

BioAnalysis

Version 2.2

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BioAnalysis Overview

BioAnalysis is the analysis software developed by AMTI for biomechanics applications. BioAnalysis currently has Gait, Balance and Power modules.

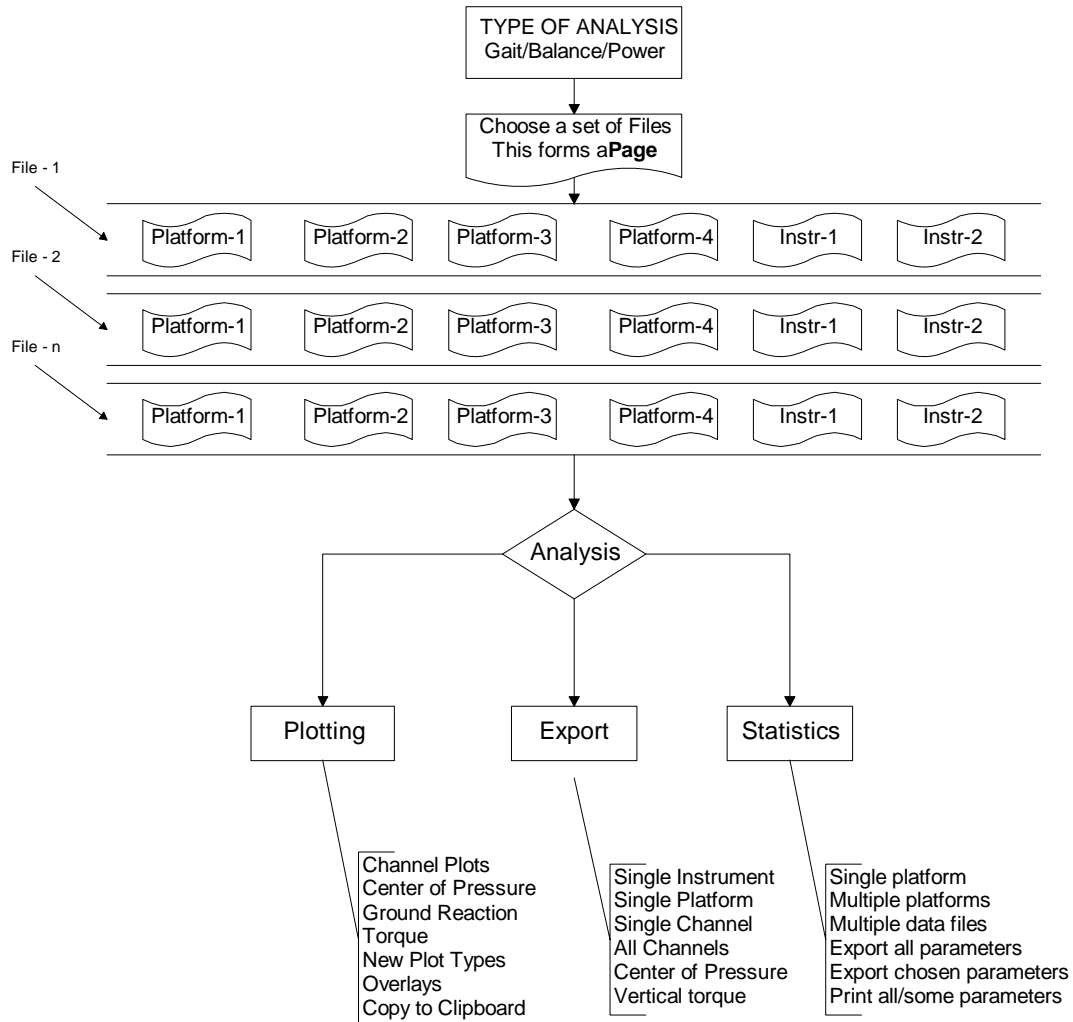
Each analysis module is designed and developed to provide you with an integrated, one stop solution, for your biomechanics analysis tasks. BioAnalysis comes with an extremely powerful and easy to use graphing tool set. You can now build fifteen fully customizable plots per page. Overlays are a click of a button away. You can also develop new types of plots and copy the plots to the windows clipboard.

BioAnalysis also comes with an exhaustive statistics module. Numerous parameters are computed on the data collected and tabulated for your research and study. The statistical parameters in each module are those most commonly used in the field of biomechanics for their particular application.

We, at AMTI, realize that it is impossible to address every type of research and study conducted in the field of biomechanics and sports. Our attempt, through this software, is to make your tasks easier. BioAnalysis therefore comes with numerous methods and techniques to export data, parameters, plots etc. For example, you may divide your data into platforms and instruments to export. You may also export a particular channel, or the center of pressure for a particular platform. You can even choose to export only selective statistical parameters. In addition, you can increase the power and utility of BioAnalysis by developing your own analysis routines, which can read your exported data.

BioAnalysis Schematic

A good way to learn software is by understanding the philosophy and organization behind it. BioAnalysis' organizational scheme is as follows :



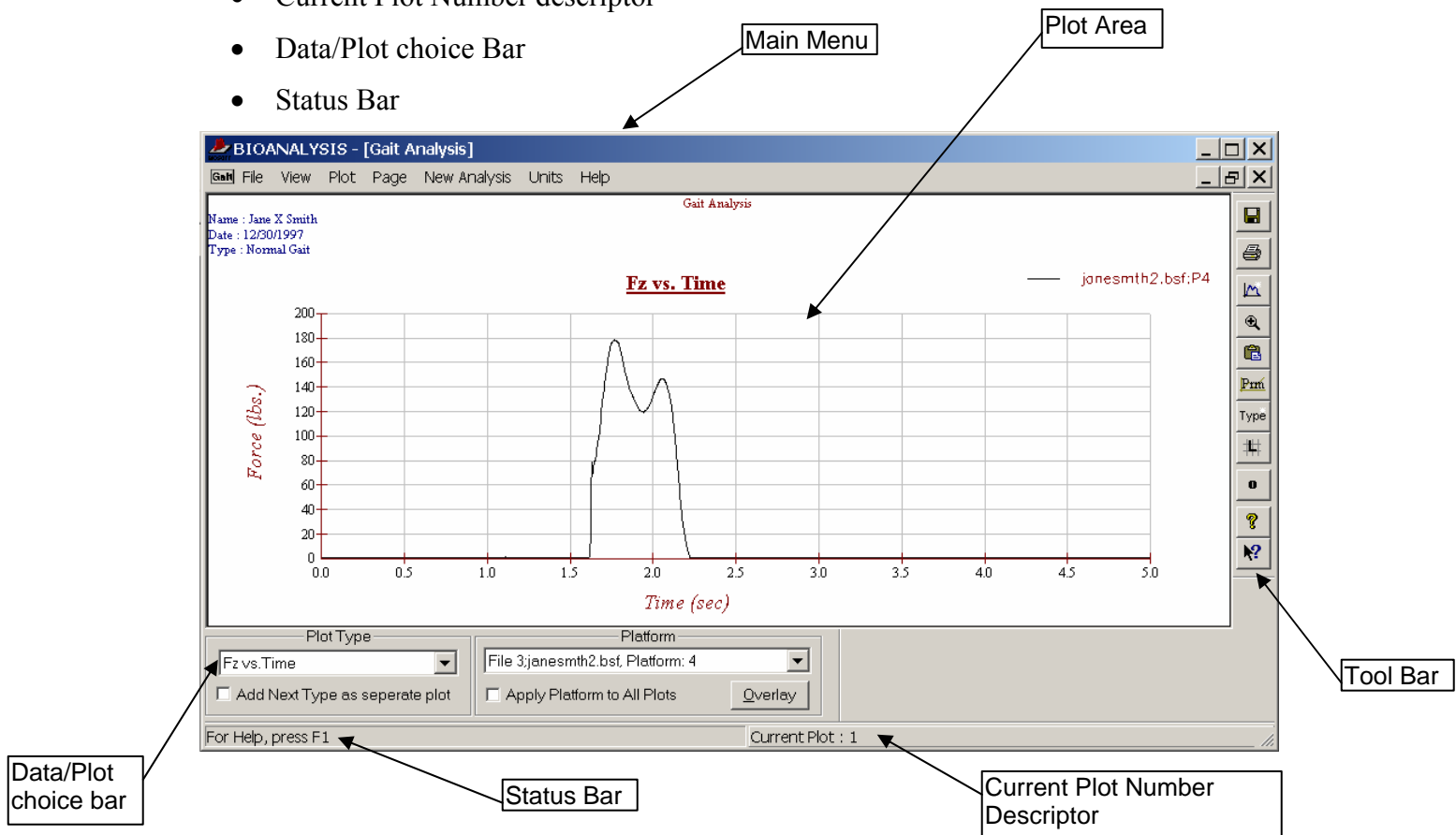
You should always think of your work in BioAnalysis as a **Page**. Every time you start a new type of analysis, you are in fact starting a new "page". Each page has multiple data files, and each data file can contain multiple instruments/platforms. For example, your files may represent different subjects within a page or study.

Once you choose the data files you would like to analyze, the application automatically parses the data files into platform and instrument data i.e. if you collected data using four platforms and saved them to a file "trial1.bsf", BioAnalysis parses them into four units : trial1>>Platform1, trial1>>Platform2, trial1>>Platform3, trial1>>Platform4. If you connected other instruments, they will also be separated into separate units.

BioAnalysis Layout

After you choose the files you want to analyze, you will start working in the analysis main screen. Your main screen is divided into five distinct areas.

- Main Menu
- Tool Bar
- Plot area
- Current Plot Number descriptor
- Data/Plot choice Bar
- Status Bar



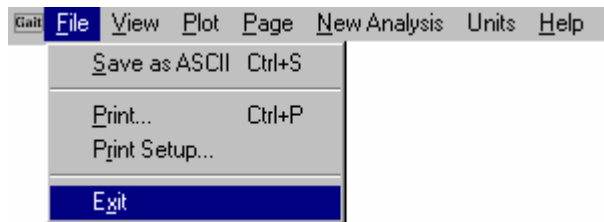
Analysis Main Menu Options

- File
- View
- Plot
- Page
- New Analysis
- Units
- Help

Menu Options

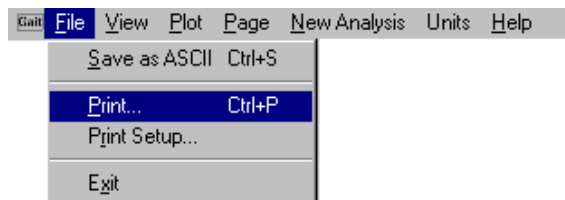
1.0 File

1.1 Exit Application



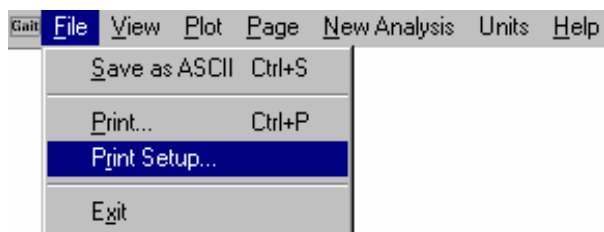
Exits the application, closing all the graph pages

1.2 Print Current Page



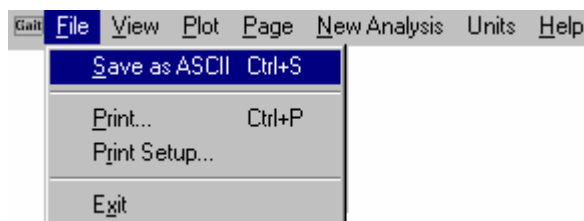
Sends the current page to a printer. You can define the printer to which you send your output to by clicking Print Setup.

1.3 Print Setup



Defines the printer for printing graphs in BioAnalysis.

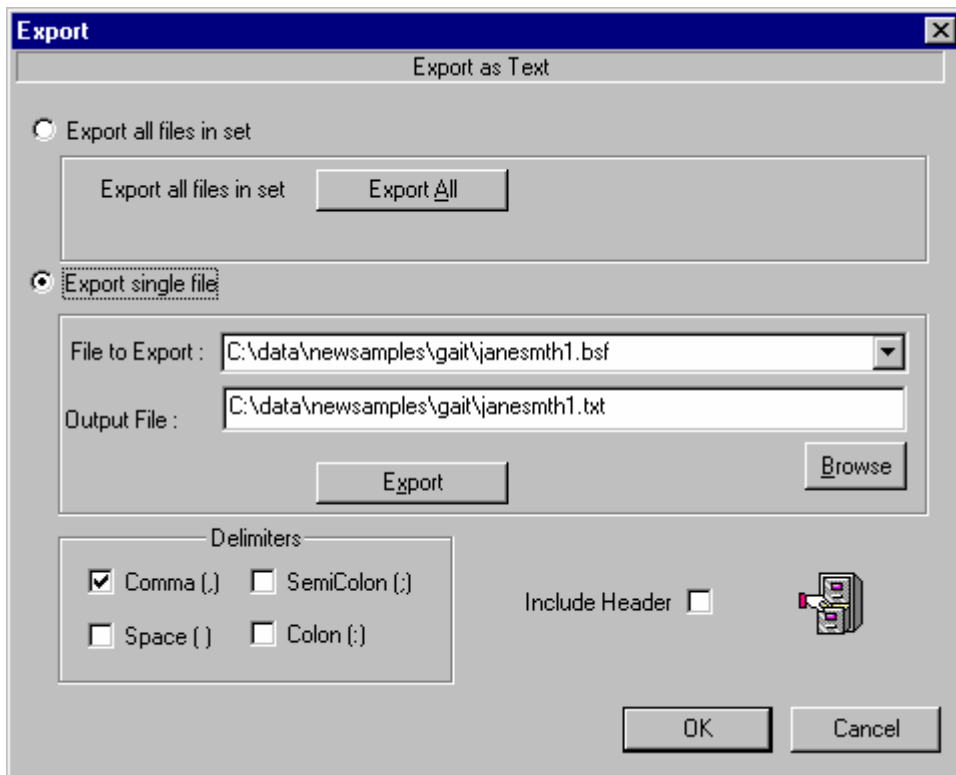
1.4 Save as ASCII



Allows you to export a binary file to a delimited text file. Choose whether or not to include the header.

1.4.1 To Export Files as Text:

To open the Export dialog box select File from the Main Menu. Then select “Save As ASCII” and the following dialog box will appear:

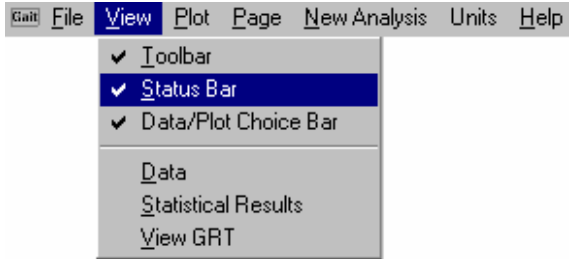


Export an individual file or all files as delimited text files:

1. Select to export a *single file* or *all files*. “Export all files” will convert all the files in the page to ASCII files. The file name will remain the same, but the extension will be changed to “txt.” When exporting a single file, you can define your own file names and extensions.
2. Select Delimiters by clicking the check box next to the delimiters of your choice. Delimiters are useful for dividing the exported data into columns for use in spreadsheet programs. The following delimiters can be inserted between columns of data:
 - Comma (,)
 - Semi - Colon (;)
 - Space ()
 - Colon (:)
3. Select *Header* if you want to include the header in the file you are exporting. The BioSoft binary file contains a header with hardware/trial information.

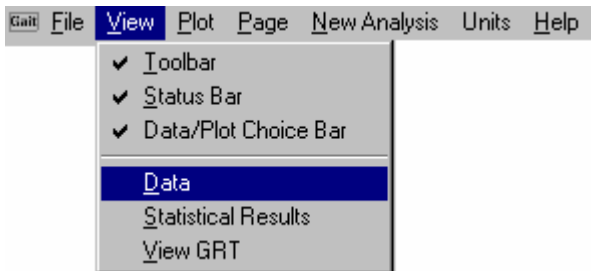
2.0 View

2.1 Status Bar



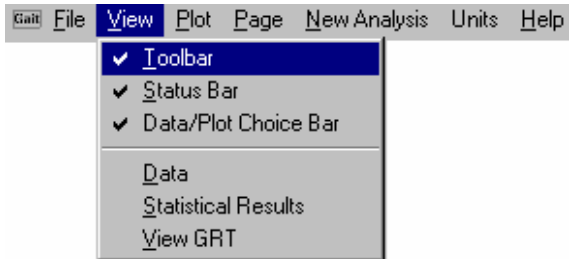
Hide/Show the status bar. The status bar, at the bottom of the graph window, shows you the parameters of the current plot.

2.2 Data

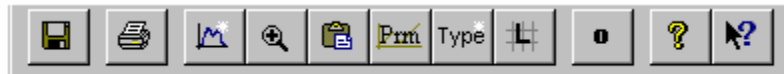


Clicking *Data* will bring up the raw data display window. Data is divided into platforms and instruments. From here, view the Center of Pressure or Channel data for the platforms, or export the data displayed.

2.3 ToolBar



Select *toolbar* to hide/show the tool bar.



In your main screen, the tool bar contains the most common utilities. It is good to get into the habit of using the buttons in the tool bar because they are faster than accessing them through the main menu. The most “common” tasks on the tool bar are as follows:

2.3.1 ToolBar Functions



Export complete file as ASCII



Print Page



New Plot Page



Zoom the current plot



Copy current page to windows clipboard



Parameters of the current plot (Background color, Titles, Fonts etc.)



