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# Creating labeling skeleton templates (VSTs)

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## About this guide

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The following topics guide you step-by-step through the process of creating a custom labeling skeleton template (also known as a Vicon labeling Skeleton Template, or VST) with Vicon Nexus.

- [About labeling skeleton templates on page 5](#)
- [Create a labeling skeleton template on page 10](#)
- [Troubleshooting labeling skeleton templates on page 38](#)

Related Nexus 2 videos, [Building a Custom VST](#) and [Using a custom VST](#), are available on YouTube.

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## Regulatory information

For Vicon Nexus regulatory details, see Vicon Nexus regulatory information in the Nexus documentation area of the Vicon documentation website ([docs.vicon.com](https://docs.vicon.com)).

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## About labeling skeleton templates

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To identify subjects and to process their motion data, Vicon Nexus requires information, such as a description of the generic relationship between segments and joints and the Vicon markers for a certain type of subject, such as a human being. This information, which identifies the markers that Nexus is to track and how these markers are connected to the underlying segments, is stored in the following file types:

- **VST – labeling skeleton template (.vst file).** Describes the generic relationship between physical markers attached to a subject and the skeletal structure to which the markers are attached for a certain type of subject, for example, a human being.
- **VSK – labeling skeleton (.vsk file).** Describes the relationship between physical markers and the skeletal structure to which the markers are attached for a specific subject of the type described in the associated VST. For example, if the VST represents a human being, the VSK contains the marker arrangement and skeletal structure calibrated for an individual person.

The workflow for creating and using these files can be summarized as follows:

- Creating a VST is a one-time task. You create a template once for a specific marker set or a general type of labeling skeleton, such as a human being. One generic labeling skeleton template (VST) can be used on many different sizes of subjects (from someone very short to someone very tall), all wearing the marker set described in the VST.
- You then calibrate the VST to a specific subject at the beginning of each capture session (but not before every trial). Subject calibration updates the generic relationships from the VST with subject-specific information, such as the length of the segments or the distance between specific markers for the subject, which is saved to a labeling skeleton (VSK) for the subject.

You only need to recalibrate if the subject changes, for example, if a different subject wears the same marker set, or if the markers are moved.

 **Important**

The labeling skeleton template (VST) is used only for labeling, so the aim is to define a labeling skeleton template that labels movement trials reliably, not one that is anatomically correct.

For more information, see:

- [When is a custom labeling skeleton template needed? on page 7](#)
- [Labeling skeleton template contents on page 8](#)
- [Requirements for creating a custom labeling skeleton template on page 9](#)

## When is a custom labeling skeleton template needed?

A labeling skeleton template defines a marker set and enables Nexus to perform automatic labeling. In many situations, the standard templates for Plug-in Gait that are supplied with your Nexus installation will produce the required labeling. However, in some circumstances, you may need to create your own custom template to provide additional information to Nexus. Examples of situations when you may need to do this include:

- When you want to include segments that are not present in Plug-in Gait, such as hand models
- When you want to include additional marker placements, such as marker clusters
- When you want to track objects, such as a golf club

After you have created a labeling skeleton template, you can use it to automatically process markers and obtain labeled trajectories for any subjects that use the same marker set.

### Important

A labeling skeleton template (VST) defines a marker set and enables Nexus to perform automatic labeling. It is not a biomechanical model that will output valid joint angles or other kinematic/kinetic variables. To compute valid kinematics or kinetics, you must either use a pre-defined biomechanical model (such as Vicon Plug-in Gait, which involves running specific pipelines in Nexus) or create your own model using Vicon BodyBuilder, MATLAB, or Python.

## Labeling skeleton template contents

The labeling skeleton template (VST) contains the following information:

- The names of the markers in the marker set (e.g. LASI, RASI)
- The skeletal structure of the subject you are tracking (e.g. the Femur connected to the Pelvis, the Tibia connected to the Femur)
- The relationship between the marker set and the skeletal structure (e.g. the LASI marker is attached to the Pelvis segment)
- The type of joints that connect the segments to other segments (e.g. ball joint, free joint)
- Other properties, such as segment, marker and joint names and colors, and how the markers are displayed in the 3D Perspective view.



## Requirements for creating a custom labeling skeleton template

For the best results, plan your initial trial, in which you will capture the marker set for the custom labeling skeleton template, to meet the following requirements:

- Avoid occlusion (hidden markers). For example:
  - Do not include more than one subject in the volume.
  - Ensure that the subject can complete the required movement without assistance, or the use of crutches or other mobility aids, or that, if these are necessary, they do not hide the markers from the cameras.
- Ensure that the base pose (the subject's body position that is used for initial labeling) is easily reproduced by the subject.

In addition, ensure that the labeling skeleton template (VST) is built using the recommendations given in this guide, specifically that it:

- Is built using the **Labeling Template Builder** in Nexus 2, as described in this guide.

### Note

If you have created your own labeling skeleton template outside of Nexus, these instructions may still be useful, but you may need to make some adjustments to suit your particular template.

- Has at least three markers per segment

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## Create a labeling skeleton template

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If you cannot use one of the Vicon-supplied labeling skeleton templates (see *Create a new subject from a template* in the *Vicon Nexus User Guide*), you must create a labeling skeleton template (.vst file) for each type of subject whose motion is to be captured. You can then use the custom VST to automatically label trials containing subjects of that type.

