

The MotionMonitor xGen Hardware Guide: Interface to Optotrak

Overview

The MotionMonitor xGen provides three different methods for interfacing and collecting data from Northern Digital, Inc. cameras. Each method involves different levels of complexity and is appropriate for different research situations. They include:

1. The MotionMonitor xGen's C3D Model Builder
2. Rigid-bodies 6 DOF Tracking
3. Virtual Sensor 6DOF Tracking

The MotionMonitor xGen C3D Model Builder is a post-processing capability. It uses standard C3D files generated within NDI Toolbench or First Principles as input to create rigid body 6 DOF sensors; locate joint centers and define segment co-ordinate systems. If analog data was collected within NDI Toolbench or First Principles it can also be exported by way of the C3D file format.

Rigid Body 6 DOF Tracking uses NDI 6D Architect/First Principles to build Rigid Bodies which are then streamed into The MotionMonitor xGen. This assumes that each segment is being tracked by at least 3 markers attached to a rigid plate which is then attached to a subject. The marker set is first defined using NDI 6D Architect Rigid Body builder or First Principles. The resulting .rig file and associated markers are then identified in The MotionMonitor xGen and used to perform data collection and analysis.

Virtual Sensor 6 DOF Tracking assumes that each segment is being tracked by at least 3 markers rigidly attached directly to the skin or to a rigid plate. The MotionMonitor records the position and orientation of markers assigned to each body or "virtual sensor", then computes the centroid and coordinate system of these rigid bodies and uses that data to perform The MotionMonitor xGen's standard analytical and visualization routines.

These methods ultimately generate the same information for the researcher. However, where and how certain functions are performed will vary significantly for the three methods.

Note: The MotionMonitor xGen version 3.54b incorporated support for the 64-bit OAPI (version 3.16.0.10), which is compatible with all Certus hardware. However, Optotrak 3020 System Control Units are no longer supported. Optotrak hardware firmware must be updated with OptoUpdate version 3.15.00. To ensure the necessary 64-bit drivers are installed in the C:\ndigital directory, C:\ndigital\programs\x64, the OAPI version 3.16.0.10 API should also be installed.

The MotionMonitor xGen's C3D Model Builder

See the MotionMonitor xGen Knowledge Base article entitled "C3D Model Builder".

NDI First Principles

The following pages detail the necessary steps for operating an Optotrak system using NDI First Principles.

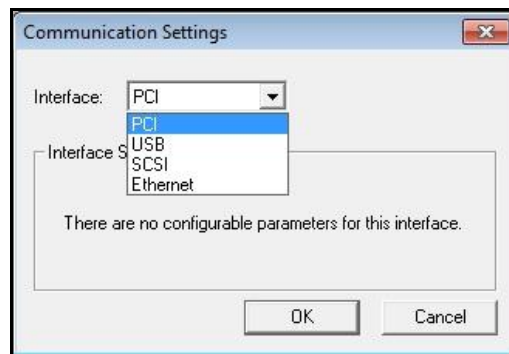
Configuring the Optotrak System using NDI First Principles

A. Open NDI First Principles

1. Double click on the NDI First Principles icon on your Desktop. Upon start up, First Principles will automatically attempt to connect to the Optotrak system, establish communication and determine hardware configuration.

B. Communication Settings

1. From Settings|Communication Settings, select the appropriate interface option from the dropdown menu.



Depending on the interface option selected, additional parameters may be required. Note: In order to use the USB interface, oapi.dll version 3.07 or later must be located within the Innsport local directory. The specific version of the oapi.dll used will depend on the firmware version of Optotrak hardware.

Note: It may be necessary to make the following modifications to the optotrak.ini file located in the C:\ndigital\settings directory after completing the Configuring the Optotrak System using NDI First Principles section of this guide.

For USB Interface: Following the entry for Driver, add "Driver64 = usblink64.dll" if it is not already there. Also, set the ResetTimeout to "5000".