Create a new type of plot



Redefine the layout of the plots in a page



Output the current plot data to a file (export a channel data)

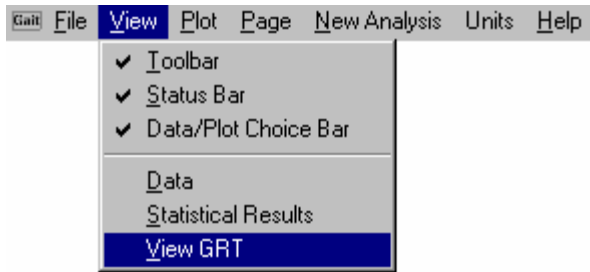


About BioAnalysis

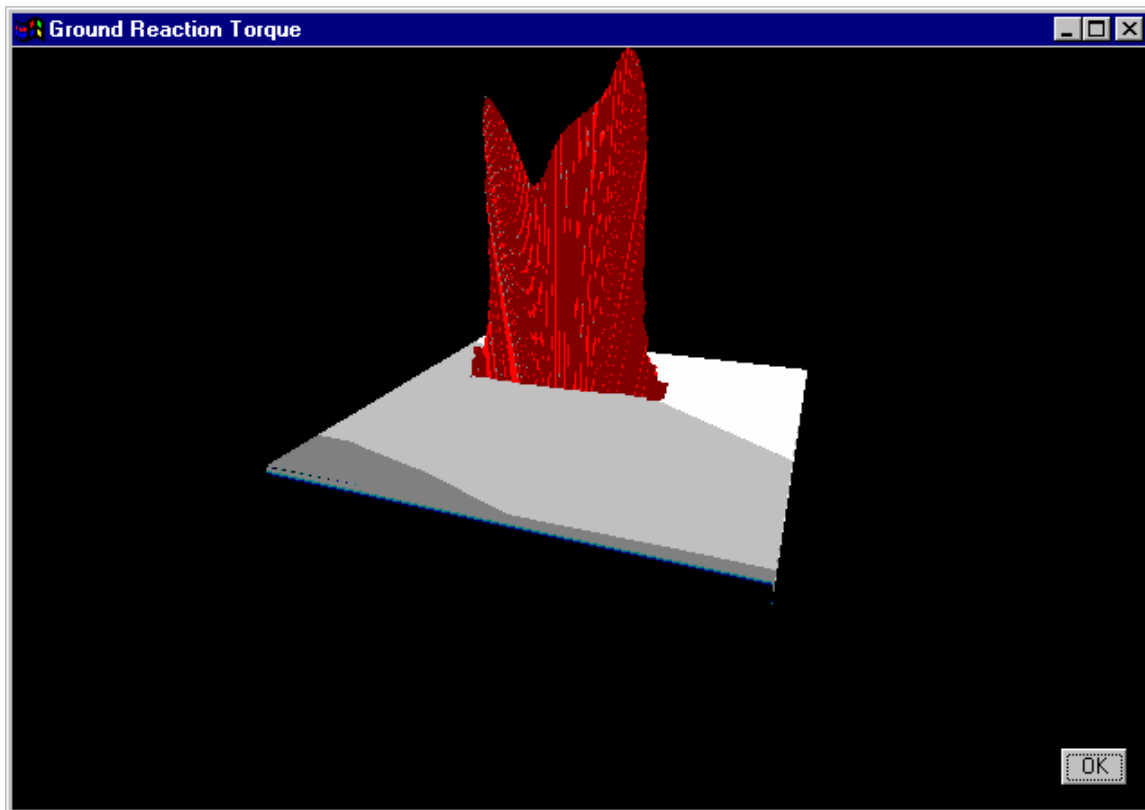


Help. First Click this, then click anything on the screen for help on it

2.4 GRT



You can view one platform's ground reaction torque in 3D. Clicking on this menu item brings up a window with controls for manipulating the image.



To optimize your screen to view the GRT, set your screen color depth to at least 16 bits:

1. Right click on any empty space on your Windows 95/98 desktop
2. Click Properties
3. Select the Settings Tab
4. Choose 16 bits (high color or true color for color depth)

2.4.1 Zoom, Rotate, Print GRT

BA11

- **Zoom in :**
Hold down the SHIFT key. Then, with the left mouse button down, move the cursor from BOTTOM to TOP.
- **Zoom out :**
Hold down the SHIFT key. Then, with the left mouse button down, move the cursor from TOP to BOTTOM.
- **Rotate about horizontal axis : (screen horizontal)**
Hold down the LEFT mouse button. Then, move the cursor from BOTTOM to TOP or TOP to BOTTOM for two directions of rotation about the horizontal axis.
- **Rotate about vertical axis : (screen vertical)**
Hold down the CONTROL key. Then, with the left mouse button down, move the cursor, LEFT to RIGHT or RIGHT to LEFT to rotate the image about the screen's vertical axis.

Printing GRT :

Unfortunately there is not a direct method for printing the GRT image. However, there is an indirect method:

- 1) Place the image in the desired orientation
- 2) Press ALT + PRINT SCREEN to copy the active window to clipboard
- 3) Start the Paint Program.
- 4) In Paint, choose EDIT, then PASTE from the menu.

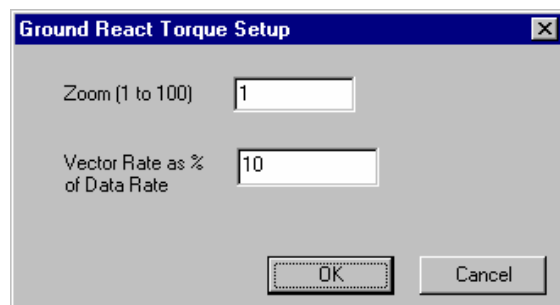
You now have a copy of the bitmap. You can also paste this image into any application that lets you paste a bitmap into it. You can print from Paint.

2.4.2 Configure GRT

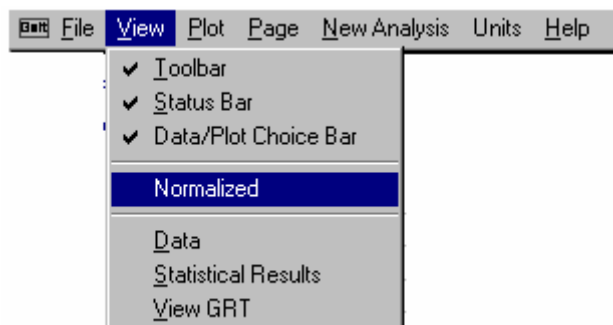
To configure the GRT image, double click anywhere on the screen.

Zoom: (1 to 100) acts like a multiplication factor for the vector length

Vector Rate: the number of vectors drawn on the screen. A rate of 100 implies that a vector is drawn for every data set, a rate of 50 implies that a vector is drawn for every other data set. The default is 50.



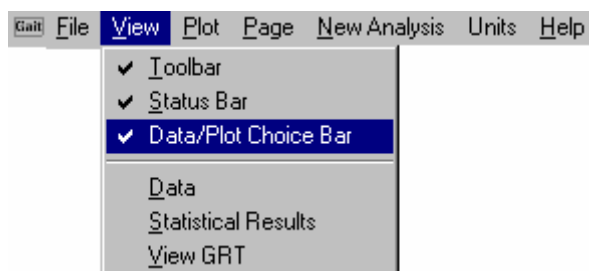
2.5 Normalized



If you are in the Gait analysis module the *Normalized* selection will be a choice on your view menu. Selecting this will allow you to view appropriate gait plots as foot contact time and normalized body weight. It will also cue the *Statistical Results* screen to create normalized statistics. The time between heel strike and toe off on a gait platform will be considered

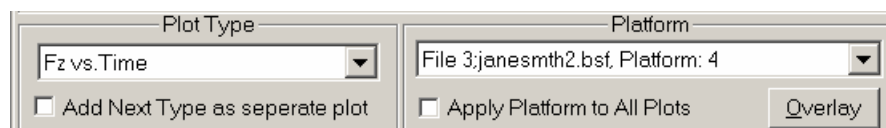
contact time. When appropriate all statistical outputs will be normalized to body weight and contact time.

2.6 Data/Plot Choice Bar



Hide/Show the Data/Plot Choice Bar.

Data/Plot Choice Bar:



The data/plot choice bar helps you add plots and data to your page. This tool bar contains most of the tools required for building your “Plot Page”. You can change the plot type, create overlays, change the data of a plot, create new plots etc.

2.6.1 Plot Types

BioAnalysis automatically graphs the various parameters in gait, balance, and power that are most often used in their respective fields. When you start the analysis module, *Fz vs. Time* for platform one is the default plot. The lower left side of the page has a list of all the plot types automatically calculated by BioAnalysis. For axis conventions, see “Platform Coordinate System” in Appendix A.

For gait analysis, the standard plots are:

- Fx vs. Time
- Fy vs. Time
- Fz vs. Time
- Mx vs. Time
- My vs. Time
- Mz vs. Time
- Center of Pressure
- Vertical Torque
- Fz Normalized
- Note: If *View, Normalized* is selected, the time axis of plots will be normalized between heel strike and toe-off (100% of the contact time).

For balance analysis, the graphs include:

- COP Avg. as Origin
- COP FP Coords
- Radius Vs. Time
- 95% Ellipse
- Time vs. Area
- FFT-COPX
- FFT-COPY
- Fx vs. Time
- Fy vs. Time
- Fz vs. Time

- Mx vs. Time
- My vs. Time
- Mz vs. Time

For power analysis, the standard plots are:

- Net Force
- Velocity
- Power
- Work

2.6.1.1 Gait Plots

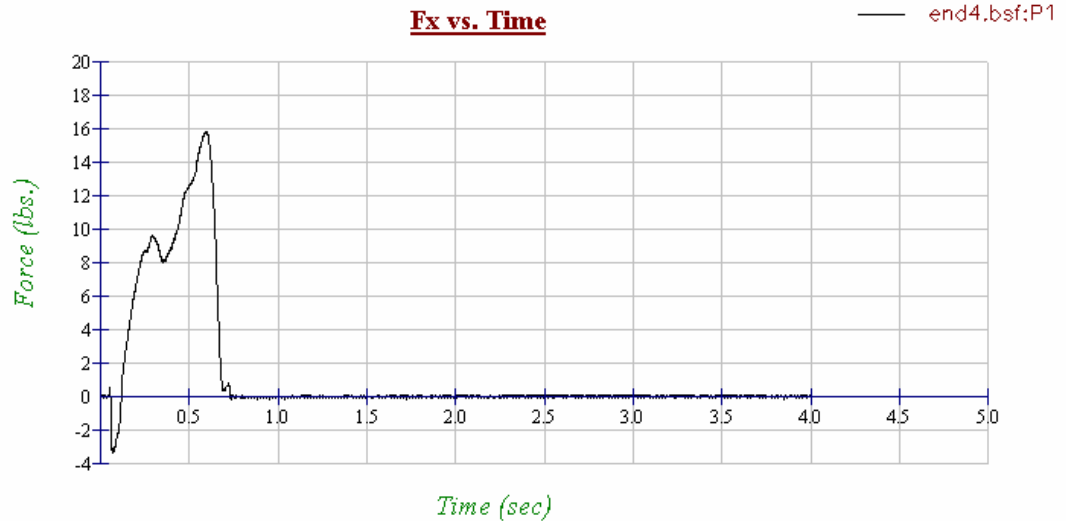
⇒ Fx vs. Time is a plot of the force along the x axis against time. For example:

Gait Analysis

Name : John M Doe

Date : 11/24/1997

Type : None



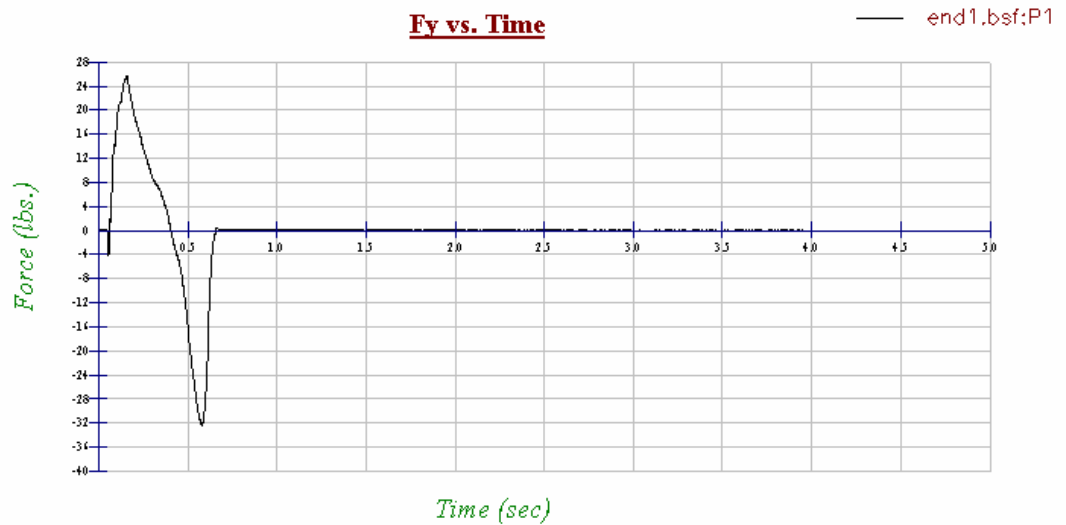
⇒ Fy vs. Time is a plot of the force along the y axis against time. For example:

Gait Analysis

Name : John M Doe

Date : 11/24/1997

Type : None



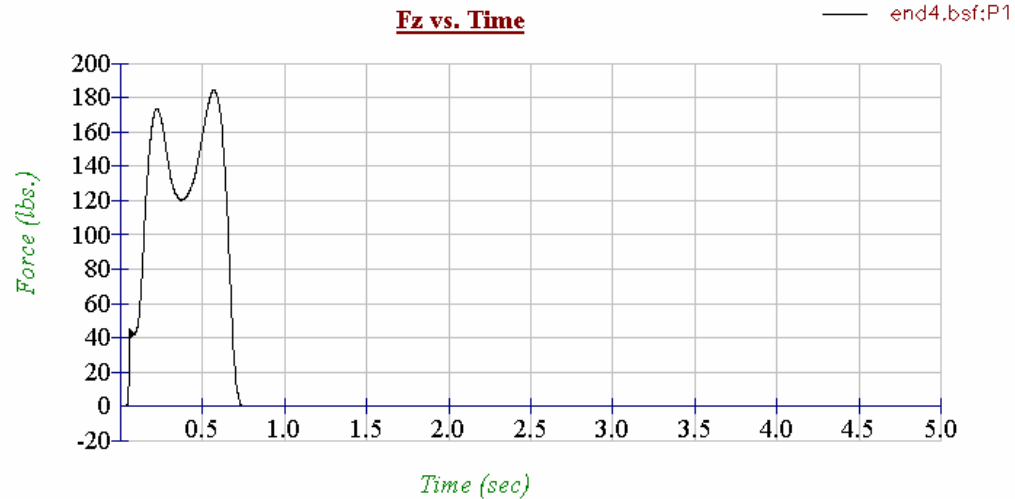
⇒ Fz vs. Time is a plot of the force along the z axis against time. For example:

Gait Analysis

Name : John M Doe

Date : 11/24/1997

Type : None



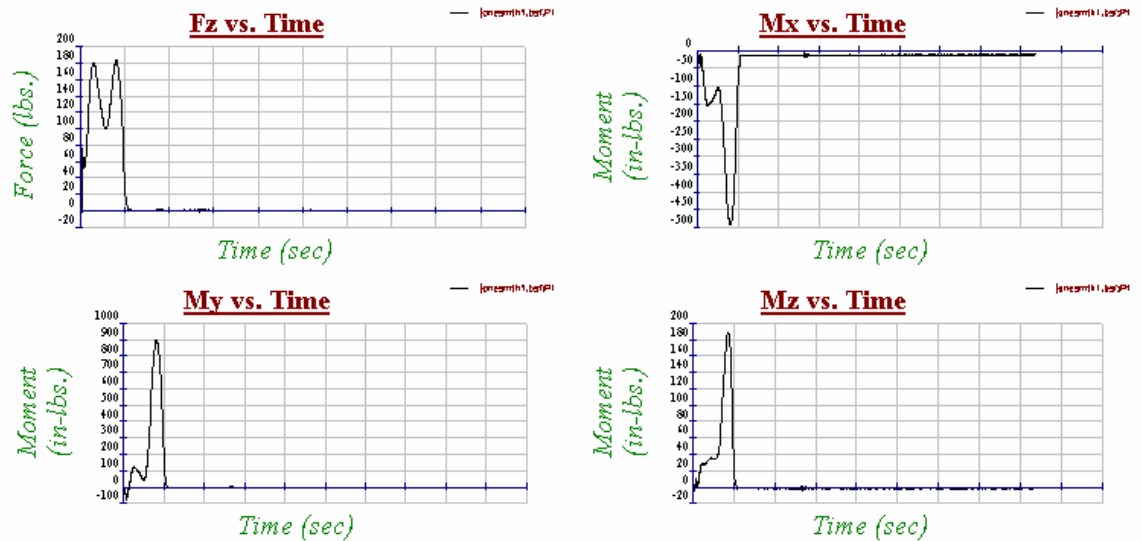
⇒ Mx Vs Time, My Vs. Time, and Mz Vs. Time are plots of the moment about the x, y, and z axes, respectively against time.

