

*BodyBuilder session 1*

# BodyBuilder Introduction

## *Session Objectives*

### 1.BodyBuilder Introduction

- What is BodyBuilder?
- How does BodyBuilder fit into my data processing workflow?
- Introduction to the BodyBuilder user interface
- Introduction to BodyLanguage
- Files required to run a BodyLanguage script

### 2.Considerations before beginning your model: Planning your Model

- What is a model?
- The Research Question
- Free body diagram
- Rigid Segments definition
- Marker Placement, based on the segment's local coordinate systems

What is BodyBuilder?

## *What is BodyBuilder?*

BODYBUILDER IS A TOOL THAT ALLOWS THE USER TO:

### 1. Edit data previously captured, reconstructed and saved using Nexus

1. Marker relabeling
2. Filtering
3. Interpolation
4. Trajectory snipping and deleting
5. Trajectory copy
6. Clean up tools

NOTE: The majority of the above operations can now be performed using Nexus

### 2. Run a script to generate new relevant variables in the trial

1. Rigid body segments definition
2. Joint angles calculation
3. Joint kinetics calculation

## CONFUSION TO BE AVOIDED BETWEEN:

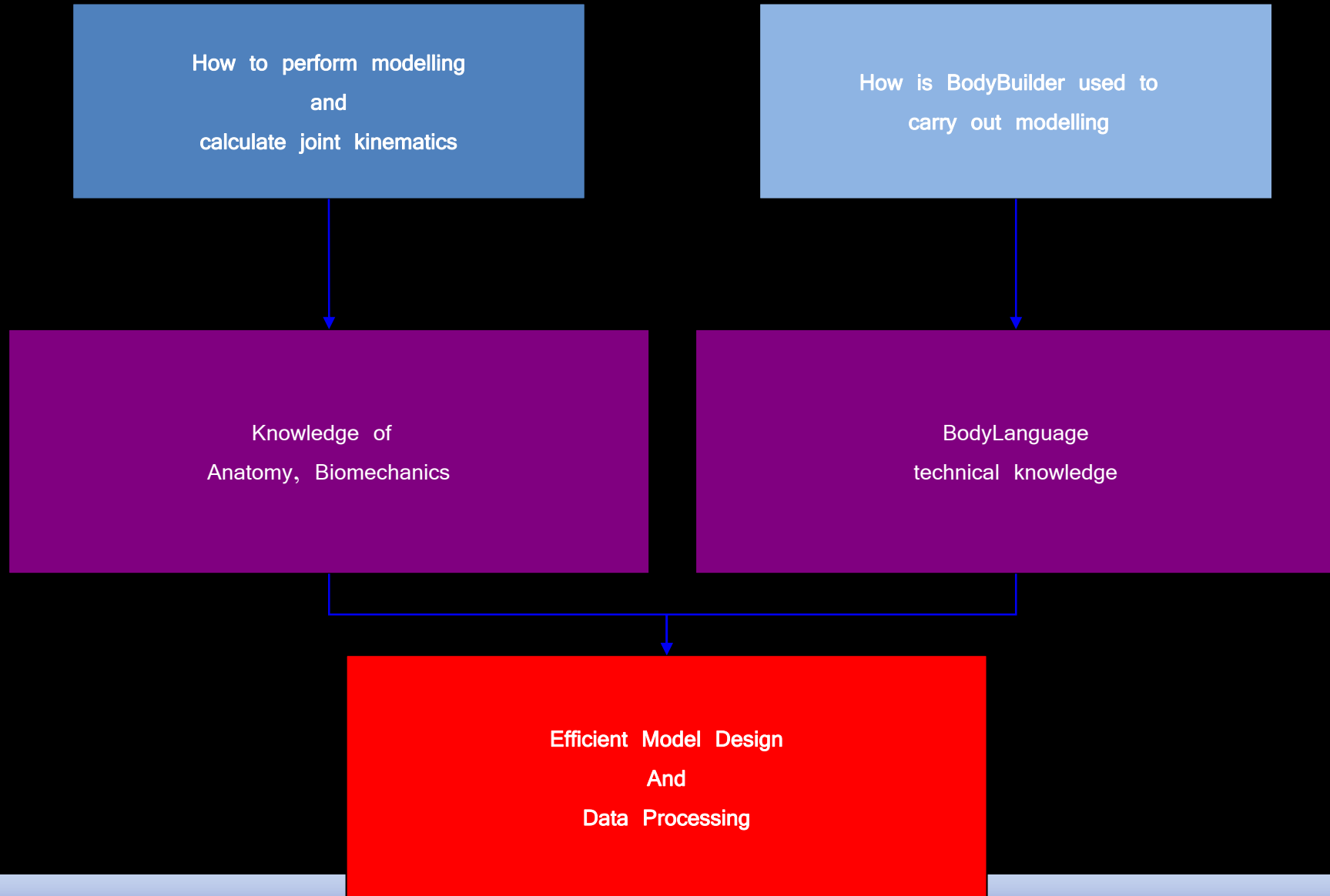
How to perform modelling  
and  
calculate joint kinematics