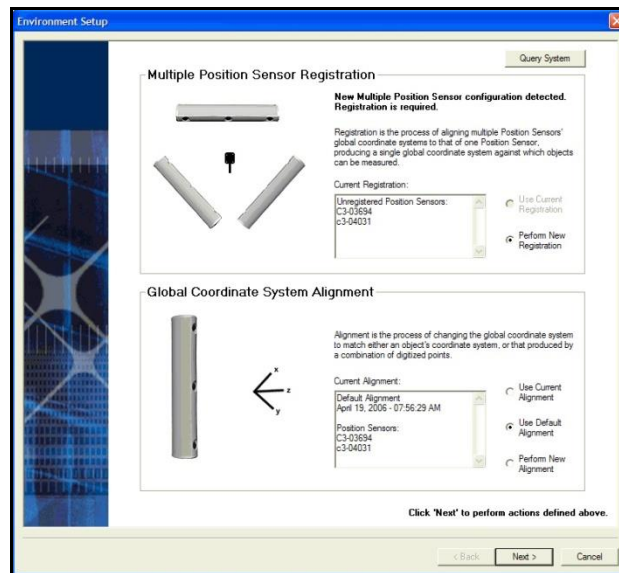
For Ethernet Interface: Following the entry for Driver, add "Driver64 = etherlink64.dll" if it is not already there. Also, set the ResetTimeout to "1500".

C. Query System

1. From Utilities|Query System. Query your system in order to ensure that the software recognizes the Optotrak hardware connected and that the software can communicate properly with all hardware. A Detected System Devices window will display information regarding the system control unit and any cameras connected to the system. Note: If First Principles cannot successfully query the Optotrak system and all of its components, The MotionMonitor xGen will not be able to successfully connect to the devices either.

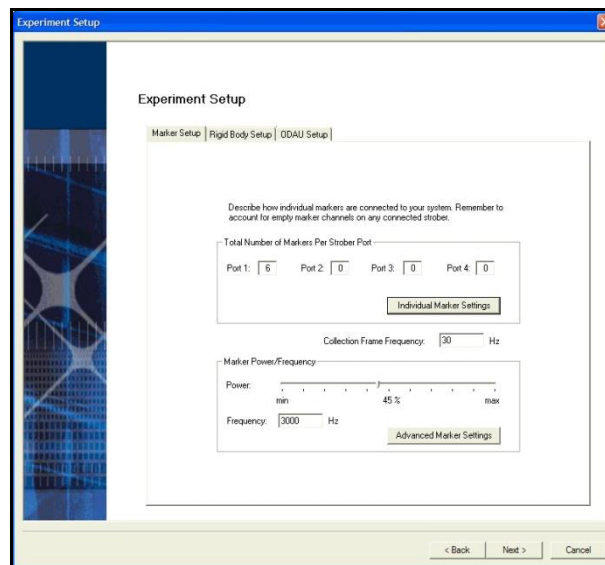
D. Environmental and Experiment Setup

1. Select Settings|Coordinate_System_Details, File|New_Experiment or File|Open_Experiment to start the Environment Setup process.



This is where the process of registering multiple position sensors would take place as well as selecting how your coordinate system is defined. Under normal conditions the default coordinate system of a position sensor can be selected here, as an experimental global coordinate system can be easily defined within The MotionMonitor.

- Next, continue with the setup of your experiment by specifying the number of markers connected to each strober port as well as the marker power and frequency. Click Next and then Finish to complete the experiment setup.

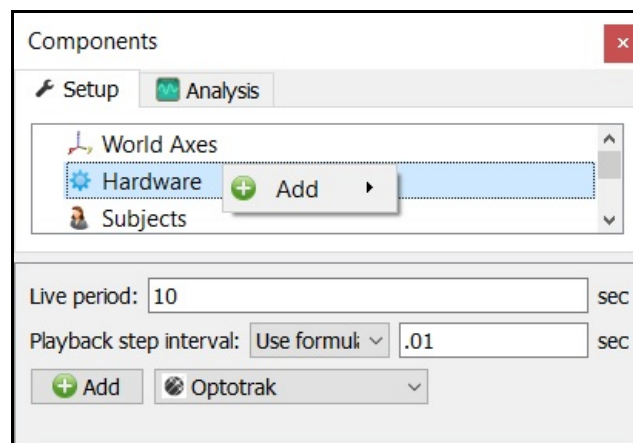


- With all of the markers in view of the position sensor, go to View|Text_View to confirm that you can see the marker data in real time. Right click within the View window to define what data are reported. Note: If data cannot be seen here, it will not be seen in The MotionMonitor xGen either.
- First Principles must be closed before proceeding to The MotionMonitor xGen.