Gait Analysis

Name : Jane X Smith

Date : 12/30/1997

Type : Normal Gait



⇒ The Vertical Torque Vs. Time is a plot of the moment along the vertical axis along a period of time. This vertical torque takes into account the moment along the z axis (the output of channel 6), in addition to all forces (F_x , F_y) applied at distances (COP_x , COP_y) resulting in moments.

$$VerticalTorque = M_z + F_x * (COP_y) - F_y * (COP_x)$$

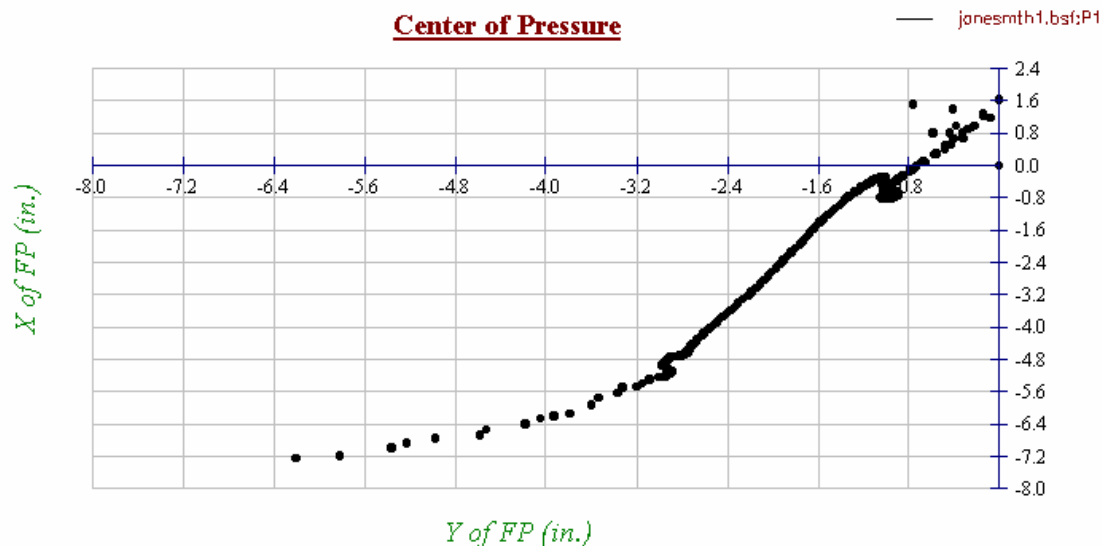
⇒ The *COP* graph represents the x coordinate plotted against the y coordinate of the center of pressure. (see balance plots for equations) An example of the center of pressure in gait is shown below:

Gait Analysis

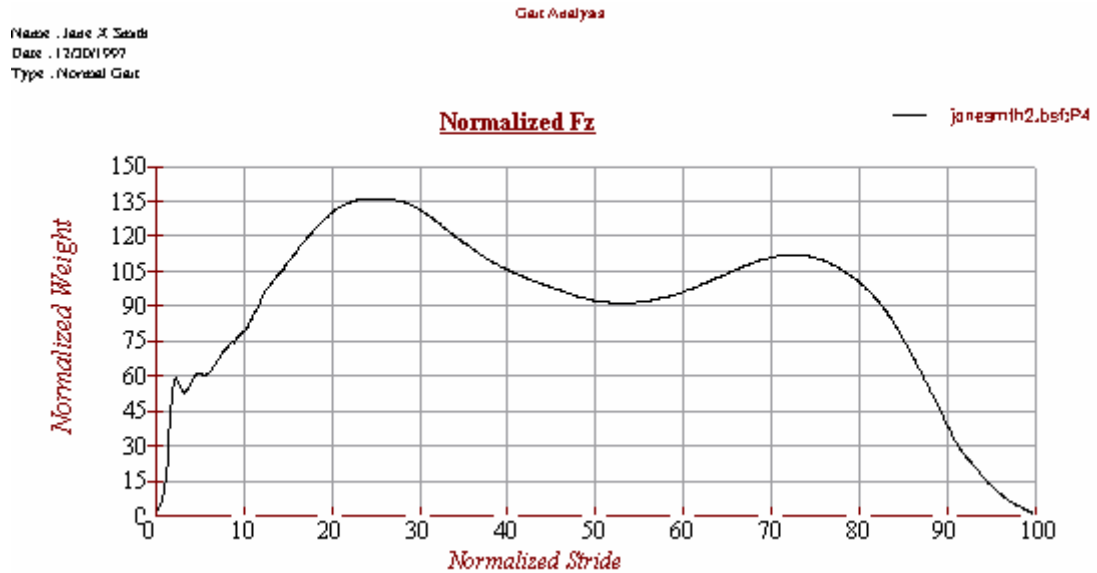
Name : Jane X Smith

Date : 12/30/1997

Type : Normal Gait

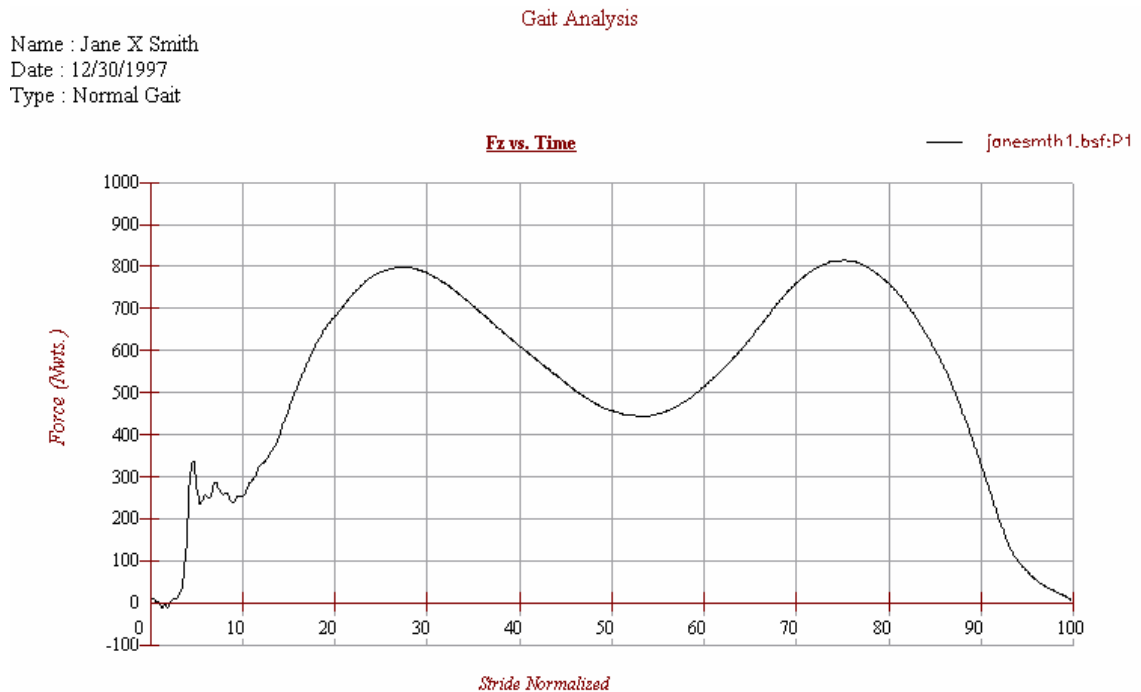


⇒ The Fz-Normalized Graph is both foot contact time, and body weight, normalized. Contact time is measured from heel strike to toe off, with toe-off representing 100 percent. The Fz force is normalized to body weight. For this plot to operate correctly, the subjects' body weight must have been entered in the Subject Setup section of Biodaq before acquisition was taken.



2.6.1.2 Normalized Gait Plots

⇒ If the *View Normalized* selection has been chosen the Fx, Fy, Fz, Mx, My, Mz, and Vertical Torque plots will appear stride normalized. The stride in this case is considered to be the time between heel strike to toe off with toe off representing 100 percent. Biosoft uses an auto mark feature to determine the toe off and heel strike coordinates. If your plots appear inaccurate consult section 3.1 "Zoom" of this manual to learn how to override BioSoft's coordinate selections with your own.



2.6.1.3 Balance Plots and COP Calculations

⇒ The *COP* graph represents the x coordinate plotted against the y coordinate of the center of pressure. *COP Avg. as Origin* is a plot of the center of pressure using the average coordinate (x, y) as the center of the plot. This differs from *COP FP Coords* because this plot shows the center of pressure as it appears on the force platform. In BioAnalysis, the center of pressure is calculated using:

$$COP(x) = \left[\frac{(My + (Z_{off} * Fx))}{Fz} \right] * (-1)$$

$$COP(y) = \left[\frac{(M_x - (Z_{off} * F_y))}{F_z} \right]$$

where:

$COP(x)$ = The x coordinate of the center of pressure

$COP(y)$ = The y coordinate of the center of pressure

Z_{off} = The vertical offset from the top plate to the origin of the force platform (a negative #)

F_x = The force along the x axis

F_y = The force along the y axis

F_z = The force along the z axis

M_x = The moment about the x axis

M_y = The moment about the y axis

M_z = The moment about the z axis

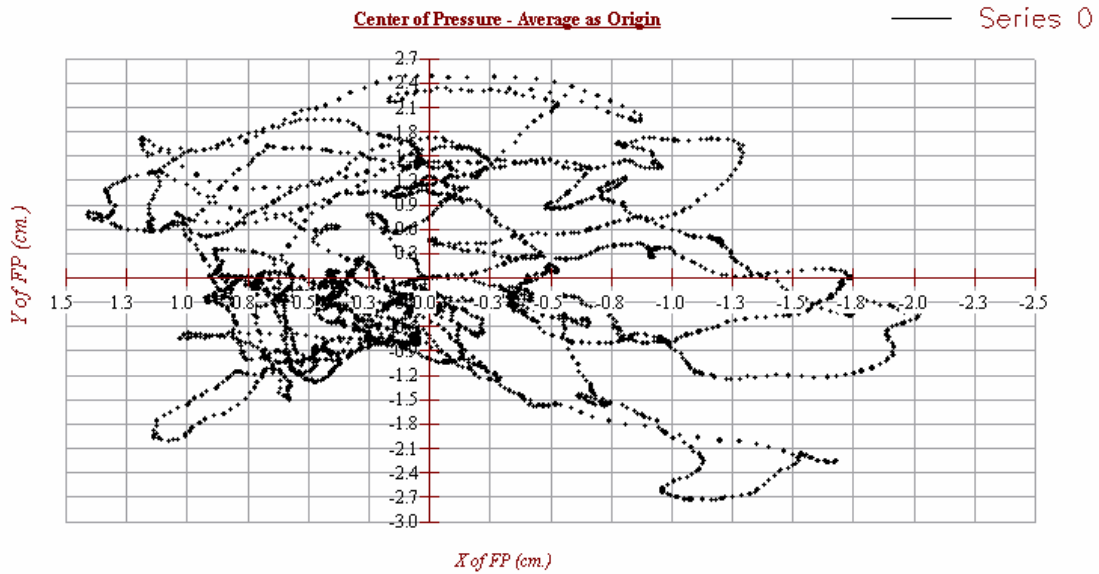
An example of a plot of the center of pressure is as follows:

Balance Analysis

Name : Jane X Smith

Date : 12/30/1997

Type : Feet apart, Eyes Closed



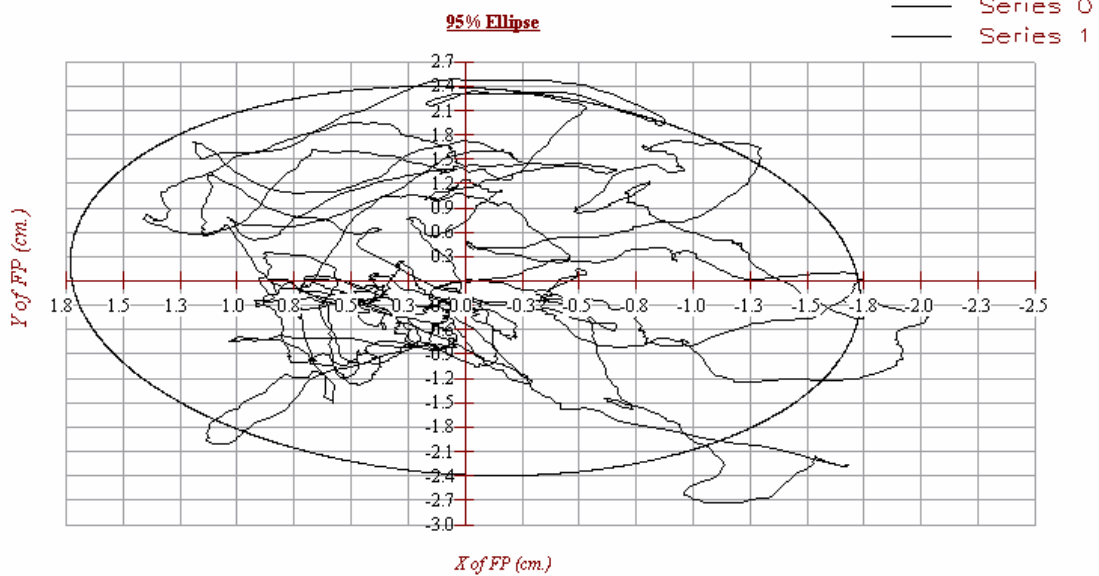
⇒ *95% Ellipse* is a plot showing an ellipse that encloses ninety five percent of the center of pressure data. See the appendix E for 95% Ellipse Calculations.

Balance Analysis

Name : Jane X Smith

Date : 12/30/1997

Type : Feet apart, Eyes Closed



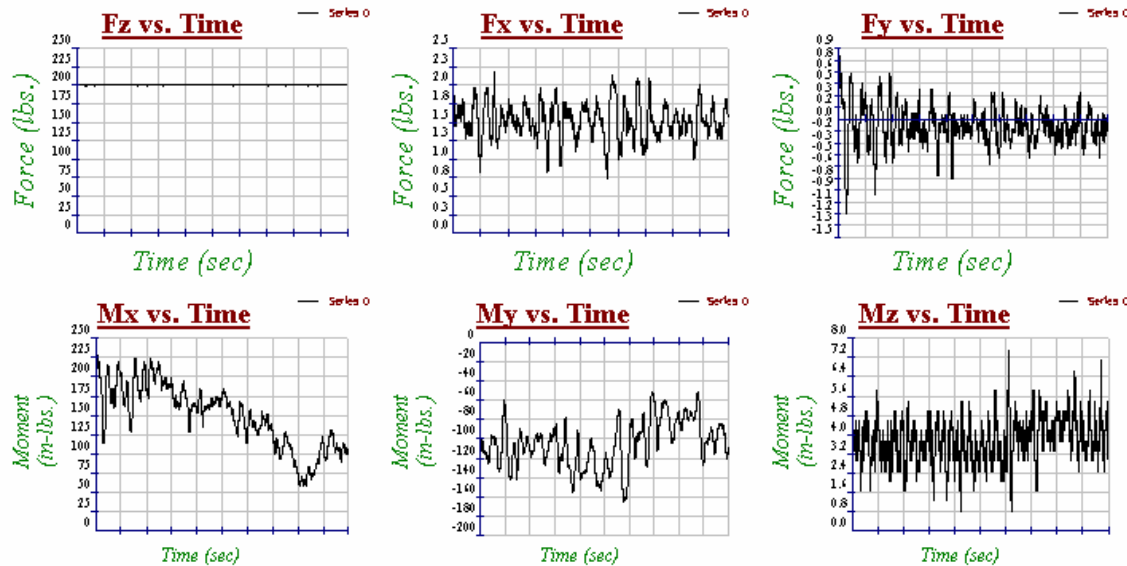
⇒ *F_x vs. Time*, *F_y vs. Time*, *F_z vs. Time*, are plots of a force, along the x, y, and z axes respectively, Versus time. For the axes conventions see Platform Coordinate System in the appendix. *M_x vs. Time*, *M_y vs. Time*, *M_z vs. Time* are plots of a moment, about the x, y, and z axes respectively, Versus time.

Balance Analysis

Name : Jane X Smith

Date : 12/30/1997

Type : Feet apart, Eyes Open



⇒ FFT-COPX is a plot of the Fast Fourier transform of the x coordinate of the center of pressure.

⇒ FFT-COPY is a plot of the Fast Fourier transform of the y coordinate of the center of pressure.

⇒ *Radius Vs. Time* is a plot of the radius against time where the radius is defined as the distance from the average center of pressure to the actual center of pressure.

$$Radius = \sqrt{(COP_x - COP_{avgx})^2 + (COP_y - COP_{avgy})^2}$$

where: COP_x= x coordinate of the center of pressure

COP_y= y coordinate of the center of pressure

COP_{avgx}= x coordinate of the average center of pressure

COP_{avgy}= y coordinate of the average center of pressure

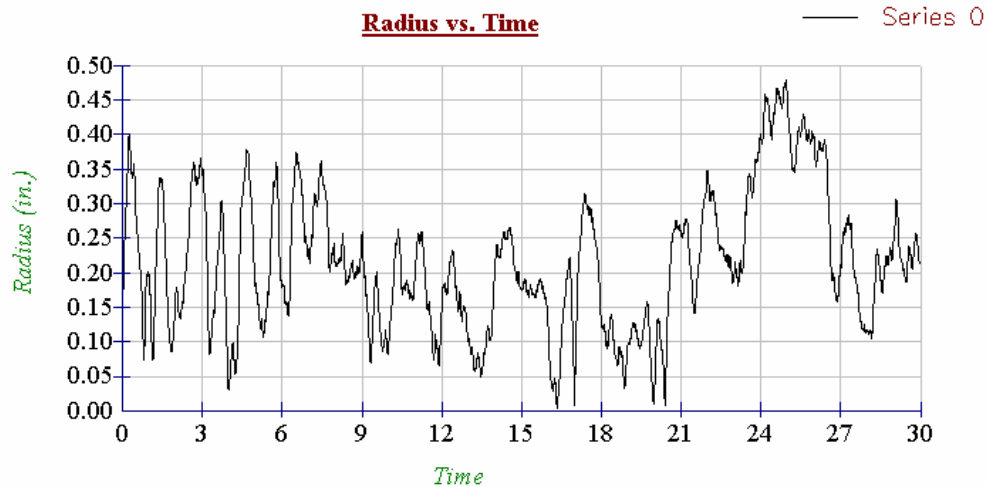
An example of a Radius Vs. Time Plot is as follows:

Balance Analysis

Name : Jane X Smith

Date : 12/30/1997

Type : Feet apart, Eyes Open



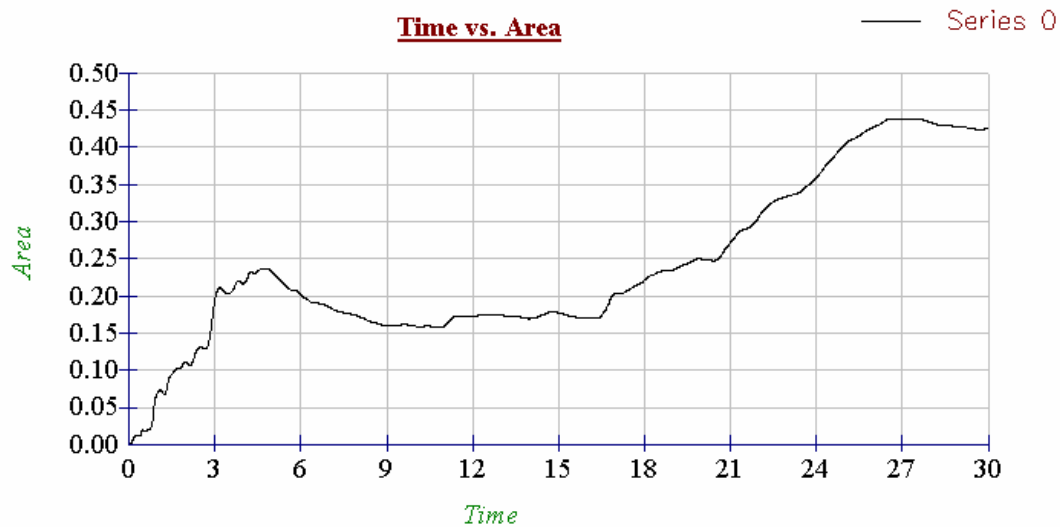
⇒ Area vs. Time is a plot of the area of the 95% confidence ellipse. From this plot, you can see whether or not the area of the 95% confidence ellipse changes.

Balance Analysis

Name : Jane X Smith

Date : 12/30/1997

Type : Feet apart, Eyes Open



2.6.1.4 Power Plots and Power Calculations

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The Power module uses the measurement of the vertical force (Fz) in addition to the subjects weight (including any objects they are holding) to determine the net force acting on the body. By applying Newton's second law (F=MA) the acceleration of the body is calculated using the vertical force (Fz) and body mass. Vertical velocity is subsequently determined by integrating the acceleration. From the vertical velocity, the software computes the power output and work functions.

Note: This model is **only for short duration** lifting actions. Do not analyze data streams longer than a few seconds... The vertical velocity calculation is a double integration that results in a cumulative error. For the first few seconds the error is negligible, however, over a long trail the error can accumulate resulting in large errors. See the example power plots in the software for more detail.