How is BodyBuilder used to  
carry out modelling

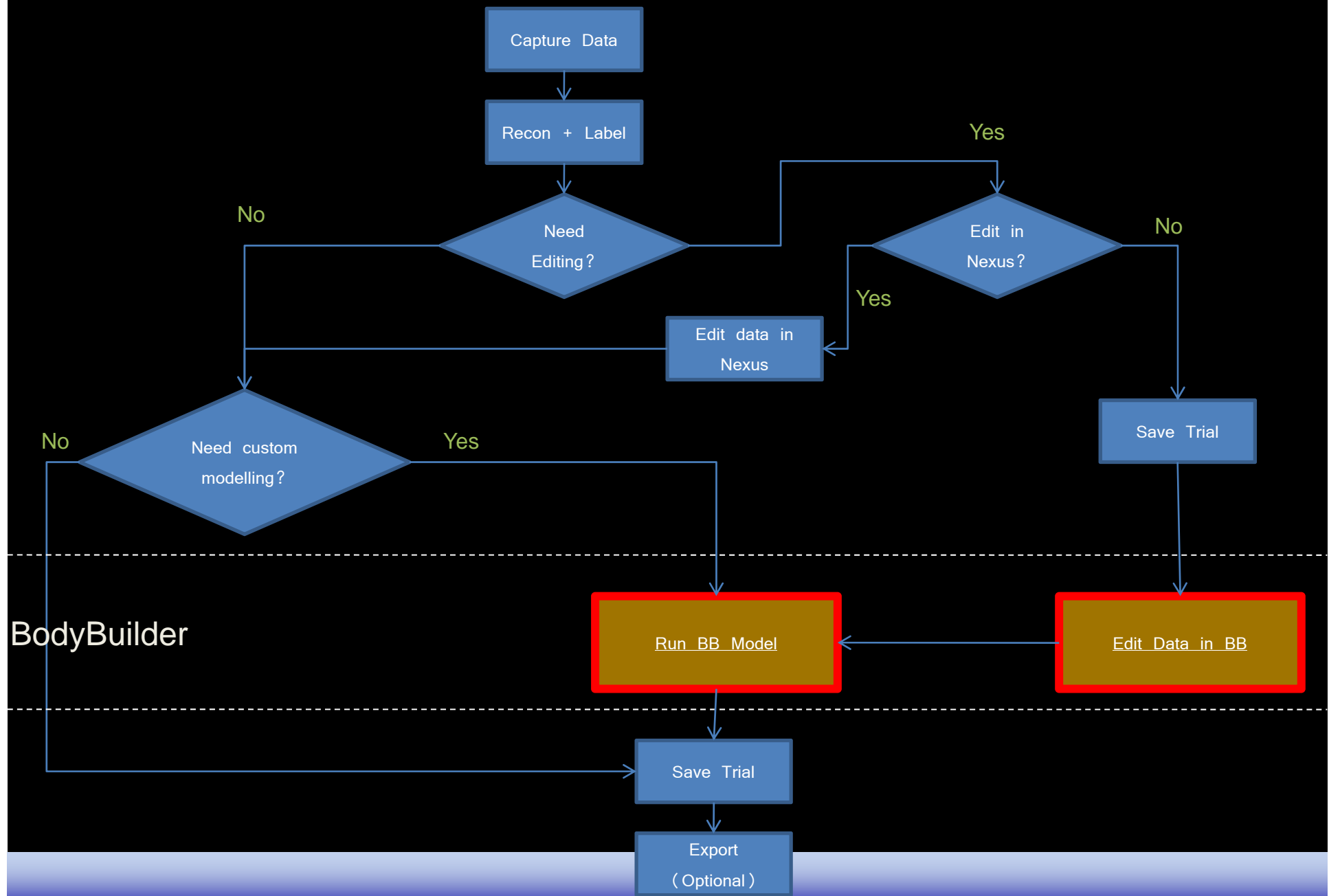
Knowledge of  
Anatomy, Biomechanics

BodyLanguage  
technical knowledge

Efficient Model Design  
And  
Data Processing



## How does BodyBuilder fit into my data processing workflow?



# The BodyBuilder Interface

# Introduction to BodyBuilder interface

Menus &  
Toolbar

Workspace

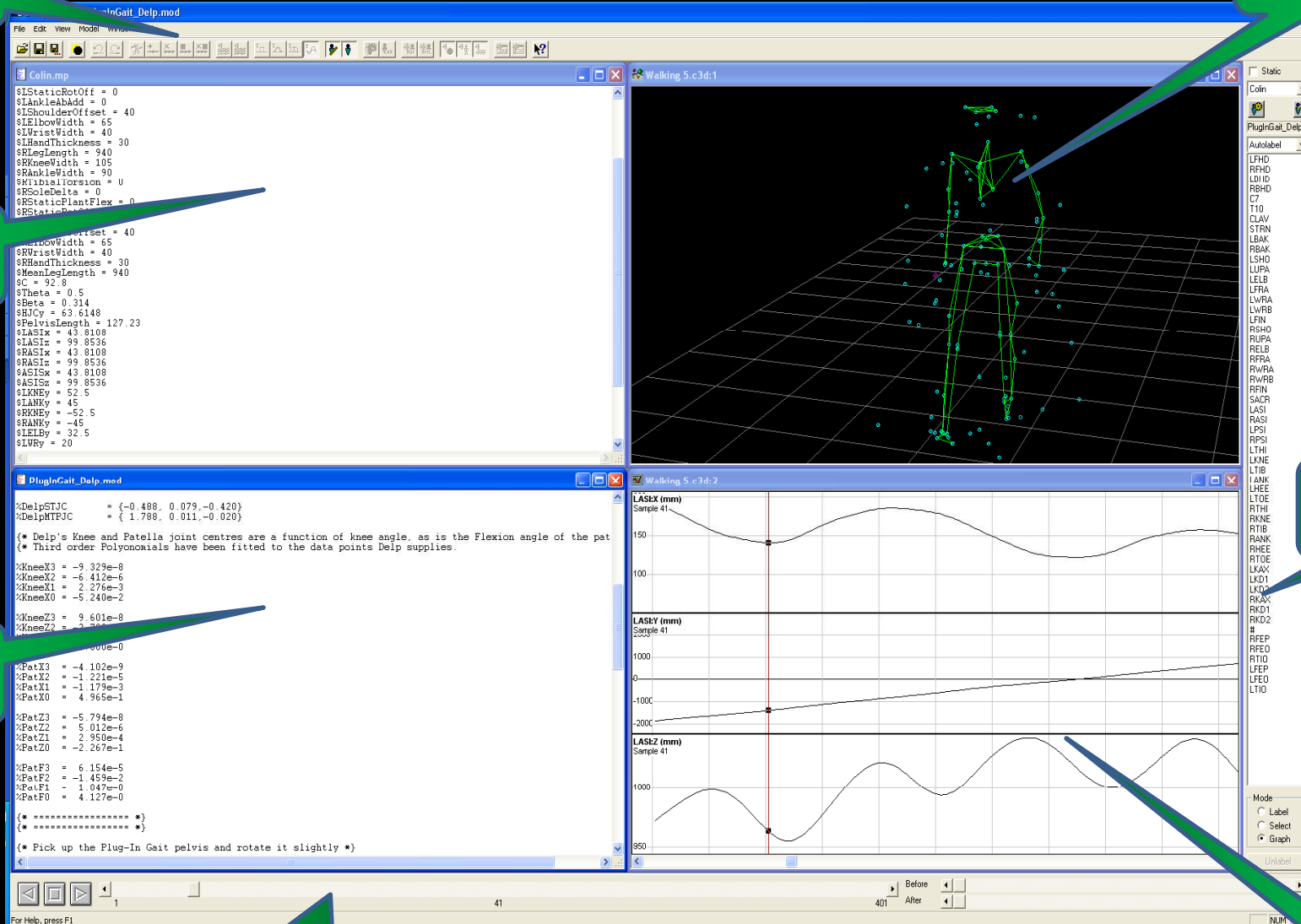
Subject  
Params

Model Script

Marker set

Timebar

Graph View