Rigid Body 6 DOF Tracking & Virtual Sensor 6DOF Tracking

These approaches rely on 3DOF marker data being combined into 6DOF rigid bodies. The process can be accomplished either through NDI 6D Architect/First Principles via the creation of .rig files, The MotionMonitor via the creation of Rigid Body Collections or a combination of both. Regardless of which application produces the 6DOF sensor out of 3DOF markers, the data can be used interchangeably throughout The MotionMonitor xGen. The step by step procedures for using .rig files and creating Rigid Body Collections within The MotionMonitor xGen are covered in the following pages. The procedures for generating .rig files through NDI 6D Architect/First Principles are not covered here.

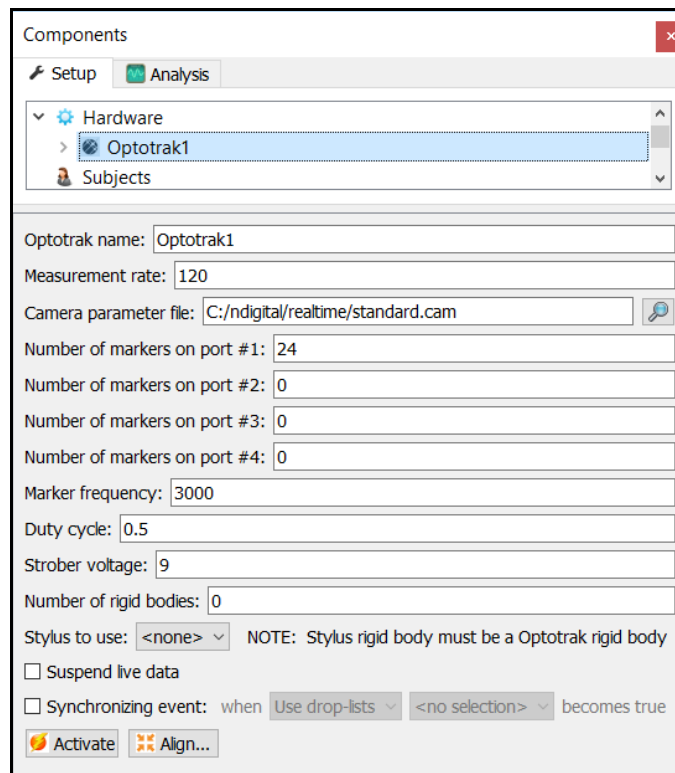
1. Start The MotionMonitor xGen and go to the Hardware node in the Setup Components window. Add the Optotrak device from the Add button in the parameters panel at the bottom of the Components window or by right clicking the Hardware node and adding the device through the cascading drop list.



2. Click on the Optotrak device to bring up the Optotrak parameters panel. Specify the measurement rate (commonly referred to as the Frame Frequency in Optotrak documentation) and browse to the Camera parameter file containing the position sensor registration and alignment. The number of markers specified for each port should match the number of LEDs physically connected to each strober port (including any markers that belong to .rig files or tools). The Marker frequency (1,000 to 4,600), Duty cycle (10 to 85) and Strober voltage (6.0 to 12.0) should also each be specified.

Note: Please refer to the Optotrak Certus User guide for a more detailed description of these Optotrak parameters and warnings for these settings, in order to avoid injury and/or property damage and to help extend the life of your Optotrak hardware. These are the same parameters specified in the First Principles steps previously outlined for defining the Experiment Setup.

If streaming rigid body files defined through 6D Architect/First Principles, the number of rigid bodies should be specified to match the number of rigid bodies that have been configured. Otherwise, leave this field set to 0.



