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**Biomech Planar Motion Analysis System  
User's Manual**

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# Chapter 1

## INTRODUCTION

This manual describes how to use a series of programs called, BIOMECH (copyright Kinesiology Department, University of Waterloo). The manual mainly describes how to develop a control file. A control file essentially describes, to the computer, the user's input data, how the computer should process the data, what headings should be used for the printed output, and what

The manual defines the format of each line of the control file followed by a detailed description of each parameter in the line. In this context, line refers a block of information that may be contained on up to 3 actual lines in the file. Therefore, these lines of information will, henceforth, be referred to as "CARD#"s. This distinction is necessary due to the potential for a "READ" statement in the source FORTRAN program to need more information than may be contained in any one eighty column card image (i.e., computer card). In FORTRAN, data must be read using a specific format. The following is a sample of FORTRAN format statements (>indicates start of card image, ^ indicates a blank):

16I5 = 16 integers in 5 column fields, right justified

(e.g., >^^^10^^^1^^^5 ...)

8F10.0 = 8 real numbers in 10 column fields (use a decimal)

(e.g., >^234.56^^^0.0^^^-67.784 ...)

80I1 = 80 integers in one column fields

(e.g., >51^^1100111 ...)

80Z1 = 80 hexadecimal digits in one column fields

(where A=10, B=11, C=12, ... F=15)

(e.g., >51^^11A00B111 ...)

8(A8,2X) = 8 names made from 8 letters & 2 blanks

(e.g., >MARKER 1^^Marker 2^^Lt.wrist^^ ...)

20F4.1 = 20 real numbers in four column fields

(all of the following are read in FORTRAN as 6.0)

(e.g., >6.0^6.00^^60^^6. ...)

I5,1X,A4 = a 5 digit integer, 1 blank, and 4 letters, right-justified

(e.g., >^^25^^IFS)

## Chapter 2

### BIOMECH CARD FORMAT

#### 2.1 CARD# 1

Trial code and descriptive title. (20A4)

TRCODE \*\*\*\*\* TITLE \*\*\*\*\*

TRCODE is an 8 character trial code (numbers are permitted in the code name). Try to use a code that indicates the nature of the motion, the trial number, and the subject's initials. The initials of the person that digitized the data should also appear on this card.

```
RE01RC Running, Left side (with orthotics), ..., by DGER.
```

TITLE is an 80 character string naming the analysis. The first spaces are usually reserved for the trial code to allow the user to identify the analysis both in the control file and in the output listings. Include information about the motion under investigation and initials of researcher and/or the person who digitized the data.

#### 2.2 CARD# 2

The description of the film and basic information about the analysis. (16I5)

NPOSN		NPTS		NSBSP		NLIMBS		NHCYCL		NPASS		NEMG		
NSEG	NPOS	NJTS		MODEL		NCYCL		INIT		NCODES		NINCR		
7	71	59	10	1	1	2	3	50	0	5	1	5	0	1

NSEG is the number of body segments to be analyzed. Maximum number of segments is 16.

NPOSN is the number of frames of raw cinefilm data digitized including the frames before and after the trial used for the filter to "warm up". In the sample above NPOSN=71 frames. This does not include the frame(s) digitized for scaling data since all scaling should be completed with the program CINEDATA before preparing this file. Do NOT use NPOSN > 160.

NPOS is the number of frames of film to be used in the analysis, starting with frame number one (i.e., ignoring negatively numbered frames and frame 0). Do NOT have NPOS greater than 150. NPOS must be 4 or more less than the largest positive frame number and 8 less than NPOSN above.

NPTS is the number of pairs of digitized coordinates; NPTS=10 in the sample implies that 10 markers were digitized per frame. Maximum number of points is 30 (was 20).

NJNTS is the number of joints to be included in a relative angle kinematic analysis. If no such analysis is planned use "0".

NSBSP is the Number of Sets of Body Segment Parameters. Either 1 or 2 sets are permitted, however, each frame of coordinate data must utilize only one set. The selection is made by CARD# 19. NSBSP is normally "1" but "0" or blank "" are equivalent.

MODEL is a code indicating which theoretical model of the human body is to be used in the kinetic analysis. MODEL=2 was used in the sample should usually be selected.

1 indicates a simple link-segment model of NSEG segments. The order of segments must be from a free end to a free or "grounded" end. The trunk needs no identification.