The equations used to calculate the net force, velocity, work, and power are:

$$NF_j = F_j - Wt$$

$$V_j = \sum_{i=1}^j \frac{NF_i}{Wt/g} * dT$$

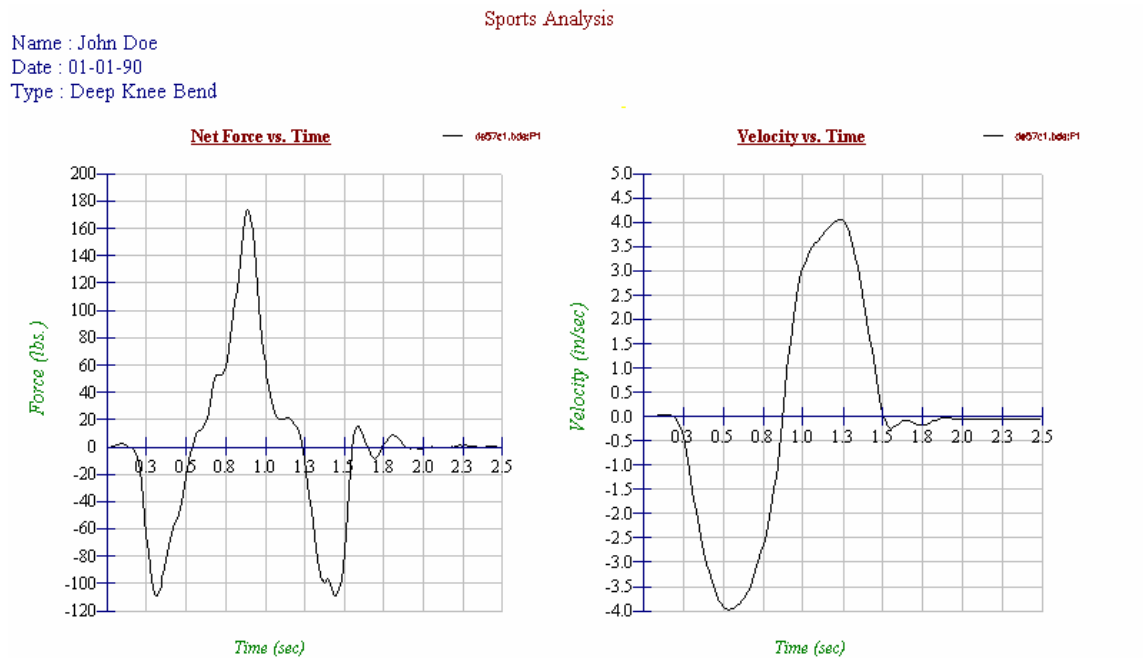
$$P_j = F_j * V_j$$

$$W_j = \sum_{i=1}^j P_i * dT$$

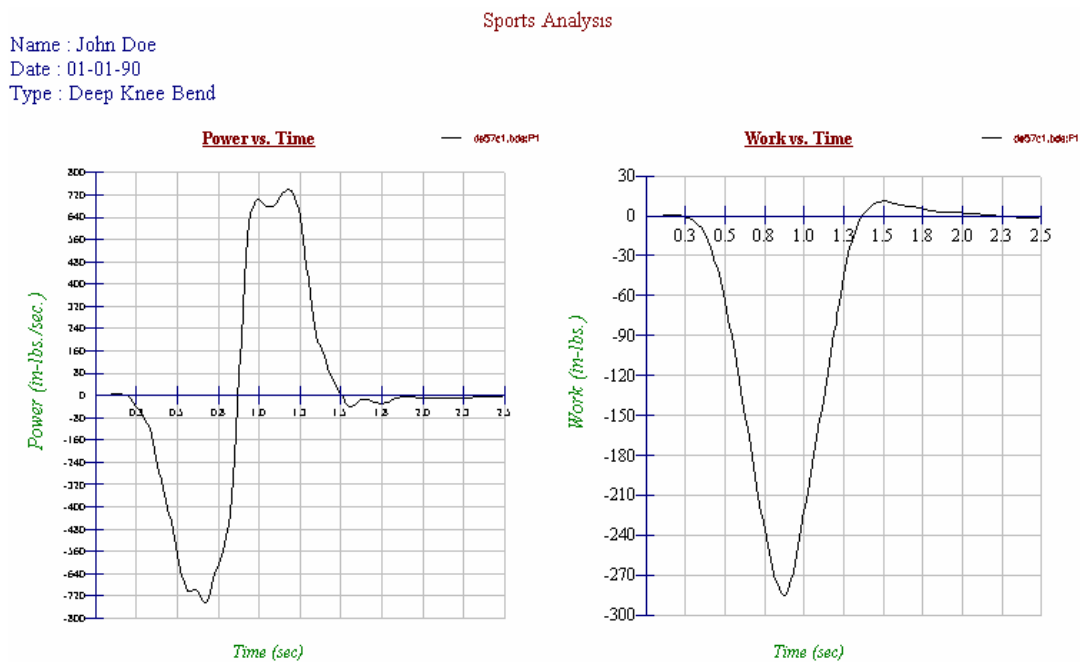
where:

- g = acceleration due to gravity;
- dT = sampling interval;
- Wt = weight of the subject (including items they carry);
- F_j = the jth Fz datum during the test;
- NF_j = net (unbalanced) force acting on the center of mass of the subject (including the items they carry) at the time of the jth datum;
- V_j = vertical velocity (positive upward) of the center of mass of the subject (including the items they carry) at the time of the jth datum;
- P_j = Power Associated with F_j;
- W_j = cumulative work done by Fz through the jth datum.

An example of net force and velocity plots are as follows:



An example of work and power plots are as follows:



2.6.2 Add a Plot

1. Enable *Add next type as separate plot*
2. Select the *plot type* for the new plot.
3. Click *Yes* when asked if you want a new plot.
At this point, a new plot will be added.

2.6.3 Change the Plot Type

1. Clear *Add next type as separate plot*.
2. Click on the plot you want to change.
3. Select a different plot type from the list on the lower left of the Data/Plot choice bar.

2.6.4 Change the Platform Number of a Plot

⇒ Single Plot:

1. Click on the plot you want to change
2. Select a different platform from the Data/Plot choice bar

⇒ All Plots:

1. Enable *Apply Platform to All Plots*.
2. Select a different platform from the Data/Plot choice bar.

2.6.5 Create an overlay of different platforms

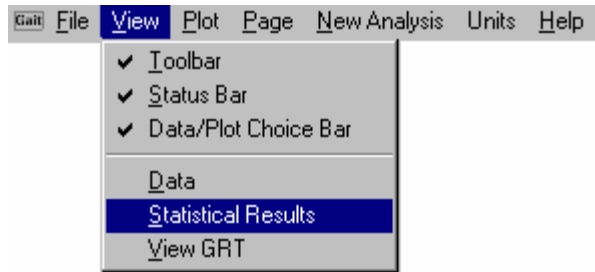
⇒ Single plot

1. Click on the plot you want to change
2. Click *Overlay* (You will be presented with a list of all platforms)
3. Select a platform to appear on your plot
4. Click *Add* (>>)
5. To remove an unwanted platform click *Remove* (<<)
6. Click OK

⇒ All Plots

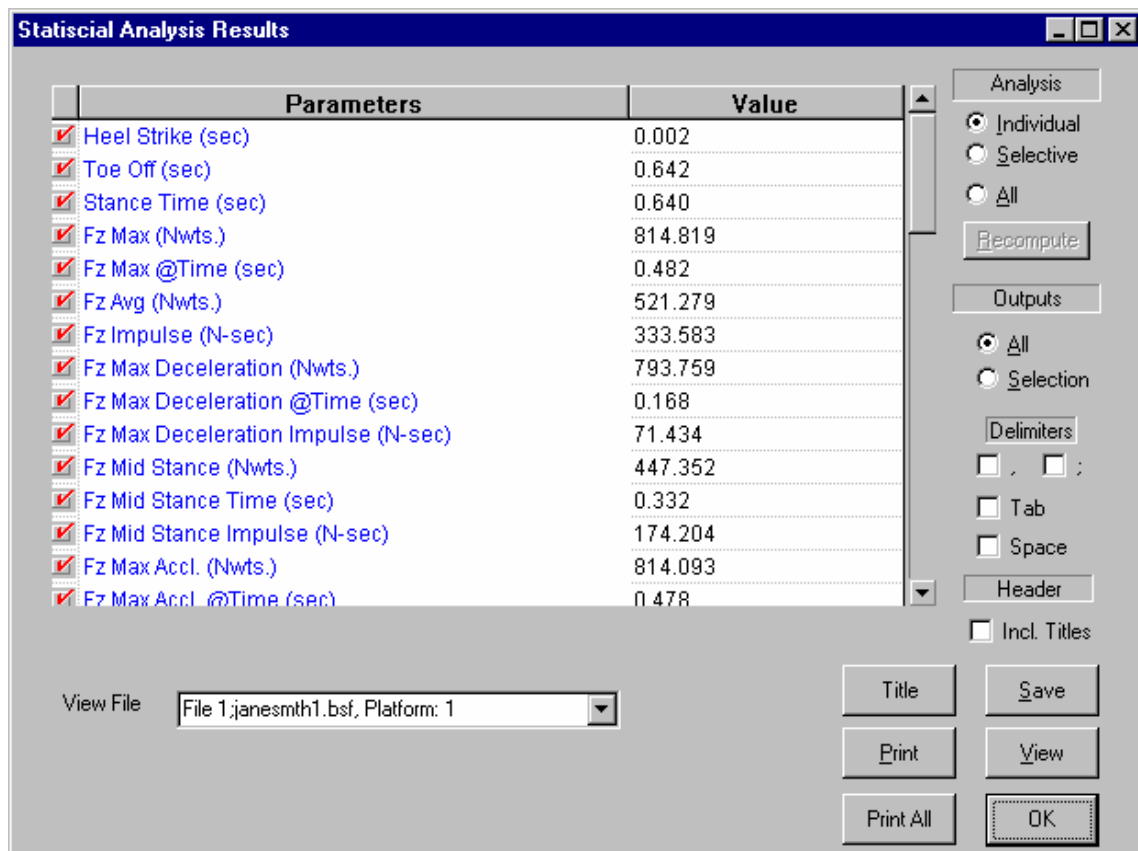
1. Enable *All plots*
2. Click *Overlay* (You will be presented with a list of all platforms)
3. Select a platform to appear on your plot
4. Click *Add* (>>)
5. To remove an unwanted platform click *Remove* (<<)
6. Repeat 3-4 until all the desired platforms are selected
7. Click *OK*

2.7 Statistical Results



Every analysis module in BioAnalysis comes with a statistical module. Clicking on *Statistical Results* brings up a window with different options for doing a statistical analysis on the data collected.

STATISTICAL ANALYSIS



BioAnalysis calculates the most common parameters for Gait, Balance and Power.

2.7.1 Statistics Units

The units of the statistical parameters are determined in the main screen of BioAnalysis.

Note: Before using statistical analysis, check to be certain that the different events marked in the zoom screen (e.g. Heel Strike, Mid Stance etc.) are correct.

2.7.2 Analysis Types

⇒ *Individual*

Choosing this option lets you do a statistical analysis on a single file and single platform. You can choose the file and platform from a list provided at the bottom of the screen (*View File*)

⇒ *Selective*

Choosing this option lets you do a statistical analysis on selected files and platforms:

- 1) Choose *Selective* Under Analysis
- 2) Enable the boxes next to the platforms you want to analyze (a checked box means it is enabled)
- 3) Click *Recompute* to evaluate.

The statistical results shown will now have four values : Min, Max, Avg. & SD

Min : The minimum value of the parameter of all the data units chosen for analysis

Max: The maximum value of the parameter of all the data units chosen for analysis

Avg.: The average value of the parameter of all the data units chosen for analysis

SD : Standard deviation of the parameter of all the data units chosen for analysis

⇒ *All*

Choosing this option lets you do a statistical analysis on all the data units present in the set:

- 1) Select *All* under Analysis
- 2) Click *Recompute* to evaluate.

The statistical results shown will now have four values : Min, Max, Avg. & SD.

Min : The minimum value of the parameter of all the data units chosen for analysis

Max: The maximum value of the parameter of all the data units chosen for analysis

Avg.: The average value of the parameter of all the data units chosen for analysis

SD: Standard deviation of the parameter of all the data units chosen for analysis

2.7.3 Definitions for BioSoft's Statistical Parameters During Gait

Note: The following definitions will alter slightly if *View, Normalized* has been selected. The time units, where appropriate, will be presented as percent stride. Fz, where appropriate, will be represented as percent bodyweight.

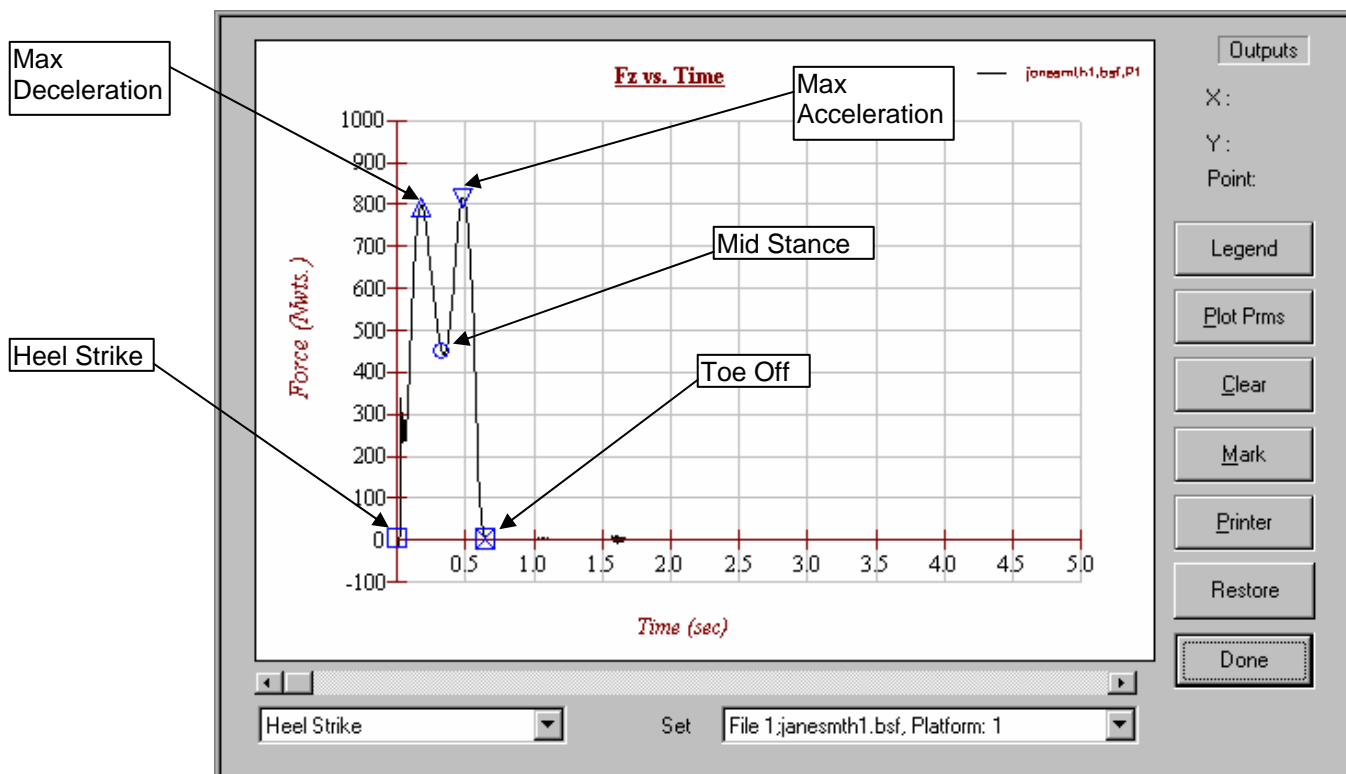
Gait Parameter	Definition
Heel Strike (HS) (sec)	Point in time when the heel hits the ground at the beginning of the stance phase.
Toe Off (TO) (sec)	Point in time when toe is lifted off the ground at the end of the stance phase, thus starting the swing phase.
Stance Time (sec)	Point in time between Heel Strike (HS) and toe off (TO) (i.e., time when foot is in contact with the ground).
Fz Max (lbs), (N)	Maximum Force Along the Vertical Axis.
Fz max @ Time (sec)	Time at which the maximum vertical Force occurs.
Fz Avg (lbs), (N)	Average force on the vertical axis.

Gait Parameter, cont.	Definition, cont.
Fz Impulse (t=0 to Fz max) (lb·sec), (N·sec)	$\int_0^{Fz \max} (Fz) dt$ The area under the Force (z-axis) Vs. Time curve from 0 to Fz maximum.
Fz Max Deceleration (MD) (lbs), (N)	The force corresponding to the maximum deceleration (MD) on the Force (z-axis) Vs time plot (see figure following this chart).
Fz Max Deceleration @ Time (sec)	The time at which the maximum deceleration (MD) on the Force (z-axis) Vs Time plot occurs.
Fz Max Deceleration Impulse (lb·sec), (N·sec)	$\int_0^{MD} (Fz) dt$ The area under the Force (z-axis) Vs. Time curve from 0 to the maximum deceleration.
Fz Mid Stance (lbs), (N)	The force corresponding to Mid Stance (MS) on the Fz Vs Time plot. (see figure following this chart).
Fz Mid Stance Time (sec)	The time at which Mid Stance (MS) on the Force (z-axis) Vs Time plot occurs (see figure following this chart).
Fz Mid Stance Impulse (lb·sec), (N·sec)	$\int_0^{MS} (Fz) dt$ The area under the Force (z-axis) Vs. Time curve from 0 to Mid Stance.
Fz Max Accl. (lbs), (N)	The force corresponding to the maximum acceleration (MA) on the Fz Vs Time plot (see figure following this chart).
Fz Max Accl. @ Time (sec)	The time at which the maximum acceleration (MA) on the Fz Vs Time plot occurs.
Gait Parameter, cont.	Definition, cont.

Fz Max Accl. Impulse (t=0 to Maximum Accl.) (lb·sec), (N·sec)	$\int_0^{MA} (Fz)dt$ The area under the Force (z-axis) Vs. Time curve from 0 to the maximum acceleration.
Fy Max. (lbs), (N)	The maximum force along the Y-axis.
Fy Max. @ Time (sec)	The time at which the maximum force along the Y-axis occurs.
Impulse: t=0, Tfymax (Fy maximum impulse) (t=0 to Fy maximum) (lb·sec), (N·sec)	$\int_0^{Fy\max} (Fy)dt$ The area under the Force (y-axis) Vs. Time curve from 0 to Fy maximum.
Fy Min.(lbs), (N)	The minimum force along the Y-axis.
Fy Min @ Time (sec)	The time at which the minimum force along the Y-axis occurs.
Impulse: t-0, Tfymin (Fy Minimum Impulse) (t=0 to Fy minimum) (lb·sec), (N·sec)	$\int_0^{Fy\min} (Fy)dt$ The area under the Force (y-axis) Vs. Time curve from 0 to Fy minimum.
Fy Avg (lbs), (N)	The average force along the Y-axis.
Fx Maximum (lbs), (N)	The maximum force along the X-axis.
Fx Maximum @ Time (sec)	The time at which the maximum force along the X-axis occurs.
Impulse: t=0, Tfxmax (Fx Maximum Impulse) (t=0 to Fx maximum) (lb·sec), (N·sec)	$\int_0^{Fx\max} (Fx)dt$ The area under the Force (x-axis) Vs. Time curve from 0 to Fx maximum.
Fx Min (lbs), (N)	The minimum force along the X-axis.
Gait Parameter, cont.	Definition, cont.

