings recorded. The time ratings of the Musser grip for players No. 1, 3, 4, 8 and 10 were considered the slowest of the three grips due to the unsuccessful attempts. This was necessary in order to show a comparison

TABLE III

NUMBER OF FIRST, SECOND AND THIRD TOTAL AVERAGE TIME RATINGS FOR EACH GRIP OF TEST I

Time Rating	Musser Grip	Cross Stick Grip No. 1	Cross Stick Grip No. 2
First*	1	0	9
Second**	3	6	1
Third***	6	4	0

\*Fastest of the three grips.

\*\*Second fastest of the three grips.

\*\*\*Slowest of the three grips.

Nine of the ten subjects had a faster time rating using cross stick grip No. 2. This shows that the difference between the total time rating of the cross stick grip No. 2 and the other two grips was not the result of one or two subjects.

Of the three grips, the time ratings of the Musser grip were the least consistent. Five of the six "third" ratings were the result of unsuccessful attempts. Of the five subjects who completed all the interval changes, the Musser grip was "third" only once, and one of the subjects had the fastest time rating when using the Musser grip.

Table IV

By again using the computations in Table II, Table IV shows the number of times each grip had the first, second and third (best, second best and third best respectively) accuracy ratings. As before, it was necessary for the rating marks of the Musser grip for players No. 1, 3, 4, 8 and 10 to be considered the least accurate of the three grips due to the unsuccessful attempts. (The decimal figures indicate a "tie" between the grips.)

TABLE IV

NUMBER OF FIRST, SECOND AND THIRD TOTAL ACCURACY RATINGS FOR EACH GRIP OF TEST I

Accuracy Rating	Musser Grip	Cross Stick Grip No. 1	Cross Stick Grip No. 2
First*	0	1.5	8.5
Second**	2.5	6	1.5
Third***	7.5	2.5	0

\*Number of times with the best accuracy of the three grips.

\*\*Number of times with the second best accuracy of the three grips.

\*\*\*Number of times with the least accuracy of the three grips.

Because the cross stick grip No. 2 had the best accuracy 85 per cent of the time, it was clearly the most accurate of the three grips. Likewise, because of the poor accuracy ratings of the Musser grip, it was clearly the least accurate of the three grips.

#### Table V

Table V shows the number of times each grip had first, second and third time ratings for each set of interval changes. The total number of accuracy marks for each set of interval changes is also given.

Several new observations can be made with the aid of this table. The cross stick grip No. 2 had the best time and accuracy ratings in each set of interval changes. However, the greatest differences can be seen in the third and fourth sets of interval changes, both of which included the playing of an octave. In both of these instances the cross stick grip No. 2 was the fastest 90 per cent of the time.

#### Summary of Test I

The following is a summary of the over-all results of the ten subjects who participated in Test I.

Of the three grips, (a) 10 per cent of the subjects preferred the Musser grip, (b) 20 per cent preferred the cross stick grip No. 1, and (c) 70 per cent preferred the cross stick grip No. 2.

Combining the four sets of interval changes for the ten subjects, (a) the Musser grip was the fastest 10 per cent of

TABLE V

NUMBER OF FIRST, SECOND AND THIRD TIME RATINGS AND TOTAL ACCURACY MARKS FOR EACH SET OF INTERVAL CHANGES

Time Rating	Musser Grip	Cross Stick Grip No. 1	Cross Stick Grip No. 2
Intervals: CE to CA			
First	2	2	6
Second	3	3	4
Third	5	5	0
	Total Number of Accuracy Marks: 11	Total Number of Accuracy Marks: 6	Total Number of Accuracy Marks: 4
Intervals: CD to CG			
First	3.5	1.5	5
Second	2.5	4.5	3
Third	4	4	2
	Total Number of Accuracy Marks: 12	Total Number of Accuracy Marks: 10	Total Number of Accuracy Marks: 5
Intervals: CG to CC			
First	1	0	9
Second	4	6	0
Third	5	4	1
	Total Number of Accuracy Marks: 15 (-3)*	Total Number of Accuracy Marks: 20	Total Number of Accuracy Marks: 13
Intervals: CD to CC			
First	1	0	9
Second	3	6	1
Third	6	4	0
	Total Number of Accuracy Marks: 15 (-5)*	Total Number of Accuracy Marks: 29	Total Number of Accuracy Marks: 22

\*Indicates the number of unsuccessful attempts.

the time, (b) the cross stick grip No. 1 was fastest none of the time, and (c) the cross stick grip No. 2 was fastest 90 per cent of the time.

Again combining the four sets of interval changes for the ten subjects, (a) the Musser grip had the best accuracy none of the time, (b) the cross stick grip No. 1 had the best accuracy 15 per cent of the time, and (c) the cross stick grip No. 2 had the best accuracy 85 per cent of the time.

In the first set of interval changes (a) the Musser grip was fastest 20 per cent of the time, (b) the cross stick grip No. 1 was fastest 20 per cent of the time, and (c) the cross stick grip No. 2 was fastest 60 per cent of the time.