2 indicates a complex link-segment model using NSEG segments, where segments are analyzed separately, starting from their distal ends.

3 indicates a complex link-segment model using NSEG segments. This model analyzes the segments of a supported body which has unknown ground reaction forces. The supported limb must be first followed by the other limbs and trunk. The supported limb must be organized from proximal segment to distal segment; whereas, the other limbs are organized distal to proximal finishing with the trunk.

4 Allows a trunk or pelvis with 2 links. Requires seven segments and two three-segment limbs. Last segment must be the trunk.

NLIMBS is the total number of separate body limbs, EXCLUDING the trunk, modelled in the study including those created using the data for the opposite side of the body. NLIMBS must NOT be greater than 6. This may or may not include the head and neck as a limb. The sample above was drawn from a study of sculling. The bilateral symmetry of this movement allowed for the use of doubled limb masses for the arms and legs and for a "headneck" as a separate limb thus 3 was used. NLIMBS is used only by the ENERGY program.

NCYCL is the number of film frames per movement cycle. In the example presented there were 50 frames for one cycle. If the movement is not cyclic set to zero.

NHCYCL is used when a cyclic motion is studied, permitting the use of data for one side of the body to represent data for the contralateral side, shifted one-half cycle in time. Set NHCYCL to 0 if no segments are created in this way.

INIT is the frame number of the start of the activity being analyzed. This frame is preferably the tenth frame digitized, allowing the filter in the KINEMATICS program sufficient lead-in. This frame is usually indicated in the file by some 3 or 4 letter code, such as, "HSR" to indicate "Heel Strike, Right foot". INIT is usually set to 1.

NPASS is the number of dual passes of the digital filter. It may be 1, 2 or 3 only and is usually 1.

NCODES is the number of event codes entered later in this control file (CARD# 18), 0 if codes will be provided for every frame (16(A4, 1X)) or -1 if event codes are omitted.

NEMG reserved for future use; leave blank or zero.

NINCR is the frame increment. This is the number of frames by which the cinefilm frame numbers are incremented. This number is no longer necessary. Use 1, 0 or leave blank.

### 2.3 CARD# 3

First 6 are nonzero if NHCYCL (CARD# 2) is nonzero (6I5). Next 9 are nonzero if option 26 is set (CARD# 5 below) (9I5).

NSEGX	-----		MIDP	MID1	MID2	MIDP	MID1	MID2	...			
(1)	(2)	(3)	(4)	(5)	(6)	(1)	(1)	(2)	(2)	(2)	...	
0	0	0	0	0	0	11	8	9	12	1	2	...

NSEGX(1 to 6) are the numbers of the segments to be considered twice, NHCYCL frames out of phase with the real data. Use no more than 6 (was 10).

MIDP(1 to 3) are the midpoint marker numbers. They must be in the order starting one greater than the number of digitized markers (NPTS in CARD# 2).

MID1(1 to 3) and MID2(1 to 3) are the marker numbers that are to be averaged to produce a midpoint marker. You are allowed to a maximum of three midpoint markers. Once computed they may be used like any other marker in order to form segments or relative angles.

### 2.4 CARD# 4

Is used to describe the scaling information, and other external information necessary to compute length, mass, time and velocity in SI units. (8F10.0).

SF	DELTAT	REFVX	REFVY	TIME0	XOFSET	YOFSET	TBMASS
0.01	25.0	4.7	0.0	0.0	0.0	0.0	65.0

SF is the scale factor used to calculate lengths and positions in metres from the digitized coordinate data. For the sample .01 indicates that the incoming data is in centimetres.

DELTAT is the time increment, in seconds, or the camera frame rate, in frames per second. If DELTAT is < 1 then it is the time increment. If > 1 it is the frame rate. In the sample the frame

rate was 25 frames per second.

REFVX is a horizontal reference velocity in metres per second. This is useful in studies using a treadmill, with a fixed belt speed, or a moving camera system with a known velocity.

REFVY is the same as REFVX for a vertical component of velocity.

TIME0 is the time in seconds of the start of the motion. Usually 0.0, indicating that frame 1 corresponds to time 0.

