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TRAINING EFFECTIVENESS AS A FUNCTION OF  
TRAINING DEVICE FIDELITY: APPENDIXES

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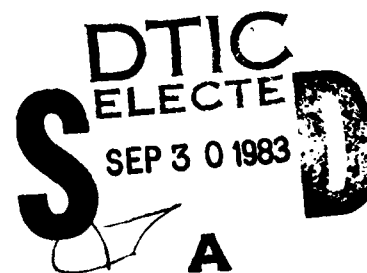
INSTRUCTIONAL TECHNOLOGY SYSTEMS TECHNICAL AREA



U. S. Army

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August 1982



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**APPENDIX A**

**SIMTRAIN PILOT PROJECT  
USERS MANUAL**

## INTRODUCTION

-----

THIS DOCUMENT IS A USERS GUIDE FOR THE SIMTRAIN PILOT PROJECT DATA GATHERING SOFTWARE. THE PROGRAM WAS DEVELOPED TO MEASURE BICYCLE WHEEL VARIANCES AT DESIRED INTERVALS DURING THE TRUEING PROCESS.

## PREPARATION

-----

THE ELECTRONICS ATTACHED TO THE TRUEING STAND AND THE SOFTWARE TO MONITOR AND RECORD THE MEASUREMENTS ARE EXECUTED ON THE LEFT HAND ECLIPSE COMPUTER IN THE MAN-MACHINE SCIENCES COMPUTER LAB. FOLLOW THE SYSTEM STARTUP PROCEDURES THAT ARE HANGING ON THE RIGHT SIDE OF THE COMPUTER. THE REMOVABLE DISK PACK THAT HAS THE PROGRAMS IS DISK PACK 42. IF THE RESULTS OF THE TRIALS ARE TO BE PRINTED, TURN ON THE PRINTER POWER SWITCH LOCATED ON THE PRINTER PEDESTAL. THE PRINTER FOR THE LEFT ECLIPSE IS THE FLOOR PRINTER NEXT TO THE DOOR.

AFTER COMPLETION OF THE SYSTEM STARTUP PROCEDURE, THE CONSOLE SHOULD HAVE OUTPUT

FILENAME?

SIMPLY TYPE A RETURN AND ENTER THE DATE AND TIME INFORMATION IN THE REQUESTED FORMAT. THE SYSTEM SHOULD RESPOND WITH AN

R

WHICH IS THE STANDARD READY PROMPT AND INDICATES THAT THE SYSTEM IS WAITING FOR A USER COMMAND.

## DATA GATHERING (WHEELRITE)

-----

THE NAME OF THE DATA GATHERING PROGRAM IS WHEELRITE. ITS FUNCTION IS TO MEASURE THE RIMS'S VARIANCES AT USER DEFINED INTERVALS AND SAVE THE DATA GENERATED IN A UNIQUE FILE WHOSE NAME IS DERIVED BY THE TYPE OF TRAINING GIVEN THE SUBJECT, THE SUBJECT'S NUMBER, AND THE TYPE OF THE EXPERIMENT BEING PERFORMED. THE DATA GENERATED INCLUDE THE VALUES OF THE LOCAL MAXIMA MEASUREMENTS OF THE RIM AND THE SUM AND AVERAGE OF THEIR ABSOLUTE VALUES FOR ONE REVOLUTION OF THE BICYCLE WHEEL. THE DATA IS STORED IN THE DATA FILE, ONE RECORD PER MEASUREMENT INTERVAL. THE DATA RECORD FILE FORMAT IS DESCRIBED IN ATTACHMENT A.

## PROCEDURE

-----

1. FROM DISK PACK 42, TYPE THE COMMAND

WHEELRITE CR (CR = CARRIAGE RETURN)

2. THE USER WILL THEN SUPPLY THE FOLLOWING INFORMATION TO FORM THE DATA FILE NAME

### A. TRAINING METHOD CODE

THE TRAINING METHOD WILL BE REQUESTED BY THE PROMPT:

INPUT TRAINER TYPE (A-Z) :

THE USER ENTERS THE CODE LETTER AND TYPES A RETURN.

### B. SUBJECT ID

THE USER WILL BE REQUESTED TO ENTER THE SUBJECT'S ID NUMBER WITH THE PROMPT:

INPUT SUBJECT ID (1-99):

THE USER ENTERS AN ID NUMBER AND TYPES A RETURN.

### C. TEST SEQUENCE CODE

THE USER WILL THEN BE ASKED TO ENTER A TEST SEQUENCE CODE AFTER THE PROMPT:

INPUT TEST ID (2 CHARACTERS):

THE USER ENTERS ONE OR TWO CHARACTERS TO IDENTIFY THE TEST BEING PERFORMED. FOR EXAMPLE, A POSSIBLE SERIES OF CODES FOR THREE PRACTICE RUNS MIGHT BE P1, P2, AND P3.

THE DATA FILE NAME WILL THEN BE GENERATED USING THESE INPUTS. THE FORMAT OF THIS NAME IS

TSS.CC

WHERE

T IS THE TRAINING CODE LETTER  
SS IS THE SUBJECT ID NUMBER. (IF THE NUMBER ENTERED IS LESS THAN 10, THIS PART OF THE NAME WILL BE OF THE FORM 0S), AND  
CC IS THE TEST SEQUENCE CODE LETTER OR LETTERS.

3. THE PROGRAM WILL THEN RESPOND WITH THE FOLLOWING LINES:

READY FOR INITIAL MEASUREMENT  
TO STOP THE PROGRAM, TYPE THE LETTER S  
TO MEASURE WHEEL, START WHEEL TURNING AND STRIKE ANY KEY

THE PROGRAM IS NOW READY TO TAKE THE INITIAL MEASUREMENT. WHEN READY TO DO THE MEASUREMENT, START THE WHEEL TURNING, IN EITHER DIRECTION, WITH SUFFICIENT SPEED TO ENSURE THAT AT LEAST TWO REVOLUTIONS WILL OCCUR AFTER STRIKING A KEY ON THE KEYBOARD. WHEN THE MEASUREMENT IS COMPLETED, THE PROGRAM RESPONDS WITH THE OUTPUT

INITIAL MEASUREMENT COMPLETE

THE PROGRAM MAY BE TERMINATED BEFORE THIS MEASUREMENT BY TYPING THE LETTER 'S'.

4. AFTER THIS INITIAL MEASUREMENT, THE PROGRAM WILL OUTPUT THE MESSAGE

READY FOR MEASUREMENT N  
TO STOP PROGRAM, TYPE THE LETTER S  
TO MEASURE WHEEL, START WHEEL TURNING AND STRIKE ANY KEY

THE PROGRAM IS NOW READY TO COLLECT THE DATA UPON COMMAND. IF THE DATA COLLECTION PROCESS IS COMPLETE, STRIKE THE 'S' KEY. THE PROGRAM RESPONDS WITH THE MESSAGE:

MEASUREMENT PROCESS COMPLETE  
NORMAL TERMINATION  
DATA WRITTEN TO FILE TSS.CC

WHERE TSS.CC IS THE NAME OF THE DATA FILE DERIVED FROM THE INPUTS OF STEP 2.

TO TAKE ANOTHER MEASUREMENT, START THE WHEEL TURNING, IN EITHER DIRECTION, AT SUFFICIENT SPEED, AND STRIKE ANY KEY (EXCEPT S) ON THE KEYBOARD. THE PROGRAM WILL RESPOND WITH THE MESSAGE

#### MEASUREMENT N COMPLETE

WHEN THE MEASUREMENT PROCESS IS COMPLETED. THE VALUE OF N IN THIS MESSAGE, AND IN THE READY MESSAGE, IS THE CURRENT SEQUENCE NUMBER IN THE SERIES OF MEASUREMENTS.

#### POSSIBLE ERRORS DURING THE PROCEDURE

-----

1. TO CORRECT A TYPING MISTAKE DURING THE DATA ENTRY IN STEP 2, SIMPLY TYPE THE '\ ' KEY ON THE KEYBOARD AND RETYPE THE DATA. THIS MAY BE DONE AS MANY TIMES AS NECESSARY PRIOR TO USING THE RETURN KEY.
2. IF THE VALUES ENTERED DURING STEP 2 GENERATE A FILE NAME OF A FILE THAT ALREADY EXISTS ON THE DISK, THE MESSAGE

FILE TSS.CC ALREADY EXISTS  
DO YOU WISH TO OVERWRITE (Y OR N) ?

APPEARS.

THE VALUE TSS.CC WILL BE REPLACED BY THE FILENAME GENERATED. IF THE QUESTION IS ANSWERED WITH THE LETTER 'Y', THE DATA FILE OF THAT NAME ON THE DISK WILL BE DELETED AND A NEW FILE OF THE SAME NAME WILL BE CREATED. THE DATA OF THE OLD FILE WILL BE LOST. ANSWERING THE QUESTION WITH 'N' (OR ANY OTHER LETTER) WILL CAUSE THE PROGRAM TO REQUEST REENTRY OF THE INFORMATION FOR STEP 2.

3. TYPING THE LETTER 'S' AFTER THE READY MESSAGE IN STEP 3 AUTOMATICALLY DELETES THE DATA FILE (WHICH WILL BE EMPTY) FROM THE DISK. THE MESSAGE

NO DATA RECORDED. DATA FILE TSS.CC DELETED FROM DISK  
WHERE TSS.CC IS THE FILE NAME GENERATED BY STEP 2.

## DATA EXAMINATION (EXAMINE)

-----

AFTER THE DATA HAS BEEN GENERATED AND STORED IN THE FILE,  
THIS PROGRAM IS USED TO DISPLAY IT IN A HUMAN READABLE FORM.

### PROCEDURE

-----

1. FROM DISK PACK 42, TYPE THE COMMAND

EXAMINE CR (CR = CARRIAGE RETURN)

2. SUPPLY THE SAME INFORMATION TO FORM THE DATA FILE NAME AS WAS DONE IN STEP 2 OF THE DATA COLLECTION PROCEDURE. THE ONLY DIFFERENCE IS IF THE VALUES ENTERED GENERATE A FILE NAME OF A NON-EXISTENT FILE, AN ERROR MESSAGE WILL BE OUTPUT AND A REQUEST FOR A NEW SET OF INFORMATION WILL BE ISSUED. TO ABORT THE PROGRAM IN THIS STEP, STRIKE THE CTRL AND 'A' KEYS SIMULTANEOUSLY.
3. WHEN A DATA FILE HAS BEEN DEFINED AND OPENED, A QUESTION IS ASKED WHETHER THE OUTPUT SHOULD GO TO THE CRT OR THE PRINTER. THIS IS DONE WITH THE MESSAGE:

OUTPUT TO PRINTER ? (0-NO, 1-YES)

4. THE USER IS THEN ASKED WHICH RECORD OF DATA HE WOULD LIKE TO SEE (OR PRINT). THE LEGAL OPTIONS ARE:

|        |                                 |
|--------|---------------------------------|
| -1     | STOP THE PROGRAM                |
| 0      | OUTPUT ALL DATA RECORDS AT ONCE |
| 1 TO N | OUTPUT SPECIFIED DATA RECORD    |

IF THE SPECIFIED DATA RECORD DOES NOT EXIST, THE REQUEST MUST BE REENTERED. THE PROGRAM WILL CONTINUE TO CYCLE IN THIS STEP UNTIL A -1 IS ENTERED.

## SYSTEM SHUTDOWN

-----

THIS SECTION DESCRIBES THE MEANS TO SHUT DOWN THE SYSTEM IN AN ORDERLY FASHION.

WHEN THE SYSTEM IS IN THE COMMAND PROCESSING MODE, AS DESCRIBED IN THE PREPARATION SECTION, SIMPLY TYPE THE COMMAND

END CR (CR = CARRIAGE RETURN)

THE SYSTEM WILL RESPOND WITH MESSAGES THAT CERTAIN DIRECTORIES HAVE BEEN CLEARED AND THAT THE MASTER DEVICE HAS BEEN RELEASED. WHEN THIS RELEASE MESSAGE APPEARS, GO TO THE COMPUTER AND FOLLOW THE SYSTEM SHUTDOWN PROCEDURES STARTING WITH STEP NUMBER 4. IF THE PRINTER WAS USED, TURN THE PRINTER POWER OFF BEFORE USING THE KEY TO TURN THE COMPUTER POWER OFF.

## ATTACHMENT A - DATA FILE RECORD FORMAT

### FILE STRUCTURE

THERE IS ONE RECORD IN THE DATA FILE FOR EACH MEASUREMENT TAKEN DURING THE EXPERIMENT. THE DATA IS STORED IN BINARY FORMAT AND WAS CREATED USING THE RECORD READ/WRITE ROUTINE OF FORTRAN 5 (READR AND WRITR). THE INITIAL MEASUREMENT IS IN RECORD ONE WITH ALL SUBSEQUENT MEASUREMENTS FOLLOWING SEQUENTIALLY.

### RECORD STRUCTURE

1. RECORD LENGTH - 208 WORDS (416 BYTES)

2. COMPOSITION AND ACCESS

THE DATA FILE RECORDS MAY BE ACCESSED BY DECLARING A COMMON BLOCK WITH THE FOLLOWING ELEMENTS.

```
COMMON /RECORD/ ITIME(3),SUM,AVG,N,VALS(100)
```

WHERE

ITIME - TIME OF DATA RECORD WAS WRITTEN TO FILE.  
(ITIME(1) = HOURS, ITIME(2) = MINUTES, AND  
ITIME(3) = SECONDS). INTEGER ARRAY

SUM - SUM OF THE ABSOLUTE VALUES OF THE LOCAL  
MAXIMA. REAL

AVG - AVERAGE OF THE ABSOLUTE VALUES OF THE LOCAL  
MAXIMA. REAL

N - NUMBER OF LOCAL MAXIMA DETECTED. INTEGER

VALS - ACTUAL LOCAL MAXIMA VALUES DETECTED. REAL  
ARRAY

THE DATA RECORDS MAY BE ACCESSED USING THE READR I/O ROUTINE OF FORTRAN 5 AFTER OPENING THE DATA FILE WITH A RECORD LENGTH OF 416 BYTES.

APPENDIX B

COMPUTER PROGRAM LISTING  
WHEEL MEASUREMENT

```

1  SURROUTINE WHEELNITE
2
3  C
4  C      SIMIRAIN PILOT TEST DRIVER
5  C
6
7  COMMON /RITE/ FREQ,FNAME
8  INTEGER FREQ      !FILE DATA RECORD NUMBER
9  REAL MAXVAL(100)  !LOCAL MAXIMA DATA BLOCK
10 INTEGER NMAX      !NUMBER OF LOCAL MAXIMA
11 INTEGER FNAME(4)
12
13 INCLUDE "PARAMETERS.IF"
14
15 C
16 C      BEGIN
17 C      INITIALIZE RUN (WINIT)
18 C      DATA FILE RECORD NUMBER (FREQ) = 1
19 C
20
21 TYPE "<12><11>SIMIRAIN DATA MEASUREMENT PROGRAM"
22 CALL WINIT(FNAME,FREQ)
23
24 C
25 C      DO UNTIL USER WISHES TO STOP PROGRAM
26 C      TELL USER TO START SAMPLE OR STOP PROGRAM
27 C      IF USER WISHES TO MEASURE WHEEL THEN
28 C          MEASURE VARIANCES AND LOCATE LOCAL MAXIMA FOR ONE
29 C          REVOLUTION OF THE WHEEL (MSAMPLE)
30 C          TELL USER THAT MEASUREMENTS ARE COMPLETE
31 C          WRITE DATA OUT TO FILE AND RECORD FREQ
32 C          IF USER VERIFIES THAT DATA IS VALID THEN
33 C              CALCULATE STATISTICS AND OUTPUT TO DATA FILE
34 C              INCREMENT DATA FILE RECORD NUMBER (FREQ)
35 C          ENDIF
36 C      ENDIF
37 C      ENDDO
38 C
39
40 CONTINUE
41 IF (FREQ .EQ. 1) TYPE "<12>READY FOR INITIAL MEASUREMENT"
42 IF (FREQ .NE. 1) TYPE "<12>READY FOR MEASUREMENT",FREQ-1
43 TYPE "TO STOP PROGRAM, TYPE THE LETTER S"
44 IF (FREQ .EQ. 1) GO TO 16
45 TYPE "TO MEASURE WHEEL, STRIKE ANY KEY"
46 CONTINUE
47 CALL GCHAR(ICHAR,IER)
48 IF (ICHAR .EQ. LETS) GO TO 20
49 IF (ICHAR .NE. 40K) GO TO 15
50
51 CONTINUE
52 CALL MSAMPLE(NMAX,MAXVAL)
53
54 TYPE "NUMBER OF LOCAL MAXIMA = ",NMAX
55
56 IF (FREQ .EQ. 1) TYPE "<12><HEL>INITIAL MEASUREMENT COMPLETE"

```

```

57 IF (FREC .NE. 1) TYPE "<12><REL>MFASUREMENT1",FREC-1," COMPLETE"
58
59 IF (FREC .NE. 1) CALL MAXPRINT(NMAX,MAXVAL)
60 CALL MSTATS(FREC,NMAX,MAXVAL)
61 CALL UPDATE(FCHAN,IER)
62 IF (FREC .EQ. 1) GO TO 17
63 WRITE(10,400)
64
65 FORMAT(//DO YOU WANT TO RECORD THIS SET OF MAXIMA ? (Y OR N) ",2)
66 CALL GCHAR(ICHAN,IER)
67 CALL PCHAR(ICHAN,IER)
68 TYPE " "
69 IF(ICHAN .NE. LETY) GO TO 20
70
71 CONTINUE
72 FWFC = FREC + 1
73 GO TO 10
74
75 CONTINUE
76
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1 DATA FILE INITIALIZATION FOR WHEELRITE PROGRAM
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57 ACCEPT "INPUT SUBJECT ID (1-99): ",SUBJECT
58 SUBJECT = MOD(SUBJECT,100)
59
60
61 WRITE(10,520)
62 FORMAT("INPUT TEST ID (2 CHARACTER): ",Z)
63 READ(11,530) TEST
64 FORMAT(S2)
65
66 ENCODE (FNAME,540) TRAINER,TEST
67 FORMAT(S1,2X,"",S2,"<0>")
68 AYTE(FNAME,2) = SUBJECT/10 + 60K
69 AYTE(FNAME,3) = MOD(SUBJECT,10) + 60K
70 IF(RESTRT) GO TO 110
71
72 CALL STAT(FNAME,ISTAT,IER)
73 IF(IER .EQ. NOFILE) GO TO 100
74 TYPE "IER FROM STAT = ",IER
75 WRITE(10,550) FNAME(1)
76 FORMAT("/<REL>FILE ",S6," ALREADY EXISTS"/
77 "DO YOU WISH TO OVERWRITE ? (Y OR N) ",Z)
78 READ(11,510)IANS
79 IF(IYTE(IANS,1) .EQ. LEIV) GO TO 100
80 GO TO 10
81
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      WHEEL VARIANCE MEASUREMENT AND LOCAL MAXIMA RECORDING ROUTINE

      SUBROUTINE WSAMPLE(NMAX,MAXVAL)
      INTEGER NMAX
      REAL MAXVAL(100)
      REAL WDATA(36)
      INTEGER WINDX
      INTEGER REVSTART
      ; NUMBER OF LOCAL MAXIMA
      ; LOCAL MAXIMA VALUES

      BEGIN
      GET THE RAW WHEEL DATA FOR ONE REVOLUTION
      FIND ALL LOCAL MAXIMA IN DATA
      FILTER OUT NOISE POINTS IN DATA
      END

      CALL GETDATA(WDATA,WINDX,REVSTART)
      CALL FINDMAX(WDATA,WINDX,REVSTART,MAXVAL,NMAX)
      CALL FILTERMAX(MAXVAL,NMAX)

      RETURN
      END

```

1 SUBROUTINE GEIDATA(MDATA,WINDX,REVSTART)

2 COMMON /MDD/ YS(36)

3 REAL MDATA(1)

4 INTEGER WINDX,REVSTART

5 DO 10 I = 1,36

6 MDATA(I) = YS(I) \* 2.

7

10

8 CONTINUE

9 MDATA(37) = MDATA(1)

10 MDATA(38) = MDATA(2)

11 WINDX = 38

12 REVSTART = 3

13 RETURN

14 END

1A

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MAXIMA DETERMINATION ROUTINE

SUBROUTINE FINMAX(WDATA,MINUX,REVSUANT1,MAXVAL,NMAX)
REAL MAXVAL(1)
REAL WDATA(1)
INTEGER MINUX
INTEGER REVSUANT1

REAL DIFF
INTEGER DIRECTION
INTEGER UP
INTEGER DOWN
REAL NVAL
REAL OVAL
REAL CMAX

INCLUDE "PARAMETERS.IF"

LOGICAL FUNCTION SAMESIGN (TRUE IF I,J ARE SAME ARITHMETIC SIGN)

SAMESIGN(I,J) = (I .LE. 0 .AND. J .LF. 0) .OR. (I .GF. 0 .AND. J .GE. 0)

BEGIN
/* DETERMINE INITIAL DIRECTION OF DATA */

FIND DIFFERENCE OF FIRST TWO ELEMENTS OF DATA
IF DIFFERENCE IS POSITIVE OR ZERO THEN
    DIRECTION IS UP
    SET CMAX TO SECOND DATA ELEMENT
ELSE
    DIRECTION IS DOWN
    SET CMAX TO FIRST DATA ELEMENT
ENDIF

/* INITIALIZE VARIABLES */

NMAX = 0; OVAL = SECOND DATA ELEMENT;

UP = 1
DOWN = -1
DIFF = WDATA(2) - WDATA(1)
IF (DIFF .LT. 0) GO TO 10
    DIRECTION = UP
    CMAX = WDATA(2)
    GO TO 20
10 CONTINUE
    DIRECTION = DOWN
    CMAX = WDATA(1)

```

```

57 20 CONTINUE
58
59 NMAX = 0.0
60 OVAL = MDATA(2)
61
62 FOR I = 3 TO MINDX DO
63   NVAL = MDATA(1)
64   CALCULATE DIFFERENCE OF ADJACENT VALUES NVAL AND OVAL
65
66 IF DIRECTION IS UP THEN
67   IF DIFFERENCE IS GREATER THAN ZERO THEN
68     IF NVAL IS GREATER THAN CMAX THEN
69       CMAX = NVAL
70     ENDIF
71 ELSE
72   IF CMAX - NVAL IS GREATER THAN NOISE THEN
73     IF I IS >= REVOLUTION START POINTER AND
74       CMAX IS SAME SIGN AS DIRECTION THEN
75       INCREMENT NMAX
76       PUT SCALED VALUE OF CMAX IN MAXVAL(NMAX)
77     ENDIF
78   CHANGE DIRECTION
79   ENDIF
80
81 DO 90 I = 3, MINDX
82
83 NVAL = MDATA(1)
84 DIFF = NVAL - OVAL
85
86 IF (DIRECTION .EQ. DOWN) GO TO 50
87 IF (DIFF .LE. 0) GO TO 30
88 IF (NVAL .GT. CMAX) CMAX = NVAL
89 GO TO 80
90 CONTINUE
91 IF (CMAX - NVAL .LE. XNOISE) GO TO 80
92 IF (1 .LT. REVSTART .OR.
93   .NOT. SAME SIGN(CMAX, DIRECTION)) GO TO 40
94 NMAX = NMAX + 1
95 MAXVAL(NMAX) = FLOAT(CMAX)
96 CONTINUE
97 DIRECTION = DOWN
98 GO TO 80
99
100 CONTINUE
101
102
103
104
105 FLSE /* DIRECTION IS DOWN */
106 IF DIFFERENCE IS LESS THAN ZERO THEN
107   IF NEW VALUE IS LESS THAN CMAX THEN
108     CMAX = NVAL
109   ENDIF
110 ELSE
111   IF NVAL - CMAX IS GREATER THAN NOISE THEN
112     IF I IS FIRST START OF REVOLUTION POINTER AND