In the second set of interval changes (a) the Musser grip was fastest 35 per cent of the time, (b) the cross stick grip No. 1 was fastest 15 per cent of the time, and (c) the cross stick grip No. 2 was fastest 50 per cent of the time.

In the third set of interval changes (a) the Musser grip was fastest 10 per cent of the time, (b) the cross stick grip No. 1 was fastest none of the time, and (c) the cross stick grip No. 2 was fastest 90 per cent of the time.

In the fourth set of interval changes (a) the Musser grip was fastest 10 per cent of the time, (b) the cross stick grip No. 1 was the fastest none of the time, and (c) the cross stick grip No. 2 was the fastest 90 per cent of the time.

### Test II--Movement of Inside Mallet

The tables for Test II correspond to those given for Test I and appear in the same order. Therefore, the explanation for each table of Test II is omitted.

#### Table VI

The choices of preferred grip are considerably different from those of Test I. The number of choices for the Musser grip (which was four) almost equaled the number for the cross stick grip No. 2 (which was five). The cross stick grip No. 1 was preferred only once.

#### Table VII

Unlike Test I, the total times for the Musser grip and cross stick grip No. 2 are extremely close. (Again, allowances must be made for the unsuccessful attempts which occurred.) Both the Musser grip and cross stick grip No. 2 had substantially better total times than the cross stick grip No. 1. Because the total number of accuracy marks of cross stick grip No. 2 was approximately half the totals of the other two grips, it (cross stick grip No. 2) was definitely the most accurate of the three grips in Test II.

#### Table VIII

The "first" time ratings are equally divided between the Musser grip and cross stick grip No. 2, with five each. The cross stick grip No. 1 had the slowest time rating a total of eight times. This table shows that the total time

TABLE VI  
TEST II (MOVEMENT OF INSIDE MALLET) RESULTS

Player	Interval Changes	Musser Grip	
		Avg. Time	Accuracy
No. 1	AF to AC	10.0	xxx
	GF to GC	9.6	
	CF to CC	10.2	xxxx
	CB to CC	10.1	xx
No. 2	AF to AC	10.1	xx
	GF to GC	9.5	xx
	CF to CC	10.0	xxx
	CB to CC	12.4	xxx
No. 3	AF to AC	12.0	
	GF to GC	11.1	x
	CF to CC	12.6	xxx
	CB to CC	17.0	xxx
No. 4	AF to AC	13.1	x
	GF to GC	11.3	x
	CF to CC	13.0	xx
	CB to CC	12.8	xxx
No. 5	AF to AC	15.7	xx
	GF to GC	20.2	xxx
	CF to CC	19.8	xxx
	CB to CC	--	
No. 6	AF to AC	13.1	
	GF to GC	11.3	
	CF to CC	12.8	xx
	CB to CC	13.8	xx
No. 7	AF to AC	10.6	
	GF to GC	9.3	x
	CF to CC	13.0	xxxx
	CB to CC	12.7	xxx
No. 8	AF to AC	10.3	x
	GF to GC	10.5	xxx
	CF to CC	12.6	xxxx
	CB to CC	--	
No. 9	AF to AC	12.8	x
	GF to GC	12.6	
	CF to CC	13.2	xx
	CB to CC	14.4	xx
No. 10	AF to AC	17.0	x
	GF to GC	17.9	xx
	CF to CC	15.7	xx
	CB to CC	16.4	xxx



TABLE VI--Continued

Cross Stick Grip No. 1		Cross Stick Grip No. 2		Grip Preferred
Avg. Time	Accuracy	Avg. Time	Accuracy	
11.5	XX	10.0	X	Musser
11.0	XXX	10.3	XX	
12.7	XXXX	11.5	XXX	
15.0	XXXX	13.6	XXX	
9.8		8.9		Cross Stick No. 1
13.0	XXX	10.2		
12.5	XXX	10.0	X	
14.9	XXXX	13.2	XX	Cross Stick No. 2
13.6	X	10.8	X	
12.9	X	10.5		
14.0	X	10.3	XX	
19.2	XXXX	14.3	XXX	Cross Stick No. 2
13.8		11.5		
12.9		9.5		
14.7	XX	12.9	XX	
20.5	XXX	12.6	XX	Cross Stick No. 2
19.3	X	13.1		
21.8	X	14.2		
20.2	XX	17.4	X	
26.3	XXXX	19.4	XXX	Musser
13.2		12.2		
14.5		13.3		
17.6	XX	13.0	X	
22.2	XXX	19.4	XX	Musser
13.8	X	11.5		
14.3	XX	10.6	X	
13.4	XXXX	13.6	XX	
18.7	XXXX	14.0	XXX	Cross Stick No. 2
11.0	X	9.6		
12.6	XX	9.2		
12.2	XX	11.2	XX	
13.1	XX	12.7	XX	Musser
16.5	X	12.7		
13.5	X	13.1	X	
13.9	XXX	14.5	XX	
16.0	XX	17.1	X	Cross Stick No. 2
12.6		11.3		
14.7	X	12.2		
13.7	XXX	12.2	XX	
19.7	XXX	19.8	XX	