Fx Min @ Time (sec)	The time at which the minimum force along the X-axis occurs.
Impulse: t=0, Tfxmin (Fx Minimum Impulse) (t=0 to Fx minimum) (lb·sec), (N·sec)	$\int_0^{F_{x\min}} (Fx) dt$ The area under the Force (x-axis) Vs. Time curve from 0 to Fx minimum.
Fx Avg (lbs), (N)	The average force along the X-axis.
Torque Max (in·lb.), (N·cm)	The maximum vertical torque.
Torque Max @ Time (sec)	The time of the maximum vertical torque.
Torque Min (in·lb), (N·cm)	The minimum vertical torque.
Torque Min @ Time (sec)	The time at which the minimum vertical torque occurs.
Torque Avg (in·lb), (N·cm)	The average vertical torque.
COP: Heel Strike X (in), (cm)	The X coordinate of the COP at Heel Strike.
COP: Heel Strike Y (in), (cm)	The Y coordinate of the COP at Heel Strike.
COP: Toe Off X (in), (cm)	The X coordinate of the COP at Toe Off.
COP: Toe Off Y (in), (cm)	The Y coordinate of the COP at Toe Off.
COP: Min Along Y-Axis X (in), (cm)	The X coordinate of the COP at the minimum point along the Y-Axis.
COP: Min Along Y-Axis Y (in), (cm)	The Y coordinate of the COP at the minimum point along the Y-Axis.
COP: Max Along Y-Axis X (in), (cm)	The X coordinate of the COP at the maximum point along the Y-Axis.
COP: Max Along Y-Axis Y (in), (cm)	The Y coordinate of the COP at the maximum point along the Y-Axis.
COP: Excursion Along Y-Axis (in), (cm)	The COP's total distance traveled in the Y direction.
COP: Min Along X-Axis X (in), (cm)	The X coordinate of the COP at the minimum point along the X-Axis.
COP: Min Along X-Axis Y (in), (cm)	The Y coordinate of the COP at the minimum point along the X-Axis.
Gait Parameter, cont.	Definition, cont.
COP: Max Along X-Axis X (in),(cm)	The X coordinate of the COP at the maximum

	point along the X-Axis.
COP: Max Along X-Axis Y (in),(cm)	The Y coordinate of the COP at the maximum point along the X-Axis.
COP: Excursion Along X-Axis (in),(cm)	The COP's total distance traveled in the X direction.
COP: Avg X (in), (cm)	The COP's average distance in the X direction.
COP: Avg Y (in), (cm)	The COP's average distance in the Y direction.
COP: Length (in), (cm)	The length of the total distance traveled by the COP.
COP: Max Velocity (in/sec), (cm/sec)	The maximum velocity traveled by the COP.
COP: Avg Velocity (in/sec), (cm/sec)	The average velocity traveled by the COP.



2.7.4 Definitions for BioSoft's Statistical Parameters During Balance

Balance Parameter	Definition
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BA35

COP-X Avg (in), (cm)	<ul style="list-style-type: none"> The average position of the x coordinate of the center of pressure. The displacement along the x axis (x) is calculated for each frame. These numbers are added together and then divided by the total number of frames (N). $AVG_x = \frac{\sum_{i=1}^N x_i}{N}$
COP-Y Avg (in), (cm)	<ul style="list-style-type: none"> The average position of the y coordinate of the center of pressure. The displacement along the y axis (y) is calculated for each frame. These numbers are added together and then divided by the total number of frames (N). $AVG_y = \frac{\sum_{i=1}^N y_i}{N}$
COP-X Max (in), (cm)	The maximum coordinate of the COP along the x-axis.
COP-X Min (in), (cm)	The minimum coordinate of the COP along the x-axis.
COP-Y Max (in), (cm)	The maximum coordinate of the COP along the y-axis.
COP-Y Min (in), (cm)	The minimum coordinate of the COP along the y-axis.
Balance Parameter, cont.	Definition, cont.
Standard Deviation- X COP	The standard deviation of the COP along the x-axis.

	$SDx = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - AVGx)^2}$
Standard Deviation- Y COP	<p>The standard deviation of the COP along the y-axis.</p> $SDy = \sqrt{\frac{1}{N} \sum_{i=1}^N (y_i - AVGy)^2}$
Avg. Displacement along X (in), (cm)	<p>Average displacement of the x coordinate of the COP.</p> $DISPavgx = \frac{\sum_{i=1}^N x_i - AVG_x }{N}$
Avg. Displacement along Y (in), (cm)	<p>Average displacement of the y coordinate of the COP.</p> $DISPavgy = \frac{\sum_{i=1}^N y_i - AVG_y }{N}$
Avg. Radial Displacement (in), (cm)	<p>The radial displacement (r_i) is calculated for each frame. These numbers are added together and then divided by the total number (N) of frames.</p> $RDavg = \frac{\sum_{i=1}^N r_i}{N} \text{ where: } r_i = \sqrt{x_i^2 + y_i^2}$
Standard Deviation - Radial Disp.	<p>The standard deviation of the radial displacement of the COP.</p> $SDrad = \sqrt{\frac{1}{N} \sum_{i=1}^N (r_i - RDavg)^2}$ <p>where: $r_i = \sqrt{x_i^2 + y_i^2}$</p>
Balance Parameter, cont.	Definition, cont.
Correlation Coefficient	The correlation coefficient of X and Y.

	$C_c = \frac{\text{cov}(x, y)}{SD_x * SD_y} = \frac{\frac{1}{N} \sum_{i=1}^N x_i * y_i}{SD_x * SD_y}$
95% Ellipse Slope	
SD- Major Axis of 95% Ellipse	Standard Deviation along the major axis.
SD- Minor Axis of 95% Ellipse	Standard Deviation along the minor axis.
95% Ellipse Area (in ²), (cm ²)	<p>Area of the 95% confidence ellipse.</p> <p>95% of the data lies within the area of this ellipse.</p>
Avg Velocity (in/sec), (cm/sec)	<p>The total length of the COP's path (L) is calculated. This number is then divided by the total number of frames (n) and the total change in time (Δt). $V_{avg} = \frac{L}{n * \Delta t}$</p>
Length (in), (cm)	<p>Total length (L) of the COP's path.</p> $L = \sum_{i=2}^n \sqrt{(x_i - x_{i-1})^2 + (y_i - y_{i-1})^2}$

2.7.5 Definitions for BioSoft's Statistical Parameters for Power

Note: The equations for the net force, velocity, work, and power are located on BA21.

Power Parameter	Definition
Max. Net-Force (lbs), (N)	Maximum value of the net force
Time @ Max. Net-Force (sec)	Time at which the maximum net force occurs
Min. Net-Force (lbs), (N)	Minimum value of the net force
Time @ Min. Net-Force (sec)	Time at which the minimum net force occurs
Max. Velocity (in/sec), (cm/sec)	Maximum value of the velocity
Time @ Max. Velocity (sec)	Time at which the maximum velocity occurs
Min. Velocity (in/sec), (cm/sec)	Minimum value of the velocity
Time @ Min. Velocity (sec)	Time at which the minimum velocity occurs
Max. Work (in-lb), (Nm)	Maximum value of work
Time @ Max. Work (sec)	Time at which the maximum work occurs
Min. Work (in-lb), (Nm)	Minimum value of work
Time @ Min. Work (sec)	Time at which the minimum work occurs
Max Power (in-lb/sec), (Nm/sec)	Maximum value of power
Time @ Max Power (sec)	Time at which the maximum power occurs
Min Power (in-lb/sec), (Nm/sec)	Minimum value of power
Time @ Min Power (sec)	Time at which the minimum power occurs

2.7.6 Outputs:

- ⇒ This allows you to output to a file or a printer.
- ⇒ All : Choose to export/print all the statistical parameters
- ⇒ Selection : Choose only a selected few statistical parameters to export/print

Delimiters

When exporting statistics to a text file, a delimiter (space, comma, colon, tab, etc.) is a tool used to separate columns of data.

Header

You can choose whether or not to include the titles of the columns of data. This way, BioAnalysis lets you append values to a previous statistical file.

If you are starting a new statistical file you probably want to export the column names. Every other time you add data to the file you do not have to use a header. This way you can build a statistical file across data sets.

BioAnalysis does not check to verify if the data chosen to be appended to an existing statistical file makes sense or not. This responsibility is left to the user (see Plot Zoom).

The order of exported columns is always preserved. Therefore enabling/choosing the same parameters for export will preserve the column numbers.

Print

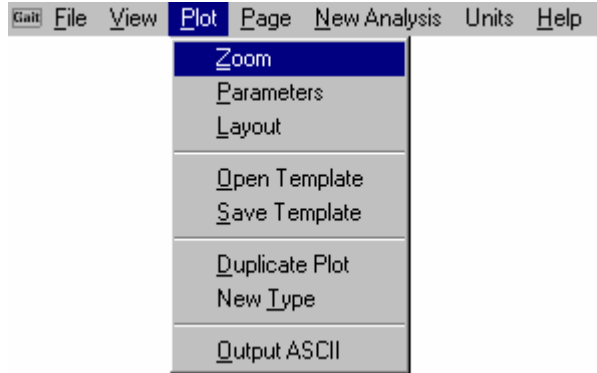
Prints the currently displayed parameters and values to a printer. If you have chosen “Selection” in Outputs, only the selected parameters are printed. If All has been chosen then all the parameters of all the files loaded are printed.

Title

Allows you to make a custom title for your printed report.

3.0 Plot

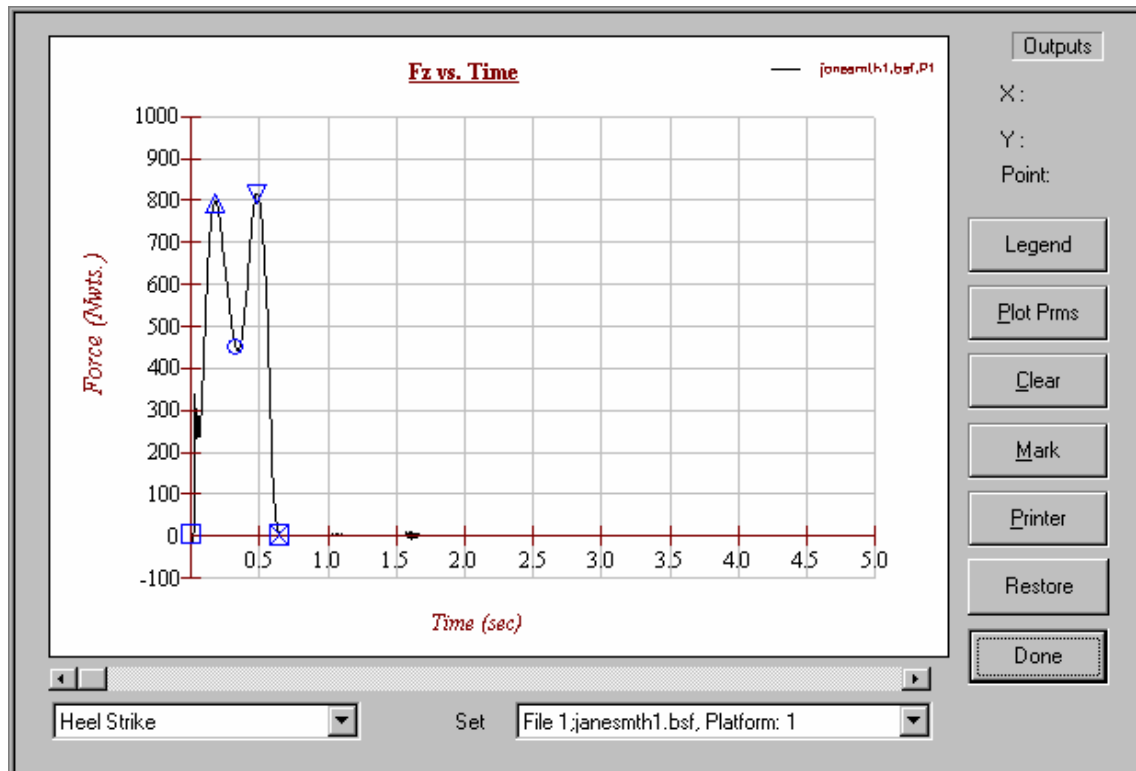
3.1 Zoom



Clicking this option lets you zoom into the current plot:

- 1) Click on the plot you would like. A rectangle should enclose the plot of choice
- 2) Click *Plot, Zoom*. The zoom window differs in form and function according to the type of plot you are zooming in on.

Zoom Plot Screen



The zoom screen allows you to enlarge a particular plot, mark events, and identify the coordinates of events.

Balance Analysis- The zoom screen balance analysis lets you look at specific x and y coordinates. There is a scroll bar, located below the graphing area, which controls a cross-hair for identifying the (x, y) coordinates of each point on a plot. Hold down the left mouse button on the scroll bar and drag it left or right to travel along the plot. You can see the x and y values on the right hand of the screen.

Gait Analysis with *View, Normalized* On - The zoom screen only allows you to view the plot. For other functionality you must turn *View, Normalized* off.

Gait Analysis with *View, Normalized* Off - The zoom plot screen depicted above is for the *Fz vs. Time* gait plot with *View, Normalized* turned off. This particular zoom screen allows you to mark events critical to calculating Gait Analysis's *Statistical Results* (See section 3.1.1 below for instructions). The events are heel strike (HS), maximum deceleration (MD), Mid Stance (MS), maximum acceleration (MA), and toe off (TO). This zoom screen also lets you determine specific x and y coordinates. If the zoom plot is not *Fz vs. Time* but some other gait plot such as *Fx vs. Time* etc. you will not be able to mark events.

3.1.1 Marking Events with the Cross hair

If using the *Fz vs. Time* plot in Gait Analysis you will be able to mark events with the cross hair. The scroll bar, located below the graphing area, controls a cross-hair for identifying the (x, y) coordinates of each point on the plot. Hold down the left mouse button on the scroll bar and drag it left or right to travel along the plot. You can see the x and y values on the right hand of the screen.

⇒ The events you will want to mark are :

- Heel Strike (HS)
- Maximum Deceleration (MD)
- Mid Stance (MS)
- Maximum Acceleration (MA)
- Toe Off (TO)

Note: BioAnalysis will have already located these events on your plot. In some cases, (i.e. if the channel is noisy) the events may not be marked properly. It is necessary to **check the event labels, and make any appropriate changes** because the Statistical analysis uses these values in preparing the summary.

⇒ To remove the previously marked events and mark new points:

1. Click *Clear*
2. Look at the bottom left of the screen for the list of events the software is looking for. The current event is shown.
3. Move the cross hair to the point which represents the event

4. Right click the plot area or click the *Mark* button. You will see a symbol corresponding to the event you have chosen.

<input type="checkbox"/>	Heel Strike
<input type="triangle-up"/>	Max Deceleration
<input type="radio"/>	Mid Stance
<input type="triangle-down"/>	Max Acceleration
<input checked="" type="checkbox"/>	Toe Off

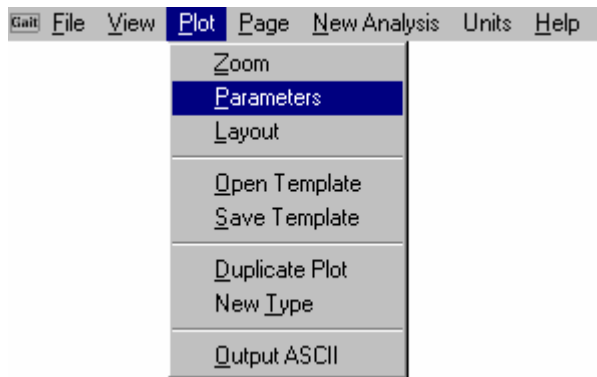
5. Repeat Steps 2-4 until you have marked all the points.
6. Click *Done*

⇒ To Print: Click *Printer*

⇒ To Add/Remove the legend: click on the button labeled legend.

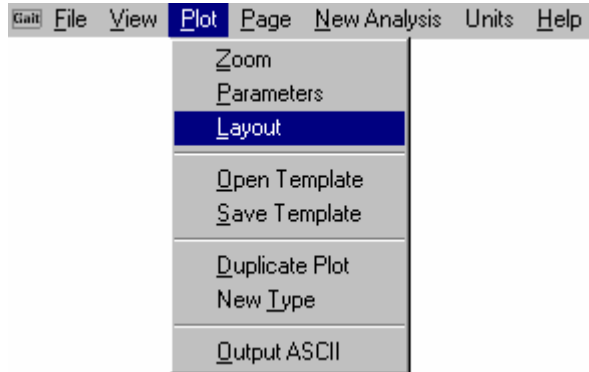
⇒ *Restore* Restores the markings to their original state.