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128 CMAX IS SAME SIGN AS DIRECTION THEN
129 INCREMENT NMAX
130 PUT SCALE VALUE OF CMAX IN MAXVAL
131 ENDIF
132 CHANGE DIRECTION
133 ENDIF
134 ENDIF
135 SET OVAL TO NVAL
136 ENDDO
137 END
138
139 IF(DIFF.GE. 0) GO TO 60
140 IF(NVAL.LT. CMAX) CMAX = NVAL
141 GO TO 80
142
143 CONTINUE
144 IF(NVAL-CMAX.LE. KNOISE) GO TO 80
145 IF(1.LT. REVSTART.OH.
146 .NOV. SAFESIGN(CMAX,DIRECTION)) GO TO 70
147 NMAX = NMAX + 1
148 MAXVAL(NMAX) = FLOAT(CMAX)
149
150 CONTINUE
151 DIRECTION = UP
152 GO TO 60
153
154 CONTINUE
155 OVAL = NVAL
156
157 CONTINUE
158
159 WRITE(12,500)NMAX,(K,(MAXVAL(1),1=K,K+4),K=1,NMAX,5)
160 FORMAT("1")/" DUMP FROM FINDMAX"/" NUMBER OF MAX = ",14/
161 /20(14," ",5(F17.5)))
162 RETURN
163 END

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MAXIMA FILTER ROUTINE  
 SURROUTINE FILTERMAX(MAXVAL,NMAX)  
 REAL MAXVAL(1)  
 INTEGER NMAX  
 REAL RNOISE  
 INTEGER LAST  
 INCLUDE "PARAMETERS.IF"  
 BEGIN  
 INITIALIZE LAST TO 0  
 FOR I = 1 TO NMAX DO  
 IF MAXVAL(1) IS NOT RNOISE THEN  
 INCREMENT LAST  
 SET MAXVAL(LAST) TO MAXVAL(1)  
 ENDDO  
 SET NMAX TO LAST  
 END  
 LAST = 0  
 RNOISE = XNOISE  
 RNOISE = FLOAT(RNOISE) \* SCALE  
 DO 10 I = 1,NMAX  
 IF (ABS(MAXVAL(1)) .LE. RNOISE) GO TO 10  
 LAST = LAST + 1  
 MAXVAL(LAST) = MAXVAL(1)  
 10 CONTINUE  
 NMAX = LAST  
 WRITE(12,500)NMAX  
 FORMAT(1,"") DERUG DUMP FROM FILTERMAX"" NUMBER OF MAXIMA = ",(4)  
 WRITE(12,510)(K,(MAXVAL(I),I=K,K+4),K=1,NMAX,5)  
 FORMAT(14,"",5(F17.5))  
 RETURN  
 END

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      LOCAL MAXIMA CONSOLE OUTPUT ROUTINE

      SUBROUTINE MAXPRINT(NMAX,MAXVAL)
      INTEGER NMAX
      REAL MAXVAL(NMAX)
      WRITE(10,500) NMAX
      FORMAT(/,"THE NUMBER OF LOCAL MAXIMA FOUND WAS ",I3/
        "THE VALUES OF THE LOCAL MAXIMA ARE:")
      DO 10 I = 1,NMAX,5
      J = I + 4
      IF(J.GT. NMAX) J = NMAX
      WRITE(10,510) I,(MAXVAL(K),K=J,I)
      FORMAT(I3," ",1X,5(F14.9))
      CONTINUE
      RETURN
      END

```

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      MAXIMA STATISTICS AND RECORDING ROUTINE

      SUBROUTINE WSTATS(FREC,NMAX,MAXVAL)
      INTEGER FREC
      INTEGER NMAX
      REAL MAXVAL(NMAX)
      COMMON /DATAREC/ ITIME,SUM,AVG,N,VALS
      INTEGER ITIME(3)
      REAL SUM
      REAL AVG
      INTEGER N
      REAL VALS(100)
      INCLUDE "PARAMETERS.IF"

      BEGIN
      SUM MAXIMA VALUES
      AVERAGE MAXIMA VALUES
      OUTPUT SUM, AVERAGE, NUMBER OF MAXIMA, AND VALUES TO FILE
      END

      SUM = 0.0
      N = NMAX

      DO 10 I = 1,NMAX
      VALS(I) = MAXVAL(I)
      SUM = SUM + ABS(VALS(I))
10 CONTINUE

      AVG = SUM / FLOAT(NMAX)

      TYPE "AVG,SUM,NMAX :",AVG,SUM,NMAX
      CALL TIME(ITIME,IFR)

      CALL WRITE(FCHAN,FREC,ITIME,I,IFR)
      IF(IFR.NE.1) TYPE "WRITE ERROR (WSTATS). FREC,IFR :",FREC,IFR
      RETURN
      END

```

1 SURROUTINE CFCHAN

2  
3 C---  
4 ROUTINE TO CLOSE DATA FILE  
5 C---  
6 C---

7 COMMON /RITE/ FRFC,FNAME

8 INTEGER FRC

9 INTEGER FNAME(4)

10 INCLUDE "PARAMFIERS.IF"

11 CLOSE FCHAN

12 TYPE "<NL>PROCESS COMPLETE"

13 TYPE "NORMAL TERMINATION"

14 IF (FRC .EQ. 1) GO TO 30

15 WRITE(10,500) FNAME(1)

16 FORMAT("DATA WRITTEN TO FILE ",S6)

17 GO TO 40

500

20 CONTINUE

21 WRITE(10,510) FNAME(1)

22 FORMAT("NO DATA RECORDED. DATA FILE ",S6," DELETED FROM DISK")

23 CALL FDELETE(FNAME)

24 CONTINUE

25 RETURN

26 END

APPENDIX C

USER DOCUMENTATION  
COMPUTER GRAPHICS SIMULATOR

## 1.0 INTRODUCTION

LEXISIM is an interactive computer graphics simulator developed for training subjects to true a bicycle wheel. The Simulator has low-physical and high-functional similarities to an actual trueing system. The LEXISIM program, developed in FORTRAN on a Lexidata System 3400 Video Image and Graphics Processor communicating with a Data General Eclipse S/200 computer, performs the following tasks:

1. Displays the demonstration graphics the instructor uses to explain the trueing procedures to the subject.
2. Provides the user with the following options for trueing the wheel:
  - a. Adjust the spokes.
  - b. Adjust the calipers.
  - c. Turn the wheel.
  - d. Stop the wheel.
  - e. Change the direction the wheel is turning.
  - f. Change the speed of the wheel.
3. Takes periodic measurements of the bicycle wheel variances.

## 2.0 EXECUTING LEXISIM

### 2.1 Setup

1. The software for LEXISIM is resident on disk pack #28 and must be executed on the left-hand Eclipse computer in the Man-Machine Sciences lab.
2. Follow the startup procedures next to the computer, loading disk pack #28 in disk drive #0. If trials are also to be run under condition "A" (high physical, high-functional system), load disk pack #42 in disk drive #1.
3. Be sure the red light on the front panel of the Lexidata processor is pushed in. There are two Lexidata processors located above the two disk drives next to the window. The LEXISIM simulator uses the lower one.
4. If trial results are to be printed, turn on the power switch on the printer located next to the door and press the ON/LINE button.
5. Turn on the power switch on the Lexidata monitor. The switch is located on the lower right corner on the front of the monitor. A cross-hair should be displayed on the monitor along with the words "IDOS REV 1.6".

### 2.2 Program Startup

1. After system startup the system responds with:

FILENAME?

Press the carriage return and enter the date and time in the requested format. The system responds with an R to indicate that the system is ready to accept user commands.

2. To start the program, type:

LEXISIM carriage  
return

The system now begins to issue prompts for user inputs.

### 2.3 Prompts and User Responses

1. The user will first be asked to supply information needed to create a data file for storing wheel measurements. Refer to the "SIMTRAIN PILOT PROJECT DATA COLLECTION" document for appropriate responses to the prompts. In addition, the following prompt will be issued:

ENTER EXERCISE NUMBER (1-3):

- a. Exercise 1 is a test trial for the instructor to demonstrate the simulator to the subject. No wheel measurements will be taken for this exercise.
  - b. Exercises 2 and 3 correspond to practice sessions 1 and 2, respectively, for the trial subject.
2. After supplying the information for the data file, the following menu will be issued:

1. EQUIPMENT COMPONENTS
2. FINDING WOBBLE
3. SPOKE ADJUSTMENT
4. FINE TUNING

TYPE 1, 2, 3, 4 (0 TO STOP DEMOS):

#### User Responses:

1. "1" - "4" - the corresponding instructor demonstration will be displayed.
  2. "0" - the simulation will begin.
3. At the start of the simulation the following menu will be issued:
    - A : ADJUST SPOKES
    - C : ADJUST CALIPERS
    - D : CHANGE DIRECTION OF WHEEL MOVEMENT
    - S : STOP WHEEL
    - T : TURN WHEEL
    - W : CHANGE SPEED OF WHEEL

TYPE A, C, D, S, T, or W:

User Responses:

1. "A" - the following prompt will be issued:

WHICH SPOKE DO YOU WANT TO ADJUST?

TYPE 1, 2, 3,... or 36 (S to STOP SPOKE ADJUSTMENT):

User Responses:

- a. "1" - "36" - the following menu will be issued:

1 : TURN SPOKE CLOCKWISE  
2 : TURN SPOKE COUNTER-CLOCKWISE  
3 : STOP ADJUSTMENTS ON SPOKE n

TYPE 1, 2, or S:

User Responses:

- i. "1" or "2" - the spoke will be adjusted in the corresponding direction.
- ii. "S" - adjustment is stopped on the current spoke.

- b. "S" - adjustment is stopped on all spokes.

2. "C" - the following menu will be issued:

I : MOVE CALIPERS IN  
O : MOVE CALIPERS OUT  
S : STOP CALIPER ADJUSTMENT

TYPE I, O, OR S:

User Responses:

- a. "I" - the calipers will be moved in.
  - b. "O" - the calipers will be moved out.
  - c. "S" - caliper adjustment will be stopped.
3. "D" - the wheel will move in the opposite direction it is currently moving.
  4. "S" - the wheel will stop turning.
  5. "T" - the wheel will start turning.

6. "W" - the following prompt will be issued:

TYPE 1, 2, OR 3 (1 = SLOWEST SPEED, 3 = FASTEST SPEED):

User Responses:

- a. "1" - the wheel will move at the slowest speed.
- b. "2" - the wheel will move at a medium speed.
- c. "3" - the wheel will move at the fastest speed.

7. Whenever the prompt "TYPE A, C, D, S, T, OR W" appears, the instructor may respond with the following options:\*

- a. "M" - a measurement will be taken of the wheel variances. Again, follow the "SIMTRAIN PILOT PROJECT DATA COLLECTION" document for appropriate responses to the prompts.
- b. "Q" - the data file for the trial will be closed and the simulation will end.

\* These two options were intentionally left off the main user option menu to prevent the subject from taking wheel measurements or ending the simulation.

2.4 Errors

- 1. If at any time an inappropriate response is given, the prompt or menu will be issued again until a valid response is given.
- 2. If the spoke adjustment option is selected while the wheel is still turning, the following message will be issued:

YOU MUST STOP THE WHEEL BEFORE ADJUSTING SPOKES

Simply stop the wheel first and then adjust the spokes.

- 3. If the wheel hits the calipers while moving, the wheel will stop and a bell will be sounded.
- 4. If the calipers are adjusted too far in or out, a bell will be sounded.

## 2.5 Data Examination:

After a simulation run, the data may be examined by using the EXAMINE program. The procedures for using EXAMINE may be found in the "SIMTRAIN PILOT PROJECT DATA COLLECTION" document.

## 3.0 CONDITION "A" TRIALS

If wheel measurements are to be taken for trials run under condition "A" (high-physical, high-functional system), use the following procedures:

1. When the system is in the command processing mode (the ready prompt, R, appears on the terminal) type the following command:

```
DIR DP1 carriage  
return
```

2. Type the command:

```
WHEELRITE carriage  
return
```

3. Follow the procedures in the "SIMTRAIN PILOT PROJECT DATA COLLECTION" document for taking wheel measurements and examining the data.
4. To return to the LEXISIM simulator while in the command processing mode, type the command:

```
DIR DP0 carriage (where 0 = zero)  
return
```

## 4.0 SYSTEM SHUTDOWN

The system may be shut down at any time when it is in the command processing mode.

1. If trials were run under condition "A", type the command:

```
RELEASE DP1 carriage  
return
```

2. Type the command:

```
END carriage  
return
```

The system will respond with the messages:

```
DIRECTORY DP0 CLEARED  
MASTER DEVICE RELEASED
```

3. Follow the remaining shutdown procedures next to the computer, starting with step #4.
4. Turn off the power switches on the line printer and Lexidata monitor.

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APPENDIX D

COMPUTER PROGRAM LISTING  
GRAPHICS DISPLAY DEVICE

```

1 C---
2 C---
3 C---
4
5 MAIN DRIVER ROUTINE FOR LEXIDATA WHEEL SIMULATOR
6
7 COMMON /RITE/ FRFC,FNAME
8
9 INTEGER FREC
10 INTEGER FNAME(8)
11
12 INITIALIZE DATA FILE FOR WHEEL MEASUREMENTS
13
14 CALL WINIT(FNAME,FREC)
15
16 TAKE INITIAL WHEEL MEASUREMENT
17
18 CALL WHEELRITE
19
20 INITIALIZE LEXIDATA DISPLAY
21
22 CALL INIT
23
24 DISPLAY INSTRUCTOR DEMOS
25
26 CALL DEMOS
27
28 START SIMULATOR
29
30 TYPE "<NL>PRESS ANY KEY TO START SIMULATOR<NL>"
31 CALL GETC(ICHAR)
32 CALL WHEEL
33
34 CLOSE DATA FILE FOR WHEEL MEASUREMENTS
35
36 CALL CFCHAN
37
38 STOP
39 FND
40
41
42
43
44
45
46
47
48

```

```

1 SUBROUTINE INIT
2 C---
3 ROUTINE TO INITIALIZE THE LEXIDATA
4 C---
5 INTEGER BUF1(3000)
6
7 OPEN THE DISPLAY
8 C---
9 C---
10 CALL DSCPM(48,49,2,IERR)
11 IF (IERR.NE. 0) GO TO 999
12
13 GET IDOS34 MAP
14 C---
15 C---
16 CALL GETMP(BUF1,IERR1)
17 IF (IERR1.NE. 1) GO TO 900
18
19 LOAD MICRO-PROGRAM
20 C---
21 C---
22 CALL DSPLD(BUF1)
23 IF (IERR.NE. 0) GO TO 999
24
25 CONFIGURE DISPLAY PARAMETERS
26 C---
27 C---
28 CALL DSCFG(511,511,8)
29 IF (IERR.NE. 0) GO TO 999
30
31 CLEAR THE DISPLAY
32 C---
33 C---
34 CALL DSCLP(-1)
35 IF (IERR.NE. 0) GO TO 999
36
37 SELECT THE HARDWARE CURSOR
38 C---
39 C---
40 CALL DSCSL(2,0,0)
41 IF (IERR.NE. 0) GO TO 999
42
43 ERASE THE MATRIX CURSOR
44 C---
45 C---
46 CALL DSCER
47 IF (IERR.NE. 0) GO TO 999
48
49 GO TO 1000
50
51 TYPE "IDOS34 FROM 111",IERR1
52 STOP
53
54 IF (IERR.FW. 34) TYPE "NO TCHS AVAILABLE"
55 IF (IERR.FW. 37) TYPE "DEVICE CODE ALREADY IN USE"
56 IF (IERR.FW. 49) TYPE "TASK ID ALREADY IN USE"

```

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```
57 IF (IERR .EQ. 65) TYPE "DEVICE TIMEOUT"  
58 STOP  
59  
60 CONTINUE  
61 RETURN  
62 END
```



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INITIAL.FR

```

1  SUBROUTINE INITIAL
2
3  C---
4  C---
5  C---
6  C---
7
8  ROUTINE TO INITIALIZE VARIABLES AND INITIALIZE THE WHEEL
9  ON THE DISPLAY
10
11  COMMON /TEMPS/ IDIRECT,ISTEMP,ISTEMP1,ISPEED
12  COMMON /SIP/ ISIP
13  COMMON /PTS/ NPOINTS(36),NDATA(180,3)
14  COMMON /SPKS/ SPNUM(5),NSTR(36,2)
15  COMMON /VLOC/ VCOUR(5)
16  COMMON /ILIR/ IL,IR
17  COMMON /LHC/ LEFT,RIGHT,CENTER
18  COMMON /IPT/ IPOINT
19  COMMON /CAL/ ILEFT,IRIGHT
20  COMMON /MOD/ YS(36)
21
22  DIMENSION INPUT(3),JSTRING(0:9)
23  INTEGER CENTER,YCOORD,SPNUM,RIGHT
24
25  JSTRING(0) = "0"
26  JSTRING(1) = "1"
27  JSTRING(2) = "2"
28  JSTRING(3) = "3"
29  JSTRING(4) = "4"
30  JSTRING(5) = "5"
31  JSTRING(6) = "6"
32  JSTRING(7) = "7"
33  JSTRING(8) = "8"
34  JSTRING(9) = "9"
35  IPOINT = 15
36  ISIP = 0
37  ITEMP = 1
38  ISPEED = 1
39  IDIRECT = 1
40
41  C---
42  C---
43  C---
44
45  INITIALIZE NUMBER OF POINTS WHEEL IS OFF CENTER AT EACH POINT
46  ALONG A REVOLUTION
47
48  DO 100 I = 1,36
49    NPOINTS(I) = YS(I) * 1000. + .5
50
51  CONTINUE
52  CALL UPDAT
53  DO 111 I = 1,180
54
55  CONTINUE
56
57  INITIALIZE CHARACTER STRINGS FOR SPOKE NUMBERS
58
59  DO 10 I = 1,9

```

```

57      NSIR(1,1) = "
58      NSIR(1,2) = JSIRING(1)
59
60      CONTINUE
61      DO 20 I = 10,36
62          NSIR(1,1) = JSIRING(1/10)
63          NSIR(1,2) = JSIRING(MOD(1,10))
64
65      CONTINUE
66
67      C---
68      C---
69      C---
70
71      CALL PWHEEL
72
73      C---
74      C---
75      C---
76
77      DO 105 I = 1,5
78          SPNUM(I) = 7-I
79
80      CONTINUE
81
82      C---
83      C---
84      C---
85
86      INTENSITY = -1
87      CALL STANUM(INTENSITY)
88
89      C---
90      C---
91      C---
92
93      DO 55 J = 1,5
94          SPNUM(1) = SPNUM(1) - 1
95          YCOORD(1) = 16 + J * 40
96
97      CONTINUE
98
99      C---
100      C---
101      C---
102
103      LEFT = IL = NDATA(IPPOINT,1)
104      RIGHT = IR = NDATA(IPPOINT,2)
105      CENTER = NDATA(IPPOINT,3)
106
107      C---
108      C---
109      C---
110
111      CALL DSVFC(LEFT,56,LEFT,256,-1)
112      CALL DSVFC(RIGHT,56,RIGHT,256,-1)

```

```

113 C---
114 C---
115 C---
116 C---
117
118 DISPLAY INITIAL SPOKES ON WHEEL
119
120 DO 150 I = 1,5
121 CALL DSCIR(CENTER,YCOORD(I),2,-1)
122 CALL DSSAD(CENTER-9,YCOORD(1)+4,-1,0,1)
123 CALL DSTXT(INSTR(SPNUM(I),1))
124 CALL DSTXT(INSTR(SPNUM(1),2))
125
126 CONTINUE
127
128 DISPLAY CALIPERS
129
130 ILEFT = 159
131 IRIGHT = 353
132 INTEN = -1
133 CALL CALIP(ILEFT,IRIGHT,INTEN)
134
135
136 START TASK 10 SPIN WHEEL
137
138
139 TASK SPIN,ID=1,PRI=0
140
141 RETURN
142 END

```

```

1
2
3 C---
4 C---
5 C---
6 C---
7
8 COMMON /MOD/ VS(36)
9 INTEGER EXPRCISE,EX1,EX2,EX3
10 DIMENSION EX1(36),EX2(36),EX3(36)
11
12 DATA EX1/30,27,22,14,0,-14,-22,-52,-72,-88,-95,-92,-78,-56,-31,-10,7,17,
13 17,12,3,-13,-33,-50,-63,-60,-64,-52,-37,-21,-12,-2,0,19,27,29/
14
15 DATA EX2/119,122,113,94,71,40,27,12,3,-1,0,6,9,10,5,-6,-23,-42,-59,
16 -74,-83,-91,-94,-92,-85,-70,-54,-35,-21,-8,1,13,33,57,82,104/
17
18 DATA EX3/77,83,80,74,65,56,44,30,12,0,-14,-30,-44,-62,-77,-89,-94,
19 -89,-73,-53,-32,-19,-17,-26,-42,-59,-75,-81,-80,-72,-60,
20 -39,-14,14,40,62/
21
22 GO TO (1,2,3),EXERCISE
23
24 1 CONTINUE
25 DO 100 I = 1,36
26   VS(I) = EX1(I) / 2000.
27
28 100 CONTINUE
29 GO TO 4
30
31 2 CONTINUE
32 DO 200 I = 1,36
33   VS(I) = EX2(I) / 2000.
34
35 200 CONTINUE
36 GO TO 4
37
38 3 CONTINUE
39 DO 300 I = 1,36
40   VS(I) = EX3(I) / 2000.
41
42 300 CONTINUE
43
44 4 CONTINUE
45 RETURN
46 END

```

```

1  C
2  C
3
4  GETMP          GET MICROPROGRAM INTO BUFFER
5  9/7/78        RNDOS VERSION
6
7  SUBROUTINE GETMP(1BUF,IERR)
8  INTEGER 1BUF(1)
9
10 CALL OPEN(2,"DOS34.PL",1,IERR)
11 IF (IERR.NE.1) GOTO 990
12 CALL RDHLK(2,0,1BUF,0,IERR)
13 CALL CLOSE(2)
14 RETURN
15
16 990
17
18 END

```