To create a labeling skeleton template in Vicon Nexus, you first define a marker set. Using the **Labeling Template Builder** in Nexus, you then create and link segments based on reconstructed markers that you select in the **3D Perspective** view, calibrate the skeleton template, and save the file for use with subsequent trials. The following topics describe how to do this:

- [Design a marker set on page 11](#)
- [Create a subject node and prepare a subject on page 12](#)
- [Capture and reconstruct the marker set on page 15](#)
- [Add parameters to a labeling skeleton template \(optional step\) on page 16](#)
- [Create the skeletal structure on page 19](#)
- [Assign marker and segment properties on page 32](#)
- [Optimize a custom labeling skeleton template on page 36](#)
- [Save a custom labeling skeleton template on page 37](#)

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## Design a marker set

Before you create a new labeling skeleton template (VST), design your marker set so that the labeled markers will give the information that is required for your work. For example, if you are creating a new VST because you are designing a new biomechanical model (which you can produce using BodyLanguage, Matlab, or Python), you must make sure that the labeled 3D marker positions will be enough, or more than enough, to calculate all the required joint centers and segment orientations.

This step is very important, because all the subsequent work you do in Vicon Nexus depends on you having initially identified a comprehensive marker set. The main purpose of setting up a labeling skeleton template in Nexus is to provide automatically labeled markers, so Nexus can process your data quickly and easily after capturing trials.

Vicon recommends that you create a full list of the markers required for your particular experiment, the labels that these markers will have, and which markers, if any, are only required for a static trial.

### Tips for designing a marker set

- In addition to preparing a list of markers, consider attaching markers to a subject and viewing them in the capture volume as part of the design process.
- Aim to have at least three markers for each required segment: two markers will give a line, but three markers will enable the calculation of a plane.
- When you create your marker set, it is often useful for both the labeling skeleton template and for your biomechanical model to have markers placed on joint axes. However, for the most efficient labeling, avoid sharing markers between segments.
- If possible, avoid placing markers where they will be subject to unwanted movement (for example, on soft tissue), and/or where they will be occluded by the subject's movement during movement trials.

After you have finished designing your marker set, you must create an empty subject in which to configure the template.

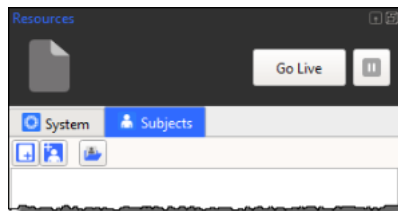
## Create a subject node and prepare a subject


After you have designed your marker set (see [Design a marker set on page 11](#)), on the **Data Management** tab, create or open a session in a database in which you want to store the trial data, and ensure that it is the active session. You can then create a new, blank subject in which to store the template (VST) information.

After you have created a subject node in Vicon Nexus, you capture a short trial and reconstruct the markers.

To create an empty subject node:

1. In the Resources pane, click on the **Subjects** tab.



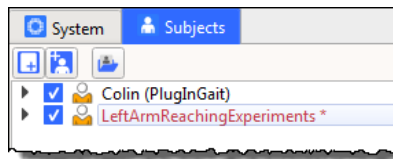
2. Click the **Create a Blank Subject** button . Nexus prompts you to enter a subject name.

3. Enter the name by which you will identify the template, such as LeftArmReachingExperiments.

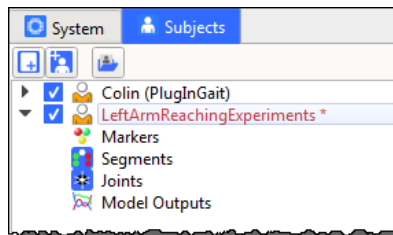
Tip

Subject names must have no more than 32 characters.

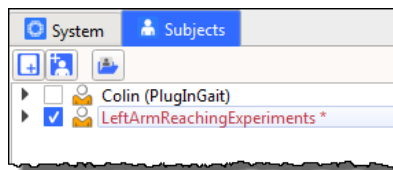
A new subject node is added in alphabetical order to the Subjects resources tree.



Sub-nodes for the minimum elements required for a VSK are automatically added: Markers, Segments, Joints, and Model Outputs.



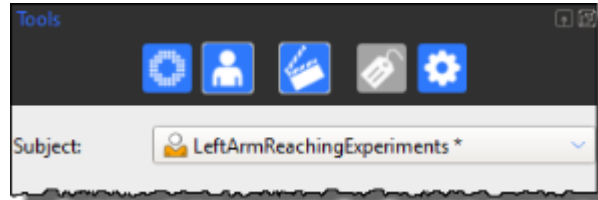
4. Make sure the check box next to your new subject name is the only box selected in the Subject list.



The subject node name is initially displayed in red to indicate that the node is empty of data, and with an asterisk \* to indicate that it has not yet been saved. When the node contains a fully populated VST or VSK, the node name is displayed in black.

5. In the Tools pane, click the Subject Preparation button .

6. From the **Subject** drop-down menu, ensure the subject you just created is selected.





7. Place markers on a subject according to the marker set you have designed. You are now ready to capture a short trial that will form the basis of your labeling skeleton template.

## Capture and reconstruct the marker set

After you have prepared your subject (see [Create a subject node and prepare a subject on page 12](#)), you can capture the marker set. To do this, you capture a brief static trial, ensuring that the subject is positioned in the required base pose (for details of how to produce a reliable base pose, see below), with all the markers visible to the cameras.