XOFSET and YOFSET are used only if NHCYCL (CARD# 2) is nonzero. These are used to indicate to the programs the distance (m) that the data for segments indicated by NSEGX (CARD# 3) must be moved to appear as the data for the contralateral limb's segments. These are determined by the distance moved by the digitized hip coordinates in NHCYCL frames. These offsets are usually zero.

TBMASS is the total body mass of the subject, in kilograms.

## 2.5 CARD# 5

Describes desired output options (80Z1). A "0" in any column indicates that the corresponding output option for the program being run will not be produced. An integer between 1 and 9 indicates that the printed output is printed with a frame-skip equal to the integer entered. Regardless of the frame-skip indicated here for the printed output, the data calculated and stored on disk will include each frame (i.e., a "1" indicates that output for each frame will be printed, while a "4" indicates that output for every fourth frame is to be printed). The list of the output options is presented as: the program name, then the column number, in brackets and lastly a brief description of the option.

CC	Program	Option description
(card column):		
1:	FOURIER/ NOISE	Reconstruct signals from the harmonic frequencies. 1 means use the suggested harmonics; 2 to 9 means use 2nd to 9th harmonics for reconstruction.
2:	FOURIER	Save reconstructed signals in disk file, <code>_.FR/_.NS</code>
3:	Reserved.	
4:	All	Horizontal planar analyses (e.g., weightlessness).
5:	ERRCHECK	Check for bad data points.
6:	ERRCHECK	Suppress check of segment lengths.
7:	ERRCHECK	Compute "out-of-plane" angles when lengths < given.
8:	All	1=cutoff freq. same for X&Y, 2=diff. cutoffs for Y
9:	All	Units for angles: 0 = degrees, 1 = radians.
10:	KINEMATIC	Save relative angle kinematics in disk file, <code>_.RA</code> .
11:	KINEMATIC	Save segment kinematics in disk file, <code>_.KS</code> .



12:	KINEMATIC	Save marker kinematics in disk file, <code>_KM</code> .
13:	KINEMATIC	Print raw marker data.
14:	KINEMATIC	Print filtered marker data.
15:	KINEMATIC	Print total body kinematics.
16:	KINEMATIC	Print relative angular kinematics.
17:	KINEMATIC	Print segment kinematics.
18:	KINEMATIC	Print marker kinematics.
19:	KINEMATIC	Make trunk length constant.
20:	KINEMATIC	Make trunk by combining several segments.
21:	KINEMATIC	Save changes in relative angles in disk file, <code>_DR</code> .
22:	KINEMATIC	Allow extra segments to follow trunk.
23:	KINEMATIC	Compute segment centres of rotation.
24:	KINEMATIC	Radii of gyration taken about axis through cofg.
25:	KINEMATIC	Use reflexive padding prior to filtering.
26:	KINEMATIC	Compute midpoint markers (see <code>CARD# 3</code> ).
27:	KINEMATIC	Use critically damped filter.
28:	KINEMATIC	Not assigned.
29:	KINEMATIC	Not assigned.
30:	KINEMATIC	Not assigned.
31:	ENERGY	Save segment energies in disk file, <code>_EN</code> .
32:	ENERGY	Print segment energies.
33:	ENERGY	Print limb & total body energies.
34:	ENERGY	Print tables of energy by energy type.
35:	ENERGY	Print internal work analysis (i.e., internal work, etc.)
36:	ENERGY	Print internal work analysis for one cycle of movement.
37:	ENERGY	Print frame-by-frame internal work analysis.
38:	ENERGY	Not assigned.
39:	ENERGY	Not assigned.
40:	ENERGY	Not assigned.
41:	MOMENTUM	Save segment momenta in disk file, <code>_MM</code> .
42:	MOMENTUM	Print segment momenta.
43:	MOMENTUM	Print estimated centres of pressure.
44:	MOMENTUM	Print total body momenta.
45:	MOMENTUM	Not assigned.
46:	MOMENTUM	Not assigned.
47:	MOMENTUM	Not assigned.
48:	MOMENTUM	Not assigned.
49:	MOMENTUM	Not assigned.
50:	MOMENTUM	Not assigned.
51:	FORCE	Save moments and powers in disk file, <code>_JP</code> .
52:	FORCE	Use external forces from control file.
53:	FORCE	Save forces and moments in disk file, <code>_FO</code> .
54:	FORCE	Print forces and moments.