The screenshot shows the 'Components' dialog box with the 'Analysis' tab selected. Under the 'Hardware' section, 'Optotrak1' is selected. The 'Number of rigid bodies' field is set to 0. The 'Stylus to use' dropdown is set to '<none>'. The 'Activate' button is highlighted.

The stylus that is being used for aligning this hardware device (i.e. digitizing a new world axes, unique from what was defined in the camera parameter file) must be selected here for the Stylus to use. After Activating the hardware, the “Align” button will result in a sequence of prompts for digitizing a new world axes layout according to the selections for the World Axes layout in the World Axes Setup Component.

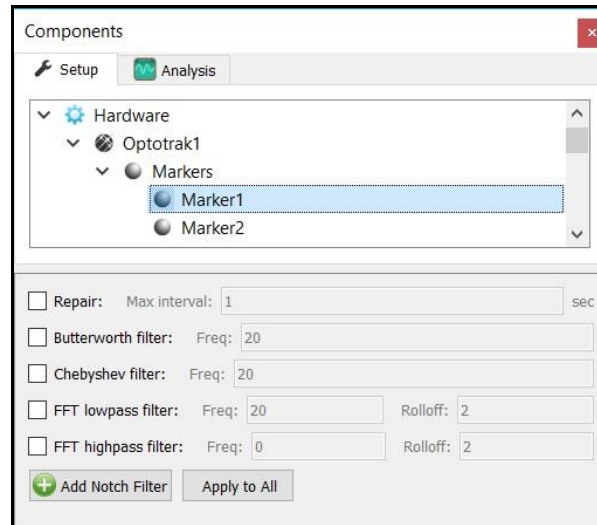
Data in the Live window can be suspended by placing a mark in the checkbox for Suspend live data. The processing and display of data in a live mode uses computer resources, so this option allows the user to optimize computer resources and free up more processing power for data collection. This setting is independent for each hardware device and once an activity has been recorded data from the full measurement rate will be accessible for analysis.

A synchronizing Boolean event can be specified for performing an active alignment of the Optotrak data stream with synchronous events from other hardware data streams. The Synchronizing event used here must be defined from Optotrak data.

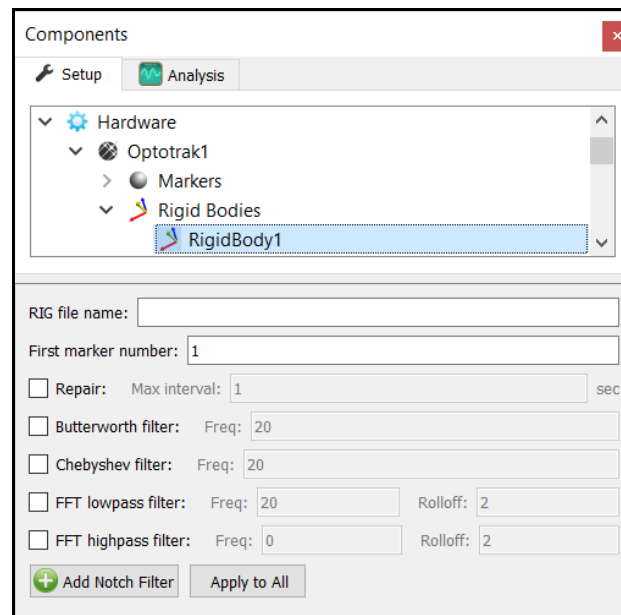
The “Activate” button will initialize the communication between The MotionMonitor xGen and Optotrak hardware.

- The Marker and Rigid Bodies Optotrak sub-nodes will update according to the number of markers on each port and number of rigid bodies specified through the Optotrak parameters panel.

The image below shows the parameters panel for Optotrak Marker data. Data repair and smoothing settings can be enabled or disabled here, pre or post data collection for marker and marker derived data. The marker order is determined first by port number and then by the sequence of the marker order on that port. For instance, the first LED on port 1 would be Marker1.