```

57 C----
58 C---- ADJUST CALIPERS
59 C----
60
61 4
62 CONTINUE
63 CALL ADJCAL
64 CALL MENU
65 GO TO 1
66
67 C----
68 C---- STOP WHEEL
69 C----
70 6
71 CONTINUE
72 ISTOP = 0
73 CALL MENU
74 GO TO 1
75
76 C----
77 C---- START WHEEL TURNING
78 C----
79 7
80 CONTINUE
81 ISTOP = 1
82 ITEMP = 0
83 ITEMP1 = 0
84 WAKEUP 2
85 WAKEUP 3
86 CALL MENU
87 GO TO 1
88
89 C----
90 C---- CHANGE SPEED OF WHEEL
91 C----
92
93 8
94 CONTINUE
95 WRITE(10,5000)
96 FORMAT ("<NL><NL>TYPE 1, 2, OR 3 (1 = SLOWEST SPEED,
97 3 = FASTEST SPEED) : ",2)
98 READ(11,6000) (INPUT(I), I = 1,3)
99 FORMAT(3M1)
100 CALL CONVERT(INPUT,IS)
101 IF ((IS .LT. 1) .OR. (IS .GT. 3)) GO TO 8
102 ISPEED = IS
103 IF (ISPEED .NE. 3) GO TO 400
104 ITEMP = 0
105 ITEMP1 = 0
106
107 400
108 CONTINUE
109 CALL MENU
110 GO TO 1
111
112 C---- MEASURE WHEEL VARIANCES
113 C----
114 C----

```

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WHEEL.FR

```

113          9      CONTINUE
114          TYPE '<NL>ARE YOU SURE YOU WANT TO TAKE A MEASUREMENT ? (Y = YES,
115             N = NO)'
116          READ(11,8000) NOYES
117          IF ((NOYES .NE. 'Y') .AND. (NOYES .NE. 'N')) GO TO 9
118          IF (NOYES .EQ. 'Y') CALL WHEELRITE
119          CALL MENU
120          GO TO 1
121
122          C---
123          C---
124          C---
125
126          11      CONTINUE
127          TYPE '<NL><NL>ARE YOU SURE YOU WANT TO QUIT ? (Y = YES, N = NO)'
128          WRITE(10,7000)
129          FORMAT('<NL>TYPE Y OR N : ',7)
130          READ(11,8000) NOYES
131          FORMAT(R1)
132          IF (NOYES .EQ. 'Y') GO TO 600
133          IF (NOYES .NE. 'N') GO TO 11
134          CALL MENU
135          GO TO 1
136
137          600      CONTINUE
138
139          RETURN
140          END

```

```

1
2
3      C---
4      C---
5      C---
6
7      SUBROUTINE SPIN
8
9      TASK TO SPIN THE WHEEL ON THE MONITOR
10
11      COMMON /TEMPS/ JDIRECT,ISTEMP,ISTEMP1,ISPEED
12      COMMON /STP/ ISTOP
13      COMMON /PTS/ NPOINTS(36),NDATA(180,3)
14      COMMON /CAL/ ILEFT,IRIGHT
15      COMMON /SPKS/ SPNUM(5),NSTR(36,2)
16      COMMON /YLOC/ YCNR(5)
17      COMMON /ILIN/ IL,IR
18      COMMON /LRC/ LEFT,RIGHT,CENTER
19      COMMON /IPT/ IPOINT
20      COMMON /CNT/ J
21
22      INTEGER LEFT,RIGHT,CENTER,SPNUM,YCNR
23
24      WAIT UNTIL USER STARTS WHEEL TURNING
25
26      IDIRECT = JDIRECT
27      WAIT 2
28      J = 0
29
30      CONTINUE
31      J = J + IDIRECT
32      IF (J .GT. 180) J = 1
33      IF (J .LT. 1) J = 180
34      IF (ISPEED .NE. 1) GO TO 250
35
36      SLOW SPEED
37
38      JSLOW = 20000
39      IF (ISPEED .EQ. 2) JSLOW = 5000
40      DO 230 KK = 1,5
41      DO 225 K = 1,JSLOW
42      CONTINUE
43      CONTINUE
44
45      CONTINUE
46      IF ((ISPEED .EQ. 3) .AND. (ISTEMP .NE. 0)) GO TO 300
47
48      ERASE CURRENT SPOKE NUMBERS ON WHEEL
49
50
51      DO 300 I = 1,5
52      CALL DSCIR(CENTER,YCNR(I),2,0)
53      CALL DSSAR(CENTER-9,YCNR(1)+4,0,0,1)
54      ITEMP = 6-1+J/5
55      IF (ITEMP .GT. 36) ITEMP = ITEMP - 36

```

```

57      CALL DSXIT(NSTR(ITEMP,1))
58      CALL DSXIT(NSTR(ITEMP,2))
59
60      CONTINUE
61      ISTEMP = 1
62      DO 400 I = 1,5
63          YCOORD(I) = 16 + I * 40 + 8 * (MOD(J,5) )
64
65      CONTINUE
66
67      CHECK IF WHEEL IS HITTING CALIPERS
68      C----
69      C----
70      C----
71
72      IL = LEFT
73      IR = RIGHT
74      IPOINT = IPOINT + IDIRECT
75      IF (IPOINT .GT. 180) IPOINT = 1
76      IF (IPOINT .LT. 1) IPOINT = 180
77      LEFT = NDATA(IPOINT,1)
78      RIGHT = NDATA(IPOINT,2)
79      CENTER = NDATA(IPOINT,3)
80      IF ((LEFT .GT. ILEFT) .AND. (RIGHT .LT. IRIGHT)) GO TO 425
81      IF (LEFT .GT. ILEFT) GO TO 415
82      LEFT = ILEFT + 1
83      RIGHT = LEFT + 50
84      GO TO 420
85
86      CONTINUE
87      RIGHT = IRIGHT - 1
88      LEFT = RIGHT - 50
89
90      CONTINUE
91      CENTER = (LEFT + RIGHT) / 2
92      TYPE "<REL>"
93      ISTOP = 0
94
95      CONTINUE
96
97      ERASE OLD RIM
98      C----
99      C----
100      C----
101
102      CALL DSVEC(IL,56,IL,256,0)
103      CALL DSVEC(IR,56,IR,256,0)
104
105      DISPLAY NEW RIM
106      C----
107      C----
108      C----
109
110      CALL DSVEC(LEFT,56,LEFT,256,-1)
111      CALL DSVEC(RIGHT,56,RIGHT,256,-1)
112      IF ((ISPEED .EQ. 3) .AND. (ISTOP .EQ. 1)) GO TO 500

```

```

113 C--- DISPLAY NEW SPOKE NUMBERS
114 C---
115
116 DO 500 I = 1,5
117 IF ((YCOORD(I)) .LT. 60) .OR. (YCOORD(I)) .GT. 250) GO TO 500
118 CALL DSCIN (CENTER,YCOORD(I),2,-1)
119 CALL DSSAO(CENTER-9,YCOORD(I)+4,-1,0,1)
120 ITEMP = 6 - I + J/5
121 IF (ITEMP .GT. 36) ITEMP = ITEMP - 36
122 CALL DSXINSTR(ITEMP,1)
123 CALL DSXINSTR(ITEMP,2)
124
125 CONTINUE
126 IF ((ISTOP .NE. 0) GO TO 525
127 IF (ISPEED .NE. 3) GO TO 515
128 IF (MOD(SPNUM(1),2) .NE. 1) GO TO 510
129
130 UPDATE SPOKE NUMBERS FOR STATIONARY WHEEL
131 C---
132 C---
133 C---
134
135 DO 505 I = 1,5
136 SPNUM(I) = SPNUM(I) - 1
137 IF (SPNUM(I) .LT. 1) SPNUM(I) = 36
138
139 CONTINUE
140
141 CONTINUE
142
143 DISPLAY SPOKE NUMBERS ON STATIONARY WHEEL
144 C---
145 C---
146 C---
147
148 INTENSITY = -1
149 CALL SIANUM(INTENSITY)
150
151 CONTINUE
152
153 WAIT IF USER STOPPED WHEEL
154 C---
155 C---
156 C---
157
158 WAIT 2
159
160 CONTINUE
161 IF ((ISPEED .EQ. 3) .AND. (ISTEMP1 .EQ. 1)) GO TO 625
162 IF (ISPEED .EQ. 3) GO TO 650
163 IF (MOD(I,5) .EQ. 0) GO TO 625
164 ISLOW = 20000
165 IF (ISPEED .EQ. 2) ISLOW = 5000
166 DO 675 JJ = 1,ISLOW
167 CONTINUE
168 GO TO 600
169
170 CONTINUE
171 ITEMP = 5 + J/5
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200

```

```

169
170 C---
171 C---
172 C---
173
174 INTENSITY = 0
175 CALL STANUM(INTENSITY)
176 ITEMP1 = 1
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204

```

ERASE SPOKE NUMBERS ON STATIONARY WHEEL

INTENSITY = 0  
CALL STANUM(INTENSITY)  
ITEMP1 = 1

CONTINUE  
DO 700 I = 1,5  
ITEMP = 6 - I + J/5  
IF (IDIRECT.EQ. -1) ITEMP = ITEMP - 1  
IF (ITEMP.GT. 36) ITEMP = ITEMP - 36  
SPNUM(I) = ITEMP

CONTINUE  
IF ((MOD(SPNUM(1),2).EQ. 1) .OR. (ISPEED.EQ. 3)) GO TO 600

700

CONTINUE  
IF ((MOD(SPNUM(1),2).EQ. 1) .OR. (ISPEED.EQ. 3)) GO TO 600

DISPLAY NEW SPOKE NUMBERS ON STATIONARY WHEEL

INTENSITY = -1  
CALL STANUM(INTENSITY)  
CONTINUE

600

UPDATE DIRECTION OF WHEEL

IDIRECT = JDIRECT  
IF (J.GT. 0) GO TO 200

RETURN  
END

```

1 SUBROUTINE MODEL(TURNS,ISPKE,Y)
2   DIMENSION Y(3)
3   C---
4   C---
5   C---
6   C---
7   C---
8   C---
9   INTEGER S, SS
10  DIMENSION YNINE(36)
11  C---
12  C---
13  C---
14  C---
15  C---
16  F9 = 1.5 * TURNS / 8.
17  L = 72
18  E = 10. ** 7
19  Z1 = 0.02
20  C---
21  C---
22  C---
23  C---
24  FOR S = 0 TO 9 STEP 1
25    Y(9,S) = F9*(2+S)**3 * (3L-4(2+S)) / (4*E1)
26  DO 100 S = 1,9
27    YNINE(S) = F9 * (2+S) ** 3 * (3*L - 8*S) / E+Z1*48.
28  CONTINUE
29  FOR S = 10 TO 17 STEP 1
30    Y(9,S) = Y(9,18-S)  BY SYMMETRY
31  C---
32  DO 200 S = 10,17
33    YNINE(S) = YNINE(18-S)
34  CONTINUE
35  FOR S = 18 TO 36 STEP 1
36    Y(9,S) = 0
37  C---
38  C---
39  C---
40  DO 300 S = 18,36
41    YNINE(S) = 0.
42  CONTINUE
43  FOR S = K-8 TO K STEP 1
44    Y(K,S) = Y(9,S-(K-9))
45  C---
46  C---
47  C---
48  ITEMP = ISPKE - A
49  DO 400 SS = 1TEMP, ISPKE
50    S = SS
51    IF (S .LE. 0) S = S + 36
52    Y(S) = YNINE(SS - (ISPKE - 9))
53    Y(S) = Y(S) + 0.1 * Y(S) * (RANDOM(1) - 0.5)
54  C---
55  CONTINUE
56

```

```

57 C---
58 C---
59 C---
60 C---
61 ITEMP = ISPOKE + 1
62 JTEMP = ISPOKE + 8
63 DO 500 SS = ITEMP, JTEMP
64   S = SS
65   IF (S .GT. 36) S = S - 36
66   Y(S) = YNINE(ISPOKE + 9 - SS)
67
68 CONTINUE
69 C---
70 C---
71 C---
72 C---
73 ITEMP = ISPOKE + 9
74 JTEMP = ISPOKE + 17
75 DO 600 SS = ITEMP, JTEMP
76   S = SS
77   IF (S .GT. 36) S = S - 36
78   Y(S) = 0.
79
80 CONTINUE
81 C---
82 C---
83 C---
84 C---
85 ITEMP = ISPOKE - 18
86 JTEMP = ISPOKE - 9
87 DO 700 SS = ITEMP, JTEMP
88   S = SS
89   IF (S .LE. 0) S = S + 36
90   Y(S) = 0.
91
92 CONTINUE
93 RETURN
94 END
95

```

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MENU.FR

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SUBROUTINE MENU

C---  
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C---

ROUTINE TO OUTPUT USER OPTION MENU

```

TYPE " <NL><NL>      A : ADJUST SPOKES "
TYPE "      C : ADJUST CALIPERS "
TYPE "      D : CHANGE DIRECTION OF WHEEL MOVEMENT "
TYPE "      M : MEASURE WHEEL VARIANCES "
TYPE "      Q : QUIT "
TYPE "      S : STOP WHEEL "
TYPE "      T : TURN WHEEL "
TYPE "      W : CHANGE SPEED OF WHEEL "

```

RETURN  
END

```

1
2
3 C---
4 C---
5 C---
6
7
8 COMMON /SP/ ISTOP
9 COMMON /PIS/ NPOINTS(36),NDATA(180,3)
10 COMMON /SPKS/ SPNUM(5),NSTR(36,2)
11 COMMON /YLOC/ YCOORD(S)
12 COMMON /ILIR/ IL,IR
13 COMMON /LRC/ LEFT,RIGHT,CENTER
14 COMMON /IPT/ IPOINT
15 COMMON /CAL/ ILEFT,IRIGHT
16 COMMON /MOD/ YS(36)
17
18 DIMENSION YY(36),INPUT(3)
19
20 INTEGER CENTER,YCOORD,RIGHT,SPNUM
21
22 C---
23 C---
24 C---
25
26 IF (ISTOP.EQ. 0) GO TO 10
27 TYPE "<REL>"
28 TYPE "<NL><NL>*****"
29 TYPE "*** YOU MUST STOP THE WHEEL BEFORE ADJUSTING SPOKES ***"
30 TYPE "*****"
31 GO TO 90
32
33 C---
34 C---
35 C---
36
37 PROMPT USER FOR SPOKE NUMBER
38
39
40 CONTINUE
41 TYPE "<NL><NL>WHICH SPOKE DO YOU WANT TO ADJUST ? "
42 WRITE(10,1000)
43 FORMAT ("<NL>TYPE 1, 2, 3, ..., OR 36 ( 3 10 STOP SPOKE ADJUSTMENT) : ",2)
44 READ(11,2000) (INPUT(I), I = 1,3)
45 FORMAT(3I1)
46 IF (INPUT(1).EQ. " S") GO TO 90
47 CALL CONVERT(INPUT,ISPOKE)
48 IF ((ISPOKE.LT. 0).OR. (ISPOKE.GT. 36)) GO TO 10
49 IMOD = MOD(ISPOKE,2)
50
51 C---
52 C---
53 C---
54
55 PROMPT USER FOR DIRECTION OF SPOKE ADJUSTMENT
56
57
58 CONTINUE
59 TYPE "<NL><NL> 1: TURN SPOKE CUCKWISE"
60 TYPE " 2: TURN SPOKE COUNTER-CUCKWISE"
61 TYPE " 3: STOP ADJUSTMENTS ON SPOKE",ISPOKE
62 WRITE(10,4000)

```

```

57 4000 FORMAT('<NL>TYPE 1, 2, OR 3 : ',2)
58 READ(11,3000) ICHAR
59 FORMAT(R1)
60 IF (ICHR .EQ. 'S') GO TO 10
61 IF ((ICHR .NE. '1') .AND. (ICHR .NE. '2')) GO TO 14
62 IDIR = 1
63 IF (ICHR .EQ. '2') IDIR = 2
64 TURNS = 1./A.
65 IF ((IDIR .EQ. 2) .AND. (IMOD .EQ. 1)) TURNS = -TURNS
66 IF ((IDIR .EQ. 1) .AND. (IMOD .EQ. 0)) TURNS = -TURNS
67
68 C---
69 C---
70 C---
71
72 CALL MODEL(TURNS, ISPOKE, YY)
73 DO 13 I = 1, 36
74   YS(I) = YS(I) + YY(I)
75
76 13 CONTINUE
77
78 C---
79 C---
80 C---
81
82 DO 20 I = 1, 36
83   NPOINTS(I) = YS(I) * 1000 + .5
84
85 20 CONTINUE
86 CALL UPDAT
87
88 ERASE OLD SPOKES
89
90 C---
91 C---
92 C---
93
94 DO 40 I = 1, 5
95   CALL DSCIR(CENTER, YCOORD(I), 2, 0)
96   CALL DSSAO(CENTER-9, YCOORD(I)+4, 0, 0, 1)
97   ITEMP = 6-I+.5
98   IF (ITEMP .GT. 36) ITEMP = ITEMP-36
99   CALL DSIXT(NSIR(ITEMP, 1))
100  CALL DSIXT(NSIR(ITEMP, 2))
101 CONTINUE
102
103 CHECK IF WHEEL IS HITTING THE CALIPERS
104
105 IL = LEFT
106 IR = RIGHT
107 IC = CENTER
108 LEFT = NDATA(IPPOINT, 1)
109 RIGHT = NDATA(IPPOINT, 2)
110 CENTER = NDATA(IPPOINT, 3)
111 IF ((LEFT .GT. ILFFI) .AND. (RIGHT .LT. IRIGHT)) GO TO 60
112 IF ((LEFT .GT. ILFFI) GO TO 50

```

```

113 LEFT = ILEFT + 1
114 RIGHT = LEFT + 50
115 GO TO 55
116
117 CONTINUE
118 RIGHT = IRIGHT - 1
119 LEFT = RIGHT - 50
120
121 CONTINUE
122 CENTER = (LEFT + RIGHT) / 2
123 TYPE = <BEL>
124 ISTOP = 0
125
126 CONTINUE
127
128 ERASE OLD POSITION OF THE WHEEL
129
130
131 CALL DSVEC(IL,56,IL,256,0)
132 CALL DSVEC(IR,56,IR,256,0)
133
134
135 DISPLAY NEW POSITION OF WHEEL
136
137
138 CALL DSVEC(LEFT,56,LEFT,256,-1)
139 CALL DSVEC(RIGHT,56,RIGHT,256,-1)
140
141
142 DISPLAY SPOKE NUMBERS
143
144
145 DO 80 I = 1,5
146 IF ((YCOORD(I) .LT. 56) .OR. (YCOORD(I) .GT. 250)) GO TO A0
147 CALL DSCIR(CENTER,YCOORD(I),2,-1)
148 CALL DSSAO(CENTER-9,YCOORD(I)+9,-1,0,1)
149 ITEMP = 6 - I + J/5
150 IF (ITEMP .GT. 36) ITEMP = ITEMP - 36
151 CALL DSIXT(NSIX(ITEMP,1))
152 CALL DSIXT(NSIX(ITEMP,2))
153
154
155 CONTINUE
156 GO TO 16
157 CONTINUE
158
159 RETURN
160 END

```



```
57      25      CONTINUE
58      C----
59      C----
60      C----
61      C----
62
63      INIEN = 0
64      CALL CALIP(ILEFT,IRIGHT,INIEN)
65
66      DISPLAY NEW POSITION OF CALIPERS
67      C----
68      C----
69      C----
70
71      ILEFT = ITEMP
72      IRIGHT = JTEMP
73      INIEN = -1
74      CALL CALIP(ILEFT,IRIGHT,INIEN)
75      GO TO 4
76
77      30      CONTINUE
78      RETURN
79      END
```

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19

C---  
C---  
C---

SUBROUTINE CALIP(ILEFT,IRIGHT,INTEN)

ROUTINE TO DRAW OR ERASE CALIPFRS

IITEMP = ILEFT - 22  
JITEMP = IRIGHT + 22

CALL DSVEC(ILEFT,135,IITEMP,123,INTEN)  
CALL DSVEC(ILEFT,135,IITEMP,147,INTEN)  
CALL DSVEC(IITEMP,123,IITEMP,147,INTEN)  
CALL DSVEC(IRIGHT,135,JITEMP,123,INTEN)  
CALL DSVEC(IRIGHT,135,JITEMP,147,INTEN)  
CALL DSVEC(JITEMP,123,JITEMP,147,INTEN)

RETURN  
END

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UPD1.FR

## SUBROUTINE UPD1

ROUTINE TO UPDATE THE POSITION OF WHEEL AT EACH POINT ALONG A REVOLUTION

COMMON /PTS/ NPPTS(36),NDATA(180,3)  
DIMENSION IPIX(5)

```

DO 17 I = 1,36
  LAST = I - 1
  IF (LAST .EQ. 0) LAST = 36
  DO 14 K = 1,5
    IPIX(K) = (NPPTS(I) - NPPTS(LAST)) / 5
  
```

```

CONTINUE
NTEMP = MOD((NPPTS(I) - NPPTS(LAST)),5)
IF (NTEMP .NE. 0) CALL REFINE(NTEMP,IPIX)
DO 15 K = 1,5
  NPTR = (I-1) * 5 + K
  IOVER = NPPTS(LAST)
  DO 18 L = 1,K
    IOVER = IOVER + IPIX(L)
  
```

```

CONTINUE
LEFT = NDATA(NPTR,1) = IOVER + 231
RIGHT = NDATA(NPTR,2) = LEFT + 50
CENTER = NDATA(NPTR,3) = (LEFT + RIGHT) / 2
  
```

CONTINUE

```

CONTINUE
RETURN
END
  
```

```

1 SUBROUTINE STANUM(INTEN)
2
3 C---
4 C---
5 C---
6
7 INTEGER XCOORD(5), YCOORD(5), SPNUM
8
9 COMMON /SPKS/ SPNUM(5), NSTR(36,2)
10
11 DATA XCOORD/446,415,301,346,314/
12 DATA YCOORD/428,448,458,456,444/
13 X
14 DATA XCOORD/314,346,301,415,446/
15 X
16 DATA YCOORD/444,456,458,448,428/
17
18 DO 200 J = 1,5
19   CALL DSSAO(XCOORD(1),YCOORD(1),INTEN,0,1)
20   CALL DSTAT(NSTR(SPNUM(1),1))
21   CALL DSTAT(NSTR(SPNUM(1),2))
22 CONTINUE
23 RETURN
24 END

```

```

1  SUBROUTINE REFINE(KTEMP,IPIX)
2  C---
3  C---
4  C---
5  C---
6
7  DIMENSION IPIX(5)
8
9  IONE = 1
10 IF (KTEMP .LT. 0) IONE = -1
11 GO TO (1,2,3,4), ABS(KTEMP)
12
13 1  CONTINUE
14   IPIX(3) = IPIX(3) + IONE
15   GO TO 10
16
17 2  CONTINUE
18   IPIX(2) = IPIX(2) + IONE
19   IPIX(4) = IPIX(4) + IONE
20   GO TO 10
21
22 3  CONTINUE
23   IPIX(2) = IPIX(2) + IONE
24   IPIX(4) = IPIX(4) + IONE
25   IPIX(5) = IPIX(5) + IONE
26   GO TO 10
27
28 4  CONTINUE
29   DO 5 I = 1,4
30     IPIX(I) = IPIX(I) + IONE
31
32 5  CONTINUE
33
34 10 RETURN
35 END

```