55:	FORCE	Print work done by moments.
56:	FORCE	Use a marker as centre of pressure of external force (see CARD# 34).
57:	FORCE	Not assigned.
58:	FORCE	Not assigned.
59:	FORCE	Crank segment. External forces from a bicycle crank.
60:	FORCE	Segment which holds a weight. Defined in CARD#14.
61:	POWER	Print segment powers.
62:	POWER	Print total body powers.
63:	POWER	Print joint powers.
64:	POWER	Save segment powers in disk file, <code>_PS</code> .
65:	POWER	Save joint powers in disk file, <code>_PJ</code> .
66:	POWER	Print trunk powers.
67:	POWER	Use relative angular kinematics.
68:	POWER	Compute compliant power at foot.
69:	POWER	Not assigned.
70:	POWER	Not assigned.
71:	MUSCLE	Save muscle kinematics in disk file, <code>_MU</code> .
72:	MUSCLE	Save muscle lengths to BioProc <code>.ASC</code> file.
	..	
	..	
	..	
80:	Reserved.	

41	0110011110011100001	1111110	000011110	101010
----	---------------------	---------	-----------	--------

Indicating that the FOURIER, KINEMATICS, ENERGY, and MOMENTUM programs may be run with this control file with the output options as specified by the entries in the various columns. For example the “41” in columns 1 and 2 indicate that the that when the Fourier program is run the signal will be FOURIER program should reconstruct signals using 4 harmonics and that these signals should be stored in a disk file. The final “110” indicates that segmental momenta should be printed and stored on disk but not the centres of pressure.

## 2.6 CARD# 6

Is used to indicate the desired effective cutoff frequency of the zero-lag, fourth-order, Butterworth, low-pass filter. (20F4.1). A recommended cut-off frequency is 6.0 Hz. One entry of this parameter (CUTOFF) is needed for each of the markers. In the sample given, ten markers will be filtered, with cutoff frequencies of 4 Hz for the first 3 markers, and with filter cutoff frequencies of 5.5 Hz for the last 7 markers. NOTE, a zero (0.0) will eliminate filtering (this is NOT recommended). If option 8 (CARD# 5) is 2 a second set of cutoffs must be provided for the Y coordinates. Otherwise these cutoffs are used for both X and Y coordinates.

## 2.7 CARD# 7

Is a list of marker numbers to be used in a Fourier analysis. Each of the markers may be analyzed, and are listed as (16I5). These are members of the array MARKF (markers for fourier), and any of the markers may be so analyzed. For the sample markers 1, 3, 7, and 10 will be fourier analyzed. Maximum of 16 markers can be processed (was 20).

This CARD# may be left blank unless FOURIER or similar data smoothing programs are used. A precaution, which applies to several of the following CARD#s, is that with the CARD# included you can always run the Fourier (or other) analysis without more fuss than changing the NOPTNS values. If this card is left blank, the user may forget where the MARKF card (or others like it) belongs, and would waste considerable time referring back to this document searching for the necessary information.

## 2.8 CARD#s 8 to 12

Are the names of the segments, markers, joints, and limbs. These CARD#s are all in the same format (8(A8,2X)), thus the names must be eight characters in length or shorter.

### 2.8.1 CARD# 8

Is a list of the segment names ordered based on the MODEL selected in CARD# 2. Start with the distal or free-ended segment, and proceed towards the torso, one limb at a time. Order must agree with CARD#s 13, 15, 16, 17, and 20 to 24. Called array NAMES.

Foot	LowerLeg	Thigh	Hand	Forearm	UpperArm
------	----------	-------	------	---------	----------

### 2.8.2 CARD# 9

Is a list of the names of the joints at the proximal ends of the segments listed in CARD# 8. These are called NAMEJ and must be listed in the same order as the segments.

Ankle	Knee	Hip	Wrist	Elbow	Shoulder
-------	------	-----	-------	-------	----------

### 2.8.3 CARD# 10

Are the names of the digitized body markers in digitizing order. The elements of this CARD# are all in an array named, NAMEM, which has NPTS elements (see CARD# 2).

Toes	Ankle	Knee	Hip	Shoulder
------	-------	------	-----	----------

2.8.4 CARD# 11

Is the list of NJNTS joints for which relative angular kinematics are to be computed. The array is called NAMERJ for NAMEs of Relative Joints.