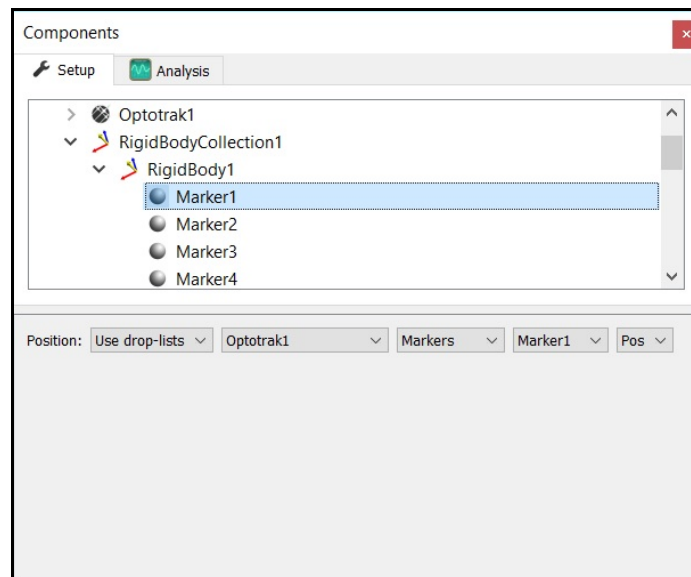
The image below shows the parameters panel for Optotrak Rigid Body data. Data repair and smoothing settings can be enabled or disabled here, pre or post data collection for Rigid Body and Rigid Body derived data. The RIG file name for any tools or rigid bodies defined through of NDI 6D Architect/First Principles should also be specified here along with the number for the first marker used in the RIG definition. The name of the RIG file should follow the nomenclature, smart_01.rig.



4. After all these parameters have been configured the Optotrak hardware device can be activated from the Optotrak parameters panel. Click the “Activate” button to initialize the communication between The MotionMonitor xGen and Optotrak hardware.
5. If only receiving 3DOF marker data from Optotrak, 6 DOF rigid bodies can be defined through **The MotionMonitor xGen** as seen in the dialog below. Rigid Body Collections can be added to the Setup Components dialog window as a Hardware device from the Add button in the parameters panel at the bottom of the Components window when Hardware node is selected or by right clicking the Hardware node and adding the device through the cascading drop list.

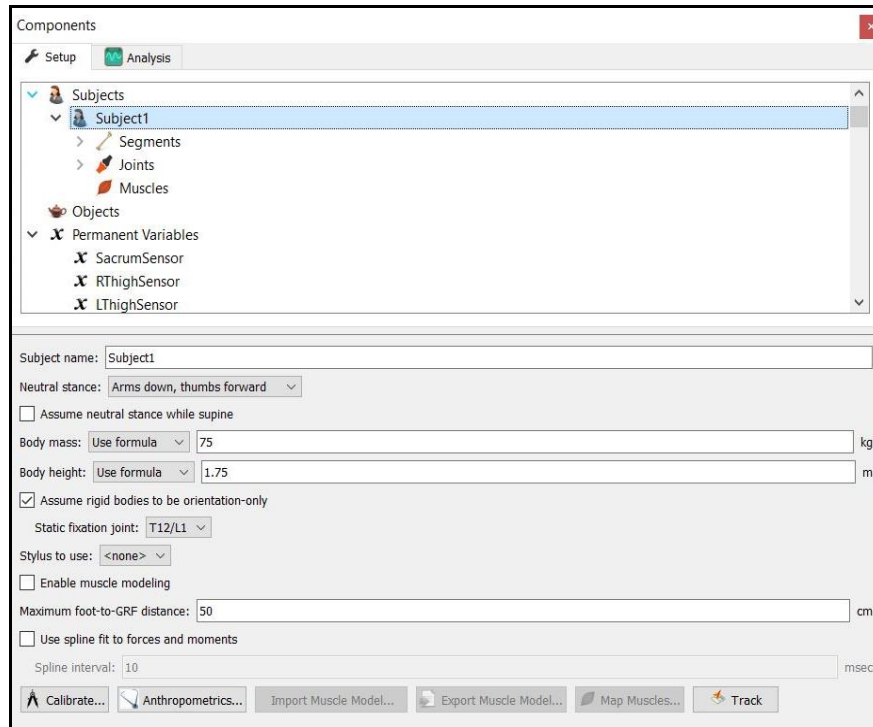
Multiple Rigid Bodies can be added to a Rigid Body Collection, each of which can be defined using different combinations of marker assignments. Rigid Bodies can be added to a Rigid Body Collection by clicking the “Add Rigid Body” button in the parameters panel for the Rigid body Collection or by right clicking on the Rigid Body Collection and selecting Add Rigid Body. Markers can be added to a Rigid Body by clicking the “Add Marker” button in the parameters panel for the Rigid body or by right clicking on the Rigid Body and selecting Add Marker. Remember that 3 or more markers are required to create a Rigid Body.