## *Introduction to BodyBuilder interface*

Lets go to BodyBuilder and learn how to:

1. Uses Eclipse Data Manager to open trials just like Nexus (Workstation)
2. Marker list on right hand side – just like Workstation
3. Designating a trial as Static
4. Editing tools

BodyLanguage

## *Introduction to BodyLanguage*

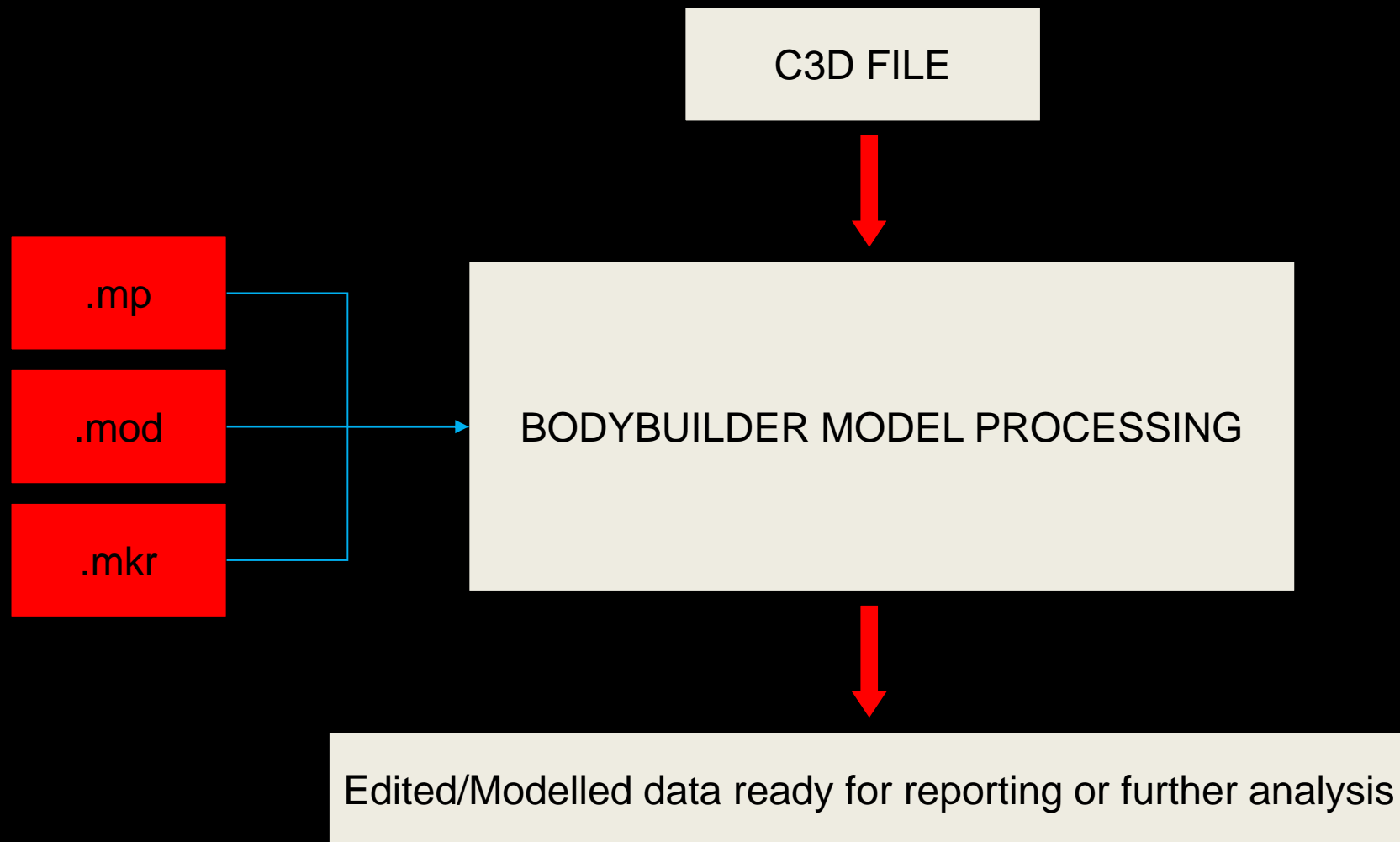
BodyLanguage is a programming language specific to BodyBuilder, that allows the user to create scripts using some custom-built functions oriented to biomechanical modeling.