Ankle	Knee	Q-angle	Neck	Shoulder
-------	------	---------	------	----------

2.8.5 CARD# 12

Is a list of names, each in the array "NAMEL", for the names of the limbs that are being studied. This CARD# must be prepared with regard to CARD#s 3 and 24, which describe the segments to be analyzed twice, one half cycle out-of-phase, and the type of segment, respectively. For example, if the foot, lower leg, and thigh segments were being analyzed twice and the trunk was being studied CARD# 3 would be:

1	2	3	0	0	0	...
---	---	---	---	---	---	-----

indicating that the foot (segment 1), the lower leg (segment 2), and the thigh (segment 3) are to be considered twice. Once as the real data for the digitized information and once as the data for the contralateral limb. CARD# 12 would then be:

Rt.Leg	Lt.Leg	Torso
--------	--------	-------

# 24 would have to be:

1 2 2 0

to indicate the type of segments used to make the limbs (this will be explained in detail in the description of CARD# 24).

2.9 CARD# 13

Is the list of lengths of segments (L) in metres. These lengths are in the same order as defined in CARD# 8 and are used primarily by program, ERRCHECK (8F10.5).

0.300	0.420	0.395	0.225	0.245	0.285
-------	-------	-------	-------	-------	-------

2.10 CARD# 14

Is the subject's body weight in newtons (N), height in metres (m), and the weight of an external object in newtons (N). Format: F10.5. This CARD# may be zero or blank if the TBMASS (CARD# 4) has

been included. Called TOTWT, TBHT, and WTOBJ in the programs. TBHT is used by the MUSCLE program. WTOBJ is used by FORCE program. Be sure to include the segment number as option 60 and the point of application as IFPC in CARD#33.

TOTWT	TBHT	WTOBJ
0.00	0.0	0.0

## 2.11 CARD# 15

Is the list of segment weight proportions (PCTWT), where each of the entries in the list is the percentage of total body weight for the segments being studied, (8F10.5). These weight proportions may be derived from a number of sources. (It is recommended (Hay, Kinesiology 3 and 4, 1973 and 1974) that the proportions used in this analysis be taken from a study of cadavers as closely matched with the subjects of the study as is possible, and that the marking systems be identical to the markings used in deriving the proportions).

## 2.12 CARD# 16

Is the array PCTR, which defines the location of the segment centres of gravity (r-values) (8F10.5). PCTR is in the order of the segments in CARD# 8. Each entry is the ratio of the distance from the defined proximal end of the segment (CARD# 20) to the segment centre of gravity, to the length of the segment.

i.e., 
$$\frac{\text{length (prox. end to CG)}}{\text{total segment length}}$$

(Note, where applicable, use the HIP marker as the proximal end of the trunk segment.)

## 2.13 CARD# 17

Is the array PCKT, or the list of K values for the segments being studied. These K values are the ratios of the radii of gyration to the segment length for rotations about the defined proximal end of the segment. (8F10.0).

\* Note, CARD#s 14 to 17 must be repeated with the appropriate data if a second set of anthropometrics are used (NSBSP = 2).

## 2.14 CARD# 18

Is used to identify the name and frame number of any event codes (I5,1X,A4). If NCODES = 0 (CARD# 2), events are indicated by a 4-character code in each frame (16(A4,1X)) of the output from CINEDATA. If NCODES=-1 these cards are omitted.



2	3	4	8	7	6	8	4
---	---	---	---	---	---	---	---

The sample indicates that the proximal marker of the FOOT is the ankle, for the LOWLEG is the knee, etc.

### 2.16.2 CARD# 21

Is the list of "IDIST", the marker numbers identifying the distal markers of each segment.

1	2	3	9	8	7	10	6
---	---	---	---	---	---	----	---

The sample indicates that the distal marker for the FOOT is the toe, for the LOWLEG is the ankle, etc.

### 2.16.3 CARD# 22 and 23

Are indices of the proximal and distal joint centres of rotation, respectively. CARD#s 22 and 23 may simply duplicate CARD#s 20 and 21, if the markers were placed on the (estimated) joint centres of rotation. These two cards may also be blank if there is no difference between the segment markers and the joint centres of rotation, but blanks may be trouble in later editing for other uses.

