English

07/2014

exocad

Configuration Guide

Model Creator

exocad.com

Configuration Guide by exocad GmbH

Contact

Julius-Reiber-Str. 37
64293 Darmstadt
Germany

phone: +49-6151-629489-0
fax: +49-6151-629489-9

info@exocad.com
exocad.com

Document version (author)

MKTCG-001-1407 (cr), 07-14

Contents

1 Introduction

This configuration guide targets our OEM's wishing to customize the Model Creator module.

Model Creator is intended to design dental cast models from intra-oral, bite impression or other unprocessed scan data.

This document covers the customization of the Model Creator module. It gives all information needed to enable the OEM to customize the Model Creator module.

1.1 Overview

The information given in this guide shall enable our OEM's to create new model types, attachments and implant lab analogs, to integrate them to the Model Creator libraries and to make other adjustments.

Chapter 2 provides all information necessary for creating a new library entry for model types including descriptions of the required files, the configuration options and the (presetting of) construction parameters. It contains additional sections concerning the composition of a plate and the jaw curve.

All information necessary for creating a new attachment library entry and a new implant lab analog library entry will be given in chapter 3 and in chapter 4, respectively.

Appendix A lists instructions on common tasks, Appendix B gives information concerning common problems.

1.2 General Recommendations

The mesh must define an oriented 2-dimensional manifold which is properly embedded into $\mathbb{R}^3$ (i.e. it must not be self-intersecting). Depending on the application, it may or may not have a boundary.

Recommended Data Format

For storage of the mesh, it is recommended to choose a file format that explicitly stores mesh connectivity. The use of the STL file format is discouraged for this reason. Instead, we recommend the use of the *Object File Format* (`.off`).

1.3 Definitions

Alignment
: The process of adjusting the scan data so that they are in proper relative position to the base plate or bounding plane.

Attachment
: A piece of custom geometry to be added to a plateless model base, e.g. for articulator support.

Die
: A single component of a plate-type model. See also: Separate Die.

Ditch
: A trench in the model base around the stumps.

Jaw Curve
: A graph representing the jaw arch.

Key Pin
: Irregularly shaped pin at the bottom of the dies, giving each die a more distinctive shape so it is less likely inserted into an incorrect hole in the model base.

Model Base

The main part of a plateless model, which is usually comprised of the healthy teeth, and may contain receptacles for separate dies.

Model Type

A particular variant of either plateless or plate-type model, possibly along with a set of construction parameter constraints.

Orientation

The direction of surface normals.

Pin Groove

A depression on the bottom of the model base around each hole for the dies' key pins. Intended to facilitate removal of the dies.

Plateless Model

A dental cast model that is not to be placed onto a base plate. It may have a detachable die for each stump or selected teeth which is held in place without the need for any additional supporting structure.

Plate-Type Model

A dental cast model that is to be placed onto a particular base plate. In general it consists of multiple dies which are designed to fit onto the base plate in and only in the appropriate location. The dies are kept in the correct relative position to each other only by the use of the base plate.

Seating Area

The flat horizontal area at the bottom of the dies and holes in the model base that prevents the dies from falling through.

Separate Die

A part of a model that is detachable or separate from the model base.

2 Model Type Library

Model Creator maintains a model type library for a collection of base plate geometries to be used for plate-type models. It may also contain particular configurations for plateless models. This chapter explains how model types can be added to this library.

2.1 Overview

This section gives an overview of the steps and files that are necessary when adding a new model type. For detailed information on creating a new model type see 2.5 for a plate-type model and 2.6 for a plateless model.

In order to add a model type to the library, a new folder needs to be created in the `library/modelcreator/plates` subdirectory of your DentalCAD installation folder. The new directory must contain the following files:

- a configuration file that includes all information about the model type as a `ModelBuilderLibraryEntry` (see chapter 2.2.1)
- in case of a plate-type model: mesh files of the plate (see chapter 2.2.2)
- in case of a plateless model: optional geometry information file(s) for the visualization object(s) (see chapter 2.2.3)

2.2 Files

2.2.1 Configuration File

The configuration file (`config.xml`) defines the properties of the model type as a `ModelBuilderLibraryEntry` (see 2.5.2 and 2.6.1 for examples). The given tags are explained in Tables 2.1 and 2.2.