As an example, a rigid body segment – i.e. a three dimensional coordinate system rigidly associated with a body segment – can be created with just one line of code using BodyLanguage. Using any other general purpose programming language, the same operation would require several lines of code.

The same can be said for joint kinematics and kinetics calculations.

Files required to run a BodyLanguage  
script

## *Bodybuilder – files required for processing*



## *Required BodyBuilder file types - .C3D*

### .C3D File – Processed Data

This file holds all of the processed information from a trial

- 3D marker positions
- Calculations from BodyBuilder Model
- Scaled analog data

The C3D file format is a biomechanical standard accepted by all Vicon software and many 3<sup>rd</sup> party software programs intended for biomechanical use

[www.c3d.org](http://www.c3d.org)

## *Required BodyBuilder file types - .MOD*

### .MOD File – Model Script

This file contains the BodyLanguage code the user writes

Typically the model script contains

- Rigid Body Segments definition
- Joint angles calculation
- Joint Moments calculations
- Other custom calculations

The model script file often contains two sections:

1. Static Trial processing
  - Most models have a static step
  - Used to gather static anthropometric measurements
2. Dynamic Processing
  - Used to process dynamic trials
  - The dynamic part of the model often uses the results from the static processing

## *Required BodyBuilder file types - .MP*

### .MP File – Model Parameters

This file is a reference for the calculations. It contains constant values that the model script (.MOD file) can use. The .mp file can be edited both automatically using the PARAM command in a model script and manually, by editing it using any text editor.

A .MP file typically contains:

- Subject measurements (anthropometrics)
- Static trial calculations (angular offsets)
- Mathematical constants (gravity, Pi, E...)

NOTE: Irrespective of whether the model script provides for the use of the subject parameters saved in the .MP file, a .MP file must exist for every model (even if empty).

NOTE: the *.mod* file is appended to the *.mp* file when the processing is launched

## *Required BodyBuilder file types - .MKR*

### .MKR File – Marker File

A .MKR file is simply a list of labels

The marker list shown at the right hand side of the BodyBuilder window reflects the content of the .MKR file

With the .MKR file the user can also control how the markers are joined in the 3D workspace

In general, a .MKR file provides marker labels, used for

- Label trajectories
- Select labelled trajectories
- Graph a labelled trajectory