### 2.16.4 CARD# 24

Is the list of segment types (IT), (16I5) which indicate to the program package how to model each segment. IT=0 indicates the trunk segment, IT=1 indicates a free-ended segment, like the hand or foot. IT=2 indicates a segment with both ends connected to another segment. The order of IT is as in CARD# 8. (MODEL 1 does not require IT=0: use a "2" instead.)

1	2	2	1	2	2	1	0
---	---	---	---	---	---	---	---

NOTE, no segments may follow the trunk segment, unless NOPTNS(20) (CARD# 5) is in use. In such a case, the segments following the trunk, and forming the trunk, are combined mathematically to form a "complex" trunk or upper body. This will save printing costs and retain accuracy in the trunk model. An example of this trunk model is a combination called the HAT, or Head-Arms-Trunk.

### 2.17 CARD# 25

Is a list of correction factors (CP), for correcting the "R" values (CARD# 16) when the proximal segment marker is not on the proximal joint centre of rotation. No sample is provided, but will be

included in the complete sample file at the end of this document as all zeros to indicate that information may be required in other applications (8F10.5). Both CARD# 25 and CARD# 26 are entered in metres.

#### 2.18 CARD# 26

Has the same application as CARD# 25, when the distal segment marker is not the same as the joint rotation centre (8F10.5).

#### 2.19 CARD#s 27 to 32

Are used if relative angles of joints are being calculated. The number of entries on CARD#s 27 to 32 must equal the number of relative angles being calculated. The order of entries to this these CARD#s must match the order of joints named for analysis in CARD# 11 (16I5). If no relative angular kinematics are required insert 7 lines of blanks.

##### 2.19.1 CARD# 27

Is the list I1PROX, of marker numbers nearest to the joint(s) of the first segment of the pair of segments whose angular information is to be analyzed. I. e., if studying the relative angles of the segments forming the elbow and shoulder joints, the I1PROX for the forearm would be (in the current example), marker #7, the elbow, and marker #6, the shoulder, respectively.

2	3	4	7	6
---	---	---	---	---

with the order of these indices agreeing with CARD# 11.

##### 2.19.2 CARD# 28

Is the list I1DIST, of marker numbers farthest from the joint(s) of the first segment of the pair of segments whose angular information is to be analyzed. I.e., if studying the relative angles of the elbow and shoulder, I1DIST of the forearm would be marker #8, the wrist and of the upper arm would be marker #7, the elbow, respectively.

1	2	3	8	7
---	---	---	---	---

again, with the order as in CARD# 11.

##### 2.19.3 CARD# 29

Is the list I2PROX, of the marker numbers nearest to the joint(s) of the second segment of the pair of segments.



#### 2.19.4 CARD# 30

Is the list I2DIST, of the marker numbers nearest the joint(s) of the second segment of the pair of segments forming that joint. A sample of CARD#s 29 and 30, would be:

2	3	4	7	6
3	4	5	6	5

Describing the segments of the second segment of the pair. In the samples of CARD#s 27 to 32, the joints being examined may be drawn in a stick-figure using these CARD#s and CARD#s 10 for the marker names and digitizing order, and CARD# 11 for the joint names and order. Thus, the ankle joint is made up of the segments described by marker 2 to marker 1 and marker 2 to marker 3, as seen by the vertical alignment of the numbers in column five of the sample CARD#s 27 to 30.

#### 2.19.5 CARD# 31

Is the list of DIRECT, which specifies the direction for computing joint or relative angles. A “1” indicates that the positive direction for the joint angles is the counterclockwise direction whereas a “-1” indicates the joint angles should increase in the clockwise direction.

1	-1	1	1	-1
---	----	---	---	----

Indicating that the ankle, hip and elbow are increasing in angle if the change in angle between frames is counterclockwise, and that the knee and shoulder angles increase when the joint angle increases in the clockwise direction.

#### 2.19.6 CARD# 32

Is the list ABIAS, of angles which are to be added to the relative angles that are calculated. The angles are all in degrees, (8F10.5).

-90.00	0.00	-180.00	0.00	-180.00
--------	------	---------	------	---------

#### 2.20 CARD# 33

Is the FORTRAN format statement describing the digitized data. The format must read all of the data for a frame, and must include the columns describing the frame number of the data contained on that card (format T78,I3). In this example, the data for 10 (x,y) points will require 20 sets of F6.1 fields for the coordinates. The READC subroutine expects the data as sets of 12F6.1, so that you can put only six points worth of information on each line of the data file.