TABLE VII

## TIME AND ACCURACY TOTALS FOR MOVEMENT OF INSIDE MALLETS

Player	Musser Grip		Cross Stick Grip No. 1		Cross Stick Grip No. 2	
	Total Avg. Time	Total Accuracy	Total Avg. Time	Total Accuracy	Total Avg. Time	Total Accuracy
No. 1	39.9	9	50.2	13	45.4	9
No. 2	42.0	10	50.2	10	42.3	3
No. 3	52.7	7	59.7	7	45.9	6
No. 4	50.2	7	61.9	5	46.5	4
No. 5	55.7 (-1)*	8	87.6	8	64.1	4
No. 6	51.0	4	67.5	5	57.9	3
No. 7	44.6	8	55.2	11	49.7	6
No. 8	33.4 (-1)*	8	48.9	7	42.7	4
No. 9	53.0	5	59.9	7	57.4	4
No. 10	67.0	8	60.7	7	55.5	4
Total	489.5 (-2)**	74	601.8	80	507.4	47

\*Indicates that one of the four sets of interval changes was not successfully completed.

\*\*Indicates that two of the forty sets of interval changes were not successfully completed.

ratings for the three grips was indeed the result of all ten subjects and not one or two "special cases."

TABLE VIII

NUMBER OF FIRST, SECOND AND THIRD TOTAL AVERAGE TIME RATINGS FOR EACH GRIP OF TEST II

Time Rating	Musser Grip	Cross Stick Grip No. 1	Cross Stick Grip No. 2
First*	5	0	5
Second**	3	2	5
Third***	2	8	0

\*Fastest of the three grips.

\*\*Second fastest of the three grips.

\*\*\*Slowest of the three grips.

Table IX

The cross stick grip No. 2 clearly has the best accuracy, while the ratings of the other two grips are almost identical.

TABLE IX

NUMBER OF FIRST, SECOND AND THIRD TOTAL ACCURACY RATINGS FOR EACH GRIP OF TEST II

Accuracy Rating	Musser Grip	Cross Stick Grip No. 1	Cross Stick Grip No. 2
First*	.5	0	9.5
Second**	4.5	5	.5
Third***	5	5	0

\*Number of times with the best accuracy of the three grips.

\*\*Number of times with the second best accuracy of the three grips.

\*\*\*Number of times with the least accuracy of the three grips.

Table X

Only in the first set of interval changes does the cross stick grip No. 2 show a substantial time rating lead over the Musser grip. The time ratings of these two grips are almost identical in the second and third sets of interval changes.

In the last set of interval changes, the Musser grip has the best of the three time ratings. Of the eight "mallet movements" covered by Test I and Test II, this is the only instance in which another grip had a better time rating than cross stick grip No. 2.

Summary of Test II

The following is a summary of the over-all results of the ten subjects who participated in Test II.

Of the three grips, (a) 40 per cent of the subjects preferred the Musser grip, (b) 10 per cent preferred the cross stick grip No. 1, and (c) 50 per cent preferred the cross stick grip No. 2.

Combining the four sets of interval changes for the ten subjects, (a) the Musser grip was the fastest 50 per cent of the time, (b) the cross stick grip No. 1 was fastest none of the time, and (c) the cross stick grip No. 2 was fastest 50 per cent of the time.

Combining the four sets of interval changes for the ten subjects, (a) the Musser grip had the best accuracy 5 per cent of the time, (b) the cross stick grip No. 1 had the best

TABLE X

NUMBER OF FIRST, SECOND AND THIRD TIME RATINGS  
AND TOTAL ACCURACY MARKS FOR EACH SET OF  
INTERVAL CHANGES FOR TEST II

Time Rating	Musser Grip	Cross Stick Grip No. 1	Cross Stick Grip No. 2
	Intervals: AF to AC		
First	1.5	0	8.5
Second	7.5	1	1.5
Third	1	9	0
	Total Number of Accuracy Marks: 11	Total Number of Accuracy Marks: 7	Total Number of Accuracy Marks: 2
	Intervals: GF to CC		
First	5	0	5
Second	4	1	5
Third	1	9	0
	Total Number of Accuracy Marks: 13	Total Number of Accuracy Marks: 14	Total Number of Accuracy Marks: 4
	Intervals: CF to CC		
First	4.5	0	5.5
Second	3.5	4	2.5
Third	2	6	2
	Total Number of Accuracy Marks: 29	Total Number of Accuracy Marks: 26	Total Number of Accuracy Marks: 18
	Intervals: CB to CC		
First	6	0	4
Second	2	5	3
Third	2	5	3
	Total Number of Accuracy Marks: 21 (-2)*	Total Number of Accuracy Marks: 33	Total Number of Accuracy Marks: 23

\*Indicates the number of unsuccessful attempts.

accuracy none of the time, and (c) the cross stick grip No. 2 had the best accuracy 95 per cent of the time.