```

1
2
3 C---
4 C---
5 C---
6
7 DIMENSION INPUT(3)
8
9 ISPOKE = -1
10 IF ((INPUT(1) .LT. 020060K) .OR. (INPUT(1) .GT. 020071K)
11 +
12 +
13 +
14 +
15 +
16 +
17 +
18 +
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97 +
98 +
99 +
100

```

ROUTINE TO CONVERT CHARACTER INPUT TO INTEGER

DIMENSION INPUT(3)

ISPOKE = -1

IF ((INPUT(1) .LT. 020060K) .OR. (INPUT(1) .GT. 020071K) .OR. (INPUT(2) .LT. 020040K) .OR. (INPUT(2) .GT. 020071K) .OR. (INPUT(3) .NE. 020040K)) GO TO 100

ISPOKE = INPUT(1) - 020060K

IF (INPUT(2) .LT. 020060K) GO TO 100

ISPOKE = ISPOKE + 10 + INPUT(2) - 020060K

CONTINUE

RETURN

END

```

1
2
3 C----
4 C----
5 C----
6 C----
7
8 DIMENSION IX(8),IY(8),JX(8),JY(8),KX(20),KY(20),IRAD(3),OUT(1000)
9
10 INTEGER OUT
11
12 DATA IRAD/105,121,136/
13
14 NPTS = 1000
15 DEL = 3.14159 * 2. / NPTS
16 IXCENT = 375
17 IYCENT = 350
18 DO 400 I = 1,3
19   IRADIUS = IRAD(I)
20   DO 300 J = 1,5,365
21     OUT((J-114) * 2 - 1) = IXCENT + IRADIUS * COS(J * DEL)
22     OUT((J-114) * 2) = IYCENT + IRADIUS * SIN(J * DEL)
23
24 CONTINUE
25 CALL DSPNT(250,-1,OUT)
26
27
28
29 CONTINUE
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56

```

SUBROUTINE PMHEEL  
 THIS ROUTINE DRAWS A PORTION OF A BICYCLE WHEEL ON  
 THE LOWER RIGHT CORNER OF THE MONITOR  
  
 DIMENSION IX(8),IY(8),JX(8),JY(8),KX(20),KY(20),IRAD(3),OUT(1000)  
 INTEGER OUT  
 DATA IRAD/105,121,136/  
 NPTS = 1000  
 DEL = 3.14159 \* 2. / NPTS  
 IXCENT = 375  
 IYCENT = 350  
 DO 400 I = 1,3  
 IRADIUS = IRAD(I)  
 DO 300 J = 1,5,365  
 OUT((J-114) \* 2 - 1) = IXCENT + IRADIUS \* COS(J \* DEL)  
 OUT((J-114) \* 2) = IYCENT + IRADIUS \* SIN(J \* DEL)  
 CONTINUE  
 CALL DSPNT(250,-1,OUT)  
 CONTINUE  
  
 DISPLAY SPOKE CIRCLES ON WHEEL  
  
 KRADIUS = 112  
 NPTS = 20  
 DEL = 3.14159 \* 2. / NPTS  
 KXCENT = 375  
 KYCENT = 350  
 DO 500 I = 1,NPTS  
 KX(I) = KXCENT + KRADIUS \* COS(I \* DEL) \* 2  
 KY(I) = KYCENT + KRADIUS \* SIN(I \* DEL)  
 CONTINUE  
  
 DO 600 I = 3,7  
 CALL OSCIR(KX(I),KY(I),2,-1)  
 CALL OSCIR(KX(I),KY(I),1,-1)  
 CONTINUE  
  
 600 CONTINUE  
  
 DISPLAY SHADING ON WHEEL  
  
 CALL DSVEC(373,478,400,478,-1)  
 CALL DSVEC(374,480,380,480,-1)  
 CALL DSVEC(390,482,395,482,-1)

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PMHFEL.FM

```

57 CALL DSVEC(335,473,350,473,-1)
58 CALL DSVEC(340,475,345,475,-1)
59
60 CALL DSVEC(300,460,310,460,-1)
61
62 CALL DSVEC(425,467,435,467,-1)
63
64 C---
65 C---
66 C---
67
68 CALL DSCIR(375,320,15,-1)
69 CALL DSCIR(375,320,3,-1)
70 CALL DSCIR(375,290,15,-1)
71
72 C---
73 C---
74 C---
75
76 NPIS = 8
77 DEL = 3.14159 * 2. / NPIS
78 IRADIUS = 12
79 JRADIUS = 12
80 IXCENT = 375
81 IYCENT = 320
82 JXCENT = 375
83 JYCENT = 290
84 IOFF = 0
85 DO 100 I = 1, NPIS
86   IX(1) = IXCENT + IRADIUS * COS(I * DEL + IOFF)
87   IY(1) = IYCENT + IRADIUS * SIN(I * DEL + IOFF)
88   JX(1) = JXCENT + JRADIUS * COS(I * DEL + IOFF)
89   JY(1) = JYCENT + JRADIUS * SIN(I * DEL + IOFF)
90   CALL DSCIR(IX(1),IY(1),1,-1)
91   IF (I .NE. 2) CALL DSCIR(JX(1),JY(1),1,-1)
92
93 CONTINUE
94 CALL DSCIR(375,290,3,-1)
95 DO 200 I = 372,378
96   CALL DSVEC(I,290,1,304,0)
97
98 CONTINUE
99 CALL DSVEC(372,290,372,305,-1)
100 CALL DSVEC(378,290,378,305,-1)
101
102 C---
103 C---
104 C---
105 CALL DSVEC(JX(8),JY(8),JX(8)+40,JY(8)+50,-1)
106 CALL DSVEC(JX(1),JY(1),KX(3),KY(3),-1)
107 CALL DSVEC(IX(8),IY(8),IX(8)+50,IY(8)+75,-1)
108 CALL DSVEC(IX(1),IY(1),KX(4),KY(4),-1)
109 CALL DSVEC(IX(2)+2,IY(2)+3,KX(5),KY(5),-1)
110 CALL DSVEC(IX(2),IY(2),KX(6),KY(6),-1)
111 CALL DSVEC(IX(3),IY(3),IX(3)-50,IY(3)+40,-1)
112 CALL DSVEC(JX(1),IY(1),KX(7),KY(7),-1)

```

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CALL DSVEC(JX(4),JY(4),JX(4)-80,JY(4)+50,-1)  
RETURN  
END

```

1
2
3 C---
4 C---
5 C---
6
7
8
9
10
11
12
13
14
15
16 1000
17
18 2000
19
20 C---
21 C---
22 C---
23
24
25
26
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28
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```

SUBROUTINE DEMOS

ROUTINE TO DISPLAY INSTRUCTOR DEMOS

INTEGER DEMO

TYPE "<NL> 1: EQUIPMENT COMPONENTS "

TYPE " 2: FINDING WUBBLE"

TYPE " 3: SPOKE ADJUSTMENT"

TYPE " 4: FINE TUNING"

CONTINUE

WRITE (10,1000)

FORMAT("<NL>TYPE 1, 2, 3, 4 (0 TO STOP DEMOS) : ",2)

READ (11,2000) DEMO

FORMAT(R1)

CLEAR SCREEN

CALL DSCLR(-1)

IF (DEMO.EQ. " 0") GO TO 60

IF (DEMO.EQ. " 1") GO TO 20

IF (DEMO.EQ. " 2") GO TO 30

IF (DEMO.EQ. " 3") GO TO 40

IF (DEMO.EQ. " 4") GO TO 50

GO TO 10

CALL DEMO1

GO TO 10

CALL DEMO2

GO TO 10

CALL DEMO3

GO TO 10

CALL DEMO4

GO TO 10

CONTINUE

RETURN

END

```

1 SUBROUTINE DEMO1
2
3 C---
4 C---
5 C---
6
7 DIMENSION IX(8),IY(8),KX(8),KY(8),LX(16),LY(16),MX(8),MY(8)
8 DIMENSION NX(8),NY(8)
9
10 INTEGER MDS12,X(8),Y(8)
11
12 DISPLAY WHEEL AND MUR
13 C---
14 C---
15
16 CALL DSCIR(256,256,5,-1)
17 CALL DSCIR(256,256,10,-1)
18 CALL DSCIR(256,256,35,-1)
19 CALL DSCIR(256,256,115,-1)
20 CALL DSCIR(256,256,130,-1)
21
22 C---
23 C---
24 C---
25
26 CALL DSVEC(253,291,250,371,-1)
27 CALL DSVEC(259,291,262,371,-1)
28 CALL DSVEC(249,386,249,400,-1)
29 CALL DSVEC(263,386,263,400,-1)
30 CALL DSVEC(100,400,412,400,-1)
31 CALL DSVEC(100,403,412,403,-1)
32 CALL DSVEC(100,400,100,403,-1)
33 CALL DSVEC(412,400,412,403,-1)
34 CALL DSVEC(179,339,168,354,-1)
35 CALL DSVEC(177,337,162,352,-1)
36 CALL DSVEC(179,339,177,337,-1)
37 CALL DSVEC(159,349,167,357,-1)
38 CALL DSVEC(159,349,151,357,-1)
39 CALL DSVEC(167,357,159,365,-1)
40 CALL DSVEC(151,357,159,365,-1)
41 CALL DSVEC(153,359,151,361,-1)
42 CALL DSVEC(157,363,155,365,-1)
43 CALL DSVEC(147,357,159,369,-1)
44 CALL DSVEC(144,360,156,372,-1)
45 CALL DSVEC(147,357,144,360,-1)
46 CALL DSVEC(159,369,156,372,-1)
47
48 IX1 = 147
49 IY1 = 357
50 IX2 = 144
51 IY2 = 360
52 ON 50 I = 1,5
53   IX1 = IX1 + 2
54   IY1 = IY1 + 2
55   IX2 = IX2 + 2
56   IY2 = IY2 + 2

```

```

57 CALL DSVEC(IX1,IY1,JX2,IY2,-1)
58
59 CONTINUE
60
61 C----
62 C----
63 C----
64
65 NPTS = 8
66 DEL = 3.14159 * 2. / NPTS
67 IRADIUS = 28
68 JRADIUS = 115
69 KRADIUS = 35
70 LRADIUS = 113
71 OFF = 1
72 OFF1 = -1
73 DO 100 I = 1,NPTS
74   X(I) = 256 + IRADIUS * COS(I * DEL)
75   Y(I) = 256 + IRADIUS * SIN(I * DEL)
76   CALL DSCIR(X(I),Y(I),2,-1)
77 CONTINUE
78
79 DO 200 I = 1,NPTS
80   IX(I) = 256 + JRADIUS * COS(I * DEL + OFF)
81   IY(I) = 256 + JRADIUS * SIN(I * DEL + OFF)
82   JX(I) = 256 + LRADIUS * COS(I * DEL + OFF)
83   JY(I) = 256 + LRADIUS * SIN(I * DEL + OFF)
84   CALL DSVEC(X(I),Y(I),IX(I),IY(I),-1)
85
86 CONTINUE
87
88 NPTS2 = 16
89 DEL2 = 3.14159 * 2. / NPTS2
90 DO 250 I = 1,NPTS2
91   LX(I) = 256 + KRADIUS * COS(I * DEL2)
92   LY(I) = 256 + KRADIUS * SIN(I * DEL2)
93
94 CONTINUE
95 DO 300 I = 1,NPTS
96   KX(I) = 256 + JRADIUS * COS(I * DEL + OFF1)
97   KY(I) = 256 + JRADIUS * SIN(I * DEL + OFF1)
98   MX(I) = 256 + LRADIUS * COS(I * DEL + OFF1)
99   MY(I) = 256 + LRADIUS * SIN(I * DEL + OFF1)
100 CALL DSVEC(LX(I*2-1),LY(I*2-1),KX(I),KY(I),-1)
101
102 CONTINUE
103
104 C----
105 C----
106 C----
107
108 DO 400 I = 1,NPTS
109   CALL DSCIR(MX(I),MY(I),2,-1)
110   CALL DSCIR(MX(I),MY(I),2,-1)
111   CALL DSCIR(MX(I),MY(I),1,-1)
112   CALL DSCIR(MX(I),MY(I),1,-1)

```

```
113
114      400      CONTINUE
115
116      C----
117      DISPLAY WRENCH
118      C----
119      C----
120
121      CALL WRENCH
122
123      C----
124      C----
125      C----
126
127      CALL DSSAD(175,450,-1,0,1)
128      CALL DSXT("1. EQUIPMENT COMPONENTS")
129
130      RETURN
131      END
```

```

1
2
3
4 C---
5 C---
6 C---
7
8
9
10
11
12
13
14 C---
15 C---
16 C---
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33 C---
34 C---
35 C---
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53 C---
54 C---
55 C---
56
```

SUBROUTINE DEMO2

ROUTINE TO DISPLAY INSTRUCTOR DEMO 2 (FINDING MORBLE)

DIMENSION IX(8), IY(8), JX(8), JY(8), KX(16), KY(16), IRAD(3), OUT(1000)

INTEGER OUT

DATA IRAD/110,126,141/

DISPLAY RIM

NPTS = 1500  
DEL = 3.14159 \* 2. / NPTS  
IXCENT = 256  
IYCENT = 256  
DO 200 I = 1,3  
IRADIUS = IRAD(I)  
DO 100 J = 125,625  
OUT((J-124) \* 2 - 1) = IXCENT + IRADIUS \* COS(J \* DEL)  
OUT((J-124) \* 2) = IYCENT + IRADIUS \* SIN(J \* DEL)  
CONTINUE  
CALL DSPNT(500,-1,OUT)  
CONTINUE

DISPLAY CIRCLES ON RIM

KRADIUS = 117  
NPTS = 16  
DEL = 3.14159 \* 2. / NPTS  
KXCENT = 256  
KYCENT = 256  
DO 300 I = 1,NPTS  
KX(I) = KXCENT + KRADIUS \* COS(I \* DEL) \* 2  
KY(I) = KYCENT + KRADIUS \* SIN(I \* DEL)  
CONTINUE

DO 400 I = 2,6  
CALL DSCIR(KX(I),KY(I),2,-1)  
CALL DSCIR(KX(I),KY(I),1,-1)  
CONTINUE

DISPLAY SPIKE NUMBERS

```

57 CALL DSSAD(KX(6)+4,KY(6)+4,-1,0,1)
58 CALL DS1XT("1")
59 CALL DSSAD(KX(5)+5,KY(5),-1,0,1)
60 CALL DS1XT("2")
61 CALL DSSAD(KX(4)+5,KY(4)-3,-1,0,1)
62 CALL DS1XT("3")
63 CALL DSSAD(KX(3)+5,KY(3)-7,-1,0,1)
64 CALL DS1XT("4")
65 CALL DSSAD(KX(2)+5,KY(2)-10,-1,0,1)
66 CALL DS1XT("5")

```

```

C---
67 ADD SHADING TO RIM
68
69 C---
70 C---
71

```

```

72 CALL DSVEC(254,307,201,307,-1)
73 CALL DSVEC(255,308,201,308,-1)
74 CALL DSVEC(271,392,276,392,-1)
75 CALL DSVEC(216,302,231,302,-1)
76 CALL DSVEC(221,304,226,304,-1)
77 CALL DSVEC(187,373,197,373,-1)
78 CALL DSVEC(306,376,316,376,-1)

```

```

C---
79 DISPLAY HUB
80
81 C---
82 C---

```

68

```

83 CALL DSCIR(256,150,20,-1)
84 CALL DSCIR(256,110,20,-1)
85 CALL DSCIR(256,150,4,-1)
86 CALL DSCIR(256,110,4,-1)
87 DO 350 I = 252,260
88     CALL DSVEC(I,110,1,116,0)
89

```

```

90 CONTINUE
91 CALL DSVEC(252,110,252,130,-1)
92 CALL DSVEC(260,110,260,130,-1)
93

```

```

C---
94 DISPLAY SPOKE CIRCLES ON HUB
95
96 C---
97

```

```

98 NPIS = 8
99 DEL = 3.14159 * 2. / NPIS
100 IRADIUS = 16
101 JRADIUS = 16
102 IXCENT = 256
103 IYCENT = 150
104 JXCENT = 256
105 JYCENT = 110
106 DO 500 I = 1, NPIS
107     IX(I) = IXCENT + IRADIUS * COS(I * DEL)
108     IY(I) = IYCENT + JRADIUS * SIN(I * DEL)
109     JX(I) = JXCENT + IRADIUS * COS(I * DEL)
110     JY(I) = JYCENT + JRADIUS * SIN(I * DEL)
111     CALL DSCIR(IX(I),IY(I),1,-1)
112     IF (I .NE. 2) CALL DSCIR(JX(I),JY(I),1,-1)

```

```

113          CONTINUE
114          500
115          C---
116          C---
117          C---
118
119          DISPLAY SPOKES
120
121          CALL DSVEC(JX(1),JY(1),JX(2)+40,JY(2)+40,-1)
122          CALL DSVEC(JX(1),JY(1),KX(2),KX(2),-1)
123          CALL DSVEC(JX(1),JY(1),IX(2)+50,IY(2)+100,-1)
124          CALL DSVEC(JX(1),JY(1),KX(3),KX(3),-1)
125          CALL DSVEC(JX(2)+2,IY(2)+6,KX(4),KX(4),-1)
126          CALL DSVEC(JX(2),IY(2),KX(5),KX(5),-1)
127          CALL DSVEC(JX(3),IY(3),IX(3)+45,IY(3)+75,-1)
128          CALL DSVEC(JX(3),JY(3),KX(6),KX(6),-1)
129          CALL DSVEC(JX(4),JY(4),JX(4)-40,JY(4)+45,-1)
130
131          DISPLAY CALIPERS
132
133          CALL DSVEC(168,377,183,388,-1)
134          CALL DSVEC(168,377,183,362,-1)
135          CALL DSVEC(183,388,183,362,-1)
136          DO 700 I = 168,183
137              CALL DSVEC(1,545-1,183,388,-1)
138
139          CONTINUE
140
141          CALL DSVEC(193,330,193,304,-1)
142          CALL DSVEC(193,330,208,315,-1)
143          CALL DSVEC(193,304,208,315,-1)
144          DO 800 I = 193,208
145              CALL DSVEC(1,523-1,193,304,-1)
146
147          CONTINUE
148
149          DISPLAY TITLE
150
151          CALL DSSAU(200,450,-1,0,1)
152          CALL DSTXT("2. FINDING MORALE")
153
154          RETURN
155          END
156

```

```

1  SURROUTINE DEMO3
2
3  C---
4  C---
5  C---
6
7  ROUTINE TO DISPLAY INSTRUCTOR DEMO 3 (SPOKE ADJUSTMENT)
8
9  DIMENSION OUT(804),IRAD(6)
10 INTEGER OUT
11
12 DATA IRAD/140,155,157,163,193,195/
13
14 DISPLAY DIRECTIONAL ARROWS
15
16 DO 5 I = 7,9
17   CALL DSCIR(210,203,1,-1)
18   CALL DSCIR(256,159,1,-1)
19
20 CONTINUE
21
22 DO 6 J = 1,10
23   CALL DSVEC(150+J,500,250+J,0,0)
24   CALL DSVEC(330+J,500,205+J,0,0)
25
26 CONTINUE
27 DO 8 I = 192,198
28   CALL DSVEC(212,1,218,195,-1)
29
30 CONTINUE
31 DO 9 I = 148,154
32   CALL DSVEC(253,1,248,151,-1)
33
34 CONTINUE
35
36 C---
37 C---
38 C---
39
40 NPTS = 2000
41 DEL = 3.14159 * 2. /NPTS
42 IXCENT = 350
43 IYCENI = 300
44 DO 30 I = 1,6
45   IRADIUS = IRAD(I)
46   DO 10 J = 1900,1400
47     OUT((J-999) * 2 - 1) = IXCENI + IRADIUS * COS(J * DEL)
48     OUT((J-999) * 2) = IYCENI + IRADIUS * SIN(J * DEL)
49
50 CONTINUE
51
52 CALL DSPNT(400,-1,OUT)
53
54 CONTINUE
55
56 C---

```

**DF 403.FR**

71

```

1
2
3      C---
4      C---
5      C---
6
7
8
9
10     SUBROUTINE DEM04
11
12     ROUTINE TO DISPLAY INSTRUCTOR DEMO 4 (FINE TUNING)
13
14
15     DIMENSION YCOORD(7),XCOORD(7),JSTRING(7),IX(7,8),IY(7,8)
16     DIMENSION IOUT(1500),IXCENT(2)
17
18     INTEGER YCOORD,XCOORD
19
20     DATA XCOORD/250,252,248,246,245,248,252,250/
21     DATA YCOORD/121,164,207,252,293,336,379/
22     DATA IXCENT/451,415/
23
24     JSTRING(7) = "1"
25     JSTRING(6) = "2"
26     JSTRING(5) = "3"
27     JSTRING(4) = "4"
28     JSTRING(3) = "5"
29     JSTRING(2) = "6"
30     JSTRING(1) = "7"
31
32     DISPLAY DOTTED LINE
33
34
35     DO 100 I = 100,385,15
36         CALL DSVEC(280,1,280,1+10,-1)
37     CONTINUE
38
39     DISPLAY RIM
40
41     NPTS = 10000
42     DEL = 3.14159 * 2. / NPTS
43     IYCENT = 256
44     IRADIUS = 700
45     DO 165 J = 1,2
46         IXC = IXCENT(J)
47         DO 155 I = 4675,5350
48             IOUT((I-4674) * 2 - 1) = IXC + IRADIUS * COS(I * DEL)
49             IOUT((I-4674) * 2) = IYCENT + IRADIUS * SIN(I * DEL)
50         CONTINUE
51     CALL DSPNT(675,-1,1001)
52     CONTINUE
53
54     DISPLAY SPINKE CIRCLES
55
56     NPTS = 8
57     DEL = 3.14159 * 2. / NPTS

```

```

57 IRADIUS = 4
58 DO 200 I = 1,7
59   CALL DSCIN(XCOORD(I),YCOORD(I),4,-1)
60   CALL DSCIR(XCOORD(I),YCOORD(I),1,-1)
61   CALL DSSAD(XCOORD(I)-3,YCOORD(I)+6,-1,0,1)
62   CALL DSTXI(JSTRING(I))
63   DO 150 J = 1,NPTS
64     IX(1,J) = XCOORD(I) + IRADIUS * COS(J * DEL)
65     IY(1,J) = YCOORD(I) + IRADIUS * SIN(J * DEL)
66
67   CONTINUE
68
69   CONTINUE
70   CALL DSVEC(IX(1,1),IY(1,1),IX(1,5),IY(1,5),-1)
71   CALL DSVEC(IX(2,3),IY(2,3),IX(2,7),IY(2,7),-1)
72   CALL DSVEC(IX(3,4),IY(3,4),IX(3,8),IY(3,8),-1)
73   CALL DSVEC(IX(4,2),IY(4,2),IX(4,6),IY(4,6),-1)
74   CALL DSVEC(IX(5,1),IY(5,1),IX(5,5),IY(5,5),-1)
75   CALL DSVEC(IX(6,4),IY(6,4),IX(6,8),IY(6,8),-1)
76   CALL DSVEC(IX(7,3),IY(7,3),IX(7,7),IY(7,7),-1)
77
78 C---
79 C---
80 C---
81
82   DISPLAY TITLE
83
84   CALL DSSAD(210,450,-1,0,1)
85   CALL DSTXI("4. FINE TUNING")
86
87   RETURN
88   END

```

## SUBROUTINE WRENCH

ROUTINE TO DISPLAY SPOKE WRENCH FOR INSTRUCTOR DEMO 1

CALL DSCIN(75,275,10,-1)  
 CALL DSCIR(75,275,20,-1)  
 DO 100 I = 55,70  
   CALL DSVEC(1,0,1,511,0)

CONTINUE

100

CALL DSVEC(70,255,50,267,-1)  
 CALL DSVEC(70,257,50,269,-1)  
 CALL DSVEC(70,295,50,283,-1)  
 CALL DSVEC(70,293,50,281,-1)  
 CALL DSVEC(50,267,49,267,-1)  
 CALL DSVEC(49,267,49,269,-1)  
 CALL DSVEC(49,281,49,283,-1)  
 CALL DSVEC(48,270,50,270,-1)  
 CALL DSVEC(48,280,50,280,-1)  
 CALL DSVEC(48,270,48,273,-1)  
 CALL DSVEC(50,270,50,273,-1)  
 CALL DSVEC(48,277,48,280,-1)  
 CALL DSVEC(50,277,50,280,-1)  
 CALL DSVEC(47,273,47,277,-1)  
 CALL DSVEC(49,273,49,277,-1)  
 CALL DSVEC(47,273,49,273,-1)  
 CALL DSVEC(47,277,49,277,-1)  
 CALL DSVEC(50,269,49,269,-1)  
 CALL DSVEC(50,281,49,281,-1)  
 CALL DSVEC(50,283,49,283,-1)

RETURN  
 END

APPENDIX E  
TRAINING DEVICE FIDELITY RATING FORMS

Rater: Brock

Date: 6/15/82

Physical Similarity

| 1                                                     | 2 | 3 | 4                                                                          | 5 | 6 | 7                                               |
|-------------------------------------------------------|---|---|----------------------------------------------------------------------------|---|---|-------------------------------------------------|
| Looks and feels<br>nothing like the<br>real equipment |   |   | Is moderately<br>like the actual<br>equipment in<br>appearance and<br>feel |   |   | Looks and feels<br>like the actual<br>equipment |

Functional Similarity

| 1                                                                                     | 2 | 3 | 4                                                                                                        | 5 | 6 | 7                                                                                         |
|---------------------------------------------------------------------------------------|---|---|----------------------------------------------------------------------------------------------------------|---|---|-------------------------------------------------------------------------------------------|
| Does not work<br>like actual<br>equipment<br>(controls, dis-<br>plays do not<br>work) |   |   | Works like actual<br>equipment in some<br>respects (controls<br>and displays work<br>but without effect) |   |   | Works exactly<br>like the actual<br>equipment<br>(controls, displays<br>work with effect) |

Please rate each device on the above scales.