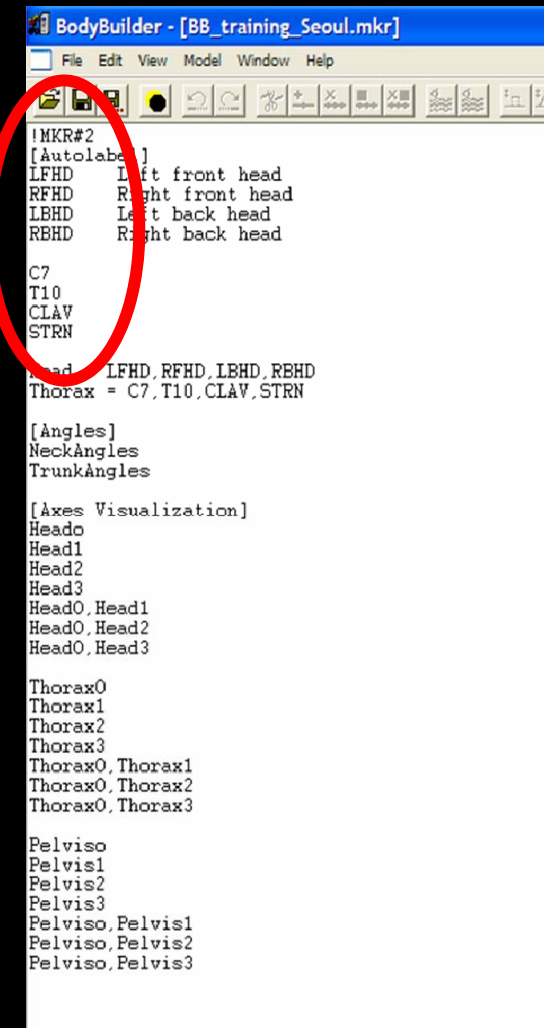
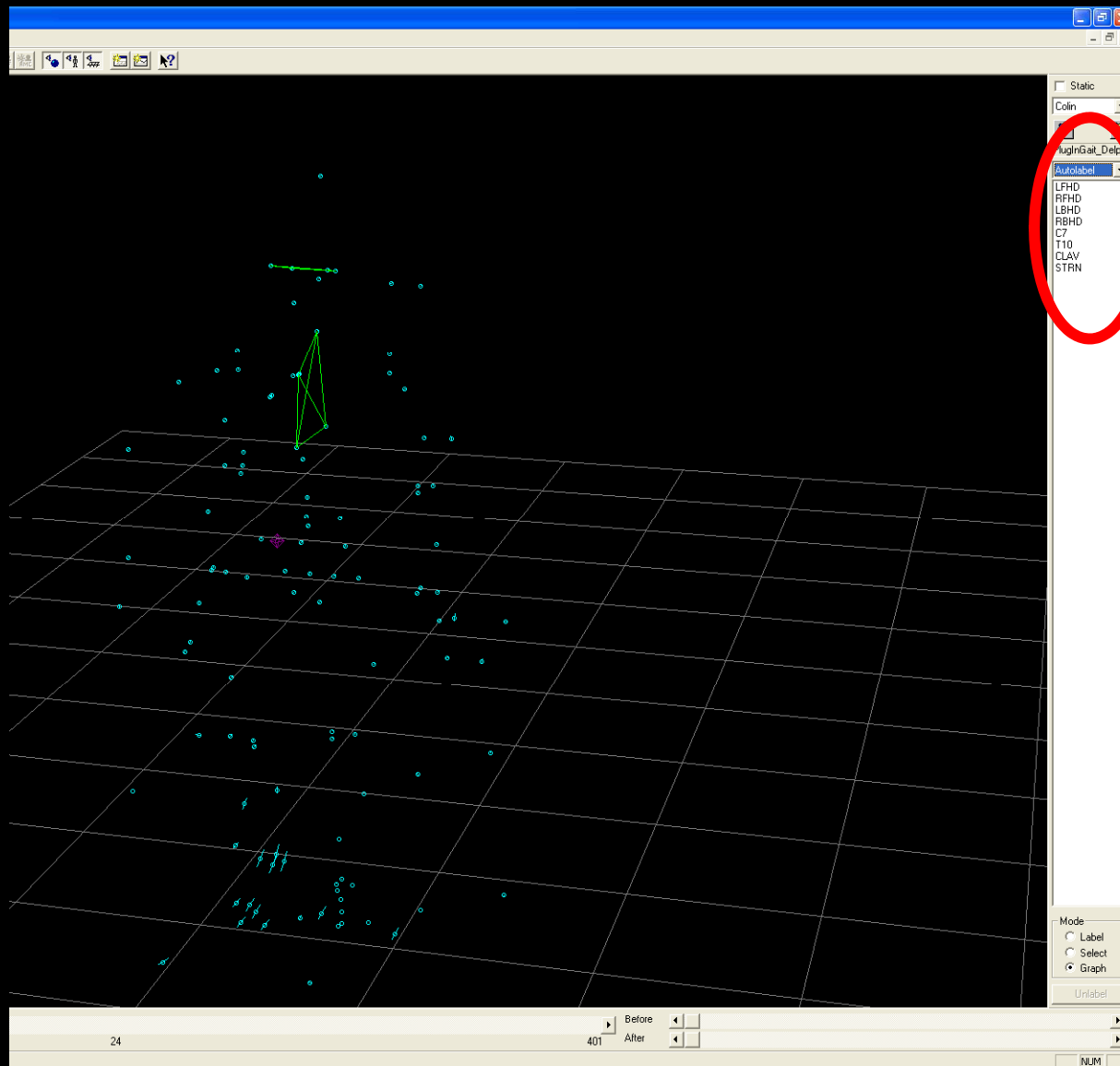
## *Introduction to BodyBuilder interface*