3.2 Plot Parameters



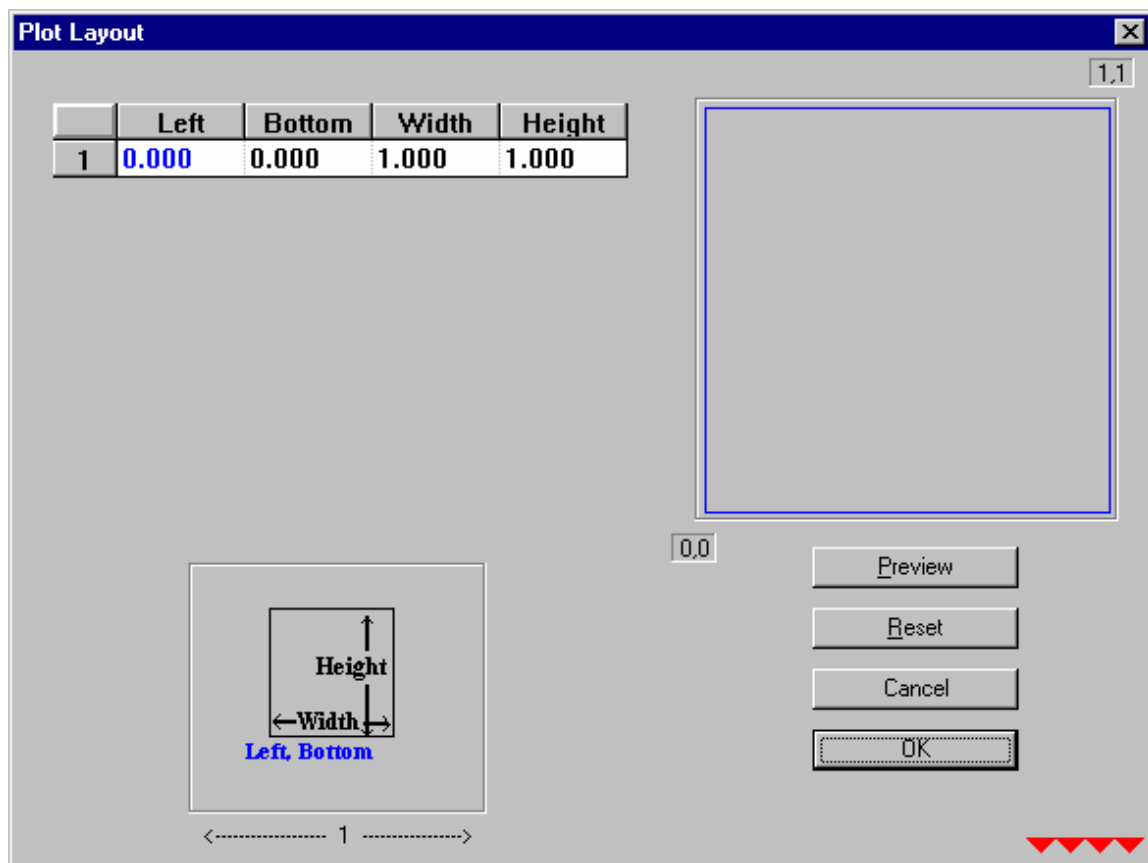
All the graphs and plots in BioAnalysis are customizable. First select Parameters from the Plot menu. The Plotting Parameters dialog box will appear. See section 8.0 for more information.

3.3 Layout



BioAnalysis provides you with a default layout grid for the plots on your page. To change the layout of your plots in the page select this option. The Plot Layout dialog box will appear.

3.3.1 Plot Layout Screen



All plots in a page are laid out by default. You have the freedom to define the size and placement of each plot on a page.

Every plot on a page is defined by four values: The x coordinate and y coordinate of a point in the bottom left corner, and the height and width of the plot.

All the values are normalized to the page height and width (not considering the area occupied by header). Therefore, all the values are less than or equal to one. For example if you define the width of the plot to be one, the plot will occupy the whole width of the page. Your plot origin should be defined as an offset from the origin at the bottom left corner.

Changing plot layout parameters :

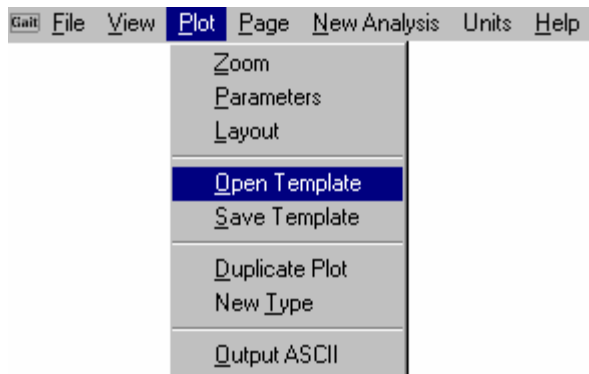
In the spread sheet shown, double click the value you would like to change. Make any appropriate changes. You will not be able to enter a value greater than one into any of these columns.

Preview

You can preview your settings by clicking the *Preview* button. This shows you how the plots will look on the page with the settings you defined. If you do not like your settings, click the Reset button to return back to the original values.

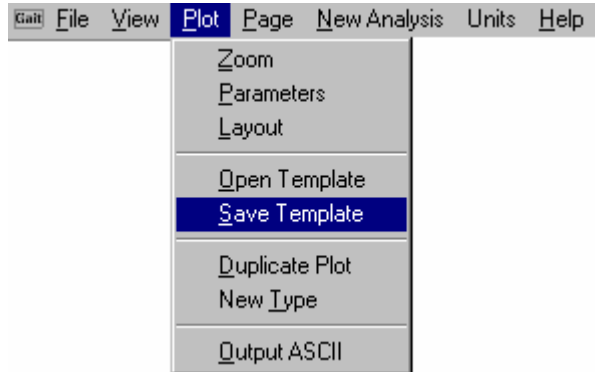
To make the software implement the changes, click on the OK button. If you do not want to use the values you provided, click Cancel and you will exit without making the changes.

3.4 Open Plot Template



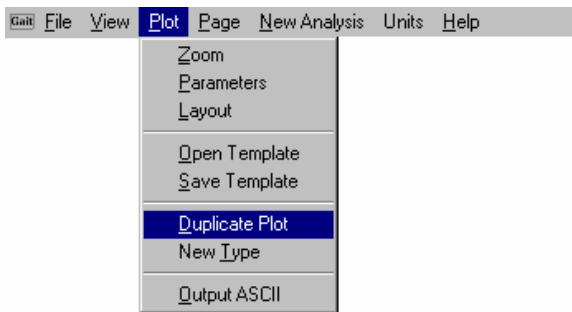
You can open a template file that has predetermined settings for a page. These settings will be applied to the data currently chosen for analysis. Separate the template files for different kinds of analysis. Do not use settings for a gait analysis template on a balance analysis and vice-versa.

3.5 Save Plot Template



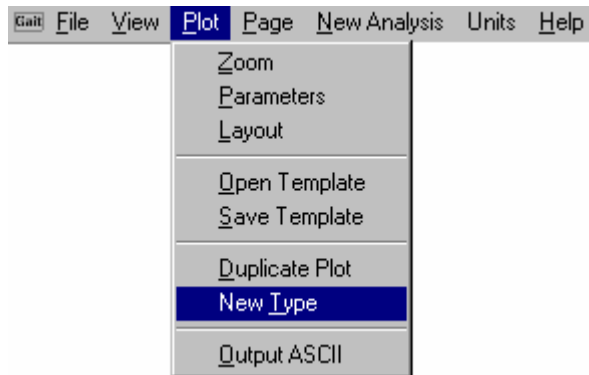
Save your settings to a template file. This template can later be applied to other plot pages.

3.6 Duplicate Plot



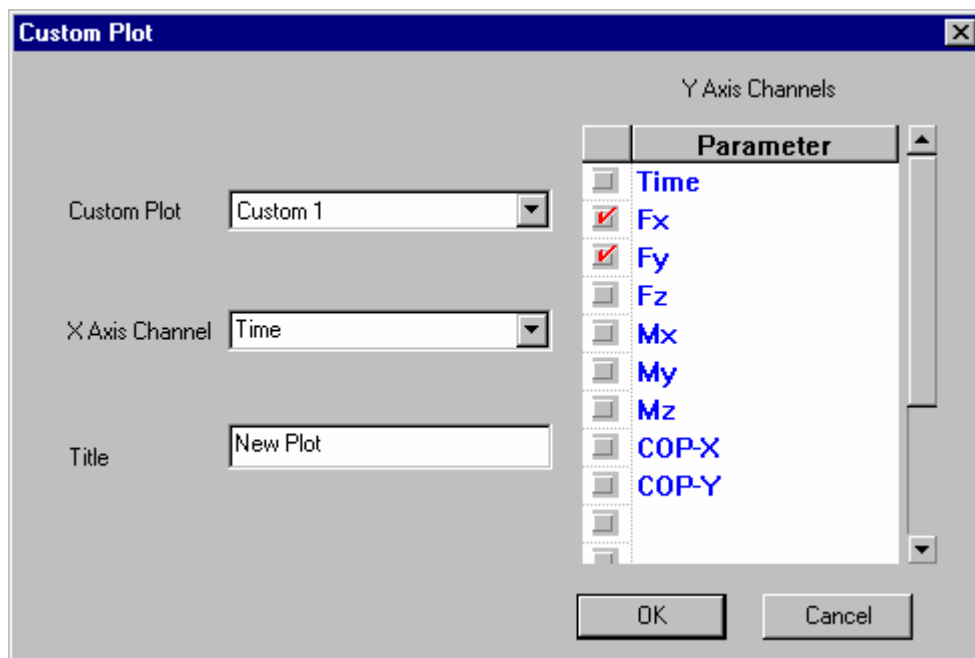
Choosing this option duplicates a Page along with its data files. This is a quick method of starting a new plot page.

3.7 New Plot Type



BioAnalysis lets you define new plot types for your analysis. For example, you can plot Fx, Fy, and Fz versus time. When you select New Type, the Custom Plot dialog box appears and you can define a custom plot. You can define a maximum of ten custom plots.

3.7.1 Create Custom Plots



BioAnalysis allows you to make up to ten custom plots per page in addition to some pre defined plot types. When creating a customized plot, remember :

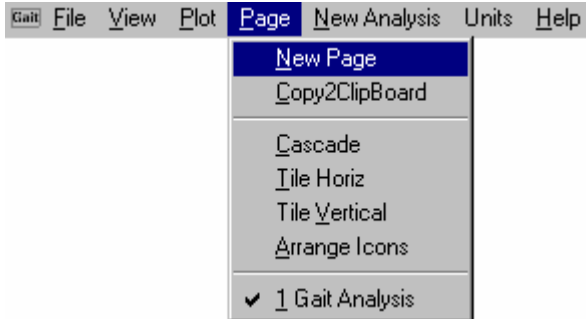
- ⇒ Define custom plots sequentially (custom-2 plot before custom-3 plot)
- ⇒ You must provide a title for your custom plots to represent your plot in the plot type bar. For example, if plotting Fx, Fy and Fz on the y-axis and Time on the x-axis, you could title the plot “Forces vs. Time.”
- ⇒ You may define multiple channels/types for the y axis, but only one for the x-axis.

To create a customized plot:

1. Select *new plot type*
2. Choose the X-Axis Channel data type
3. Click all the appropriate Y-Axis data types
4. Give the plot a title
5. Click *OK*
6. Select your plot name from the plot type window at the bottom left of the screen

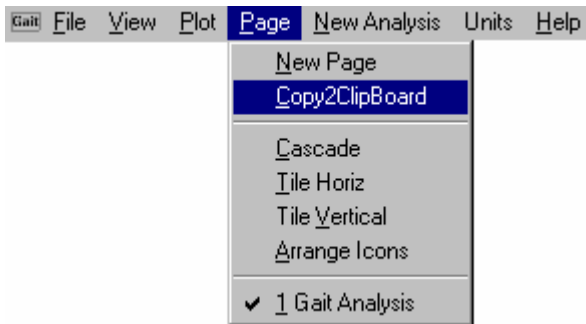
4.0 Page

4.1 New Page

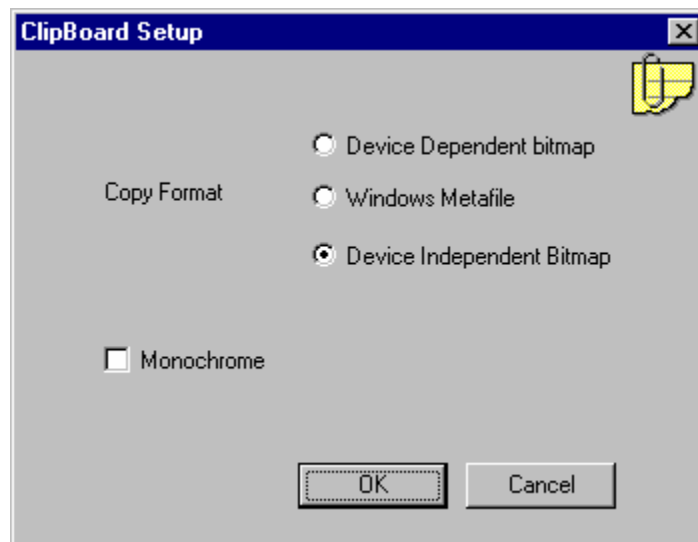


Choose this option to start a new analysis page for the same kind of analysis. For example, if you are currently in gait analysis, choosing this option lets you start another gait analysis window with a different set of data files.

4.2 Copy to Clipboard



You can copy a BioAnalysis Page (graphing window) to the Windows clipboard. You can then paste this into any application that accepts a bitmap image (i.e. MS Word, WordPerfect, Excel, Paintbrush, etc.).



When copying to the clipboard, use the Clipboard Setup to customize the format of an export.

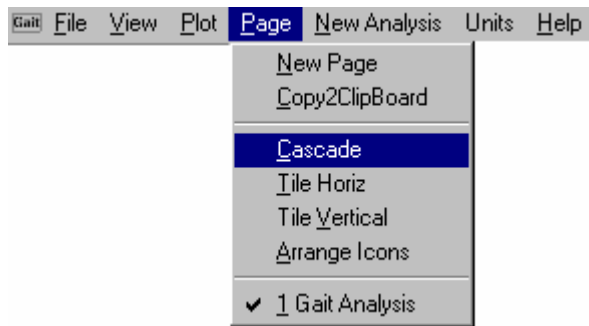
Format :

Choose the format of the plot you want to export to the clipboard: This depends on which

application you are exporting into. Some applications like MS Word accept multiple formats. There are other applications which cannot insert a Window Metafile. Try different formats if you are unsuccessful.

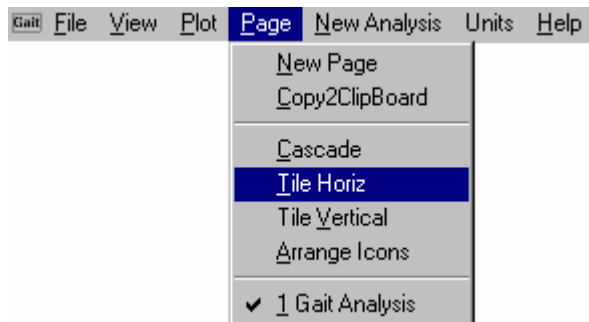
Enabling Monochrome exports the plot to the clipboard in a monochrome format.

4.3 Cascade



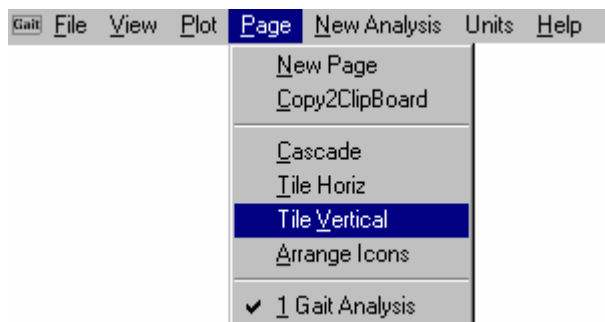
This option lets you arrange all the graphing windows in a cascade fashion (one behind the other).

4.4 Tile Horiz



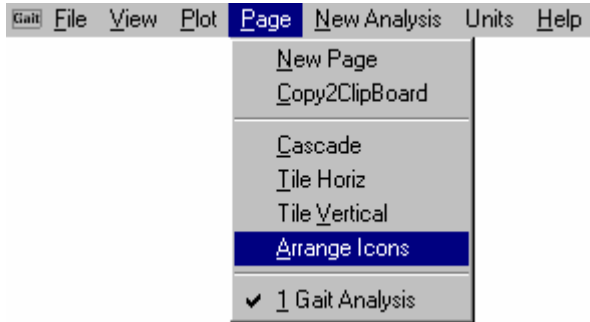
This option lets you arrange all the graphing windows horizontally. Each window takes up the whole width of the screen. The total height of your screen is shared between all the active graphing pages equally.

4.5 Tile Vertical



This option lets you arrange all the graphing windows vertically. Each window takes up the whole height of the screen. The total width of the screen is shared equally by all the active graphing pages.

4.6 Arrange Icons

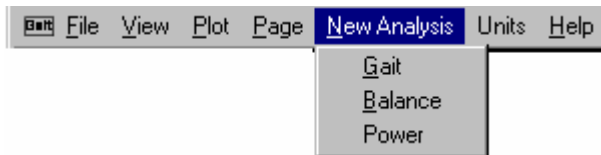


All the icon graphing windows (minimized) are arranged in an orderly fashion in the main screen of BioAnalysis.

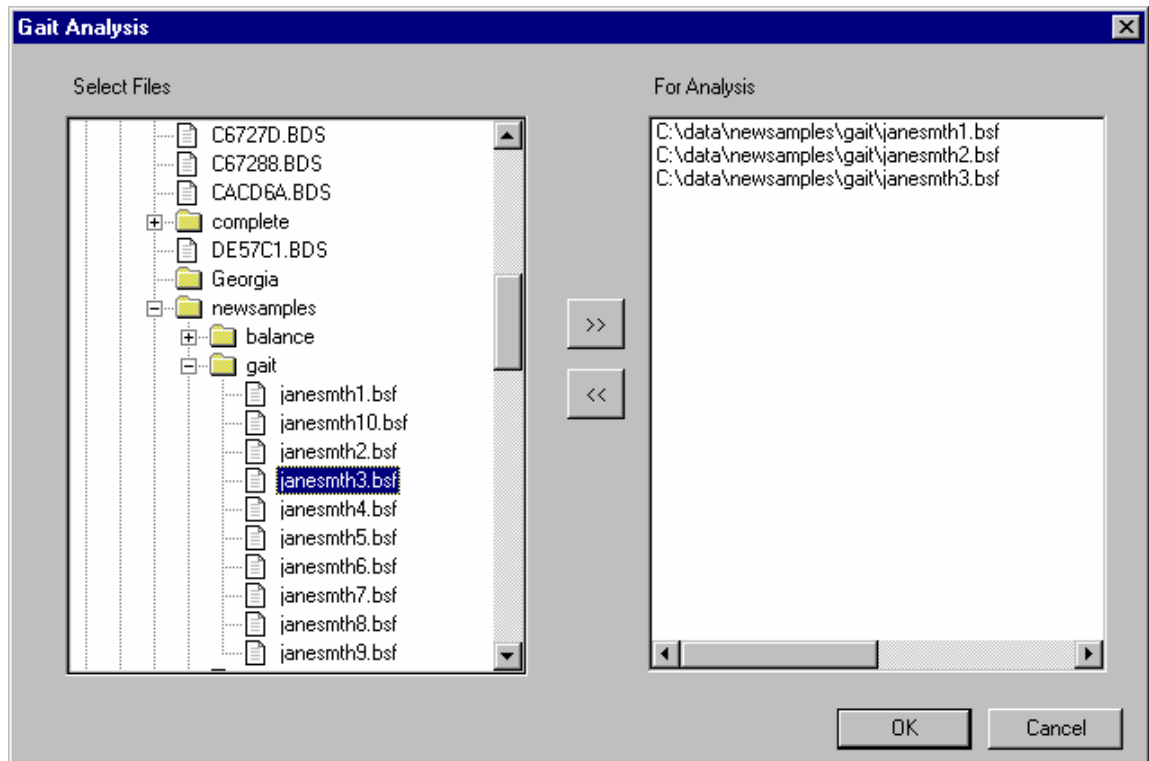
5.0 Analysis

5.1 To Start an Analysis:

1. Click *Analysis* if you do not have a file open yet,
Or *New Analysis* if you already have a file open.
2. Click *Gait*, *Balance* or *Power* to start a new analysis:



3. Select a set of data files in the Data Files Choice window. The right half of the window shows all the files chosen for analysis.
 - a) Add a file to the list for analysis by highlighting the file, and then clicking the *Add >>* button. Right clicking on the file also adds the file to the set.
Currently you can choose the following files for analysis :
 - ⇒ BioSoft (<file>. bsf) files
 - ⇒ Accusway Files (<file> . swl) files
 - ⇒ Bedas-2 Files (<file> . bds) files
 - b) Remove a file from your set by highlighting the file, then click *Remove <<*.
Right clicking on the file also removes the file from the set.