Device

|    |                        |          |
|----|------------------------|----------|
| HH | 1. Physical similarity | <u>7</u> |
|    | Functional similarity  | <u>7</u> |
| MM | 2. Physical similarity | <u>4</u> |
|    | Functional similarity  | <u>5</u> |
| LL | 3. Physical similarity | <u>2</u> |
|    | Functional similarity  | <u>1</u> |
| HL | 4. Physical similarity | <u>2</u> |
|    | Functional similarity  | <u>5</u> |
| LH | 5. Physical similarity | <u>6</u> |
|    | Functional similarity  | <u>3</u> |

Rater: L. Miller

Date: 6/15/82

Physical Similarity

| 1                                                     | 2 | 3 | 4                                                                          | 5 | 6 | 7                                               |
|-------------------------------------------------------|---|---|----------------------------------------------------------------------------|---|---|-------------------------------------------------|
| Looks and feels<br>nothing like the<br>real equipment |   |   | Is moderately<br>like the actual<br>equipment in<br>appearance and<br>feel |   |   | Looks and feels<br>like the actual<br>equipment |

Functional Similarity

| 1                                                                                     | 2 | 3 | 4                                                                                                        | 5 | 6 | 7                                                                                         |
|---------------------------------------------------------------------------------------|---|---|----------------------------------------------------------------------------------------------------------|---|---|-------------------------------------------------------------------------------------------|
| Does not work<br>like actual<br>equipment<br>(controls, dis-<br>plays do not<br>work) |   |   | Works like actual<br>equipment in some<br>respects (controls<br>and displays work<br>but without effect) |   |   | Works exactly<br>like the actual<br>equipment<br>(controls, displays<br>work with effect) |

Please rate each device on the above scales.

Device

|    |                        |          |
|----|------------------------|----------|
| HH | 1. Physical similarity | <u>7</u> |
|    | Functional similarity  | <u>7</u> |
| MM | 2. Physical similarity | <u>3</u> |
|    | Functional similarity  | <u>3</u> |
| LL | 3. Physical similarity | <u>4</u> |
|    | Functional similarity  | <u>4</u> |
| HL | 4. Physical similarity | <u>3</u> |
|    | Functional similarity  | <u>4</u> |
| LH | 5. Physical similarity | <u>6</u> |
|    | Functional similarity  | <u>1</u> |

Rater: Modrick

Date: 6/15/82

Physical Similarity

| 1                                                     | 2 | 3 | 4                                                                          | 5 | 6 | 7                                               |
|-------------------------------------------------------|---|---|----------------------------------------------------------------------------|---|---|-------------------------------------------------|
| Looks and feels<br>nothing like the<br>real equipment |   |   | Is moderately<br>like the actual<br>equipment in<br>appearance and<br>feel |   |   | Looks and feels<br>like the actual<br>equipment |

Functional Similarity

| 1                                                                                     | 2 | 3 | 4                                                                                                        | 5 | 6 | 7                                                                                         |
|---------------------------------------------------------------------------------------|---|---|----------------------------------------------------------------------------------------------------------|---|---|-------------------------------------------------------------------------------------------|
| Does not work<br>like actual<br>equipment<br>(controls, dis-<br>plays do not<br>work) |   |   | Works like actual<br>equipment in some<br>respects (controls<br>and displays work<br>but without effect) |   |   | Works exactly<br>like the actual<br>equipment<br>(controls, displays<br>work with effect) |

Please rate each device on the above scales.

Device

|    |                        |          |
|----|------------------------|----------|
| HH | 1. Physical similarity | <u>7</u> |
|    | Functional similarity  | <u>7</u> |
| MM | 2. Physical similarity | <u>3</u> |
|    | Functional similarity  | <u>4</u> |
| LL | 3. Physical similarity | <u>1</u> |
|    | Functional similarity  | <u>1</u> |
| HL | 4. Physical similarity | <u>2</u> |
|    | Functional similarity  | <u>5</u> |
| LH | 5. Physical similarity | <u>4</u> |
|    | Functional similarity  | <u>2</u> |

Rater: Daniels

Date: 6/15/82

Physical Similarity

| 1                                                     | 2 | 3 | 4                                                                          | 5 | 6 | 7                                               |
|-------------------------------------------------------|---|---|----------------------------------------------------------------------------|---|---|-------------------------------------------------|
| Looks and feels<br>nothing like the<br>real equipment |   |   | Is moderately<br>like the actual<br>equipment in<br>appearance and<br>feel |   |   | Looks and feels<br>like the actual<br>equipment |

Functional Similarity

| 1                                                                                     | 2 | 3 | 4                                                                                                        | 5 | 6 | 7                                                                                         |
|---------------------------------------------------------------------------------------|---|---|----------------------------------------------------------------------------------------------------------|---|---|-------------------------------------------------------------------------------------------|
| Does not work<br>like actual<br>equipment<br>(controls, dis-<br>plays do not<br>work) |   |   | Works like actual<br>equipment in some<br>respects (controls<br>and displays work<br>but without effect) |   |   | Works exactly<br>like the actual<br>equipment<br>(controls, displays<br>work with effect) |

Please rate each device on the above scales.

Device

|    |                        |          |
|----|------------------------|----------|
| HH | 1. Physical similarity | <u>7</u> |
|    | Functional similarity  | <u>7</u> |
| MM | 2. Physical similarity | <u>4</u> |
|    | Functional similarity  | <u>2</u> |
| LL | 3. Physical similarity | <u>1</u> |
|    | Functional similarity  | <u>1</u> |
| HL | 4. Physical similarity | <u>2</u> |
|    | Functional similarity  | <u>6</u> |
| LH | 5. Physical similarity | <u>6</u> |
|    | Functional similarity  | <u>1</u> |

APPENDIX F

ILLUSTRATIONS OF DEVICE HL  
(COMPUTER GRAPHICS)

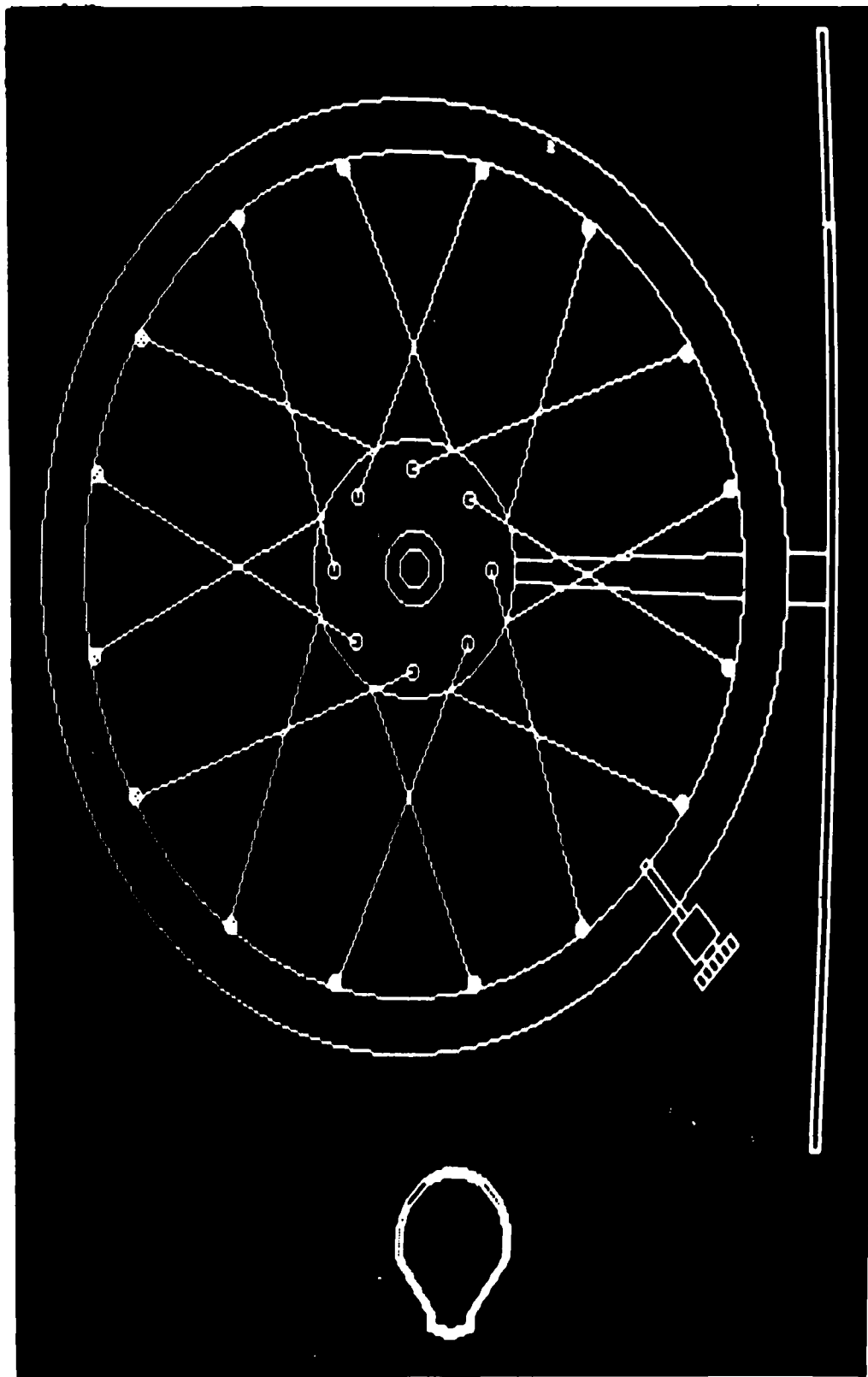


Figure F-1 Equipment components--graphics display device.

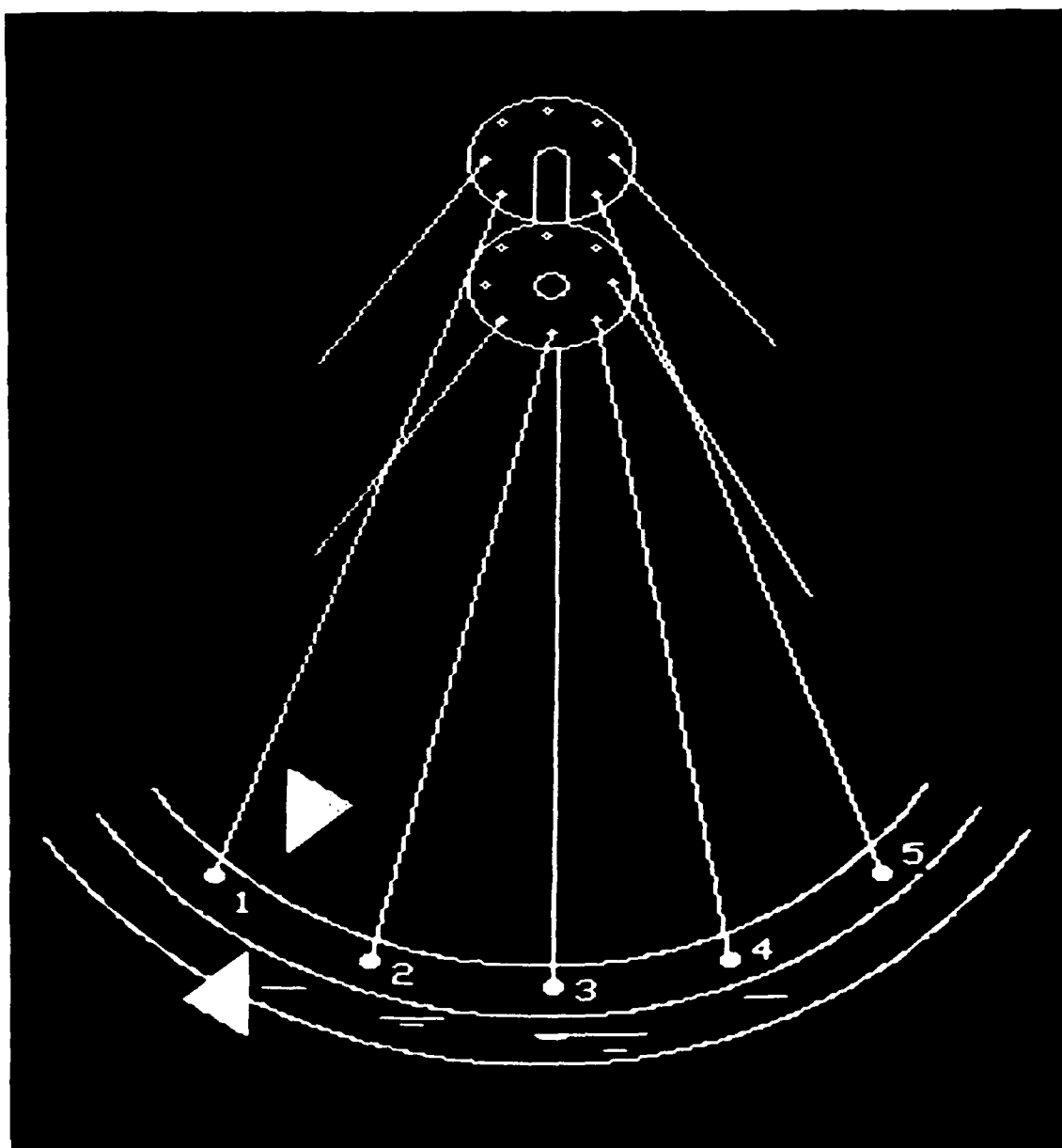


Figure F-2. Finding wobble--graphics display device.

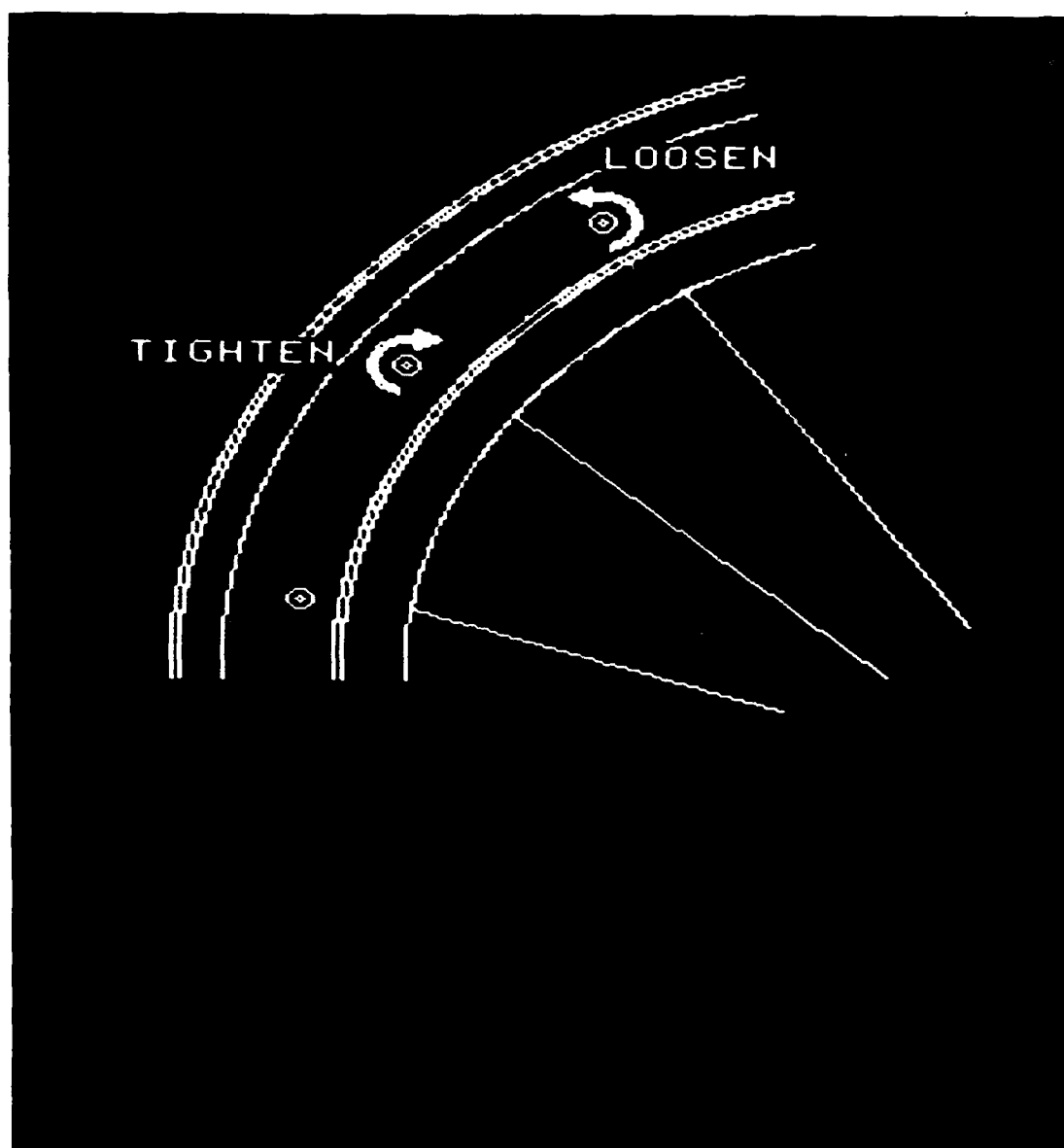


Figure F-3. Spoke adjustment--graphics display device.

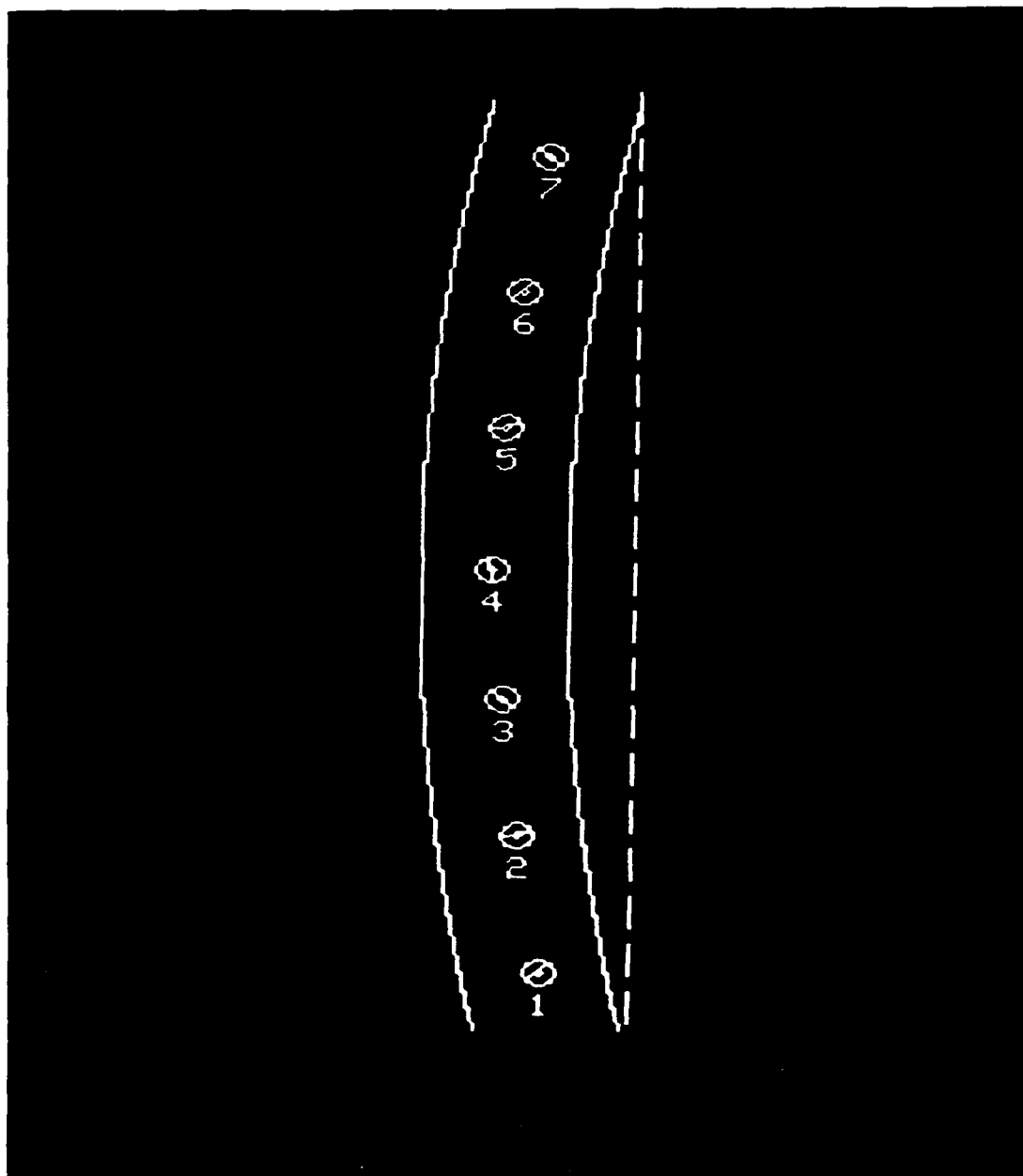


Figure F-4. Fine tuning--graphics display device.