To capture a trial containing the markers:

1. With the subject in the middle of your capture volume, ensure you can see the subject's unlabeled markers in the **3D Perspective** view.
2. Position the subject in the required base pose. Ensure that the pose meets the following criteria:
  - Easy for the subject to achieve and to reproduce
  - All the markers are clearly visible to all cameras. For example, if the subject requires assistance or a mobility aid to achieve the base pose, ensure that these do not hide any markers from the cameras. Also avoid positioning limbs in such a way as to hide markers (for example, arms folded or legs crossed).
3. Perform a short (a few seconds) static capture. To do this:
  - a. With Nexus in Live mode, in the **Subject Preparation** pane  , click **Start** in the **Subject Capture** section. The **Start** button label changes to **Stop**.
  - b. Click **Stop** to finish the capture.
4. To reconstruct the markers, on the tool bar click the **Reconstruct** button  , or run the **Reconstruct** pipeline.
5. In the **3D Perspective** view, check that all the markers attached to your subject have been reconstructed.

You can now add any required parameters to the template.

## Add parameters to a labeling skeleton template (optional step)

If required, you can add parameters to a labeling skeleton template to enable you to specify the physical measurements of your subject(s) (such as height, weight, and limb lengths).

When you add subject parameters to a template, you can specify which parameters the labeling skeleton requires, which are optional, and the default measurements for the parameters that you specify.

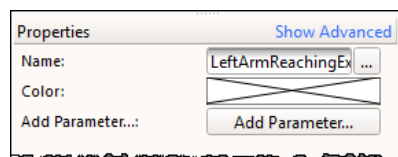
**Tip**

If parameters have been specified for a group of subjects, you can search for a particular parameter using the search functionality on the **Data Management** tab.

You add parameters to a labeling skeleton template in the Properties section in Nexus.

To add parameters to a labeling skeleton template:

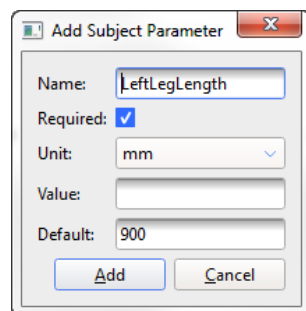
1. In the **Subjects Resources** tree, ensure that the subject you created earlier is the only subject selected.
2. In the **Properties** section at the bottom of the pane, click the **Add Parameter** button.



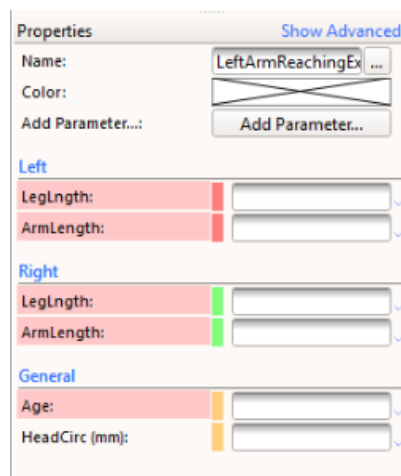


3. In the **Add Subject Parameter** dialog box, enter the following:

- ▮ **Name:** Enter a name for the parameter. Do not use spaces. If you prefix the name with Right or Left (for example, LeftLegLength), it appears in the corresponding section (**Left**, **Right**, or if unspecified, **General**) in the Properties pane.
- ▮ **Required:** If this parameter is required for the labeling skeleton, select the check box; if the measurement is optional, clear the check box.
- ▮ **Unit:** Select the units of measurement (mm, deg, kg, etc.). If you are entering a parameter for which no suitable units are displayed (eg, Age), select None.
- ▮ **Value:** Enter the parameter value that is initially displayed and can be edited after the subject has been measured. You can leave this field blank if preferred.
- ▮ **Default:** Enter a measurement that can be selected if no other measurement is entered. You can leave this field blank if preferred.



4. Click **Add**. The parameter is displayed under the General, Right, or Left sections, depending on the name you gave it. Required parameters are highlighted in pink until you supply a value for them; optional parameters (like HeadCirc in the following example), are not highlighted.



5. Continue adding parameters until you have specified all the parameters needed for your template.

You can now create the skeletal structure for your template.

## Create the skeletal structure

After you have reconstructed the markers (see [Capture and reconstruct the marker set on page 15](#)) so that the capture contains all the markers that your template (VST) requires, and added any required parameters, you can create the skeletal structure, using the **Labeling Template Builder** section of the **Subject Preparation** tab.

The purpose of the skeletal structure is to define how the markers move with respect to each other, so that Nexus can use this information to automatically label the markers in real time as well as offline. The aim is to create a labeling skeleton template that will, when scaled to a subject, reliably and automatically label movement trials.

### Important

The template is used only for labeling in Nexus, so the aim is to define a labeling skeleton template that helps the labeler get it right, not one that is anatomically correct.

As explained in the following topics, creating the skeletal structure consists of creating segments between markers, and linking the segments with joints:

- [Create segments on page 20](#)
- [Link segments on page 27](#)

You can then set the marker, segment, and joint properties (see [Assign marker and segment properties on page 32](#)).

## Create segments


You create segments from the markers you reconstructed previously (see [Capture and reconstruct the marker set on page 15](#)) using the **Labeling Template Builder** in the **Subject Preparation** tab of the **Tools** pane. Typical segments you would create for a live subject include Pelvis, Head, Femur, etc.

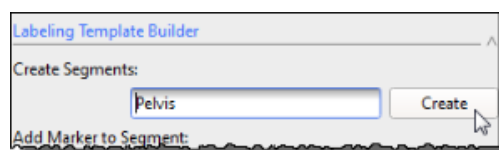
You create the segments for your template by grouping markers that move in roughly the same way. For example, if you have three markers on the shank, one at the knee joint, one half-way down the shank and one at the ankle joint, these three markers can be considered to be attached to the same segment (known as the TIBIA segment).