The sample that describes the data for this example is:

```
(12F6.1/8F6.1,T78,I3)
```

An example of a format for 14 pairs of digitized coordinates is:

```
(12F6.1/12F6.1/4F6.1,T78,I3).
```

## Chapter 3

### ADDITIONAL INFORMATION

Additional information is only included at the bottom of the control file if force related information is appended to the file. The force information is appended, in the following format, as one line per sample of force plate data: FCX1, FCY1, FCX2, FCY2, and an index IFPC are in the same line in the file, (4F10.0,I5). The coordinates are in centimetres:

FCX1 and

FCY1 are the x-y coordinates of an external force.

FCX2 and

FCY2 are the x-y coordinates of a second external force.

These two points and the IFPC are used ONLY in cases where NOPTNS(56) is set (CARD#5) usually only one of the force-plate points, the centre, is identified by (FCX1,FCY1) IFPC is the Index of Force Plate Centre, identifying the marker number in the list of digitized points which correspond to the marker for the force plate. I. e., if the force plate was marker #8, the IFPC in the sample below would be an "8" in column 45, according to the input format, This option is not often used.

270.00	5.00	0.00	0.00	8
--------	------	------	------	---

The sample indicates that the external force measurement occurs 270 cm to the right of, and 5 cm above the origin of the digitized film, and that the force plate was marker number 8 in the list of digitized data.

#### 3.1 EXTERNAL FORCE DATA

The following cards must contain the following on each card.

NFRM is the film frame number corresponding with the external force stored in this line of data (I3).

MEF is the segment number which is in direct contact with the external force. (1X,I2)

EFX is the measured external force in the x-direction. (F8.3)

EFY is the measured external force in the y-direction. (F8.3)

EX is the x-coordinate of the point of application of the force (F8.3)

EY is the y-coordinate of the point of application of the force (F8.3)

There is a facility for including two sets of force data, per digitized frame, as when using two different force platforms, simultaneously. In such an application, the force information for the second set is included on the same line of force data. The input format for each of the lines of force data is: (I3,1X,2(I2,4F8.3)).

A sample of a couple of lines of force plate data are:

5	1	284.2	1845.3	-20.24	0.0				
6	1	480.8	1908.7	-21.42	0.0	4	42.34	145.34	...

The first of these lines shows a force occurring in film frame 5, applied to the foot (segment 1), with a force of 284.2 N in the X direction, a force of 1845.3 N in the Y-direction, applied at a point 20.24 cm from the force plate centre, at ground level (0.0 cm above the force plate).

A sample of a control-file follows, containing information from a running study. The data included at the bottom of the control file (named RE01RC.CFB) is real data, and was being analyzed at the time of this writing. An index is provided at the top of file to show the column numbers more easily.



# Chapter 5

## SAMPLE COORDINATE DATA FILE

Sample of the data produced by the CINEDATA program:

```
1234567890123456789012345678901234567890123456789012345678901234567890
      |  10  |  20  |  30  |  40  |  50  |  60  |  70  |
522.9 139.3 496.8  90.9 495.9  52.9 453.9  24.9 447.5  27.5 458.6  12.4 REC1 -3
468.4  10.7                                     REC2 -3
540.8 150.4 509.6  97.0 506.7  55.6 461.6  15.8 455.2  21.2 465.4   8.4 REC1 -2
474.8   4.1                                     REC2 -2
554.1 146.9 533.1  92.9 509.2  50.8 470.5  21.2 461.5  25.5 461.6  13.1 REC1 -1
469.6   3.8                                     REC2 -1
566.9 150.2 543.1  89.8 521.6  56.8 474.1  30.8 468.6  36.5 465.1  20.5 REC1  0
470.6  11.0                                     REC2  0
578.1 150.9 555.9  92.0 530.6  54.7 485.2  34.9 481.0  44.7 472.3  23.9 REC1  1
474.8  16.2                                     REC2  1
.      .      .      .      .      .      .      .      .      .      .      .      .      .
.      .      .      .      .      .      .      .      .      .      .      .      .      .
.      .      .      .      .      .      .      .      .      .      .      .      .      .
```