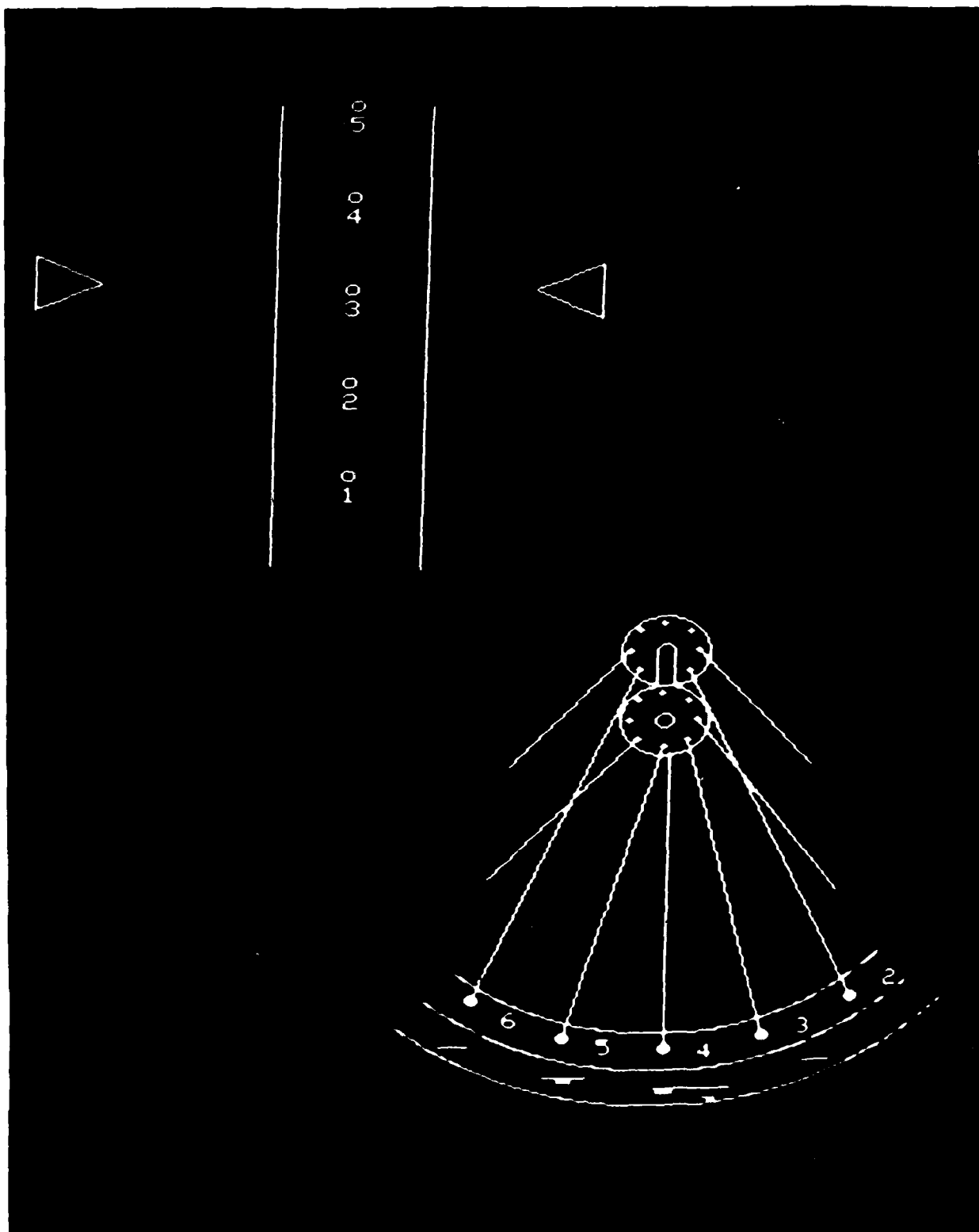


Figure F-5. Graphics driver display for demonstration and practice of wheel truing.

APPENDIX G  
ILLUSTRATIONS OF DEVICE LL  
(LINE DRAWINGS)

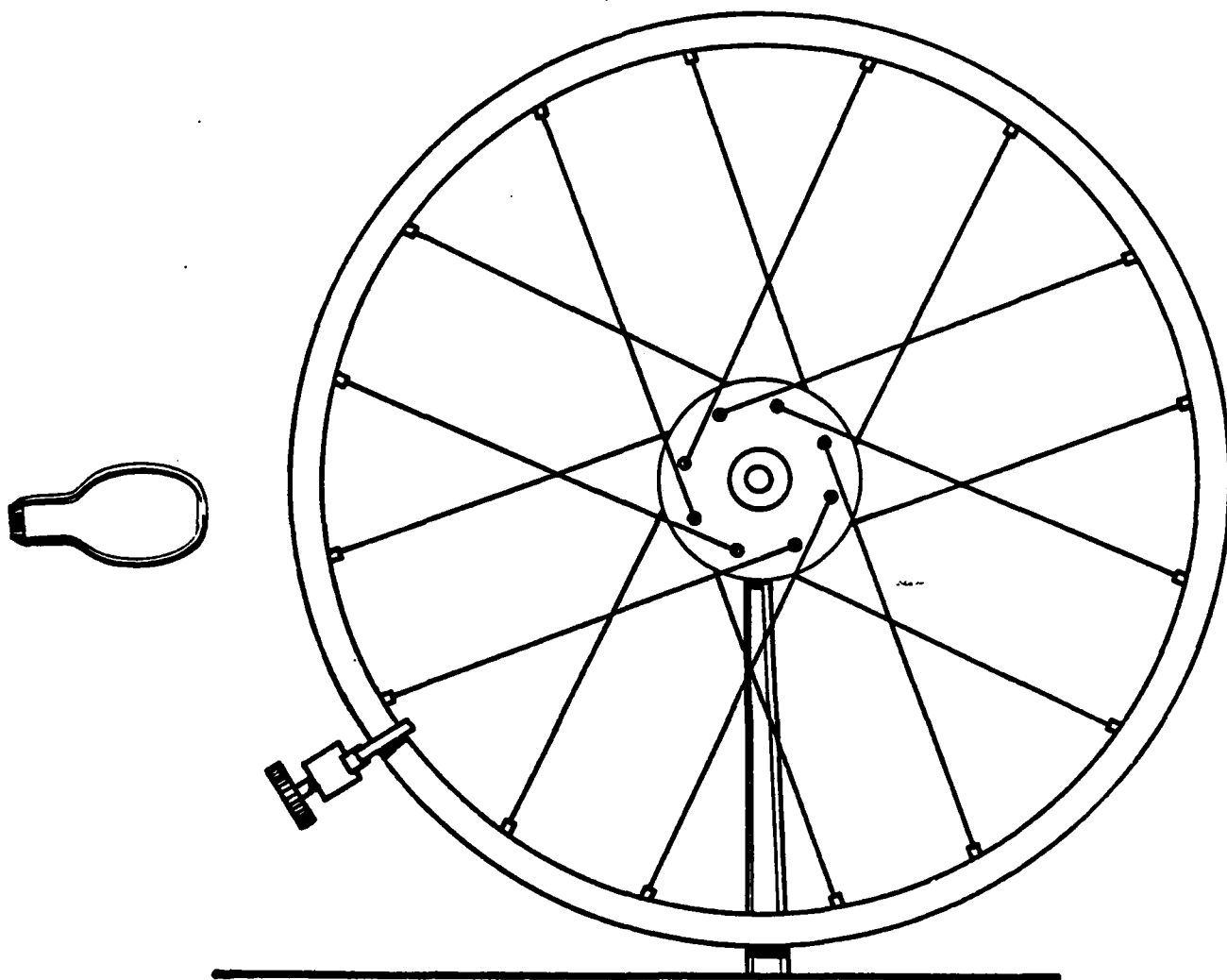


Figure G-1. Equipment components.

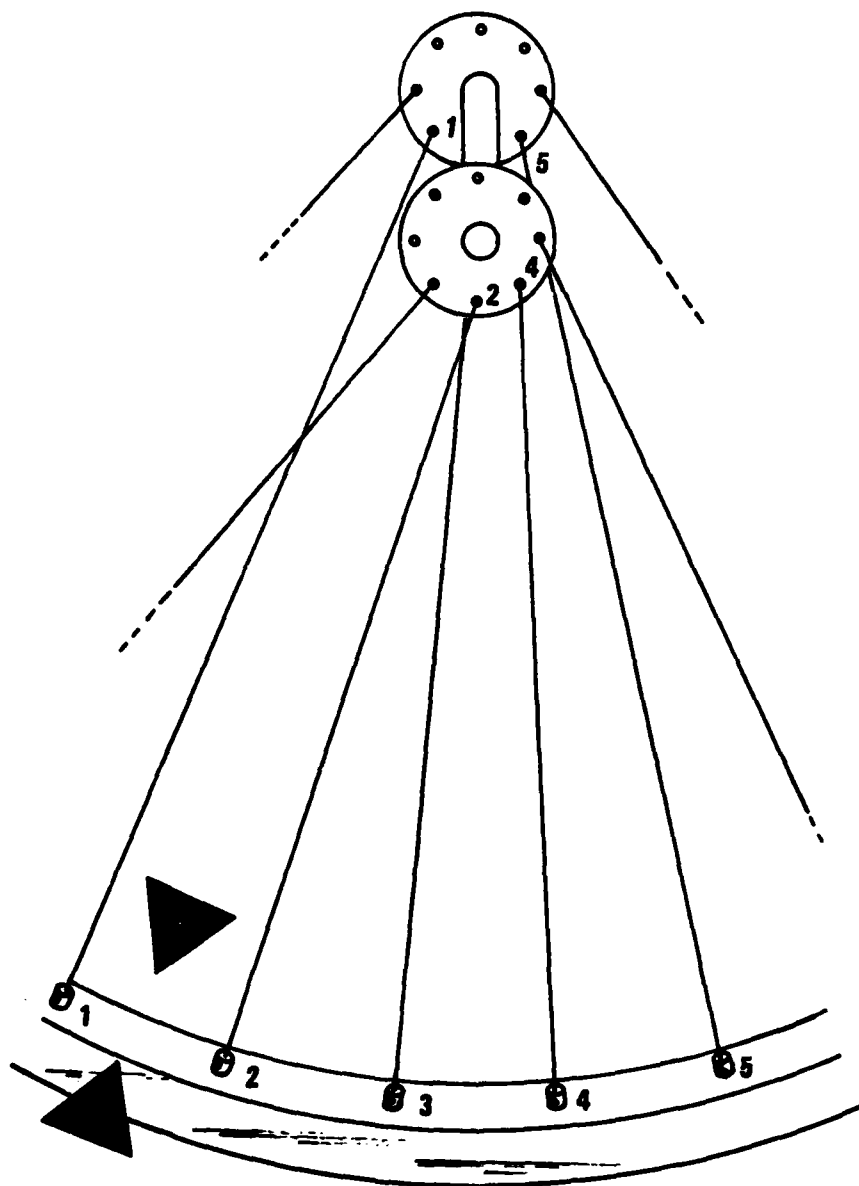


Figure G-2. Finding wobble.

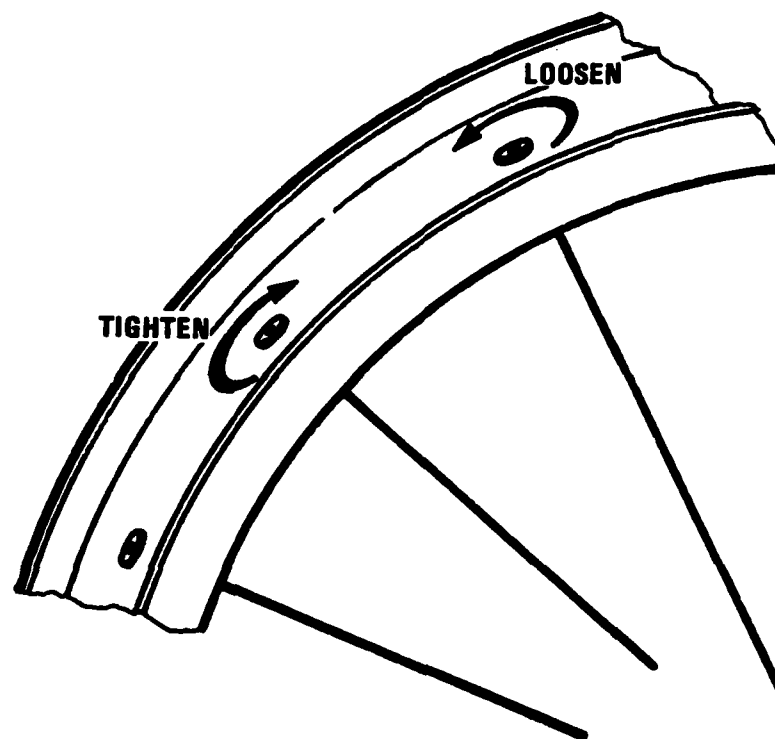


Figure G-3. Spoke adjustment.

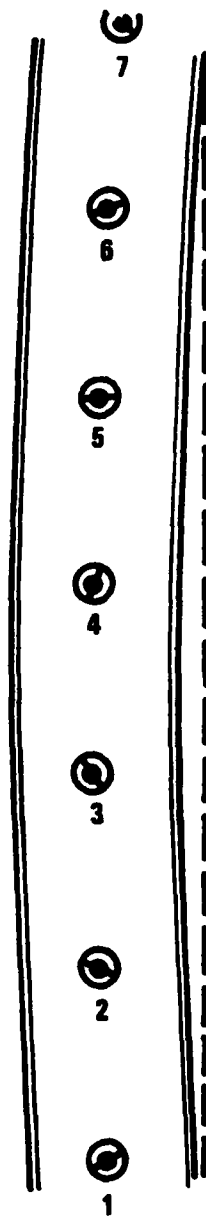


Figure G-4. Fine tuning.

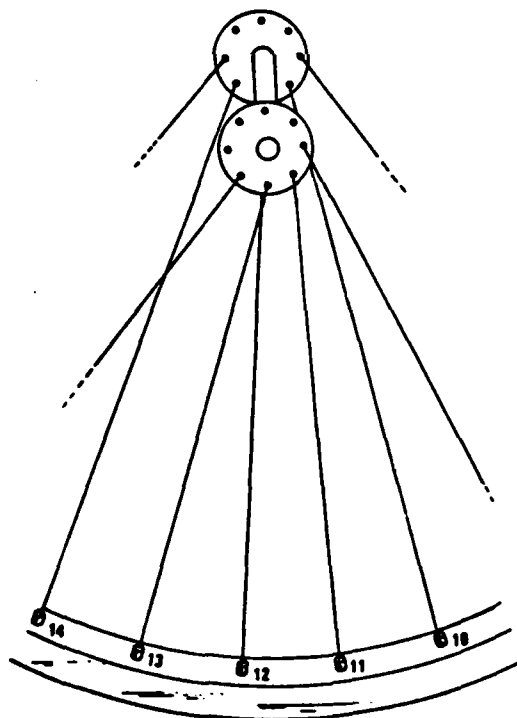
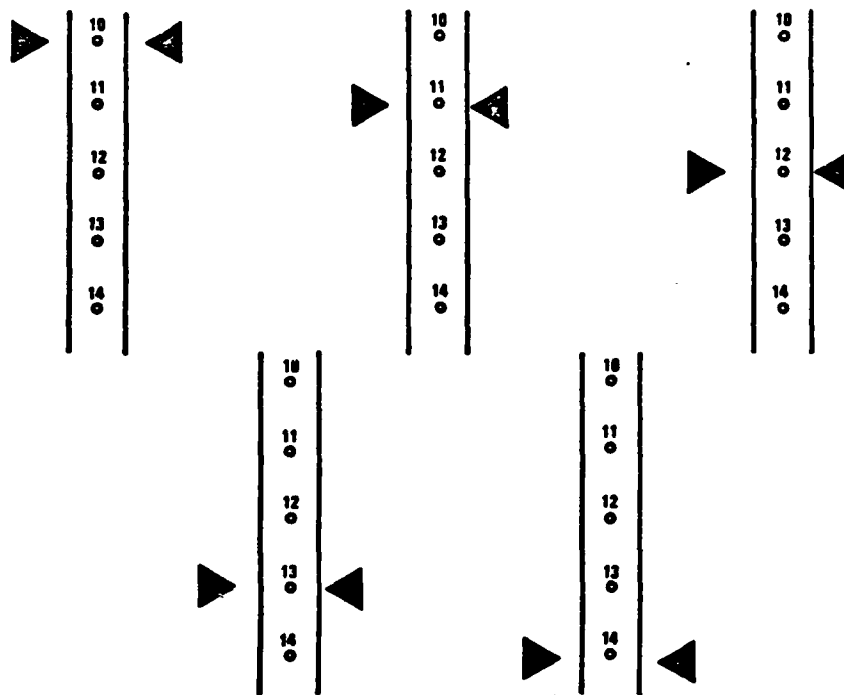


Figure G-5. Simulator exercise (demonstration).

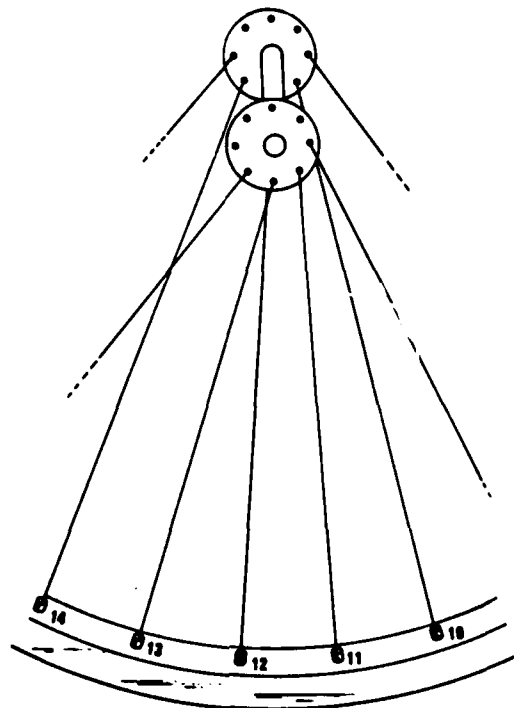
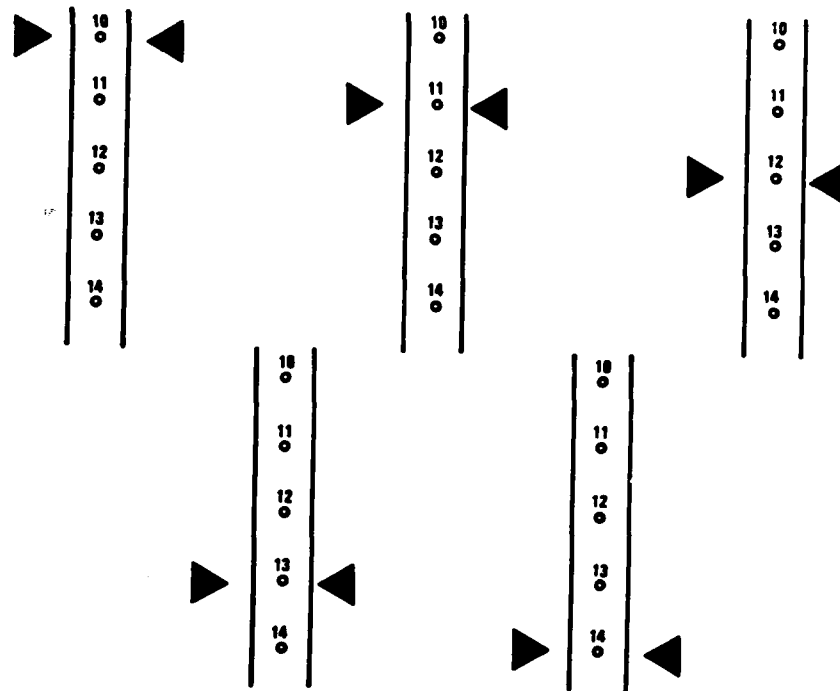


Figure G-6. Exercise 1.

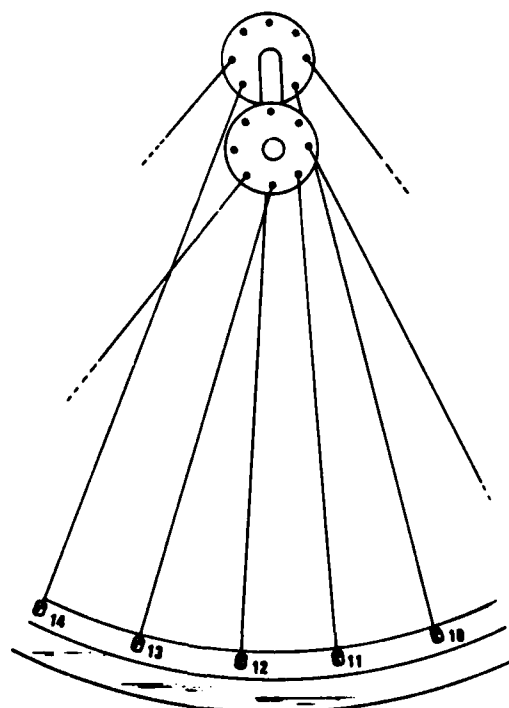
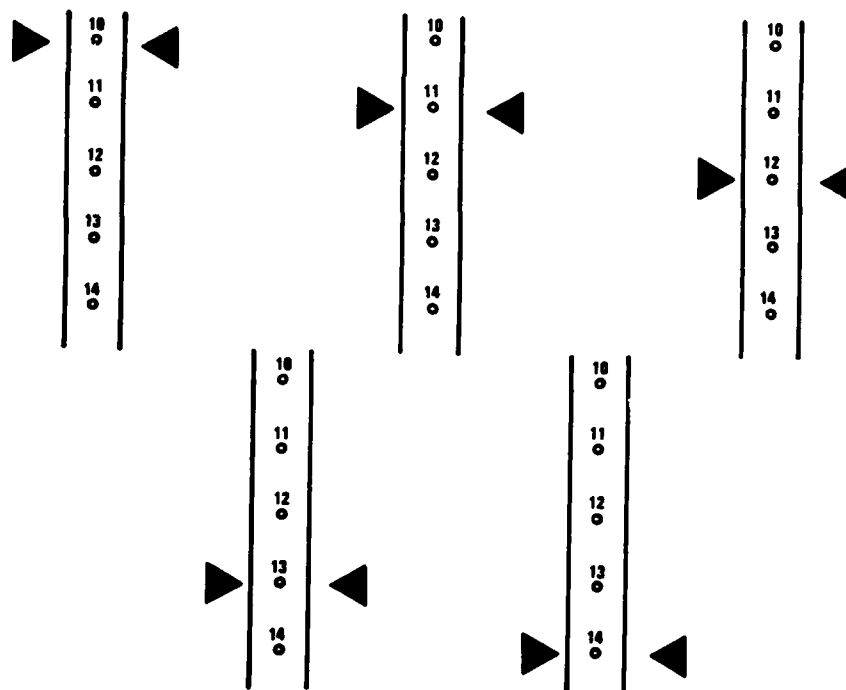


Figure G-7. Exercise 2.