In the first set of interval changes, (a) the Musser grip was fastest 15 per cent of the time, (b) the cross stick grip No. 1 was fastest none of the time, and (c) the cross stick grip No. 2 was fastest 85 per cent of the time.

In the second set of interval changes, (a) the Musser grip was fastest 50 per cent of the time, (b) cross stick grip No. 1 was fastest none of the time, and (c) cross stick grip No. 2 was fastest 50 per cent of the time.

In the third set of interval changes, (a) the Musser grip was fastest 45 per cent of the time, (b) cross stick grip No. 1 was fastest none of the time, and (c) cross stick grip No. 2 was fastest 55 per cent of the time.

In the fourth set of interval changes, (a) the Musser grip was fastest 60 per cent of the time, (b) cross stick grip No. 1 was fastest none of the time, and (c) cross stick grip No. 2 was fastest 40 per cent of the time.

#### Test III--Movement of the Hand

The tables of Test III correspond to those of Test I and Test II, thus the explanations for the tables are omitted.

#### Table XI

The two "cross stick" grips were each chosen four times as the preferred grip. The Musser grip was preferred only twice.

TABLE XI  
TEST III (MOVEMENT OF THE HAND) RESULTS

Player	Interval Changes	Musser Grip	
		Avg. Time	Accuracy
No. 1	CE to FA <sup>b</sup>	8.6	
	CE to F <sup>#</sup> A	6.6	x
	CG to CG	10.0	xx
	CC to CC	9.5	xxx
No. 2	CE to FA <sup>b</sup>	6.7	x
	CE to F <sup>#</sup> A	5.7	xx
	CG to CG	6.1	xx
	CC to CC	7.2	xx
No. 3	CE to FA <sup>b</sup>	9.0	x
	CE to F <sup>#</sup> A	7.6	
	CG to CG	8.9	xx
	CC to CC	10.1	xx
No. 4	CE to FA <sup>b</sup>	7.6	
	CE to F <sup>#</sup> A	6.9	
	CG to CG	7.9	xx
	CC to CC	8.9	xx
No. 5	CE to FA <sup>b</sup>	6.2	x
	CE to F <sup>#</sup> A	6.2	xx
	CG to CG	8.2	xx
	CC to CC	7.5	xx
No. 6	CE to FA <sup>b</sup>	6.8	
	CE to F <sup>#</sup> A	5.7	
	CG to CG	6.1	xx
	CC to CC	7.1	xxx
No. 7	CE to FA <sup>b</sup>	6.2	x
	CE to F <sup>#</sup> A	6.1	xx
	CG to CG	7.1	xxx
	CC to CC	6.9	xxx
No. 8	CE to FA <sup>b</sup>	9.2	xxxx
	CE to F <sup>#</sup> A	7.7	xx
	CG to CG	8.9	xx
	CC to CC	10.8	xxx
No. 9	CE to FA <sup>b</sup>	9.1	
	CE to F <sup>#</sup> A	7.5	
	CG to CG	10.2	xxx
	CC to CC	12.4	xx
No. 10	CE to FA <sup>b</sup>	9.4	
	CE to F <sup>#</sup> A	8.4	x
	CG to CG	10.5	xx
	CC to CC	11.1	xx

TABLE XI--Continued

Cross Stick Grip No. 1		Cross Stick Grip No. 2		Grip Preferred
Avg. Time	Accuracy	Avg. Time	Accuracy	
8.2	x	8.4		Cross Stick No. 2
7.2		7.8	x	
10.6	x	11.0	xx	
9.7	xx	9.9	xx	
5.8		6.2		Musser
5.5	xxx	6.1	x	
7.1	xxx	7.5	xxxx	
6.6	xxxx	7.8	xxxx	
7.5		6.6		Cross Stick No. 1
7.1		7.1		
8.0	x	10.1	xxx	
8.0	xx	9.4	xx	
7.1		6.6		Cross Stick No. 1
6.5		6.7		
9.0	xx	8.8	x	
8.7	xx	9.7	xx	
6.0	x	6.1		Cross Stick No. 2
6.2	x	5.8		
8.1	xxx	6.8	xxx	
9.5	xxx	8.6	xx	
6.0	x	5.7		Cross Stick No. 2
5.6		4.9		
6.5	x	6.0	xx	
7.1	xx	5.7	x	
6.2	x	5.4	x	Musser
5.4	x	5.5	xx	
6.5	xx	7.4	xxxx	
6.4	xxx	6.9	xx	
7.8	xx	8.1	x	Cross Stick No. 1
6.5	xx	7.9	x	
7.6	xxx	8.4	xx	
7.6	xxxx	9.5	xxx	
7.2		7.0		Cross Stick No. 2
6.4		7.1		
9.6	xx	9.4	xx	
9.6	xx	9.1	xxx	
8.7		8.8		Cross Stick No. 1
9.0	x	8.7		
9.7	xx	10.1	x	
10.1	xx	11.9	xxx	



Table XII

The difference between "total times" for each of the three grips is rather small. This is also true of the total accuracy rating. Although the margin is small, the Musser grip is "third" in both cases.