### **Lets go to BodyBuilder and learn how to:**

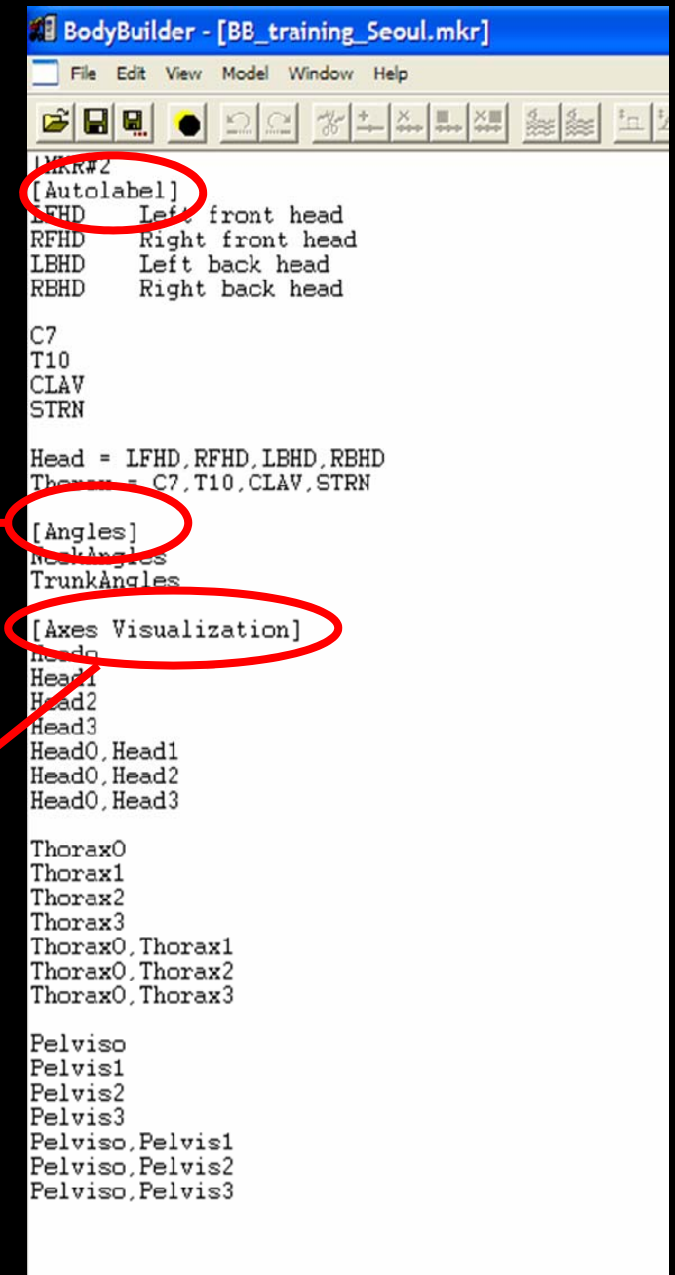
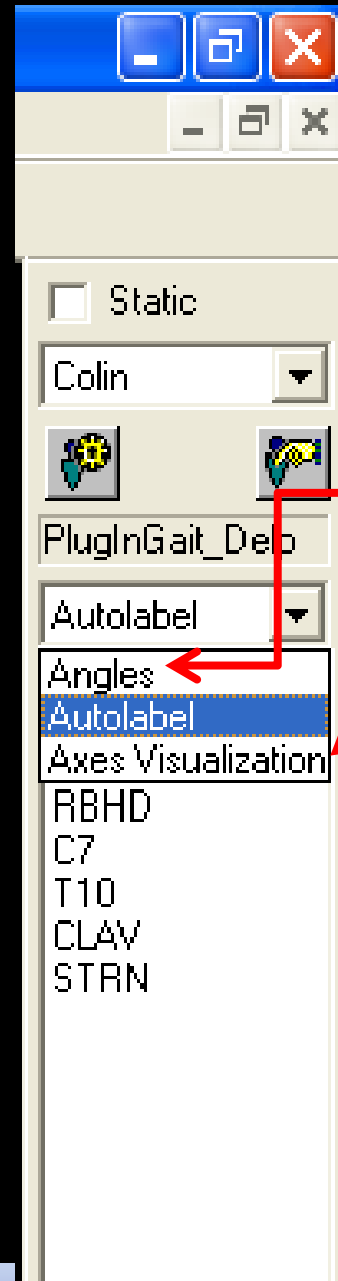
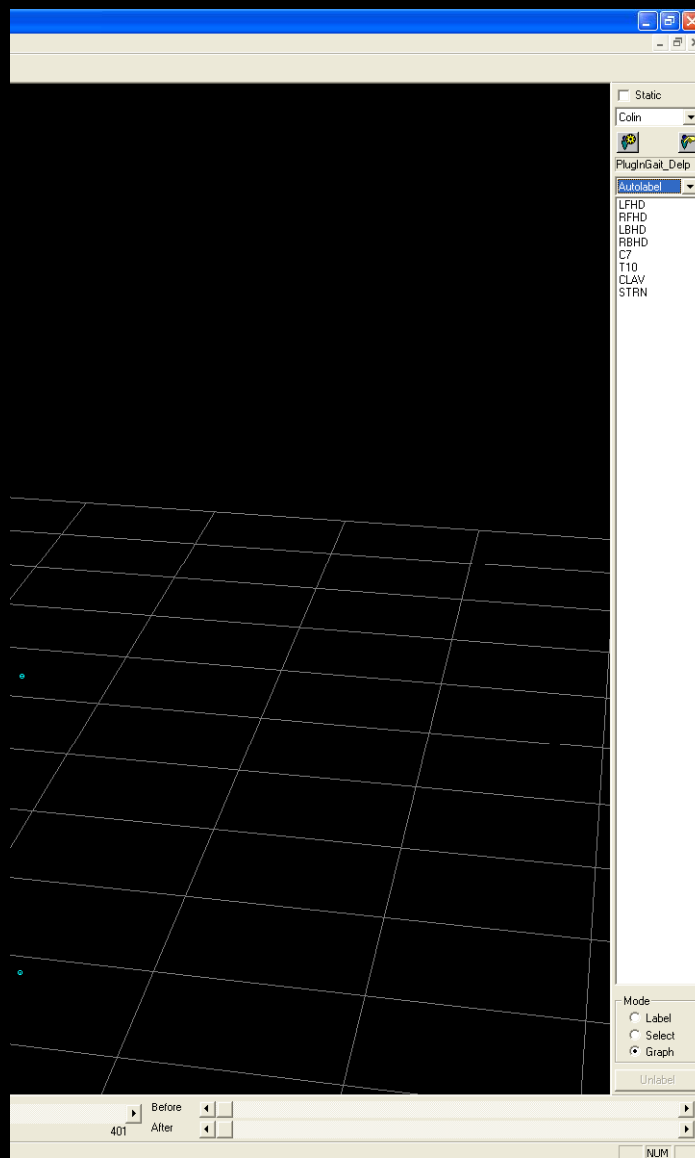
1. Tell BB what MOD, MP, and MKR files to use (Model Menu – Subject Setting or shortcut)
2. Run a model (Model Menu – Run Model ... or shortcut)
3. View outputs (use MRK file sections to select what parameter to graph)
  - Multiple graphs
4. Output to ASCII from BodyBuilder