You can also consider markers that are placed close to a joint to be part of both the proximal and distal segment. For example, a marker placed on the anterior superior iliac spine (ASIS) can be considered to be part of both the pelvis and the thigh segments, even though it is actually attached to the pelvis segment.

Ideally, a segment should be defined by three or more markers: one to define the origin, one to define the primary axis of the segment and one to define the secondary axis. If the segment is the child segment of another segment, the secondary axis marker can be omitted. In addition, any number of additional markers that do not specifically define the segment's axes can be added.

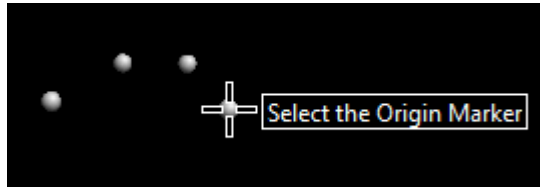
To create segments:

1. Go to the **Subject Preparation** tab of the **Tools** pane .
2. In the **Labeling Template Builder** section, click in the **Create Segments** field. Enter a name for the first segment, for example Pelvis, and then click **Create**.



Segment names can contain spaces, and if they are preceded by **L** or **R**; or **Left** or **Right** (followed by a space), they are automatically colored appropriately if you are using the default color scheme.

The mouse pointer changes to a cross-hair with the label **Select the Origin Marker**.

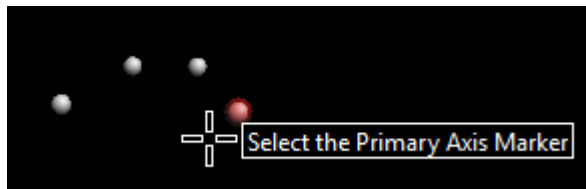


3. In the 3D Perspective view, click on the marker that defines the origin of the segment you are creating. For the Pelvis, this could be the LASI or the RASI marker.

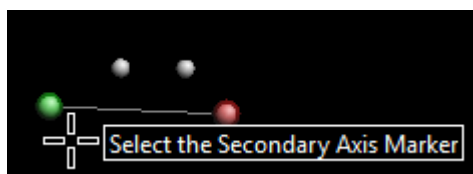
**Tip**

Choose the origin marker for distal segments to be on a more proximal segment. However, remember that the purpose of the labeling skeleton template is to define a labeling skeleton that is suitable for labeling. The segments are related to marker positions, not to joint centers as in a biomechanical model.

Nexus highlights the selected marker. The mouse pointer label changes to **Select the Primary Axis Marker**.

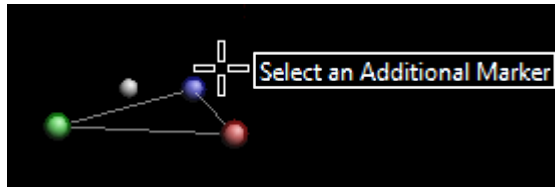


4. Click on the marker that defines the primary or long axis of the segment you are creating. For the Pelvis, this could be the unused LASI or RASI marker. The marker is highlighted and the mouse cursor label changes to **Select the Secondary Axis Marker**

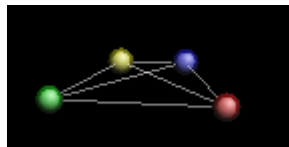


- Click on the marker that defines the secondary axis. The marker is highlighted and the mouse cursor label changes to **Select an Additional Marker**.  
This marker will fully define the segment by requiring the primary axis and the secondary axis marker to be in the same plane. For the Pelvis, this could be the SACR marker.

- Click on the chosen marker.



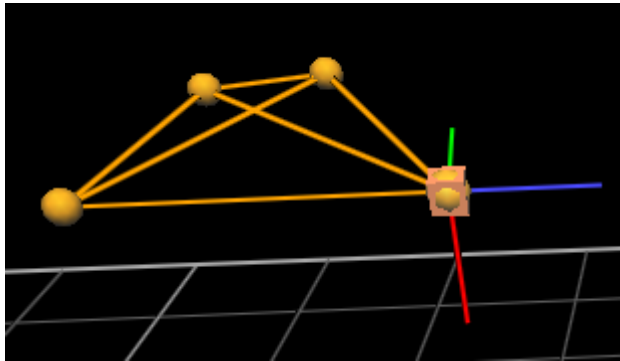
- In the same way, select any other markers that you want to associate with the same segment.



**Tip**

If you have problems selecting a marker, it may be because the selection operation selects something else, like the bounding box of a segment. To turn off the visualization of the segment, clear the **Subjects** option in the **Options** dialog box.

8. When you have finished creating the segment, click again on the **Create** button. In the 3D Perspective view, the selected markers are now displayed in gold. The segment's axes are displayed as X=red, Y=green and Z=blue. By convention, the Z axis is the primary axis and the secondary axis marker defines the YZ plane.



✔ Tip

If, at any point in the steps above, you make a mistake (for example, you click on the wrong marker), you must finish creating the segment first and then use the Undo operation to remove the segment. You can do this by either using the CTRL+Z shortcut or clicking the Undo button on the Nexus toolbar. You can then recreate the segment.

9. Repeat the above steps to define all segments.  
If possible, make the origin marker of each new (proximal) segment on the distal segment at a 'joint'.  
All markers must be part of at least one segment.