Table XIII

Although the total times for the three grips were rather close, the cross stick grip No. 1 clearly had the fastest individual time ratings. Likewise, the Musser grip clearly had the slowest individual time ratings.

Table XVI

The accuracy of the two "cross stick" methods was, for all practical purposes, the same. The instances in which the mallets did not strike the notes of an interval at the same time occurred more often when using the Musser grip than either of the two "cross stick" grips. This was the main reason why the Musser grip had the least accurate rating.

Table XV

The time ratings of the first set of interval changes show that the Musser grip was the slowest of the grips 95 per cent of the time.

The Musser grip time ratings are better in the second set of interval changes and are approximately the same as those of the cross stick grip No. 2. (Both of these grips are slower, however, than cross stick grip No. 1.)

The ratings of the third set of interval changes are almost equal, with the cross stick grip No. 1 showing a slight lead.

TABLE XII

## TIME AND ACCURACY TOTALS FOR MOVEMENT OF THE HAND

Player	Musser Grip		Cross Stick Grip No. 1		Cross Stick Grip No. 2	
	Total Avg. Time	Total Accuracy	Total Avg. Time	Total Accuracy	Total Avg. Time	Total Accuracy
No. 1	34.7	6	35.7	4	37.1	5
No. 2	25.7	7	25.0	10	27.6	9
No. 3	35.6	5	30.6	3	33.2	5
No. 4	35.6	5	31.3	4	31.8	5
No. 5	28.1	7	29.8	8	27.3	5
No. 6	25.7	5	25.2	3	22.3	3
No. 7	26.3	9	24.5	7	25.2	9
No. 8	36.6	11	29.5	11	33.9	7
No. 9	39.2	5	32.8	4	32.6	5
No. 10	39.4	5	37.5	5	39.5	4
Total	326.9	65	301.9	59	310.5	57

TABLE XIII

NUMBER OF FIRST, SECOND AND THIRD TOTAL AVERAGE TIME RATINGS FOR EACH GRIP OF TEST III

Time Rating	Musser Grip	Cross Stick Grip No. 1	Cross Stick Grip No. 2
First*	1	6	3
Second**	3	3	4
Third***	6	1	3

\*Fastest of the three grips.

\*\*Second fastest of the three grips.

\*\*\*Slowest of the three grips.

TABLE XIV

NUMBER OF FIRST, SECOND AND THIRD TOTAL ACCURACY RATINGS FOR EACH GRIP OF TEST III

Accuracy Rating	Musser Grip	Cross Stick Grip No. 1	Cross Stick Grip No. 2
First*	1	5	4
Second**	4	2	4
Third***	5	3	2

\*Number of times with the best accuracy of the three grips.

\*\*Number of times with the second best accuracy of the three grips.

\*\*\*Number of times with the least accuracy of the three grips.

TABLE XV

NUMBER OF FIRST, SECOND AND THIRD TIME RATINGS  
AND TOTAL ACCURACY MARKS FOR EACH SET OF  
INTERVAL CHANGES FOR TEST III

Time Rating	Musser Grip	Cross Stick Grip No. 1	Cross Stick Grip No. 2
Intervals: CE to FA <sup>b</sup>			
First	0	5	5
Second	.5	4.5	5
Third	9.5	.5	0
	Total Number of Accuracy Marks: 8	Total Number of Accuracy Marks: 6	Total Number of Accuracy Marks: 2
Intervals: CE to F <sup>#</sup> A			
First	2	5.5	2.5
Second	2.5	3	4.5
Third	5.5	1.5	3
	Total Number of Accuracy Marks: 8	Total Number of Accuracy Marks: 5	Total Number of Accuracy Marks: 5
Intervals: CG to CG			
First	3	4	3
Second	3	4	3
Third	4	2	4
	Total Number of Accuracy Marks: 22	Total Number of Accuracy Marks: 20	Total Number of Accuracy Marks: 24
Intervals: CC to CC			
First	2	6	2
Second	4	2.5	3.5
Third	4	1.5	4.5
	Total Number of Accuracy Marks: 24	Total Number of Accuracy Marks: 26	Total Number of Accuracy Marks: 24

### Summary of Test III

The following is a summary of the over-all results of the ten subjects who participated in Test III.

Of the three grips, (a) 20 per cent of the subjects preferred the Musser grip, (b) 40 per cent preferred the cross stick grip No. 1, and (c) 40 per cent preferred the cross stick grip No. 2.

Combining the four sets of interval changes for the ten subjects, (a) the Musser grip was the fastest 10 per cent of the time, (b) the cross stick grip No. 1 was fastest 60 per cent of the time, and (c) the cross stick grip No. 2 was fastest 30 per cent of the time.

Combining the four sets of interval changes for the ten subjects, (a) the Musser grip had the best accuracy 10 per cent of the time, (b) the cross stick grip No. 1 had the best accuracy 50 per cent of the time, and (c) the cross stick grip No. 2 had the best accuracy 40 per cent of the time.