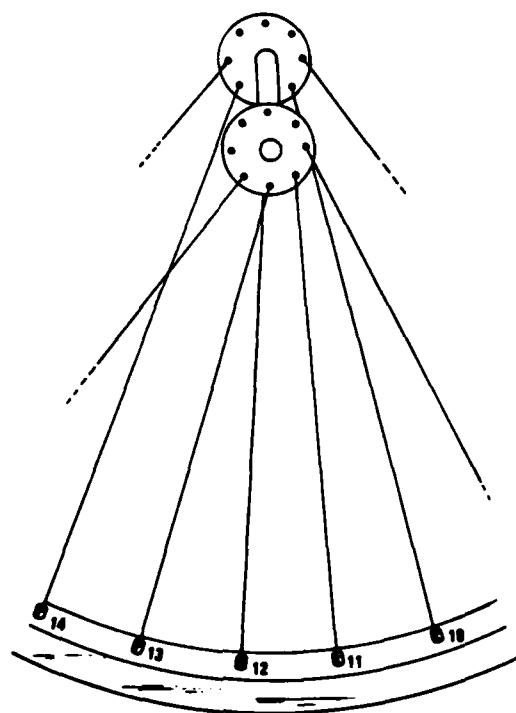
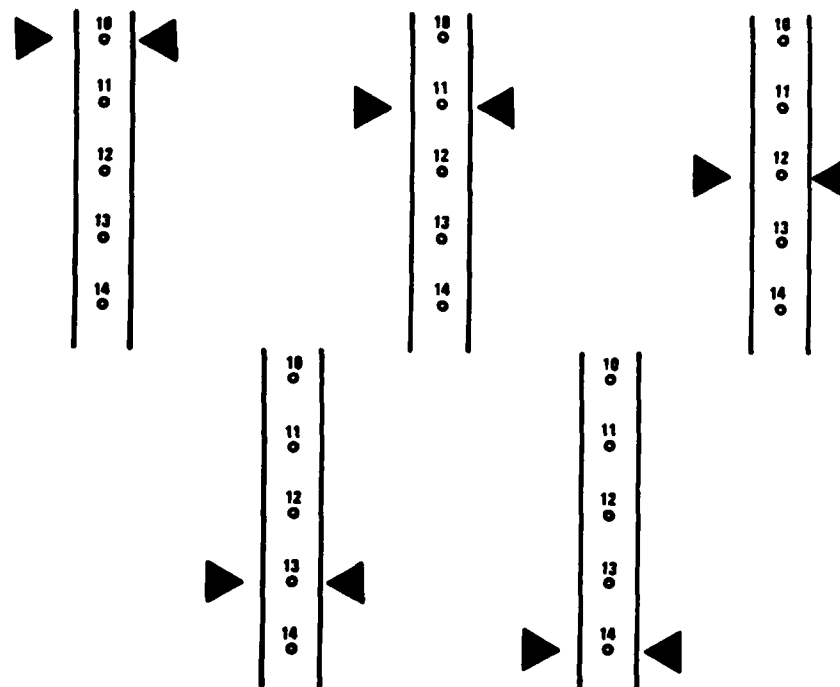


Figure G-8. Exercise 3.

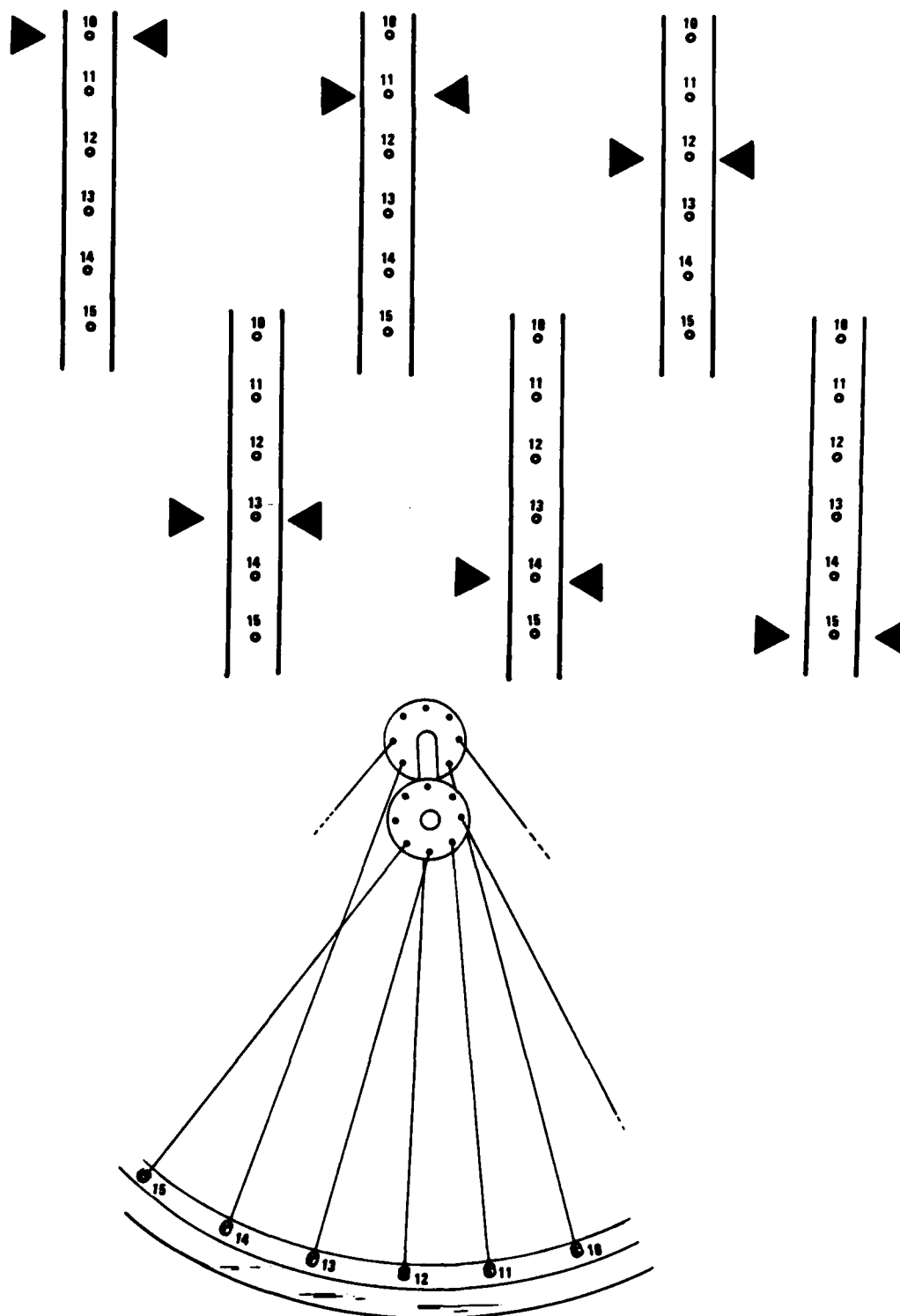


Figure G-9. Exercise 4.

APPENDIX H

INSTRUCTIONS TO SUBJECTS

SIMTRAIN TASK 2 SIMULATOR FIDELITY EXPERIMENT:  
SCRIPT AND GENERAL PROCEDURE

I. INTRODUCTION: EXPLANATION OF EXPERIMENT

This study compares different methods of teaching people mechanical skills. We're trying to find out which methods work better. The skill we're studying in this experiment is how to true, or balance, a bicycle wheel--that is, how to get out the side-to-side wobble. First, I'll demonstrate how to true a bicycle wheel using \_\_ (pictures, this copy of a bicycle wheel, computer graphics, or a bicycle wheel, as appropriate). Then you'll have a chance to practice on the \_\_ (pictures ... a bicycle wheel). Finally, I'll put an actual bicycle wheel out of balance and ask you to true it. I'll do this two (or four, for condition HH) times and each time you will have 15 minutes to true it. I'll take a measurement every three minutes. If you have any questions during the demonstration or practice (or first two trials, for condition LL), be sure to ask.

II. DEMONSTRATION BY EXPERIMENTER

| <u>Instruction</u>                                                                                                                                                                                        | <u>Action</u>                                                                                          |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| First, let me demonstrate. The parts we'll be using to true the wheel are:<br>bicycle rim   nipples<br>hub           spoke wrench<br>spokes        caliper                                                | Point out parts on training device. Use Figure G-1 for condition LL). Use Figure F-1 for condition HL. |
| The caliper is used to find where wheel is out of balance. If the wheel is closer to the left side of the caliper, as it is here, it means the wheel is pulling towards the left at that point. It is off | Point out on device.<br>Use Figure F-2 for condition HL.<br>Use Figure G-2 for condition LL.           |

## Instruction

center here. If it would be closer to the right side, the wheel would be pulling towards the right.

Once we've found where the wheel is out of balance, how do we fix it? We fix it by loosening or tightening the spokes. If the rim pulls to this side, the reason is that the spoke going to the same side of the hub is too tight; so it needs to be loosened. The spoke going to the other side of the hub should then be tightened so it will pull the rim over toward this side. This means you will need to loosen spokes that go to the same side of the hub that the wheel is pulling towards and tighten spokes that go to the opposite side of the hub.

Spokes are tightened and loosened by tightening or loosening these nipples. The nipples are tightened and loosened with the spoke wrench. The spoke wrench fits around the nipples and is used to turn them.

To tighten a nipple, turn it clockwise as you're looking at it from the outside of the rim. To loosen a nipple, turn it counterclockwise as you're looking at it from the outside.

## Action

Point out on device.  
Use Figure F-2 for HL, and  
Figure G-2 for LL.

Point out spokes, nipples,  
spoke wrench.  
Use Figure F-2 for HL, and  
Figure G-2 for LL.  
Demonstrate on LL, MM, and LH.

Demonstrate on HH and LH.  
Show Figure F-3 for HL, and  
Figure G-3 for LL.  
Point out on LH.

### Instruction

Wheels usually aren't out of balance only at one spoke; usually a whole line of spokes is out of balance.

In this case, the middle spoke needs the most adjustment. It needs to be turned the most, while the spokes at the ends of the group need the least adjusting. For example, if spokes \_\_\_ to \_\_\_ (fill in from simulator) are out of alignment, spoke \_\_\_ (middle spoke) would need perhaps a half-turn while spokes \_\_\_ (end spokes) might need an eighth-turn.

(Condition HH)

The rim here is close to the right caliper, which means it pulls to the right and needs to be pulled back to the left. Spoke \_\_\_ goes to the right side of the hub so it needs to be loosened. It's loosened by turning it counter-clockwise. The next spoke, \_\_\_, goes to the left side of the hub. So if we tighten it, the rim will be pulled to the left. It's tightened by turning it clockwise.

### Action

Point out on device.

Show Figure F-4 for HL, and Figure G-4 for LL.

Before HH begins, put two deviations in the wheel--one for demonstration and one for practice.

True the section of the wheel just pointed out.

Continue similarly until the rim section is trued.

## Instruction

## Action

(Condition MM)

Turn your head while I put in a deviation. You can look now. The rim here is closer to the right caliper, which means it pulls to the right and needs to be pulled back to the left. The spoke goes to the right side of the hub, so it must be loosened. It's loosened by turning it counterclockwise. The next spoke goes to the left so it needs to be tightened.

Adjust caliper to illustrate a deviation to the right.

Demonstrate. Repeat the prior instructions with a second and third deviation, illustrating deviations to the left, and a balanced wheel.

(Condition LL)

Here these figures represent the rim, spokes, and caliper at different positions on the rim. In 3, the rim is closer to the right side of the caliper. In 2 and 4 it's also closer, and in 1 and 5 the rim looks about midway in the caliper.

Show Figure G-5.

Spoke 12 is in the middle, so I'll turn it the most, perhaps half a turn. Spokes 11 and 13 I'll turn less, perhaps a quarter-turn, because they are on the ends. Spokes 10 and 14 I won't turn because they are positioned evenly in the caliper. Looking at the bottom picture, spoke 12 goes to the left side of the hub. Since I want to pull the rim toward the left,

### Instruction

### Action

I will tighten it by turning it clockwise. Spokes 11 and 13 go to the right side of the hub, and should be loosened in order to pull the rim to the left. These spokes are loosened by turning them counterclockwise.

Make clockwise turning motion.

(Condition LH)

Turn you head while I adjust the wheel. You can look now. The rim here is closer to the right caliper, which means it pulls to the right and needs to be pulled back. The spoke goes to the right side of the hub, so it must be loosened. It's loosened by turning it counterclockwise. The spoke above it goes to the left, so it needs to be tightened.

Adjust wheel to a position where it is closer to one side of caliper.

Make turning motions with wrench.

Repeat with two additional positions.

(Condition HL)

This represents a bicycle rim, these are spokes, and these are caliper. This view of the wheel is included so you can tell which side of the hub the spokes go toward.

Show Figure F-5.

Point out parts.

Using the computer, I can do all the things I need to do to true the rim. I can turn the wheel by pressing T and return.

Point out menu on the display.  
Press T and R (return).

| <u>Instruction</u>                                                                                                                                                                                                                                                         | <u>Action</u>          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| I can make the wheel go faster by pressing "W," return, and "Z" for faster and return.                                                                                                                                                                                     | Press W, R, then Z, R. |
| I can stop the wheel by pressing "S," return.                                                                                                                                                                                                                              | Press S, R.            |
| I can adjust the caliper by pressing "C," return, and then "I" for in and return.                                                                                                                                                                                          | Press C, R, then I, R. |
| I can adjust the spokes. For instance, if I want to fix the wheel at the place where it is now, I would press "A," return, to adjust spokes.                                                                                                                               | Press A, R.            |
| Now the display asks what spoke I want to adjust. I'll want to adjust "29" so I'll press "29," return.                                                                                                                                                                     | Press 29, R.           |
| Now I need to tell the computer if I want to loosen or tighten spoke 29. The rim is going to the left, and looking at the bottom picture, spoke 29 is also going to the left side of the hub, so I want to loosen it. To loosen a spoke I should turn it counterclockwise. | Point out on display   |
| The display says counterclockwise is "2" so I will press "2," return.                                                                                                                                                                                                      | Press 2, R.            |

### Instruction

### Action

This moves the rim a little to the left. It's still not centered in the caliper so the nipple needs to be turned counterclockwise again.

Continue pressing 2, R until rim is centered between caliper.

It's centered now, so I'll stop the adjustments on this spoke by pressing "S," return. I can adjust spokes 30 and 28 similarly. To stop all adjustments on the spokes at this position, I'll press "S," return.

Press S, R.

Press S, R.

Now I can turn the wheel again to find another deviation by pressing "T" and return.

Press T, R.

Here's another deviation so I'll stop the wheel here.

Press S, R when the wheel is close to one side of the caliper.

I can fix this deviation just as I did the one before--by pressing "A," then pressing the number of the spoke and turning it clockwise or counterclockwise. Do you have any questions?

Demonstrate

### III. PRACTICE

Now you'll have a chance to practice using \_\_ (pictures, the computer, this copy of a wheel, this wheel).

Instruction

Action

(Condition HH)

You'll have two 15-minute trials, and I'll take a measurement every three minutes. If you have any questions during these trials, be sure to ask. After these two trials you'll get a second set of two 15-minute trials during which you won't be able to ask questions.

E puts in a standard set of deviations, takes the initial measurement, and calls S back in. S gets one 15-minute trial, after which E trues wheel if necessary and puts in a standard deviation for the second 15-minute trial.

Would you leave the room while I put the wheel out of balance?

Call subject back in.

Go ahead.

(Condition MM)

Turn your head, and I'll put in a deviation. Now show me how you would turn the nipples with the spoke wrench. If you have any questions be sure to ask.

E adjusts caliper to a predetermined position.

Repeat for three additional deviations.

(Condition LL)

I'll show you a series of pictures like the one we just went through. I'd like you to tell me which spokes should be adjusted and how much.

Present Figures G-6 through G-10.

Instruction

Action

Also, tell and show me in which direction the nipple should be turned. Be sure to ask questions if there is anything you aren't certain about.

(Condition HL)

Would you like to do this now? I'll help you and we'll do it together.

E puts the second exercise on the screen. S sits in front of the CRT and works for 15 minutes. E takes a measurement every three minutes.

(Condition LH)

Turn your head and I'll adjust the wheel to show a deviation.

Adjust wheel so wheel is closer to one side of caliper.

Now show me how you would turn this nipple with the spoke wrench to fix the deviation. If you have any questions be sure to ask.

Repeat for three additional deviations.

IV TWO PERFORMANCE TRIALS (ALL CONDITIONS)

Instruction

Action

For each trial

Now if you'll leave the room for a few minutes, I'll put the wheel out of true.

(Call subject back in.)

- (a) E trues wheel
- (b) E puts in predetermined amount of deviation into rim
- (c) E measures initial deviation
- (d) S instructed to true wheel

Instruction

Now see if you can true the wheel.  
You'll have 15 minutes and I'll  
take a measurement every three  
minutes

Action

1. E takes deviation measurements every three minutes
  2. Trial continued for 15 minutes, excluding measurement time
- (e) E does not answer questions

V. POST-EXPERIMENT PROCEDURES

Thank subject. Give him/her \$15, ask subject to sign a form acknowledging receipt of the money, and answer any questions the subject may have.

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APPENDIX I

RAW DATA

# APPENDIX I

## RIM DEVIATIONS\* BY SUBJECT AND CONDITION

| Condition | Subject No. | Practice 1 Measurements |       |       |       |       |       |         |       |       |       | Performance 1 Measurements |       |         |       |       |       |       |       |         |   | Performance 2 Measurements |   |   |   |  |  |  |  |  |  |
|-----------|-------------|-------------------------|-------|-------|-------|-------|-------|---------|-------|-------|-------|----------------------------|-------|---------|-------|-------|-------|-------|-------|---------|---|----------------------------|---|---|---|--|--|--|--|--|--|
|           |             | Initial                 | 1     | 2     | 3     | 4     | 5     | Initial | 1     | 2     | 3     | 4                          | 5     | Initial | 1     | 2     | 3     | 4     | 5     | Initial | 1 | 2                          | 3 | 4 | 5 |  |  |  |  |  |  |
| HH        | 1           | .2151                   | .1227 | .0578 | .0473 | .0340 | .0340 | .2213   | .1068 | .0646 | .0553 | .0536                      | .0513 | .1536   | .0904 | .1037 | .0819 | .0816 | .0771 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 2           | .1400                   | .0669 | .0618 | .0434 | .0385 | .0388 | .2114   | .0874 | .0521 | .0434 | .0499                      | .0530 | .1836   | .0544 | .0581 | .0567 | .0592 | .0553 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 3           | .1782                   | .1743 | .2139 | .1896 | .1179 | .1131 | .2420   | .2309 | .2187 | .1966 | .1731                      | .1510 | .1859   | .1473 | .0776 | .0697 | .0510 | .0417 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 4           | .2278                   | .3023 | .2261 | .1986 | .4137 | .6194 | .2777   | .0812 | .0632 | .4652 | .1816                      | .0793 | .2644   | .0638 | .0853 | .0468 | .0519 | .0507 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 5           | .2474                   | .2383 | .2111 | .0847 | .0567 | .0453 | .3247   | .1218 | .0901 | .0751 | .0669                      | .0714 | .2763   | .0612 | .0300 | .0468 | .0448 | .0490 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 6           | .2425                   | .3156 | .3097 | .2556 | .2488 | .2343 | .2822   | .2403 | .2638 | .2683 | .2063                      | .1411 | .2335   | .3375 | .2700 | .2882 | .3060 | .2142 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 7           | .2607                   | .4913 | .2080 | .1485 | .1250 | .0901 | .2853   | .1898 | .1145 | .1040 | .1111                      | .1431 | .3171   | .3601 | .1145 | .0618 | .0961 | .0980 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 8           | .2326                   | .0604 | .0870 | .0706 | .1482 | .0757 | .3352   | .0870 | .0638 | .0411 | .0391                      | .0334 | .2559   | .3556 | .0507 | .0309 | .0334 | .0366 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 9           | .2357                   | .2326 | .3275 | .2125 | .2244 | .2567 | .1420   | .1692 | .0978 | .1193 | .0714                      | .0714 | .0677   | .2901 | .2638 | .1938 | .2017 | .1301 | .1148   |   |                            |   |   |   |  |  |  |  |  |  |
|           | 10          | .2522                   | .2391 | .1564 | .2366 | .1966 | .1278 | .2714   | .3678 | .5279 | .3018 | .3791                      | .3134 | .2134   | .5687 | .4293 | .3284 | .3069 | .5998 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 11          | .2910                   | .2675 | .1278 | .0720 | .0717 | .0776 | .2802   | .1102 | .0300 | .0402 | .0337                      | .0360 | .3494   | .0859 | .1063 | .0708 | .0272 | .0272 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 12          | .3111                   | .0912 | .1187 | .1459 | .1034 | .1102 | .2394   | .3958 | .2567 | .2428 | .1448                      | .0938 | .2669   | .1896 | .1312 | .0734 | .0601 | .0436 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 13          | .2241                   | .2298 | .2513 | .2593 | .0745 | .0598 | .3179   | .3723 | .2663 | .1278 | .1074                      | .0708 | .2236   | .1380 | .1235 | .0612 | .0303 | .0385 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 14          | .2669                   | .2284 | .1587 | .0649 | .0261 | .0232 | .3202   | .2083 | .1918 | .1669 | .0589                      | .0448 | .2448   | .0808 | .0289 | .0315 | .0167 | .0082 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 15          | .2632                   | .0833 | .0295 | .0261 | .0244 | .0193 | .3222   | .0623 | .0541 | .0303 | .0264                      | .0139 | .2777   | .0405 | .0255 | .0170 | .0258 | .0159 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 16          | .2550                   | .2170 | .1383 | .1269 | .1145 | .1298 | .2873   | .1785 | .1125 | .0839 | .0995                      | .2003 | .2493   | .2139 | .0992 | .0674 | .0470 | .0422 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 17          | .2431                   | .0431 | .0507 | .0295 | .0414 | .0340 | .2913   | .0635 | .0422 | .0584 | .0601                      | .0422 | .2527   | .0320 | .0193 | .0278 | .0247 | .0238 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 18          | .2754                   | .2159 | .0833 | .0694 | .0366 | .0615 | .2896   | .1193 | .0589 | .1516 | .0400                      | .0213 | .2686   | .0975 | .0201 | .0088 | .0031 | .0065 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 19          | .2598                   | .1629 | .1071 | .0737 | .0397 | .0042 | .2986   | .1068 | .0394 | .0315 | .0176                      | .0181 | .2822   | .1998 | .0632 | .0283 | .0340 | .0167 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 20          | .2714                   | .3658 | .2765 | .3426 | .2454 | .2165 | .2850   | .1119 | .0609 | .0462 | .0357                      | .0621 | .2595   | .1927 | .0312 | .0332 | .0349 | .0170 |         |   |                            |   |   |   |  |  |  |  |  |  |
| HL        | 1           | .2260                   | .1735 | .1806 | .1524 | .0924 | .0910 | .2714   | .2525 | .2284 | .1828 | .0842                      | .0612 | .3610   | .2380 | .1403 | .0740 | .0697 | .0819 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 2           | .2260                   | .2271 | .2375 | .2375 | .2462 | .2424 | .2284   | .3791 | .2278 | .3154 | .4358                      | .3295 | .2771   | .2051 | .2221 | .1969 | .3366 | .4488 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 3           | .2260                   | .1839 | .1689 | .1689 | .1716 | .1716 | .2774   | .2916 | .2610 | .2675 | .2828                      | .2802 | .3026   | .2661 | .2763 | .3171 | .3499 | .3635 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 4           | .2260                   | .1715 | .1650 | .1672 | .1550 | .1533 | .2748   | .2408 | .1193 | .1743 | .0697                      | .2570 | .1932   | .0816 | .0595 | .0487 | .0587 | .0570 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 5           | .2260                   | .1718 | .1553 | .1744 | .1704 | .1610 | .2536   | .2505 | .2652 | .3709 | .2542                      | .2510 |         |       |       |       |       |       |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 6           | .2260                   | .1627 | .1559 | .1473 | .1258 | .1138 | .2457   | .3173 | .1085 | .1873 | .1757                      | .1417 | .2346   | .0572 | .0380 | .0238 | .0465 | .0513 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 7           | .2260                   | .1709 | .1706 | .1406 | .1053 | .1003 | .2292   | .2448 | .1354 | .1295 | .0850                      | .0827 | .2870   | .1193 | .0672 | .0609 | .0547 | .0363 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 8           | .2260                   | .1872 | .1696 | .1245 | .0985 | .0859 | .2397   | .2414 | .1091 | .1014 | .0754                      | .0649 | .2845   | .2151 | .1890 | .0720 | .0527 | .0504 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 9           | .2260                   | .1442 | .1082 | .0538 | .0537 | .0282 | .2746   | .0411 | .0278 | .0400 | .0213                      | .0159 | .2516   | .0855 | .0354 | .0241 | .0153 | .0150 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 10          | .2260                   | .2100 | .2100 | .1772 | .1772 | .1190 | .2638   | .1794 | .0887 | .0349 | .0221                      | .0062 | .2831   | .0966 | .0487 | .0380 | .0303 | .0306 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 11          | .2260                   | .2072 | .2469 | .1524 | .1251 | .1202 | .2527   | .2434 | .1544 | .0439 | .0340                      | .0232 | .2941   | .0768 | .1000 | .0439 | .0147 | .0258 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 12          | .2260                   | .2003 | .1734 | .1412 | .1189 | .0847 | .2638   | .2553 | .2049 | .0567 | .0462                      | .0303 | .2683   | .1136 | .0337 | .0201 | .0269 | .0241 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 13          | .2260                   | .2054 | .1641 | .1603 | .1391 | .1322 | .2641   | .1046 | .0337 | .0368 | .0249                      | .0136 | .3372   | .0502 | .0436 | .0309 | .0210 | .0258 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 14          | .2260                   | .1655 | .1655 | .1397 | .1201 | .0982 | .2612   | .2230 | .2210 | .2179 | .1686                      | .1179 | .3312   | .3352 | .4950 | .5633 | .5905 | .6497 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 15          | .2260                   | .2393 | .2076 | .2278 | .1958 | .1476 | .2448   | .1544 | .1374 | .1196 | .1910                      | .1383 | .2961   | .1995 | .1451 | .1204 | .0944 | .0595 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 16          | .2260                   | .2195 | .2605 | .2603 | .2601 | .2601 | .2397   | .2187 | .2771 | .1983 | .1989                      | .1425 | .2782   | .1896 | .1233 | .0842 | .1034 | .0533 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 17          | .2260                   | .2224 | .1966 | .1997 | .2072 | .2053 | .2573   | .1727 | .1199 | .1686 | .1680                      | .0910 | .3026   | .2168 | .1150 | .0592 | .0434 | .0340 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 18          | .2260                   | .2124 | .1659 | .1316 | .1484 | .1447 | .2516   | .3536 | .2060 | .1573 | .1631                      | .1173 | .2046   | .1969 | .1411 | .1014 | .0706 | .0626 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 19          | .2260                   | .3397 | .2651 | .2852 | .3003 | .2541 | .2397   | .2584 | .2298 | .2697 | .2301                      | .2003 | .3046   | .2502 | .2502 | .2646 | .2731 | .2712 |         |   |                            |   |   |   |  |  |  |  |  |  |
|           | 20          | .2260                   | .2335 | .2335 | .2374 | .2374 | .2295 | .2544   | .1964 | .1964 | .1828 | .1714                      | .1340 | .3029   | .1983 | .1380 | .1295 | .0629 | .0782 |         |   |                            |   |   |   |  |  |  |  |  |  |