 **Important**

When creating child segments, remember that the markers you select will need to be linked using an appropriate joint type. It is a good idea to look ahead to the next procedure (see [Link segments on page 27](#)) to familiarize yourself with the different joint types now, so that you select the appropriate markers for segments in this step. For example, a free joint is typically used to link two segments that do not share any markers, and a ball joint is used to link two segments that share one marker. So when defining child segments, for example, a thigh segment that you intend to link to the pelvis segment using a ball joint, you must use one of the pelvis segment's markers as the origin marker of the thigh segment. In the standard gait marker set, this would mean that you would use the LASI marker as the origin, and the LKNE and LTHI markers as your other two markers for the left thigh segment. Do not worry that the LASI marker is not actually positioned on the thigh segment. Remember that the aim is to define a labeling skeleton template that helps the labeler produce the required labeling, not one that is anatomically correct.



## Tips for creating segments

When you select the markers to define a segment, keep the following basics in mind:

- One marker defines the location of one point, but not a whole segment
- Two markers define a line, with length and direction.
- Three non co-linear markers define a complete segment as well as a plane
- Four markers provide extra information which enables occluded markers to be re-created based on visible markers
- One or more of the points used to determine the location and attitude (orientation) of a segment may be derived from a neighboring segment. In fact, if the positions and attitudes of the neighboring segments are fully determined, and the degrees of freedom of the joints are defined, it may be possible to determine the location and attitude of a segment without any markers being attached to it.

You can choose any marker within the segment to be the origin of that segment, and any set of mutually perpendicular directions as the axes. However, there are a few guidelines which simplify these choices.

- The majority of models in biomechanics involve linked segments which form a chain, such as Pelvis-Femur-Tibia-Foot, and such models describe the movements of each segment relative to the more proximal segment.
- The auto-labeler will perform better if the skeletal topology defined in the template file roughly matches the real anatomical structure. Therefore, Vicon strongly recommends that you define the labeling skeleton template using segments that are as close to the real anatomy as possible.

The following are additional tips and recommendations to help you in defining segments:

- Start by defining the root segment (the most proximal) and work your way towards the leaf segments (the most distal ones). Often, the root segment will be the pelvis or the thorax segment when defining a human labeling skeleton template, but it could be any segment.
- When defining child segments, remember that they can share markers with the parent segment. For example, the anterior superior iliac spine (ASIS) marker can be used to define the pelvis segment, but can also be the origin marker of the femur segment. Similarly, a marker placed on knee can be used as the primary axis marker for the femur segment, but also the origin marker of the shank segment.

- 
- Where possible, align a segment's primary axis with the biomechanical long axis. Where there is no obvious long axis (as in the pelvis or trunk segment), the long axis can be defined using any two markers.
  - If two markers are assigned to the same segment and the distance between the two markers will change significantly during the trial, the labeler will not perform as well. Markers placed on the top of the shoulders, for example, can be part of the trunk segment if the intended movement to be captured does not involve a lot of shoulder movement. Conversely, if the shoulders are likely to move significantly relative to the trunk, these markers should define the primary axes of clavicle segments, the origin of which can be a marker placed at the clavicular notch.
  - If you are creating a segment with restricted movement, for example, finger markers, it may make sense for your segment to consist of only two markers.

Remember that the purpose of the labeling skeleton template is to define a skeleton that is suitable for labeling. The segments are related to marker positions, not to joint centers as in a biomechanical model.

## Link segments

After you have created all the segments, the next step is to choose suitable joint types and link the segments together to form a hierarchical skeletal structure. A joint can have up to six degrees of freedom (DOF), which indicates how freely the joint is able to move in relation to its parent segment.

When you link segments, start with the root segment and link from that until you have a continuous link chain to the leaf segment. Nexus lets you link in any order you like, but it is easier to keep track if you follow the chain.

### Tip

To display the segment bounding boxes, which enables you to select segments easily in the view pane, in the **Options** dialog box (F7), ensure the **Subjects** display is selected and in the **Properties** pane for **Subjects**, ensure that **Draw Boxes** is selected.

To link segments:

1. On the **Subject Preparation** tab of the **Tools** pane, in the **Labeling Template Builder** section, from the **Link Segments** drop-down box, choose the appropriate joint type for the two segments you intend to link and click **Link**.

### Important

When linking segments, Vicon recommends that you use the **Free Joint** for two segments that do not share any marker and the **Ball Joint** for segments that share markers. For information on the joint types, see [About joint types on page 31](#). Joint types as defined by the **Labeling Template Builder** are for the labeling skeleton, meaning that the true biomechanical joint type may not necessarily be the best choice for the skeleton. For the majority of skeletons, the Nexus 2 labeler works best when the **Ball Joint** and **Free Joint** joint types are used. The advanced joint types are only required for very specific labeling needs.

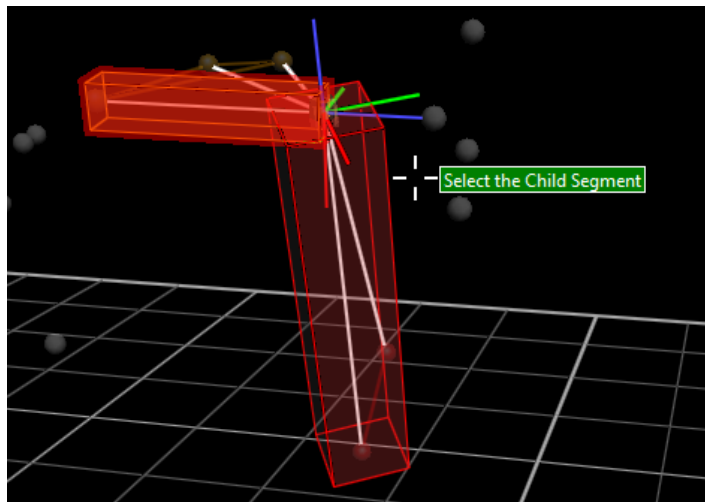
The mouse cursor changes, and the **Select the Parent Segment** tool tip is displayed.