In the first set of interval changes, (a) the Musser grip was fastest none of the time, (b) the cross stick grip No. 1 was fastest 50 per cent of the time, and (c) the cross stick grip No. 2 was fastest 50 per cent of the time.

In the second set of interval changes, (a) the Musser grip was fastest 20 per cent of the time, (b) cross stick grip No. 1 was fastest 55 per cent of the time, and (c) cross stick grip No. 2 was fastest 25 per cent of the time.

In the third set of interval changes, (a) the Musser grip was fastest 30 per cent of the time, (b) cross stick grip No. 1 was fastest 40 per cent of the time, and (c) cross stick grip No. 2 was fastest 30 per cent of the time.

In the fourth set of interval changes, (a) the Musser grip was fastest 20 per cent of the time, (b) cross stick grip No. 1 was fastest 60 per cent of the time, and (c) cross stick grip No. 2 was fastest 20 per cent of the time.

#### Test IV--Movement of Outside Mallet

Because the ten subjects who participated in Test IV had previous experience playing four-mallets, the results will not be analyzed in the same manner as the first three tests.

#### Table XVI

Table XVI gives the average time and total accuracy ratings as in the previous tests. In addition, the grip which the subject normally uses, the period of time (in months and years) which he has used the grip, and the approximate number of hours per week he has practiced using the grip is also given. The order of the players for Table I is arranged according to amount of experience. The amount of experience was based on both number of years and average practice per week. Therefore, player No. 2 with one year of an hour or less per week (approximately fifty-two hours or less) was considered to have less experience than player No. 3 with

TABLE XVI  
TEST IV (MOVEMENT OF OUTSIDE MALLET) RESULTS

Player	Interval Changes	Musser Grip		Cross Stick Grip No. 1	
		Avg. Time	Accuracy	Avg. Time	Accuracy
No. 1	CE to CA	11.8	x	9.9	x
	CD to CG	13.3	xxx	9.9	x
	CG to CC	13.0	xx	11.4	xx
	CD to CC	--		17.0	x
No. 2	CE to CA	9.5	xx	11.1	xx
	CD to CG	11.5	xxxx	10.7	xxxx
	CG to CC	10.0	xx	11.6	xxx
	CD to CC	12.5	xxxx	11.0	xxx
No. 3	CE to CA	7.0		10.6	x
	CD to CG	6.3	x	13.0	x
	CG to CC	7.2	x	11.9	x
	CD to CC	7.4	x	16.1	xx
No. 4	CE to CA	16.3	x	10.0	
	CD to CG	17.3	xx	9.1	xx
	CG to CC	14.2	xxx	8.3	x
	CD to CC	26.2	xx	14.2	x
No. 5	CE to CA	6.6	xx	10.2	xxx
	CD to CG	7.6	xx	9.0	xx
	CG to CC	6.7	x	7.8	x
	CD to CC	8.3	x	14.5	x
No. 6	CE to CA	10.9		7.5	
	CD to CG	11.0		7.8	x
	CG to CC	13.1	xxx	9.9	xxx
	CD to CC	18.5	x	12.5	x
No. 7	CE to CA	10.9		5.4	
	CD to CG	12.9		5.8	x
	CG to CC	13.2	xx	7.2	x
	CD to CC	15.6	xx	9.8	x
No. 8	CE to CA	5.0	x	6.5	x
	CD to CG	5.3	xxx	5.6	
	CG to CC	5.3	xx	6.4	x
	CD to CC	6.0	xx	8.1	xx
No. 9	CE to CA	7.3	xx	5.9	
	CD to CG	7.8	xx	5.8	xx
	CG to CC	7.5	xx	6.6	xx
	CD to CC	10.6	xxx	9.6	xxxx
No. 10	CE to CA	7.6	xxxx	6.6	xx
	CD to CG	6.5	xxx	6.0	x
	CG to CC	7.4	xxxx	6.6	x
	CD to CC	--		10.0	xxx

TABLE XVI--Continued

Cross Stick Grip No. 2		Grip Normally Used	Experience With Grip	Approximate Weekly Practice
Avg. Time	Accuracy			
8.4 8.2 9.8 15.1	x xx xx	Cross Stick No. 1	2 Months	1 Hour (or less)
8.4 8.9 11.0 11.6	xx xx xx	Cross Stick No. 2	1 Year	1 Hour (or less)
6.6 7.5 6.5 9.5	x xx	Musser	3 Months	6 Hours (or more)
6.2 7.5 5.4 10.1	x xx	Cross Stick No. 2	2 Years	1 Hour (or less)
5.9 5.7 7.0 10.1	x	Cross Stick No. 2	1 1/2 Years	2 Hours
9.7 9.5 7.5 10.7	x x xx	Cross Stick No. 1	1 1/2 Years	2 Hours
5.7 5.6 8.5 9.0	x	Cross Stick No. 1	7 Years	1 Hour (or less)
5.3 4.9 4.9 6.9	x xxx xx	Musser	2 1/2 Years	5 Hours
4.9 4.9 6.0 7.1	x xx xxxx	Cross Stick No. 2	12 Years	1 Hour (or less)
4.2 4.1 5.3 6.1	x xx	Cross Stick No. 2	6 Years	2 Hours



three months of six or more hours per week (approximately seventy-two hours or more).