\*Measured in inches

# APPENDIX I

## RIM DEVIATIONS\* BY SUBJECT AND CONDITION

| Condition | Subject No. | Practice 1 |       |       |       |       | Performance 1 |       |       |       |       | Performance 2 |       |       |   |   |   |
|-----------|-------------|------------|-------|-------|-------|-------|---------------|-------|-------|-------|-------|---------------|-------|-------|---|---|---|
|           |             | Initial    | 1     | 2     | 3     | 4     | Initial       | 1     | 2     | 3     | 4     | Initial       | 1     | 2     | 3 | 4 | 5 |
| MH        | 1           |            |       |       |       |       |               |       |       |       |       |               |       |       |   |   |   |
|           | 2           |            | .1482 | .1448 | .1439 | .1326 | .1167         | .1068 | .2247 | .2088 | .1652 | .1099         | .0935 | .0912 |   |   |   |
|           | 3           |            | .1839 | .1734 | .1765 | .1842 | .1677         | .1598 | .2570 | .2763 | .2238 | .2391         | .2267 | .0606 |   |   |   |
|           | 4           |            | .1609 | .1924 | .1301 | .0893 | .0332         | .0431 | .2595 | .1326 | .0901 | .0289         | .0346 | .0320 |   |   |   |
|           | 5           |            | .2049 | .1672 | .0918 | .0567 | .0476         | .0289 | .3573 | .1734 | .0986 | .0490         | .0306 | .0340 |   |   |   |
|           | 6           |            | .2006 | .1533 | .0592 | .0626 | .0550         | .0317 | .3318 | .2012 | .0822 | .0759         | .0838 | .0547 |   |   |   |
|           | 7           |            | .2652 | .2564 | .0666 | .0527 | .0584         | .0377 | .2921 | .1286 | .0898 | .0589         | .0612 | .0536 |   |   |   |
|           | 8           |            | .2510 | .2995 | .2731 | .2845 | .2332         | .2054 | .3122 | .1697 | .1496 | .1204         | .0774 | .0734 |   |   |   |
|           | 9           |            | .2794 | .2944 | .4120 | .3791 | .4851         | .6797 | .2780 | .2819 | .2539 | .2083         | .1856 | .1465 |   |   |   |
|           | 10          |            | .2655 | .2601 | .2561 | .2295 | .1726         | .1564 | .2729 | .2816 | .2879 | .2496         | .2726 | .2372 |   |   |   |
|           | 11          |            | .2774 | .2046 | .2289 | .1969 | .1471         | .1408 | .3202 | .3190 | .2502 | .2003         | .1791 | .1468 |   |   |   |
|           | 12          |            | .2117 | .1913 | .0740 | .0561 | .0445         | .0575 | .3012 | .2754 | .2287 | .1751         | .1598 | .1482 |   |   |   |
|           | 13          |            | .2261 | .3176 | .2386 | .1791 | .1213         | .0850 | .2961 | .1989 | .2335 | .2142         | .2185 | .1703 |   |   |   |
|           | 14          |            | .2338 | .3236 | .8344 | .4675 | .6276         | .2459 | .2692 | .3139 | .2850 | .3066         | .4094 | .5432 |   |   |   |
|           | 15          |            | .2587 | .2570 | .2454 | .2185 | .0898         | .0397 | .2831 | .1360 | .0669 | .0366         | .0292 | .0315 |   |   |   |
|           | 16          |            | .2236 | .2034 | .1587 | .0584 | .0439         | .3074 | .3100 | .2074 | .1252 | .0714         | .0638 | .0374 |   |   |   |
|           | 17          |            | .2821 | .2315 | .0748 | .0618 | .0558         | .0434 | .2527 | .0997 | .0829 | .0796         | .0544 | .0822 |   |   |   |
|           | 18          |            | .2465 | .1700 | .1686 | .1564 | .1235         | .0946 | .2505 | .0850 | .0802 | .0326         | .0397 | .0315 |   |   |   |
|           | 19          |            | .2468 | .1544 | .1193 | .0771 | .0507         | .0806 | .3202 | .1629 | .0825 | .0674         | .0224 | .0156 |   |   |   |
|           | 20          |            | .2652 | .1723 | .0431 | .0422 | .0130         | .0284 | .3400 | .1363 | .1247 | .1125         | .0649 | .0615 |   |   |   |
| LH        | 1           |            | .2590 | .3774 | .5145 | .2015 | .2910         | .0853 | .2816 | .2088 | .2355 | .0553         | .0473 | .0555 |   |   |   |
|           | 2           |            | .2100 | .2080 | .2176 | .1065 | .0615         | .0697 | .2610 | .3375 | .2026 | .1590         | .1740 | .1099 |   |   |   |
|           | 3           |            | .1652 | .1371 | .1060 | .1048 | .0938         | .0963 | .2428 | .2323 | .1904 | .1652         | .1046 | .0980 |   |   |   |
|           | 4           |            | .2380 | .1893 | .0776 | .0524 | .0425         | .0258 | .3202 | .1774 | .0793 | .0385         | .0329 | .0332 |   |   |   |
|           | 5           |            | .2593 | .3241 | .2216 | .2326 | .1966         | .1998 | .3117 | .4097 | .2896 | .2828         | .2499 | .1760 |   |   |   |
|           | 6           |            | .2440 | .1989 | .2102 | .1221 | .0944         | .0436 | .2890 | .1082 | .0635 | .1000         | .0448 | .0932 |   |   |   |
|           | 7           |            | .2626 | .2049 | .2264 | .2901 | .2287         | .1898 | .2930 | .2054 | .0884 | .0510         | .0635 | .0490 |   |   |   |
|           | 8           |            | .2380 | .1887 | .1207 | .0663 | .0487         | .0448 | .3230 | .1391 | .0564 | .0201         | .0156 | .0213 |   |   |   |
|           | 9           |            | .2828 | .3091 | .2332 | .1949 | .1830         | .2006 | .2760 | .3049 | .2646 | .2649         | .2204 | .1598 |   |   |   |
|           | 10          |            | .2434 | .2219 | .1394 | .1227 | .1437         | .0844 | .3386 | .2904 | .1652 | .1879         | .1717 | .0785 |   |   |   |
|           | 11          |            | .2513 | .3315 | .1703 | .1761 | .0839         | .1085 | .3001 | .1791 | .0938 | .1340         | .0907 | .0819 |   |   |   |
|           | 12          |            | .2264 | .3154 | .0765 | .0720 | .0490         | .0142 | .3389 | .2414 | .0796 | .0598         | .0377 | .0249 |   |   |   |
|           | 13          |            | .2468 | .1726 | .0910 | .0740 | .0618         | .0669 | .2655 | .1235 | .1408 | .0371         | .0666 | .0536 |   |   |   |
|           | 14          |            | .2539 | .2845 | .3029 | .3205 | .2224         | .2508 | .2848 | .1635 | .0567 | .0150         | .0162 | .0142 |   |   |   |
|           | 15          |            | .2525 | .1683 | .1292 | .0618 | .0224         | .0179 | .3224 | .1530 | .0849 | .0329         | .0388 | .0408 |   |   |   |
|           | 16          |            | .2890 | .0873 | .0751 | .1048 | .0929         | .1006 | .2921 | .1340 | .1080 | .0643         | .0649 | .0677 |   |   |   |
|           | 17          |            | .2425 | .0949 | .0499 | .0281 | .0380         | .0286 | .3188 | .1700 | .0374 | .0306         | .0210 | .0176 |   |   |   |
|           | 18          |            | .2593 | .1833 | .0445 | .0289 | .0502         | .0459 | .2981 | .0439 | .0558 | .0388         | .0802 | .0765 |   |   |   |
|           | 19          |            | .2578 | .2723 | .2488 | .2884 | .2227         | .1813 | .2950 | .1788 | .1825 | .1408         | .1921 | .1677 |   |   |   |
|           | 20          |            | .2624 | .3003 | .2488 | .0400 | .0544         | .0541 | .3233 | .0822 | .0337 | .0482         | .0445 | .0445 |   |   |   |
|           |             | .2550      | .1578 | .0762 | .0689 | .0374 | .0587         | .2867 | .0485 | .0196 | .0167 | .0261         | .0179 |       |   |   |   |

\*Measured in inches

# APPENDIX I

## RIM DEVIATIONS BY SUBJECT AND CONDITION

| Condition | Subject No. | Practice 1 |       |       |       |       |              |       |       |       |       | Performance 1 |       |       |   |   |              |   |   |   |   | Performance 2 |   |   |   |   |              |  |  |  |  |
|-----------|-------------|------------|-------|-------|-------|-------|--------------|-------|-------|-------|-------|---------------|-------|-------|---|---|--------------|---|---|---|---|---------------|---|---|---|---|--------------|--|--|--|--|
|           |             | Initial    |       |       |       |       | Measurements |       |       |       |       | Initial       |       |       |   |   | Measurements |   |   |   |   | Initial       |   |   |   |   | Measurements |  |  |  |  |
|           |             | 1          | 2     | 3     | 4     | 5     | 1            | 2     | 3     | 4     | 5     | 1             | 2     | 3     | 4 | 5 | 1            | 2 | 3 | 4 | 5 | 1             | 2 | 3 | 4 | 5 |              |  |  |  |  |
| LL        | 1           |            | .1862 | .1881 | .2029 | .2009 | .2865        | .3360 | .2411 | .2255 | .1686 | .0935         | .0694 | .0414 |   |   |              |   |   |   |   |               |   |   |   |   |              |  |  |  |  |
|           | 2           |            | .1896 | .2933 | .2505 | .2678 | .2802        | .2522 | .2916 | .1621 | .2071 | .0912         | .0536 | .0615 |   |   |              |   |   |   |   |               |   |   |   |   |              |  |  |  |  |
|           | 3           |            | .2635 | .2352 | .1587 | .1048 | .0827        | .0686 | .2190 | .2692 | .1550 | .1159         | .0788 | .0643 |   |   |              |   |   |   |   |               |   |   |   |   |              |  |  |  |  |
|           | 4           |            | .1972 | .2567 | .1046 | .0408 | .0587        | .0442 | .3120 | .1272 | .0955 | .0567         | .0312 | .0162 |   |   |              |   |   |   |   |               |   |   |   |   |              |  |  |  |  |
|           | 5           |            | .2040 | .1624 | .1442 | .1533 | .3020        | .0935 | .2584 | .1700 | .1125 | .0632         | .0238 | .0255 |   |   |              |   |   |   |   |               |   |   |   |   |              |  |  |  |  |
|           | 6           |            | .1972 | .2091 | .1281 | .0961 | .0425        | .0425 | .2576 | .1754 | .0652 | .0312         | .0323 | .0343 |   |   |              |   |   |   |   |               |   |   |   |   |              |  |  |  |  |
|           | 7           |            | .2468 | .3754 | .2349 | .3519 | .2754        | .2833 | .2805 | .2995 | .3836 | .1782         | .1417 | .1065 |   |   |              |   |   |   |   |               |   |   |   |   |              |  |  |  |  |
|           | 8           |            | .2542 | .2587 | .3049 | .2632 | .2400        | .2627 | .3003 | .2474 | .1731 | .1581         | .1454 | .0912 |   |   |              |   |   |   |   |               |   |   |   |   |              |  |  |  |  |
|           | 9           |            | .2539 | .2570 | .2559 | .2998 | .2969        | .3165 | .3159 | .3156 | .3122 | .3097         | .4261 | .4964 |   |   |              |   |   |   |   |               |   |   |   |   |              |  |  |  |  |
|           | 10          |            | .2763 | .2471 | .2476 | .2508 | .2533        | .2559 | .2468 | .2791 | .2536 | .3411         | .2527 | .2533 |   |   |              |   |   |   |   |               |   |   |   |   |              |  |  |  |  |
|           | 11          |            | .2663 | .2284 | .1706 | .1536 | .1374        | .1196 | .3292 | .2457 | .2383 | .2403         | .2284 | .3134 |   |   |              |   |   |   |   |               |   |   |   |   |              |  |  |  |  |
|           | 12          |            | .2221 | .2216 | .1040 | .0482 | .0516        | .0074 | .2474 | .1794 | .0414 | .0969         | .0173 | .0227 |   |   |              |   |   |   |   |               |   |   |   |   |              |  |  |  |  |
|           | 13          |            | .2627 | .3375 | .3961 | .4301 | .2108        | .1703 | .3258 | .3975 | .2513 | .1366         | .1167 | .1598 |   |   |              |   |   |   |   |               |   |   |   |   |              |  |  |  |  |
|           | 14          |            | .2363 | .3610 | .2632 | .2765 | .2561        | .2559 | .2697 | .3601 | .1768 | .2298         | .1510 | .1363 |   |   |              |   |   |   |   |               |   |   |   |   |              |  |  |  |  |
|           | 15          |            | .2389 | .0516 | .0300 | .0295 | .0266        | .0264 | .2981 | .0632 | .0201 | .0181         | .0278 | .0275 |   |   |              |   |   |   |   |               |   |   |   |   |              |  |  |  |  |
|           | 16          |            | .2431 | .2267 | .1128 | .0405 | .0258        | .0289 | .3001 | .1340 | .0530 | .0283         | .0394 | .0247 |   |   |              |   |   |   |   |               |   |   |   |   |              |  |  |  |  |
|           | 17          |            | .2482 | .3768 | .5060 | .4516 | .4086        | .2879 | .3550 | .1867 | .1522 | .1405         | .1267 | .0683 |   |   |              |   |   |   |   |               |   |   |   |   |              |  |  |  |  |
|           | 18          |            | .2627 | .2870 | .0561 | .0400 | .2066        | .0360 | .3593 | .1689 | .0553 | .0385         | .0326 | .0340 |   |   |              |   |   |   |   |               |   |   |   |   |              |  |  |  |  |
|           | 19          |            | .2264 | .1360 | .1250 | .1890 | .1116        | .0504 | .2822 | .0431 | .0499 | .0261         | .0346 |       |   |   |              |   |   |   |   |               |   |   |   |   |              |  |  |  |  |
|           | 20          |            | .2539 | .1864 | .1879 | .1791 | .1601        | .1567 | .2780 | .2238 | .1862 | .1386         | .1193 | .1046 |   |   |              |   |   |   |   |               |   |   |   |   |              |  |  |  |  |

APPENDIX J

MEANS AND STANDARD DEVIATIONS OF RAW DATA  
BY MEASUREMENT, TRIAL, AND CONDITION

|          |             | Condition   |                |                 |                |                |                |                    |         |
|----------|-------------|-------------|----------------|-----------------|----------------|----------------|----------------|--------------------|---------|
|          | Trial       | Measurement | HH<br>(N = 20) | HL<br>(N = 20*) | HM<br>(N = 20) | LH<br>(N = 20) | LL<br>(N = 20) | Experts<br>(A = 3) |         |
| Practice | 1           | Initial     | 0.24467        | 0.22600         |                |                |                |                    |         |
|          | 1           | 1           | 0.20742        | 0.20240         |                |                |                |                    |         |
|          | 1           | 2           | 0.16006        | 0.19004         |                |                |                |                    |         |
|          | 1           | 3           | 0.13487        | 0.17396         |                |                |                |                    |         |
|          | 1           | 4           | 0.11906        | 0.16243         |                |                |                |                    |         |
|          | 1           | 5           | 0.11856        | 0.14716         |                |                |                |                    |         |
|          | 1           | Initial     | 0.27624        | 0.25440         | 0.23352        | 0.24702        | 0.23646        | 0.25897            |         |
|          | 1           | 1           | 0.16855        | 0.22867         | 0.22723        | 0.21751        | 0.24479        | 0.07773            |         |
|          | 1           | 2           | 0.13347        | 0.16976         | 0.20548        | 0.15329        | 0.19909        | 0.03797            |         |
|          | 1           | 3           | 0.13248        | 0.16277         | 0.15932        | 0.12529        | 0.19337        | 0.01936            |         |
|          | 1           | 4           | 0.09780        | 0.14411         | 0.14888        | 0.10139        | 0.17668        | 0.02446            |         |
|          | 1           | 5           | 0.08540        | 0.12494         | 0.11831        | 0.09411        | 0.15473        | 0.01813            |         |
|          | Performance | 2           | Initial        | 0.25241         | 0.28819        | 0.29051        | 0.29904        | 0.28840            | 0.30582 |
|          |             | 2           | 1              | 0.17866         | 0.16692        | 0.19988        | 0.18614        | 0.21367            | 0.16840 |
| 2        |             | 2           | 0.10307        | 0.14008         | 0.16081        | 0.11363        | 0.15754        | 0.05006            |         |
| 2        |             | 3           | 0.08150        | 0.11963         | 0.12459        | 0.09438        | 0.12772        | 0.02201            |         |
| 2        |             | 4           | 0.07323        | 0.12185         | 0.11671        | 0.08779        | 0.10700        | 0.02522            |         |
| 2        |             | 5           | 0.07884        | 0.12731         | 0.10533        | 0.07130        | 0.10581        | 0.02937            |         |
| Practice |             | 1           | Initial        | 0.03763         | 0.00000        |                |                |                    |         |
|          | 1           | 1           | 0.11269        | 0.04186         |                |                |                |                    |         |
|          | 1           | 2           | 0.08912        | 0.04096         |                |                |                |                    |         |
|          | 1           | 3           | 0.09162        | 0.05400         |                |                |                |                    |         |
|          | 1           | 4           | 0.10168        | 0.06324         |                |                |                |                    |         |
|          | 1           | 5           | 0.13808        | 0.06353         |                |                |                |                    |         |
|          | Performance | 1           | Initial        | 0.04626         | 0.01470        | 0.03795        | 0.02596        | 0.02807            | 0.00858 |
| 1        |             | 1           | 0.10604        | 0.08062         | 0.06748        | 0.07489        | 0.08153        | 0.08146            |         |
| 1        |             | 2           | 0.12272        | 0.07596         | 0.15697        | 0.07909        | 0.11442        | 0.01747            |         |
| 1        |             | 3           | 0.11395        | 0.09579         | 0.11682        | 0.09090        | 0.12952        | 0.01356            |         |
| 1        |             | 4           | 0.08621        | 0.10641         | 0.15823        | 0.07068        | 0.11790        | 0.00548            |         |
| 1        |             | 5           | 0.07324        | 0.09576         | 0.14638        | 0.07139        | 0.11502        | 0.01076            |         |
| 2        |             | Initial     | 0.04559        | 0.03686         | 0.03393        | 0.02584        | 0.03777        | 0.01944            |         |
| 2        |             | 1           | 0.13937        | 0.08208         | 0.07120        | 0.09470        | 0.09128        | 0.16186            |         |
| 2        |             | 2           | 0.09924        | 0.11315         | 0.07997        | 0.07777        | 0.09826        | 0.03204            |         |
| 2        |             | 3           | 0.08746        | 0.13529         | 0.08468        | 0.08194        | 0.09288        | 0.00976            |         |
| 2        |             | 4           | 0.08482        | 0.15386         | 0.10304        | 0.07306        | 0.10192        | 0.01597            |         |
| 2        |             | 5           | 0.13151        | 0.17612         | 0.11832        | 0.05055        | 0.12144        | 0.01286            |         |

\*N = 19 for Performance Trial 2.