2. In the 3D Perspective view, click on the bounding box of the segment you want to be the parent segment.

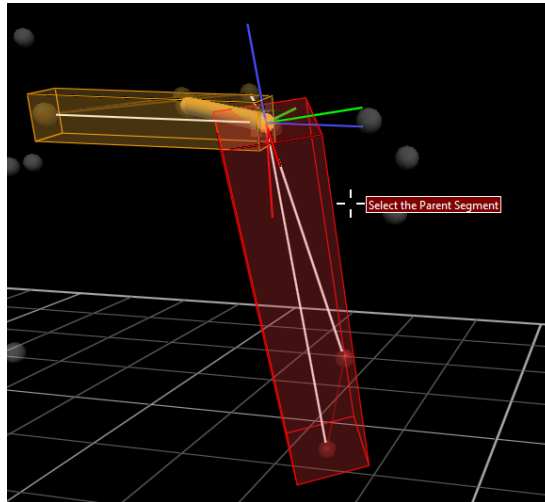
✔ Tip

If you have trouble selecting segments by clicking on the bounding boxes in the 3D Perspective view, you can also link segments by clicking on their names in the list under the Joints node in the Subjects resources tree and then clicking Link.

The segment bounding box turns red and the mouse cursor label changes to Select the Child Segment.



3. Click on the bounding box of the required segment (typically the distal segment). In the 3D Perspective view, the child segment changes color, and a cylinder appears between the parent and child to represent the link. The cursor changes back to **Select the Parent Segment**, which means that you can immediately select next parent/child pair, if you intend to use the same joint type.



4. Continue selecting parent and child segments until either you have linked all the segments or you need to change the joint type.
5. To change to a different joint type:
  - a. Click **Link**, which turns off the cursor tool tip and activates the **Link Segment** drop-down box.
  - b. Select the required joint type from the drop-down list.
  - c. To resume linking parent/child segments with the new joint type, click **Link** again.

6. When all segments are defined, click the **Link** button again to exit the segment linking utility.

When you have finished linking all the segments, the name of the subject in the **Subjects** resources tree, which was red when you first created it, is now displayed in black. The red color indicates that the subject is incomplete; for example, it has unlinked segments. The black color indicates that the subject is properly defined (markers, segments, and joints).

 **Tip**

On the **Subjects** tab, expand the **Joints** node and check that the joints are all correctly connected, and that their icons display the expected Degrees of Freedom (DOFs).

You can now assign the marker and segment properties as required.

## About joint types

To link segments, you can use the following joint types:

- **Free Joint** This joint type is used to link two segments that do not share any markers, and which can therefore move freely relative to each other. It is a 6 DOF joint with full translational as well as rotational freedom. It is used for the root segment to allow it to move freely with respect to the global origin; you cannot change the root's joint type.
- **Ball Joint** This 3 DOF joint with full rotational (but not translational) freedom, used to link two segments that share one marker, and which can therefore rotate freely around all three axes with respect to each other, but cannot translate. This joint type has the position of the child segment defined from the position of the parent joint, but its orientation can vary freely.



### Important

Use Ball Joints (3 DOF) for segments that share one marker and Free Joints (6 DOF) for segments that share none.

- **Hardy Spicer Joint** A 2 DOF joint with two rotational degrees around two axes, namely the Y and Z axes of the parent joint. This joint type has two perpendicular vectors defining the directions of the two axes around which the joint can rotate.
- **Hinge Joint** This 1 DOF joint allows rotation around a single axis only, and should be used to link two segments that share two markers. The hinge axis is aligned with the two markers that are shared.

## Assign marker and segment properties

When you have created the skeletal structure and linked all the segments, you can add the marker names and change marker colors and radius, as well as the segment and joint properties of your template. You do this using the controls on the **Subjects** tab of the **Resources** pane.

To assign marker names:

1. On the **Subjects** tab of the **Resources** pane, expand the node for your subject and select **Markers**.

By default, if you have named left and right segments when you created the segments as described in [Create segments on page 20](#), markers that are located on the left side of the body are indicated with a red marker icon in the list; markers on the right side are indicated with a green icon. Markers that are neither left nor right are indicated by a gold icon.

### Tip

The distinction between left and right markers is automatically made only if:

- You have set up the segments to belong to left or right sides as described in [Create segments on page 20](#).
- The model is not unilateral.
- You have remembered to leave a space between **Left** or **Right** and the rest of the segment name.
- The colors defined for the left and right segments are different (as in the default color scheme).

At this point, the markers have default names (Unlabeledxxx).



2. Rename each marker to represent its position on the labeling skeleton template, e.g. LASI for Left Anterior Asis. To do this, edit the name in one of the following ways:

- Click a marker name to select it and in the **Properties** pane below, enter a new name in the **Name** field; or
- In the **Subjects** tree, double-click the marker name or press Enter and overwrite it.  
You can then use your keyboard up/down arrow keys to advance to another marker and repeat the process.

To ensure that your *.vst* file complies with the *.c3d* file format, bear in mind the following points:

- A marker name can contain up to 30 alphanumeric characters (A-Z and 0-9). Do not include any punctuation, spaces, or special characters.
- The first character of the name must be alphabetical. Subsequent characters can be alphanumeric. For example, LANK1 is permitted, but 1 or L Ankle 1 is not.
- If the trial contains more than one subject, the subject name automatically prefixes the name you give the label. For example, if you define a marker LASI for a subject named Colin, the full marker label name is Colin:LASI. The sum of the subject and longest marker name must be less than 29 characters.