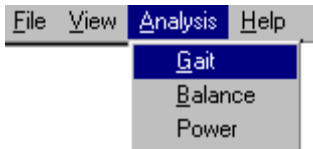


Note:

- ⇒ You can only add fifty files for each analysis
- ⇒ You can add a file several times
- ⇒ Your analysis does not start until you choose at least one file

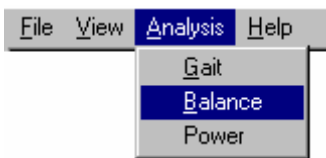
4. Once you have chosen all the files needed for your analysis, click *OK* to start analysis.

5.2 Gait Analysis



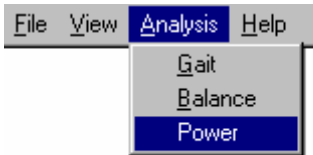
Choosing *Gait* will start the gait analysis module of BioAnalysis. All the plots, statistics and analysis tools inside this module are only for gait analysis. After selecting Gait, you will have to choose the data files on which to perform gait analysis (currently a maximum of 50). Then, you can analyze the file using tools available in the software.

5.3 Balance Analysis



Choosing *Balance* will start the balance analysis module of BioAnalysis. All the plots, statistics and analysis tools inside this module are for balance analysis. After selecting Balance, choose the data files for balance analysis (currently a maximum of 50). You can then analyze the file using the tools available in the software.

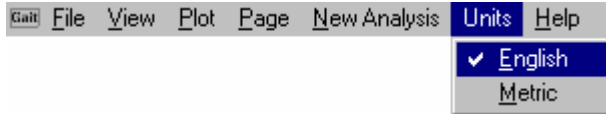
5.4 Power Analysis



Choosing *Power* will start the power analysis module of BioAnalysis. Power is currently the only Sports module available. All the plots, statistics and analysis tools inside this module are for power analysis. After selecting *Power*, choose the data files for power analysis (currently a maximum of 50). You can then analyze the file using the tools available in the software.

6.0 Units

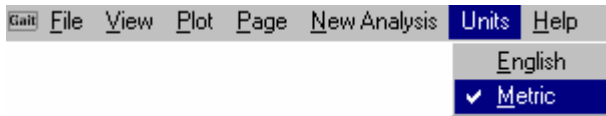
6.1 English Units



You can define *English* units as the units of operation in BioAnalysis. This is the only place where you can define your units of operation.

Now, all the Plots, the Statistical Analysis, and Exporting will be in English units.

6.2 Metric Units

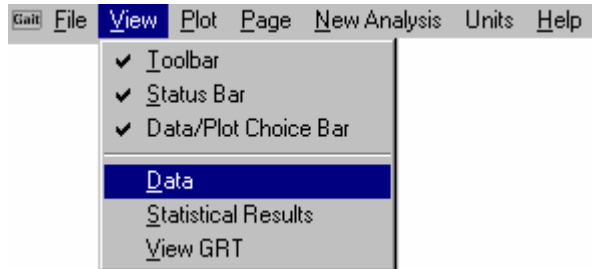


You can define *Metric* units as the units of operation in BioAnalysis. This is the only place where you can define your units of operation.

Now, all the Plots, the Statistical Analysis, and Exporting will be in Metric units.

7.0 Exporting to Text Files

7.1 View Data



Clicking *Data* will bring up the raw data display window. Data here is divided into platforms and instruments. From here, view the Center of Pressure or Channel data for the platforms, or export the data displayed.

The Data window displays a table of raw data with the following columns: Time [sec], Fx [lbs.], Fy [lbs.], Fz [lbs.], Mx [in-lbs.], My [in-lbs.], and Mz [in-lbs.]. The data is organized into 13 rows, each representing a time interval from 0.000 to 0.026 seconds. The table is scrollable, and the data is displayed in a spreadsheet-like format. Below the table, there are options to delimit the data (Comma, Tab, Space, Semi-Colon) and a dropdown menu to select the platform (File 1;trial1.bsrf, Platform: 1). There are also buttons for Save, View (Plt. Dat, Instr. Data, COP), and OK.

Time [sec]	Fx [lbs.]	Fy [lbs.]	Fz [lbs.]	Mx [in-lbs.]	My [in-lbs.]	Mz [in-lbs.]
0.000	0.041	0.041	-0.161	1.628	0.814	0.436
0.002	0.000	0.000	-0.321	0.814	0.000	-0.872
0.004	0.041	0.041	0.000	1.628	1.628	0.436
0.006	-0.041	-0.041	0.321	0.814	2.441	-0.436
0.008	-0.366	-0.244	0.803	1.628	7.324	-2.180
0.010	-0.448	-0.407	1.285	1.628	9.766	-3.052
0.012	-0.041	-0.407	2.088	1.628	12.207	-1.308
0.014	0.366	-0.285	2.409	0.000	13.835	-0.872
0.016	0.488	-0.203	3.052	-0.814	16.276	-1.744
0.018	0.366	-0.326	3.694	-0.814	20.345	-3.052
0.020	0.285	-0.529	4.015	-2.441	21.973	-3.488
0.022	0.529	-0.448	4.979	-1.628	26.042	-1.308
0.024	0.732	-0.366	5.461	-1.628	28.483	-1.308
0.026	0.814	-0.285	6.104	-1.628	31.738	-2.616

View Data is a screen that lets you view channel/cop data in a spreadsheet-like format. Data is displayed as belonging to a platform or instrument. The units of the data are determined in the main screen.

First, choose the platform (whose data you want to see) from the list provided at the bottom of the screen. You can only choose to view one platform at a time.

View type :

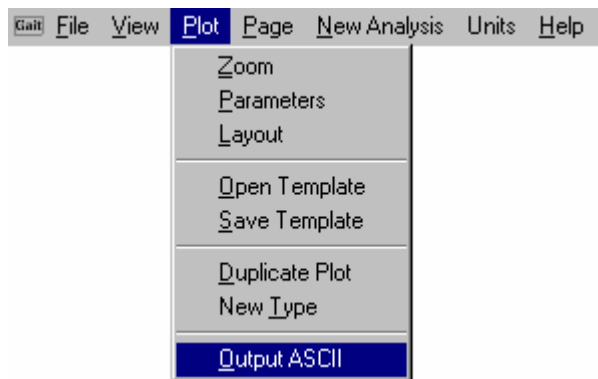
Plt. Dat : Platform data
Instr Data : Instrument data
COP : Center of Pressure data

Export what you see :

You can export the data you are viewing to a delimited text file.

1. Choose the type of delimiters between the columns of the text file (a space is the default)
2. Click on the *Save* button to export the data to a file.

7.2 Export plot data

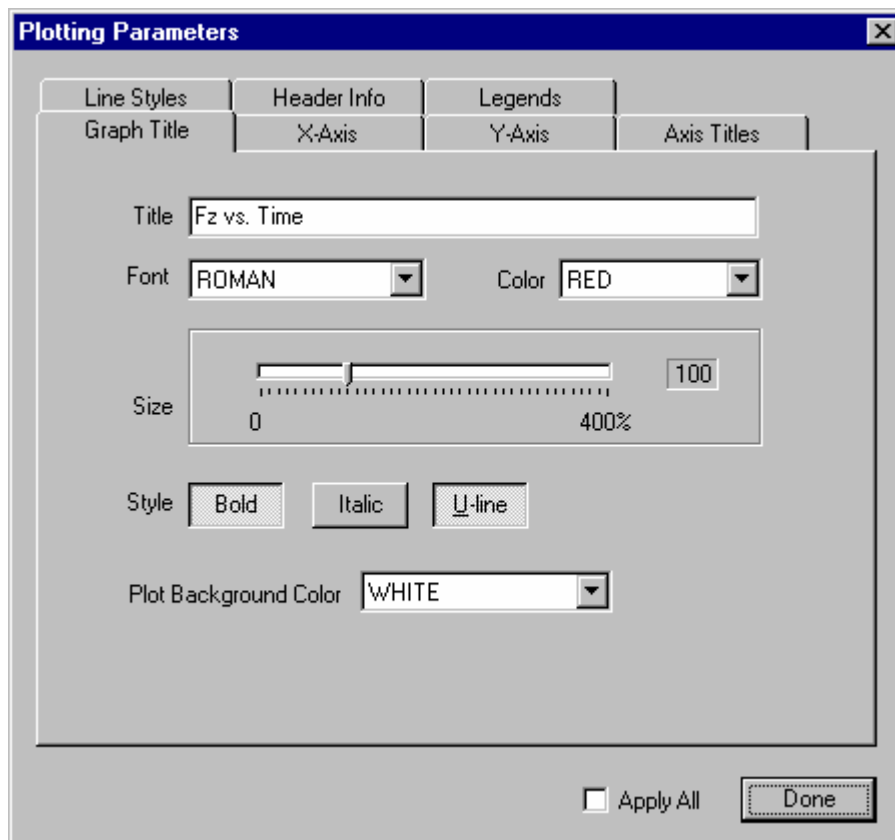


BioAnalysis lets you export a single channel of data to a delimited text file. Then you can import this channel into a spread sheet or other analysis program. When you select Output ASCII the windows Save As dialog box will appear. You can then choose the destination folder and file name.

8.0 Plot Settings/Parameters

To change the plot settings or parameters select “Plot” from the Main Menu, then “Parameters”. The Plotting Parameters dialog box will appear. You may also right click on a plot and the Plotting Parameters dialog box will appear. This option allows you to change the properties of the x and y axes, the plot titles, legends and the line styles of a plot.

8.1 Graph Title



Title: Title of the plot

Font: Font of the title

Color: Color of the title

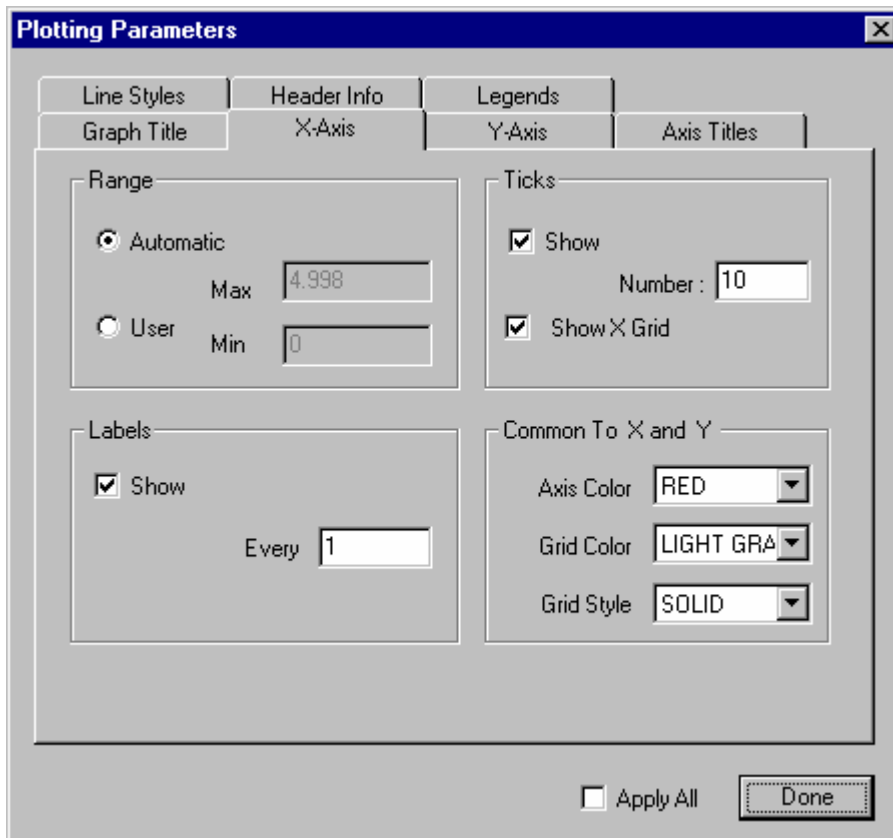
Size: Size of the Font for the graph's title

Style: Bold, Italic, Underline styles of the title (depressed means applied)

Plot Background Color: Color of the plot background

8.2 X-Axis

Allows you to change the range, labels, grid, and ticks of the x axis.



The image shows a 'Plotting Parameters' dialog box with the 'X-Axis' tab selected. The dialog has a title bar with a close button. Below the title bar are four tabs: 'Line Styles', 'Header Info', 'Legends', and 'Axis Titles'. The 'X-Axis' tab is active, showing settings for the x-axis. It is divided into four sections: 'Range', 'Ticks', 'Labels', and 'Common To X and Y'. The 'Range' section has two radio buttons: 'Automatic' (selected) and 'User'. The 'User' option has input fields for 'Max' (4.998) and 'Min' (0). The 'Ticks' section has two checked checkboxes: 'Show' and 'Show X Grid'. The 'Show' checkbox has a 'Number' input field set to 10. The 'Labels' section has a checked 'Show' checkbox and an 'Every' input field set to 1. The 'Common To X and Y' section has three dropdown menus: 'Axis Color' (RED), 'Grid Color' (LIGHT GRAY), and 'Grid Style' (SOLID). At the bottom right, there is an 'Apply All' checkbox (unchecked) and a 'Done' button.

Line Styles	Header Info	Legends	Axis Titles
Graph Title	X-Axis	Y-Axis	Axis Titles

Range

☒ Automatic
Max: 4.998
☐ User
Min: 0

Ticks

☒ Show
Number: 10
☒ Show X Grid

Labels

☒ Show
Every: 1

Common To X and Y

Axis Color: RED
Grid Color: LIGHT GRAY
Grid Style: SOLID

☐ Apply All Done

Range: The maximum and minimum of x axis. Select:

- *Automatic* to let the software determine the max/min
- *User* to let the user define the maximum and minimum by manually entering values

Ticks : Tick marks on the axis.

- Enable/Disable *Show* to show/hide the tick marks on the axis
- *Number*: The number of tick marks you want marked on the axis.
- *Show-X Grid*: Show/Hide the y-axis grid.

Labels: Labels are the values shown on x axis.

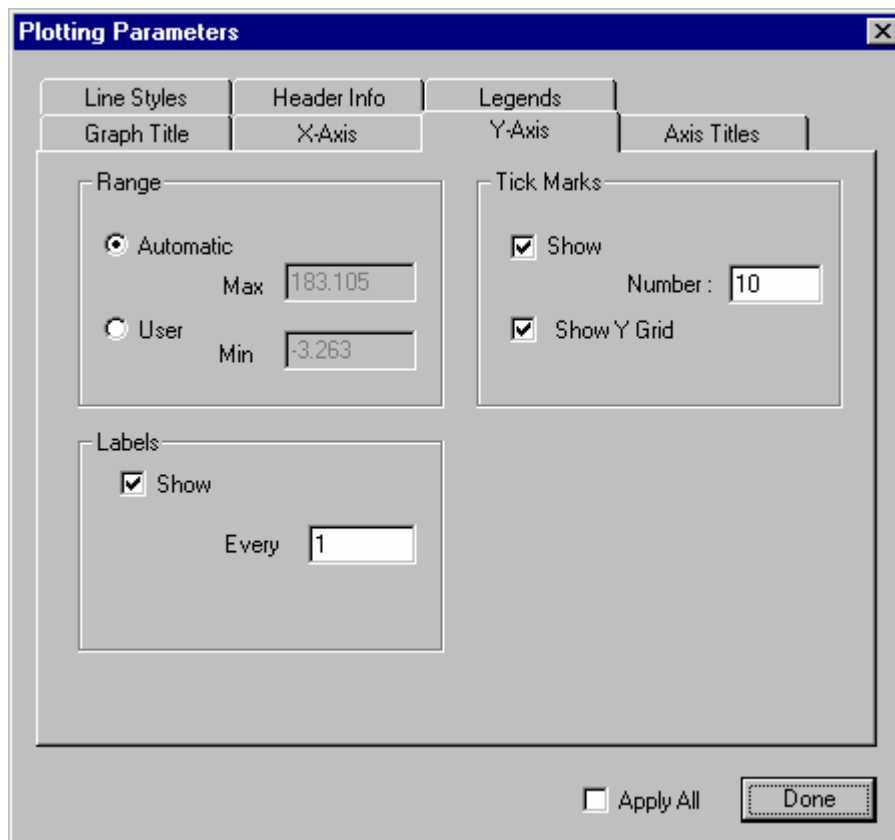
- *Show* : Enable/Disable to hide/show labels on the axis
- *Every* : Defines the labeling frequency of the ticks

Common To X and Y

- *Axis Color:* Color of the x-axis
- *Grid Color:* The color of the grid lines (For both x and y axis grid lines)
- *Grid Style:* The style of the grid lines (For both x and y axis grid lines)

8.3 Y-Axis

Allows you to change the range, labels, grid, and ticks of the y axis.



Range: The maximum and minimum of x axis. Select:

- *Automatic* to let the software determine the max/min
- *User* to let the user define the maximum and minimum by manually entering values

Tick Marks: Tick marks on the axis.

- *Enable/Disable: Show* to show/hide the tick marks on the axis
- *Number* The number of tick marks you want marked on the axis.
- *Show-Y Grid* Show/Hide the y-axis grid.