Each rigid body marker needs to be associated with an Optotrak marker which can be done either by selecting them through drop down menu selectors or defining them using a formula. Do not include markers in the rigid body definitions which will be removed for dynamic recordings. Markers can also be lassoed in the Animation window using the Shift key + Left Mouse button to create and add to an existing Rigid Body. Clicking on the Highlight button from the Rigid Body node will highlight the selected markers for that Rigid Body in the Animation Window.



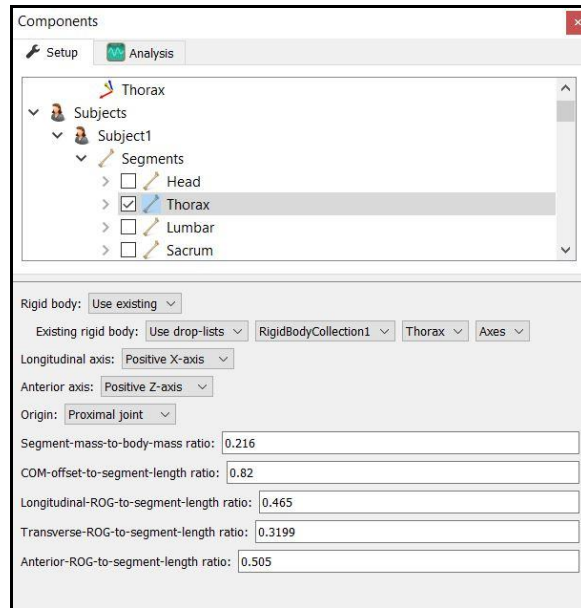
The Calibrate Rigid Bodies button takes a reading of the markers, computes centroids, creates sensor axes, establishes the relationship between markers and generally prepares the system to track the cluster of markers as 6 DOF data. Rigid Bodies can be calibrated one by one from the Rigid Body node level or all at the same time by going to the top level of the Rigid Bodies Collection and clicking the Calibrate All button. After this step, markers and their rigid body axes can be viewed in Animation window or graphed and recorded as position and orientation data.

6. The next step is to define your biomechanical model within **The MotionMonitor xGen**, which entails selecting which body segments you'll be tracking, assigning rigid bodies to track each body segment, defining segment endpoints or joint centers and generating customized segment axes, if desirable. To begin this process, right click on the Subjects header within the Components Setup tab and add a new subject by clicking on the "Add Subject" button in the Subjects parameters panel or right clicking on the Subjects node and selecting Add Subject.

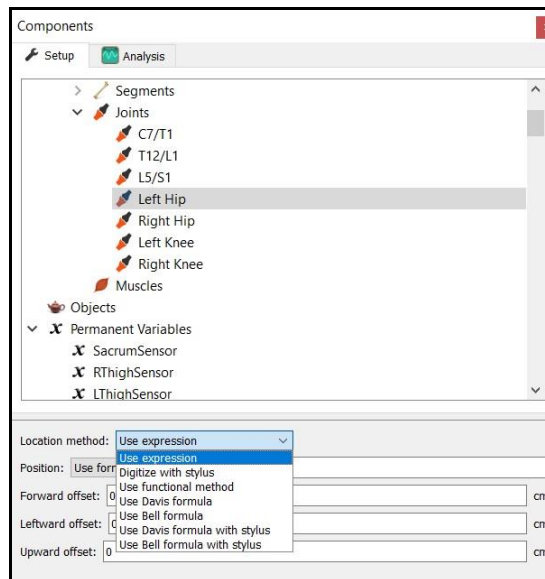


As seen above, a name can be assigned to the subject and basic anthropometric data can be entered. Confirmation for the orientation of the subject during the static reading and selection of a stylus to be used for digitizing, if required, are also selected here. A tutorial video for configuring and calibrating a stylus can be found at <https://themotionmonitor.com/support/>. The Calibrate button can be clicked after all of the required setup information has been entered.