For alternative ways to select markers, see [Selecting markers on page 35](#).

 **Tip**

If you selected multiple markers, in the **Properties** section expand each property, such as Name, by clicking on its plus sign. To save time when renaming, overwrite each name and press the Tab key twice to jump to the next field.

3. For each marker, in the **Properties** pane, edit each marker **Color**, **Radius**, and **Status** as required:
  - **Color** Click on the color bar for a marker. A color picker box opens in which you change the marker color.  
If you are using clusters, you may want to change the color of the cluster markers so that they are easily recognized.
  - **Radius** Move the slider bar to change the radius of the marker. As you do this, you can see the size of the marker change in the **3D Perspective** view.  
To set the radius back to the default size after you have changed it, click the arrow next to the slider bar and select **Set to Default**.
  - **Status** Set the marker status to **Required**, **Optional**, or **Calibration Only**.  
If you use markers that are only needed during a calibration trial, it is a good idea to set their status to **Calibration Only** so that they are not required during movement trials.  
To reset the property to its default, click the arrow to the right of the drop-down box and select **Set to Default**.
4. If required, reorder the display of markers in the **System Resources** tree. To do this, right-click the **Markers** node and then click **Reorder**. You can then move the markers up or down the **Reorder Markers** list.
5. Ensure that the whole trial is completely labeled. Check that there are no gaps, or very few gaps, in the whole trial. If, despite following the guidelines in [Requirements for creating a custom labeling skeleton template on page 9](#), the trial contains many gaps, check that your system is set up correctly. If it is, consider re-capturing the trial.
6. On the **Subjects** tab of the **Resources** pane, expand the **Segments** node. Click on one or more segments, and in the **Properties** pane, change the name and color for these as needed.
7. On the **Subjects** tab, expand the **Joints** node. If you want to change the joint names, select one or more joints and in the **Properties** section, overwrite the name (s).
8. Save the custom labeling skeleton template (VST) (see [Save a custom labeling skeleton template on page 37](#)).  
You can now use your new custom VST to autolabel movement trials (see *Calibrate a labeling skeleton in the Vicon Nexus User Guide*). However, if you find that this requires a lot of manual correction, you can improve the autolabeling by using the information from a ROM trial to update the custom VST. For more information on how to do this, see [Optimize a custom labeling skeleton template on page 36](#).

## Selecting markers

You can select markers in any of the following ways:

To select a single marker:

- Click on it in the **Subjects** tab of the **Resources** pane; or
- Click on it in the **3D Perspective** view


To select multiple markers:

- On the **Subjects** tab in the **Resources** pane, drag across multiple markers in the **Markers** sub node; or
- In a **3D Perspective** view, **CRTL + click** multiple markers

## Optimize a custom labeling skeleton template

When you created your custom labeling skeleton template, you captured a static trial (see [Capture and reconstruct the marker set on page 15](#)). Static trials are easier to work with than movement or ROM trials when using the Nexus skeleton-building workflow (see [Create the skeletal structure on page 19](#)). However, a static trial does not provide skeleton parameters that are likely to be representative of the whole of a movement trial, so are unlikely to produce the best initial label booting. To improve this initial label booting, you can provide more representative data by capturing and calibrating a movement or ROM trial. Nexus can then use the data from the movement or ROM trial to update the labeling skeleton template (VST).

To optimize a custom VST:

1. Capture a ROM trial. To do this:
  - a. With Nexus in Live mode, in the **Subject Preparation** pane , click **Start** in the **Subject Capture** section. The **Start** button label changes to **Stop**.
  - b. Have the subject move their joints through as full a joint range as possible. To produce the best calibration and auto-labeling, ensure that each joint is moved through a range that represents the movement that is likely to be captured during movement trials.
  - c. Click **Stop** to finish the capture.
2. Attach your custom skeleton labeling template (VST) to your subject (see [Create a new subject from a template](#)).
3. Reconstruct and label the ROM trial, using **AutoInitialize**, plus any manual labeling that is necessary.
4. To calibrate the ROM trial, run a **Functional Skeleton Calibration** pipeline operation. This operation optimizes the skeleton parameters used for autolabeling, including joint and marker positions for the whole trial, and calculates joint and marker statistics.
5. After you have run this operation, to provide good initial values for labeling, you update the default values of the VST with the ROM trial data contained in the current calibrated labeling skeleton (VSK). To do this, run an **Update Skeleton Parameters** operation.

You can now save the custom VST (see [Save a custom labeling skeleton template on page 37](#)).

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## Save a custom labeling skeleton template

To complete your labeling skeleton template (VST), ensure you have completed all of the following steps:

- [Design a marker set on page 11](#)
- [Create a subject node and prepare a subject on page 12](#)
- [Capture and reconstruct the marker set on page 15](#)
- [Add parameters to a labeling skeleton template \(optional step\) on page 16](#)
- [Create the skeletal structure on page 19](#)
- [Assign marker and segment properties on page 32](#)
- [Optimize a custom labeling skeleton template on page 36](#)

When you have completed all the above steps, you can save the completed labeling skeleton template.