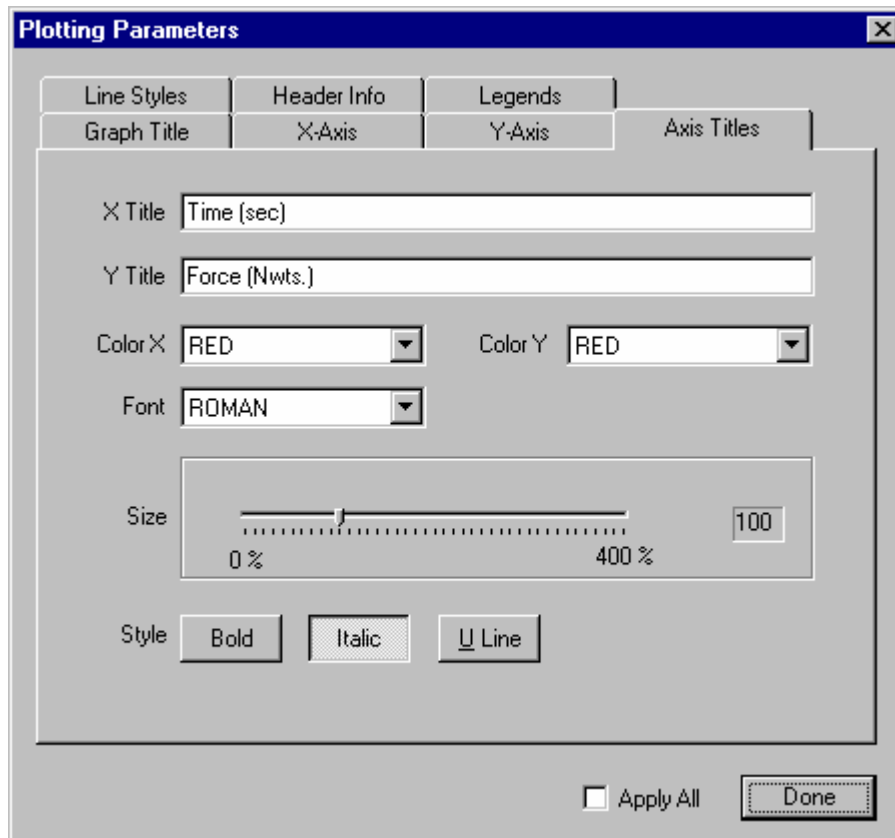
Labels: Labels are the values shown on x axis.

- *Show* : Enable/Disable to hide/show labels on the axis
- *Every* : Defines the labeling frequency of the ticks

Note: The color and style are defined in the x-axis settings

8.4 Axis Titles

Allows you to change the font, titles, color, and style of your titles.



X Title : Identifies the type of data represented on the x-axis

Y Title : Identifies the type of data represented on the y-axis

Color X : Color of the x-axis title

Color Y : Color of the y-axis title

Font : Font for both the x and y axis titles

Size : Size of the titles

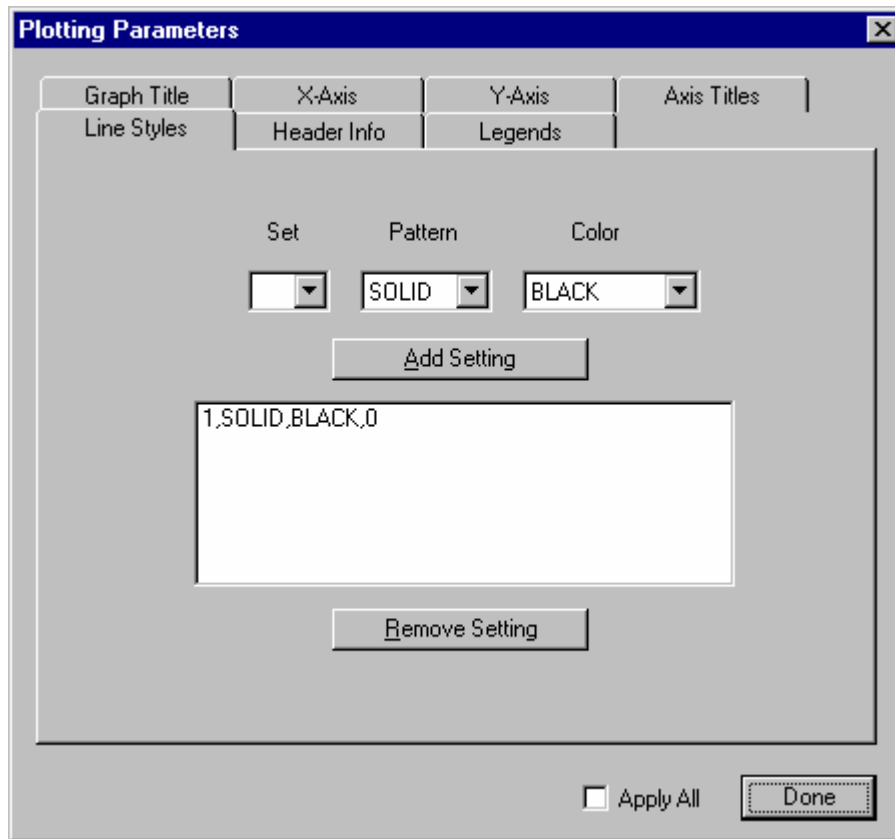
Automatic : Lets the software determine a size for you

User : Lets the user define a size. Drag the pointer to the left or right to decrease or increase the size

Style : The style of the axis titles (Bold, Italic, Underline: Depressed signifies enabled)

8.5 Line Styles

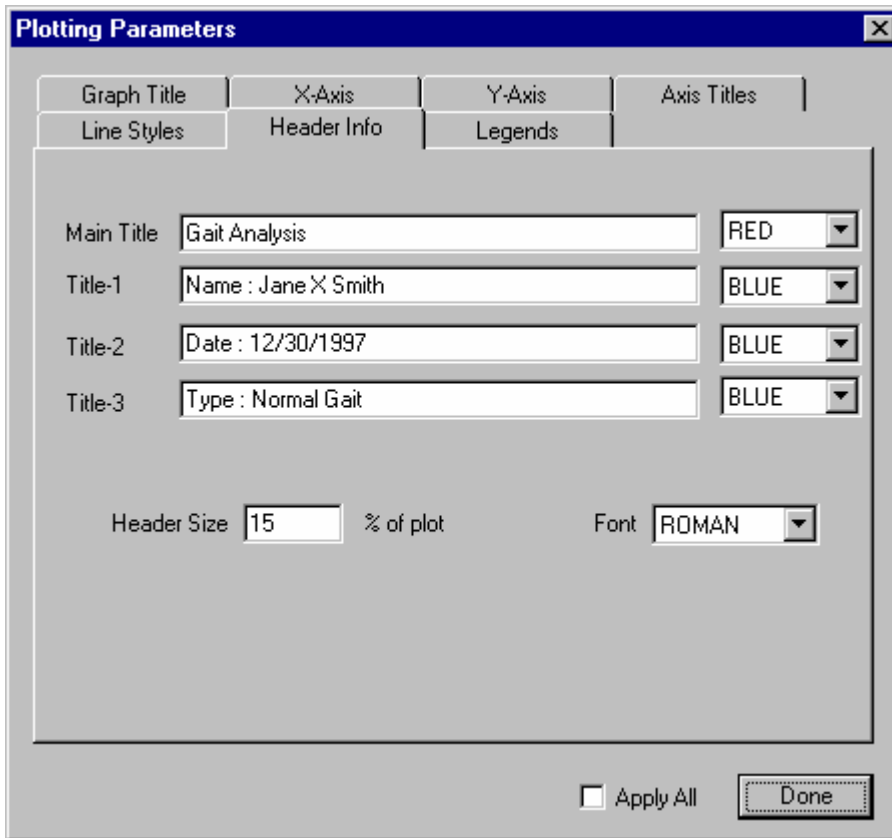
Here the line style and color may be adjusted.



To change a setting:

1. Highlight the setting you wish to change
2. Click *Remove Setting*
3. Choose the setting whose line style you would like to change
4. Select the style (Pattern) to be used
5. Choose a color for the line
6. Click *Add Setting*

8.6 Header Info



The image shows a 'Plotting Parameters' dialog box with the 'Header Info' tab selected. The dialog has a title bar with a close button. Inside, there are tabs for 'Graph Title', 'X-Axis', 'Y-Axis', 'Axis Titles', 'Line Styles', 'Header Info', and 'Legends'. The 'Header Info' tab contains the following fields:

- Main Title:** A text box containing 'Gait Analysis' and a color dropdown menu set to 'RED'.
- Title-1:** A text box containing 'Name : Jane X Smith' and a color dropdown menu set to 'BLUE'.
- Title-2:** A text box containing 'Date : 12/30/1997' and a color dropdown menu set to 'BLUE'.
- Title-3:** A text box containing 'Type : Normal Gait' and a color dropdown menu set to 'BLUE'.
- Header Size:** A text box containing '15' followed by the text '% of plot'.
- Font:** A dropdown menu set to 'ROMAN'.

At the bottom of the dialog, there is an unchecked checkbox labeled 'Apply All' and a 'Done' button.

The top portion of the plotting page is taken up by the page header. In “Header Info,” Define the settings and color of the header.

Main Title: The title on top of the plotting page.

Title -1: Typically used for defining the name of the subject whose data is being analyzed

Title -2: Typically used for defining the date data was collected on

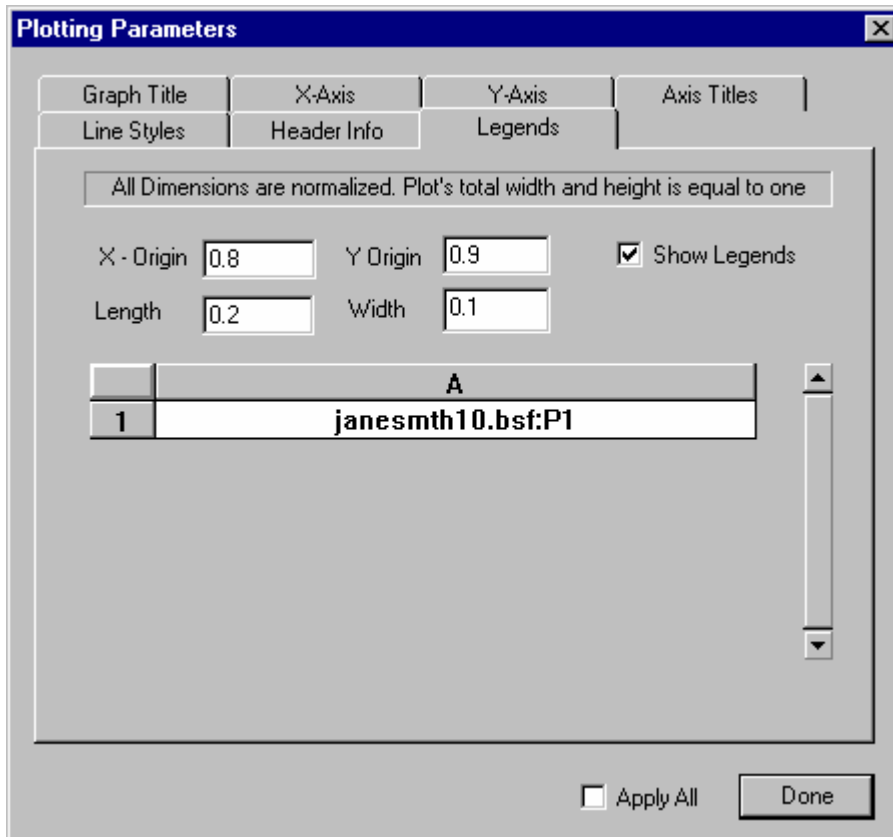
The pull down boxes next to each title box allow you to select the color for that title.

Title -3: Typically used for defining the type of data that is collected

Header Size: Percentage of the total page the header will occupy

Font Family: The font for all the titles in the header.

8.7 Legends



The image shows a 'Plotting Parameters' dialog box with a blue title bar and a close button. It contains several tabs: 'Graph Title', 'X-Axis', 'Y-Axis', 'Axis Titles', 'Line Styles', 'Header Info', and 'Legends'. The 'Legends' tab is selected. Inside the dialog, there is a text box stating 'All Dimensions are normalized. Plot's total width and height is equal to one'. Below this, there are input fields for 'X - Origin' (0.8), 'Y Origin' (0.9), 'Length' (0.2), and 'Width' (0.1). A checkbox labeled 'Show Legends' is checked. At the bottom, there is an 'Apply All' checkbox (unchecked) and a 'Done' button. A legend table is visible in the center of the dialog.

	A
1	janesmth10.bsf:P1

Changing the layout of a legend:

In the spread sheet shown, double click the value you would like to change. Make any appropriate changes.

The legend on a page is defined by four values: The x coordinate and y coordinate of a point in the bottom left corner, and the height and width of the plot.

All plots are normalized. The plot's total width and height are equal to one. You will not be able to enter a value greater than one into any of these columns.

Show Legends: Enable/Disable to show/hide legend

Apply all: Enable to apply your changes to all plots

APPENDIX A - Platform Coordinate System

All AMTI force platforms use the same coordinate axes convention. The origin is referenced to the center of the top of the surface of the platform. In actuality, the origin lies a given x, y, and z offset from the center, as shown in the platform's calibration sheets.

The positive z-axis points down on the plate, perpendicular to the cable connector. The positive y-axis points along the plate, both away from and parallel to the connector. The x-axis direction is found using the y and z-axes and the right hand rule. [If you were to stand on the platform with your back to the connector, the positive x-axis points to the left.] The moments about the three axes also follow the right hand rule. [If you point your thumb in the positive direction for any of the axes, the fingers curl in the positive direction for the moment about that axis.]

APPENDIX B - How to Calculate the COP 95% Confidence Ellipse

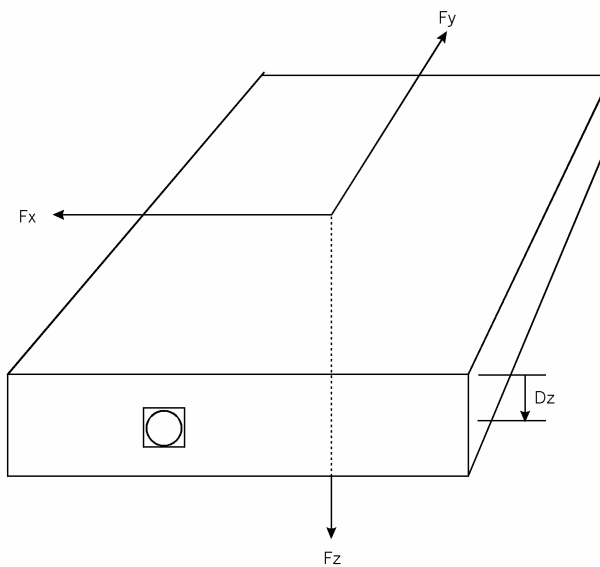
If using an Accusway platform:

$$Dz = 0;$$

If using an AMTI force platform:

Dz = is the distance from the top surface of the transducer to transducer calibrated origin.

It is provided with the platforms calibration information known as the Z offset: Z_o .



Data comes from our platforms in datasets of six channels:

$$0 = F_x; 1 = F_y; 2 = F_z; 3 = M_x; 4 = M_y; 5 = M_z.$$

F_x , F_y , F_z are conditioned transducer force outputs.

M_x , M_y , M_z are conditioned transducer moment outputs.

1. Find X_i and Y_i ,

$$X_i = \frac{(-F_{x_i} \times Dz - M_{y_i})}{F_{z_i}}$$

$$Y_i = \frac{(-F_{y_i} \times Dz + M_{x_i})}{F_{z_i}}$$

2. Calculate platform relative X_{avg} and Y_{avg} .

$$X_{avg} = \sum_{i=1}^N X_i$$

$$Y_{avg} = \sum_{i=1}^N Y_i$$

3. Subtract averages from data to determine COP mean relative data from platform relative data.

$$x_i = X_i - X_{avg}$$

$$y_i = Y_i - Y_{avg}$$

4. Calculate the standard deviation of x and the standard deviation of y.

$$\sigma_x = \frac{1}{n} \sqrt{\sum_{i=1}^n x_i^2}$$

$$\sigma_y = \frac{1}{n} \sqrt{\sum_{i=1}^n y_i^2}$$

5. Calculate the covariance of x and y.

$$\sigma_{xy} = \frac{1}{n} \sqrt{\sum_{i=1}^n x_i^2 y_i^2}$$

6. Calculate an intermediate value D.

$$D = \sqrt{(\sigma_x^2 + \sigma_y^2)^2 - 4(\sigma_x^2 \sigma_y^2 - \sigma_{xy}^2)}$$

7. The intermediate value F

F = 3.00 from table of F statistic at a confidence level of $1 - \alpha$.

Where $\alpha = 0.05$ when the sample size > 120 .

8. Calculate the length of the major axis

$$S_{major} = \sqrt{F(\sigma_x^2 + \sigma_y^2 + D)}$$

9. Calculate the length of the minor axis

$$S_{minor} = \sqrt{F(\sigma_x^2 + \sigma_y^2 - D)}$$

10. Calculate the area of the 95% ellipse.

$$AREA = (2 \times 3.1415963 \times F) \sqrt{\sigma_x^2 \sigma_y^2 - \sigma_{xy}^2}$$

11. Calculate an intermediate value

$$t = \frac{(\sigma_x^2 + \sigma_y^2 + D)}{2}$$

12. Calculate the slope of the major axis relative to x.

$$m = \frac{\sigma_{xy}}{(t - \sigma_y^2)}$$

13. Calculate the slope* of the 95-percentile ellipse.

$$ANGLE = a \tan(m)$$

*The slope is the angle between the x-axis and the minor axis of the ellipse.

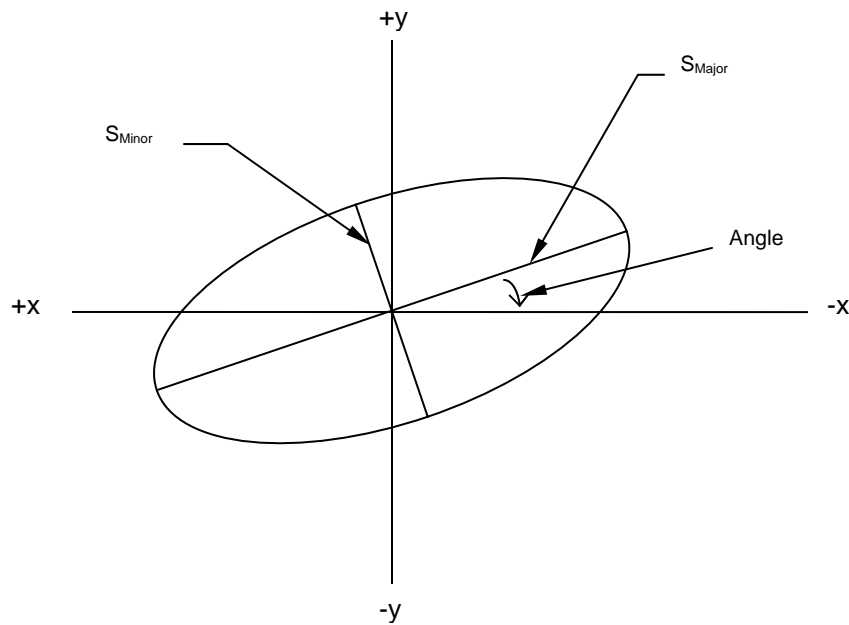


Figure B1: 95% Ellipse.