# Introduction to an MKR file

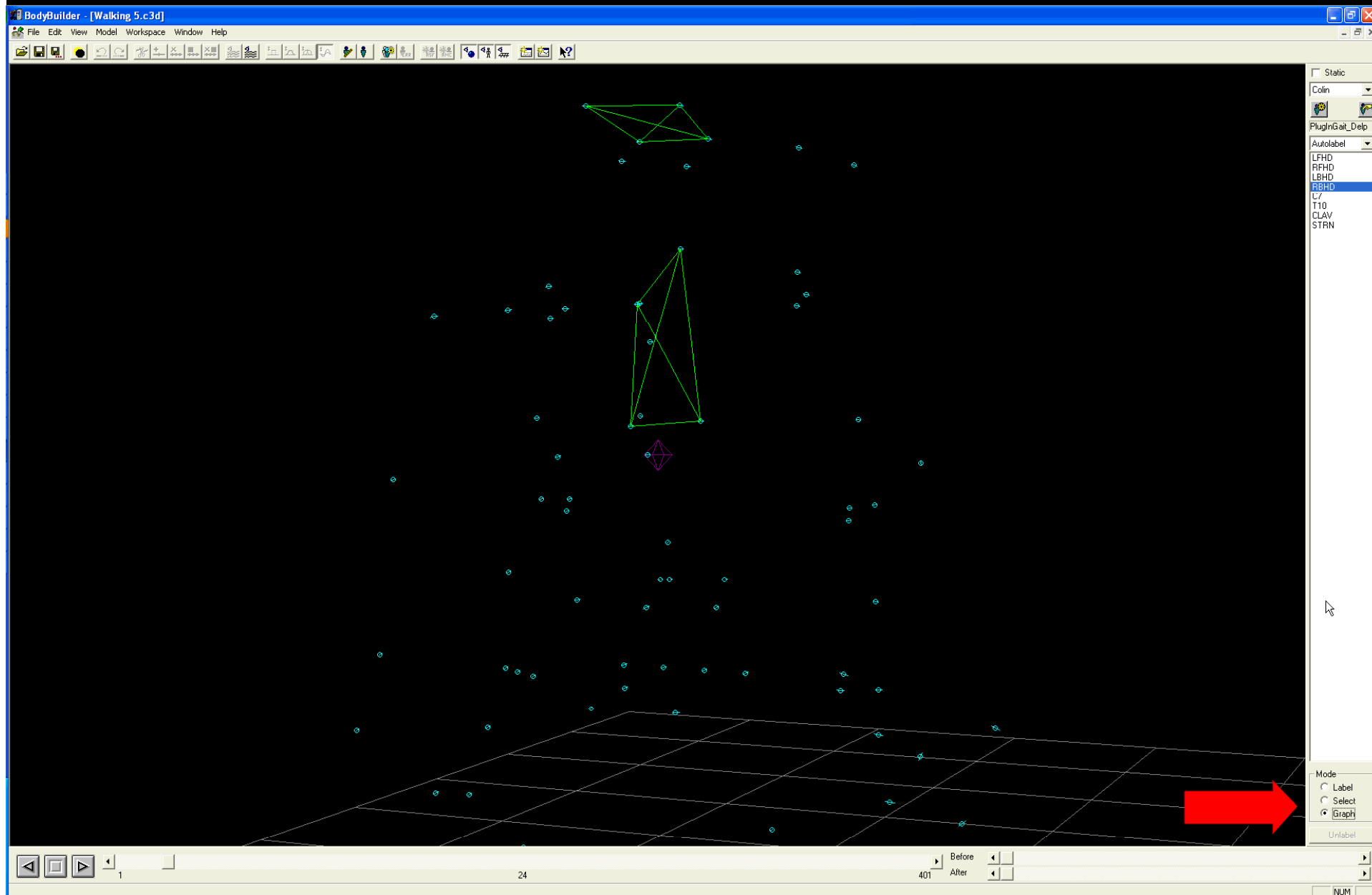
## Required BodyBuilder file types - .MKR



## Required BodyBuilder file types - .MKR



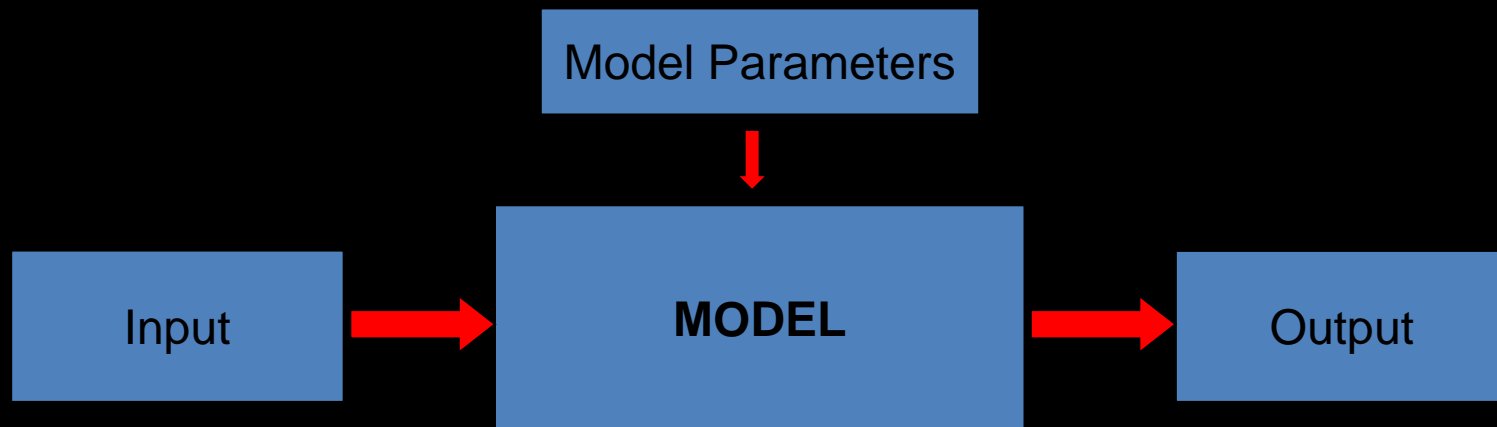
## Display graphs using the marker list



# Planning Your Model

## WHAT IS A MODEL?

A MODEL IS A MATHEMATICAL RELATION THAT ALLOWS FORESEEING THE BEHAVIOR OF THE SYSTEM THAT HAS BEEN MODELLED, GIVEN SOME KNOWN INPUTS AND PARAMETERS