To save the labeling skeleton template:

1. In the **Subjects Resources** tree, right-click the name of the subject you created (see [Create a subject node and prepare a subject on page 12](#)) and select **Save Labeling Skeleton As Template** from the context menu.
2. In the dialog box, navigate to the *Nexus ModelTemplates* folder, by default: *C:\Users\Public\Documents\Vicon\Nexus2.x\ModelTemplates*, where your template (VST) will be automatically picked up for later use.
3. Give your template a generic name that describes the type or purpose of the template, for example *LeftArmReachingExperiments* (avoid giving templates a subject-specific name, such as *JohnSmith*), and click **Save**.

If you want to start using your template immediately, you can now add subject-specific measurements and calibrate the template for your particular subject. For information, see *Prepare a subject* in the *Vicon Nexus User Guide*.

## Troubleshooting labeling skeleton templates

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If your labeling skeleton template does not automatically label your subject, review the following symptoms and recommendations.

- [I have run the subject calibration operation, but cannot see the subject being fitted to the markers. on page 39](#)
- [My subject calibrated, but it fails to automatically label in Live mode. on page 40](#)
- [My subject calibrated but is not labeling well in Live mode. on page 41](#)

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## Symptoms and recommendations

### I have run the subject calibration operation, but cannot see the subject being fitted to the markers.

- Have all the markers in your labeling skeleton template been identified?  
For the subject calibration to succeed, all the markers specified in the template must be identified in the **3D Perspective** view. To see if you have successfully done this:
  - On the **Subjects** tab in the **Resources** pane, expand the relevant subject's node.
  - Expand the **Markers** sub node.  
Each marker in the labeling skeleton is displayed. Markers that have not been identified yet will be shown in gray text, whereas identified markers will be shown in black.
  - Label any unidentified markers.
- Is the subject's name under the subject node on the **Subjects** tab shown in red?  
The red color indicates that something is missing and that the labeling skeleton is incomplete. The reasons for this could be that either the labeling skeleton is not yet fully developed, for example, if links are missing between segments; or the required subject measurements have not been defined. If the subject name is displayed in red, review these procedures:
  - [Create the skeletal structure on page 19](#) (custom labeling skeleton templates only)
  - [Save a custom labeling skeleton template on page 37](#) (custom labeling skeleton templates only)
  - Specify measurements for a subject, as described in [Create a new subject from a template in the Vicon Nexus User Guide](#).
- Is the **Subjects** display enabled in the view **Options**?
  - Press F7, or from the **Window** menu choose **Options**.
  - Below **General View Options**, ensure that **Subjects** is selected.

## My subject calibrated, but it fails to automatically label in Live mode.

- Is the Processing Output level set to at least the Labels level?
  - In the System Resources pane, select Local Vicon System.
  - In the Properties section, make sure the Processing Output level parameter in the General section is set to Labels or Kinematic Fit.
- Is the correct subject selected?
  - On the Subjects Resources tab, make sure that the subject you created and calibrated is the only subject selected.
- Is the correct labeling skeleton template still attached to the subject?
- On the Subjects Resources tab, check that the required labeling skeleton template name (on the right of the subject name, in parentheses) is still displayed.
- Is the entrance threshold for Labeling completeness set too high?

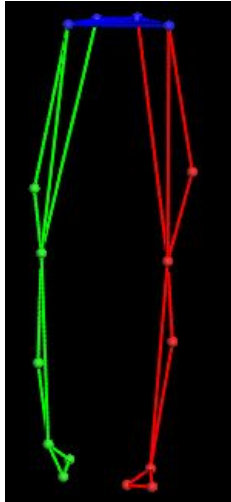
The Labeling completeness: entrance threshold parameter specifies the proportion of markers that Vicon Nexus must recognize to start labeling. If it is set too high, labeling may fail altogether. Aim to achieve a balance between setting it too low (which may result in mis-labeling when the subject first enters the volume) or too high (which may result in failure to label due to Nexus not recognizing sufficient markers for labeling to start). The default value is 0.85.

  - In the System Resources pane, select Local Vicon System.
  - In the Properties pane, go to the Labeling section and lower the Labeling completeness: entrance threshold value.
- Did the subject calibration pipeline operation succeed?
  - Sometimes the subject calibration pipeline operation will fail, as indicated by a red X instead of a green check mark by the pipeline operation name in the Pipeline Tools pane.

If it has failed, check the Communications pane Log tab for information as to why the failure occurred. Troubleshoot any error, and run the subject calibration pipeline again.



- You can help the auto labeling routine distinguish right from left by introducing asymmetry into your marker placement, for example, by placing one thigh marker higher than the other.



## My subject calibrated but is not labeling well in Live mode.

Labeling problems are often caused by tracking skeleton problems so it is often worth reviewing the data used for calibration. If you have followed the recommended workflow, and labeling is not working well, try the following steps:

1. Try recalculating the subject statistics for the type of activity performed by the subject. For example, try manually labeling a trial of the subject performing the relevant activity, then running a **Calculate Skeleton Joint & Marker Statistics** pipeline operation to recalculate statistics for this particular subject, instead of using the defaults.
2. Try a full functional calibration, by capturing a ROM trial, manually labeling it, and running a **Functional Skeleton Calibration** pipeline operation. Note that this may take some time.
3. Open the **Options** dialog box (F7) and select **Subjects**. In the **Properties** pane on the right, select **Draw Covariances**.

If there are small covariance ellipsoids, this indicates that the calibration will produce good labeling. Large covariance ellipsoids may indicate that labeling quality may be unsatisfactory. Larger than expected covariance ellipsoids may be due to a poor subject calibration. This can be caused by the existence of an incorrect label in the calibration trial, or a need for further optimization of the labeling skeleton template.