All of the ten subjects who participated in Test IV were percussionists (i.e. they also play snare drum, timpani, trap set, etc.) and were not "mallet specialists." Five of the ten subjects tested said that they averaged only an hour (or less) a week playing or practicing four mallets. The two subjects who practiced the greatest amount of time (player No. 3 and player No. 8) both used the Musser grip, and were the only two of the ten who used this grip.

#### Table XVII

Table XVII gives the average time and accuracy totals with the grip that the subject normally used underlined. Because of the unequal representation of grips (two Musser's, three cross stick grip No. 1's, and five cross stick grip No. 2's), total times and accuracy ratings are not given. This table does show, however, that the time ratings did not always improve according to the amount of experience. This fact is shown best by the time ratings of players No. 3 and No. 6.

#### Table XVIII

Table XVIII combines the two subjects who used the Musser grip, players No. 3 and No. 8.

The total time rating for the Musser grip (49.5) was the fastest of the three grips. However, the total time rating

TABLE XVII  
TIME AND ACCURACY TOTALS OF TEST IV

Player	Musser Grip		Cross Stick Grip No. 1		Cross Stick Grip No. 2	
	Total Avg. Time	Total Accuracy	Total Avg. Time	Total Accuracy	Total Avg. Time	Total Accuracy
No. 1	38.1 (-1)*	6	<u>48.2</u>	5	41.5	5
No. 2	43.5	12	44.4	12	<u>39.9</u>	<u>6</u>
No. 3	<u>27.9</u>	<u>3</u>	51.6	5	30.1	3
No. 4	74.0	8	41.6	4	<u>29.2</u>	<u>3</u>
No. 5	29.2	6	41.5	7	<u>28.7</u>	<u>1</u>
No. 6	53.5	4	<u>37.7</u>	5	37.4	4
No. 7	52.6	4	<u>28.2</u>	<u>3</u>	28.8	1
No. 8	<u>21.6</u>	<u>8</u>	26.6	4	22.0	6
No. 9	33.2	9	27.9	8	<u>22.9</u>	<u>7</u>
No. 10	21.5 (-1)*	11	29.2	7	<u>19.7</u>	<u>3</u>

\*Indicates that one of the four sets of interval changes was not successfully completed.

for cross stick grip No. 2 (52.1) is only 2.6 seconds slower. The time rating for the cross stick grip No. 1 (78.2) is 28.7 seconds slower. The total accuracy marks of the three grips were approximately the same.

TABLE XVIII

TIME AND ACCURACY TOTALS OF PLAYERS WHO  
USE THE MUSSER GRIP

Player	Musser Grip		Cross Stick Grip No. 1		Cross Stick Grip No. 2		Experience With Grip	Approx. Weekly Practice
	Total Avg. Time	Total Accuracy	Total Avg. Time	Total Accuracy	Total Avg. Time	Total Accuracy		
No. 3	27.9	3	51.6	5	30.1	3	3 Months	6 Hours
No. 8	21.6	8	26.6	4	27.0	6	2 1/2 Years	5 Hours
Total	49.5	11	78.2	9	52.1	9		

Table XIX

Table XIX combines the three subjects who used the cross stick grip No. 1.

Surprisingly, the total time rating for the cross stick grip No. 1 was not the fastest time. The cross stick grip No. 2 was recorded as being 6.4 seconds faster. The Musser grip was considerably the slowest of the three grips. The accuracy marks were approximately the same.

TABLE XIX

TIME AND ACCURACY TOTALS OF PLAYERS WHO  
USE CROSS STICK GRIP NO. 1

Player	Musser Grip		Cross Stick Grip No. 1		Cross Stick Grip No. 2		Experience With Grip	Approx. Weekly Practice
	Total Avg. Time	Total Accuracy	Total Avg. Time	Total Accuracy	Total Avg. Time	Total Accuracy		
No. 1	38.1 (-1)*	6	48.2	5	41.5	5	2 Months	1 Hour
No. 6	53.5	4	37.7	5	37.4	4	1 1/2 Years	2 Hours
No. 7	52.6	4	28.2	3	28.8	1	7 Years	1 Hour
Total	144.2	14	114.1	13	107.7	10		

\*Indicates the number of unsuccessful attempts.

Table XX

Table XX combines the five subjects who used the cross stick grip No. 2.

The total time rating for cross stick grip No. 2 is clearly the fastest of the three grips. The cross stick grip No. 2 also had a substantially better accuracy rating total. Because player No. 4 had an unusually slow time rating for the Musser grip (74.0), the total time rating for the Musser grip is considerably slower than that of the cross stick grip No. 1.