- The Segments header located under the Subject node is where the desired segments to be tracked can be enabled as well as where the assignment for which rigid body will be used to track the segment is defined. Additional basic anthropometric information can be defined here for each segment as well.

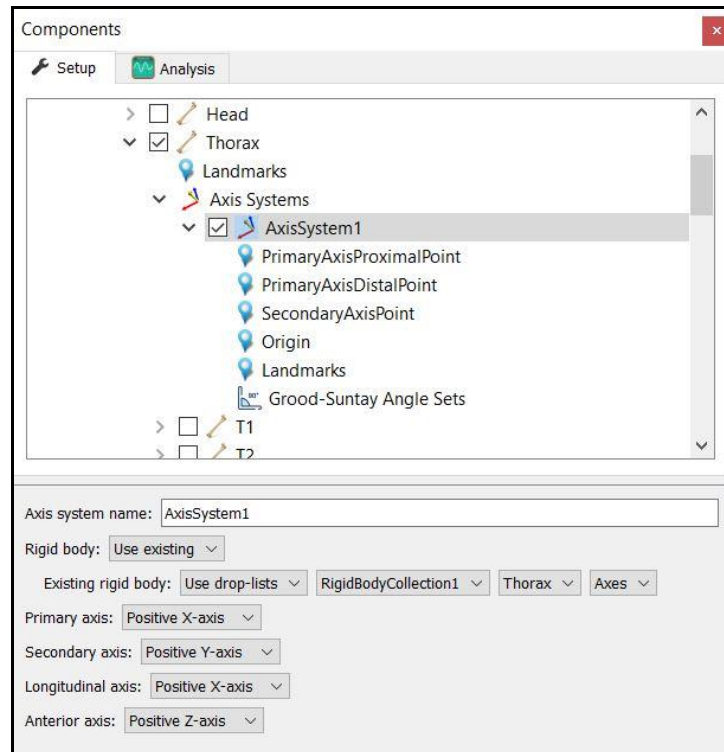


- Each body segment which is enabled will require the definition of a proximal and distal endpoint or joint centers. The required joint centers will be automatically populated based on the selection of segments.



- As seen above, each joint center can be defined using a digitizing method or expression based on marker positions. Alternatively, the hip and shoulder joints can be defined using linear regression algorithms or functional (rotational) methods.

10. Once these definitions are completed, the Subject Calibrate button can be clicked. A warning message will be displayed for any definitions have not been appropriately defined.
11. Additionally, if alternative or anatomically based local coordinate systems are desired, they can be defined by right clicking on a segment and selecting Add Axis System. First, the Rigid Body axes tracking the segment and general axes layout are selected. Then, points can be defined for the proximal and distal endpoints of the primary axis, a point along the secondary axis and a point for the Origin. The default local coordinate axes generated by **The MotionMonitor xGen** are defined as having a long axes through the joint centers and A/P and M/L axes being orthogonal to the long axes and parallel to the world when the subject was standing in the neutral position.



12. At this point, the **The MotionMonitor xGen** subject is fully defined and can be used for **biomechanical models, recording activities, performing computations and reducing data.**

See our “Getting Started Biomechanics Guide” for more information on these aforementioned topics. For further configuration of your software, visit <https://themotionmonitor.com/support/> where you can...

- Download The MotionMonitor xGen Elements PDF, a written manual explaining key features of the software
- Review tips for Best Practices in configuring your MotionMonitor xGen software for optimal performance
- Take a video tour of The MotionMonitor xGen basic elements.
- Review training and tutorial videos, including basic software functionalities.