## *Planning your BodyBuilder Model*

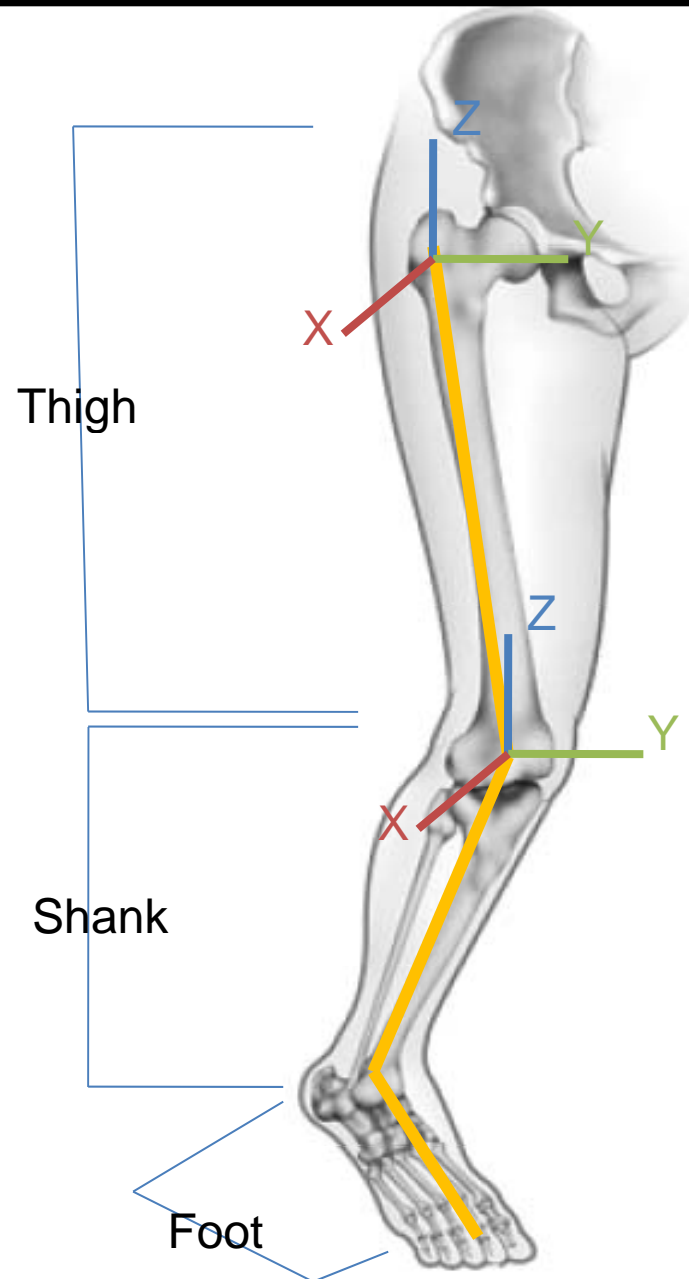
1. Draw a Free Body diagram
2. Consider your research question
  - What are the final outputs I am trying to calculate?
3. Define the rigid body segments to be defined
  - How many rigid body segments do I need to define?
  - Where do the segment origins need to be?
  - How should the segment axes be oriented?
4. Consider marker placement
  - How many markers needed on each segment?
    - At least three to obtain a 3D representation of the segment
  - Any markers needed only for the static trial? (static parameters calculation)
  - What are reasonable labels for the markers?
5. Model Processing
  - What calculations do you need to run on the static trial?
    - i.e. – constant model parameters (MP) to be used in Dynamic calculations
  - What calculations do you need to run on the dynamic trial?
    - i.e. – frame-by-frame kinematics and kinetics

## Planning your BodyBuilder Model - The free body diagram

Once the research objectives are defined, In the diagram, show:

1. the rigid segments
2. Axes locations
3. Axes orientations
4. Marker positions

A Free Body diagram can make the modeling process more stream-lined



## *BodyBuilder is just one Vicon modeling option*

- **Body Language:** A user defined model created using the BodyBuilder package and implemented through the Pipeline or separately in the BodyBuilder application. This course will cover the use of BodyLanguage.
- **Plug-in Gait:** A full body gait and general purpose model incorporated into the Workstation pipeline.
  - Actually a Body Language model who's code is preparatory to Vicon but who's calculations are referenced in many documents
    - See download on [www.vicon.com/support](http://www.vicon.com/support)
      - Plugin\_Nexus\_PluginGait\_ProductGuide\_Foundation\_Rev1.0\_2008Mar.pdf
- **Third Party Options:** This option may include Matlab, Labview, or maybe a custom designed plug in incorporating a specific model.

## Assignment 1

1. Load in the example trial, Walking 1.c3d
2. Create a gap in the LASI marker from frames 267 – 290
3. Adjust the maximum Fill Gaps range to incorporate this gap and then use the Fill All Gaps option to fill the gap. Set the Maximum Fill Gaps back to the default of 10.
4. Use the Undo button to re-create the gap in the LASI
5. Use the Copy Pattern to fill the gap in the LASI with the trajectory of the RASI
6. Run the Golem model on the trial.
  1. Then use the Edit – Delete Model Outputs to see them disappear.
7. Graph the Right and Left Knee Joint angles next to each other.
8. What are the 3 files that make up a BodyBuilder model which you run on your .C3D file? What information does each of these files hold?