TABLE XX  
 TIME AND ACCURACY TOTALS OF PLAYERS WHO  
 USE CROSS STICK GRIP NO. 2

Player	Musser Grip		Cross Stick Grip No. 1		Cross Stick Grip No. 2		Experience With Grip	Approx. Weekly Practice
	Total Avg. Time	Total Accuracy	Total Avg. Time	Total Accuracy	Total Avg. Time	Total Accuracy		
No. 2	43.5	12	44.4	12	39.9	6	1 Year	1 Hour
No. 4	74.0	8	41.6	4	29.2	3	2 Years	1 Hour
No. 5	29.2	6	41.5	7	28.7	1	1 1/2 Years	2 Hours
No. 9	33.2	9	27.9	8	22.9	7	12 Years	1 Hour
No. 10	21.5 (-1)*	11	29.2	7	19.7	3	6 Years	2 Hours
Total	201.4	46	184.6	38	140.4	20		

\*Indicates the number of unsuccessful attempts.

## CHAPTER V

### CONCLUSIONS

The conclusions of each test are given separately, along with a final summary.

#### Conclusions of Test I

The majority of the ten subjects thought that the "movement of the outside mallet" was the most comfortable (easiest, least straining, etc.) when using the cross stick grip No. 2. Also, the time and accuracy ratings of the cross stick grip No. 2 were better than the other two grips.

Five of the ten subjects were unable to complete successfully all the interval changes of Test I when using the Musser grip. Because this did not occur with either of the two cross stick grips, it is reasonable to assume that many beginning four-mallet students will find the Musser grip the most difficult of the three grips to use.

Because the unsuccessful attempts for the Musser grip appeared only in the third and fourth sets of interval changes, it must be assumed that when "movement of the outside mallet" is required, many beginning four-mallet students will have difficulty playing intervals of an octave or larger when using this grip.

### Conclusions of Test II

The larger increase of choices for the Musser grip in Test II indicates that the "movement of the inside mallet" is more comfortable than the "movement of the outside mallet" when using this grip. It appears that the cross stick grip No. 1 is the least comfortable of the three grips when "movement of the inside mallet" is required.

The third and fourth sets of interval changes of both Test I and Test II contained the playing of an octave. Because of the varying results of these two tests, it must be assumed that the amount of difficulty encountered when playing large intervals with the Musser grip depends mainly on (a) the ability of the individual player, and (b) which type of mallet movement (outside or inside) is required, rather than the actual playing of the interval itself.

### Conclusions of Test III

The choices of the preferred grip indicate that when holding the mallets in a "fixed" position (no "opening" or "closing" of the mallets) the "cross stick" grips are more comfortable than the Musser grip.

Because of the close ratings, it seems that "hand movement" is the least important of the three movements tested when judging efficiency. However, both the time rating and the accuracy rating of the Musser grip were slightly, but consistently, "third."

The extremely poor ratings of the Musser grip on the first set of interval changes can be attributed to the large hand turn which must be made when playing this particular type of interval change.

Because the time ratings of the cross stick grip No. 1 were substantially better than the other grips when playing the series of octaves (fourth set of interval changes), it is probably the most secure grip when holding the mallets in a large open position.

#### Conclusions of Test IV

Because five of the ten subjects with previous four-mallet experience said that they practiced an hour or less per week, it is a reasonable assumption that many percussionists do not spend a great deal of time using four mallets. This conclusion may seem trivial at first, but the amount of time spent practicing with four mallets should be considered when choosing a grip. If the allotted amount of practice time were small, it would seem to be logical to use the easiest grip.

The two subjects who used the Musser grip had little difficulty using the cross stick grip No. 2 as compared to using the cross stick grip No. 1.

The results indicate that a large amount of experience using cross stick grip No. 1 is necessary before it will be more efficient (at least when the outside movement of the stick is required) than cross stick grip No. 2.



The subject who had the extremely poor time rating with the Musser grip (74.0 seconds) shows that some individuals will find the Musser grip extremely awkward at first.

An individual who uses the cross stick grip No. 2 will find it fairly difficult to use either of the other two grips.

#### Summary

According to Tests I, II and III, the majority of beginning four-mallet players will find the cross stick grip No. 2 the easiest and most efficient (as far as the three movements which were tested are concerned) of the three grips. However, some individuals (a much smaller percentage) will prefer either the Musser grip or the cross stick grip No. 1. Many beginners will find the Musser grip extremely difficult. A very small percentage of beginning four-mallet students will have poor efficiency using cross stick grip No. 2.

According to the results of Test IV, the efficiency of the Musser grip and the cross stick grip No. 2 improve at a faster rate than does the efficiency of the cross stick grip No. 1.

The movements tested in this study are extremely important when playing with four mallets. However, this study was limited to the testing of three types of horizontal movements and, therefore, did not cover all the aspects of four-mallet playing. Because all factors were not included in this study, no one grip was proven to be ultimately the "best."

Each individual four-mallet player must decide for himself which grip is best suited for his particular needs. The findings of this study should aid in making that decision.

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