This file must include the following information:

- the name of the model type (tags `Supplier` and `DisplayInformation`)
- for a plate-type model the following:
  - the file name of a flat mesh describing the outline of the base plate which must have a fine and regular triangulation (tag `BasePlateFilename`)[1]
  - the file name of a mesh describing the geometry to be subtracted from the generated dies, such as pins on the base plate (tag `PinsFilename`)
- the definition of the jaw curve (tag `JawCurveControlPoints`) — mandatory for plate-type models, optionally for plateless models (see 2.4)

Optionally, the configuration file may also include the following information:

- the default total height of the model, i.e. the distance from lower jaw bottom plane to upper jaw bottom plane in mm (tag `ModelHeight`)
- minimum and maximum allowed values for the total model height in mm (tags `ModelHeightMinimum` and `ModelHeightMaximum`)
- a list of construction parameters with default values, and optionally minimum and maximum allowed values (tag `ConstructionParameters`)
- a list of visualization meshes to be shown during model alignment (tag `VisualizationMeshes`)
- further configuration options

[1] if the `BasePlateFilename` tag is missing, the configuration file will be identified as for a plateless model

2.2.2 Mesh Files for Plate-Type Models

There are two separate mesh files required: One describing the outline of the base plate and one describing the geometry to be subtracted from the generated model. For detailed information on the required characteristics of the meshes see 2.5.1.

For a recommended file format see 1.2.

2.2.3 Visualization Object Files for Plateless Models

Concerning the alignment of plateless models, Model Creator uses bounding planes. However, these bounding planes can be replaced by your own visualization objects. Use the `HideBoundingPlanes` tag (see Table 2.2) to hide the bounding planes. You can also define visualization objects for plate-type models.

There is one file required for every element of the visualization object. Any file format supported by the DentalCAD is also supported by Model Creator.

For a recommended file format see 1.2.

2.3 Presetting the Construction Parameters for Model Types

The construction parameters represent the model geometry parameters which are (under certain conditions, see the rules below) displayed in the Wizard, i.e. in the SETTINGS tab within the MODEL SEGMENTATION dialog for plate-type models and the CHANGE MODEL PARAMETERS section in the PLATELESS MODEL DESIGN dialog for plateless models. These user adjustable parameters are customizable by presetting the minimum, maximum and default values for each parameter, which can be defined in the configuration files.

The `defaultparameters.xml` in the `config` subdirectory of your DentalCAD base folder contains all application wide default parameters including the construction parameters for model types. Additionally, the model type configuration file (`config.xml`) in your model type subdirectory should be used to define parameters concerning the relating model type only (see section 2.1). If the `config.xml` file of the chosen model type lacks the required information (the relating parameter has not been defined) the software will refer to the `defaultparameters.xml` file which contains presets for all construction parameters.

The presets of minimum, maximum and default values can be defined in the `<ConstructionParameters>` section of your configuration file (for a plate-type example see 2.5.2, for a plateless example see 2.6.1).

Concerning the presets of the construction parameters the following rules apply:

- It is not necessary to provide an entry within the model type related `config.xml` file for *every* construction parameter that is available for the chosen model type.
- If an entry for a certain parameter exists, it has to contain at least the default value. In addition to the default value, the `<MinValue>` / `<MaxValue>` combination may be specified.
- If the specification for an identifier or a part of it (minimum and maximum values) is omitted, the missing values are replaced by those from the `defaultparameters.xml` file.
- The values specified in the model type related `config.xml` file apply to that particular model type only.
- Any parameter with zero range (i.e. minimum equals maximum) is omitted from the dialog, i.e. it is not visible to and hence not adjustable by the user.
- Values are to be given in mm, boolean flags as `0` or `1`.

NOTE

If you are providing a complete solution to your customers that includes production of the model e.g. by milling or printing, you should tune the construction parameters to your production system and make them invisible to the user.

2.4 Defining the Jaw Curve

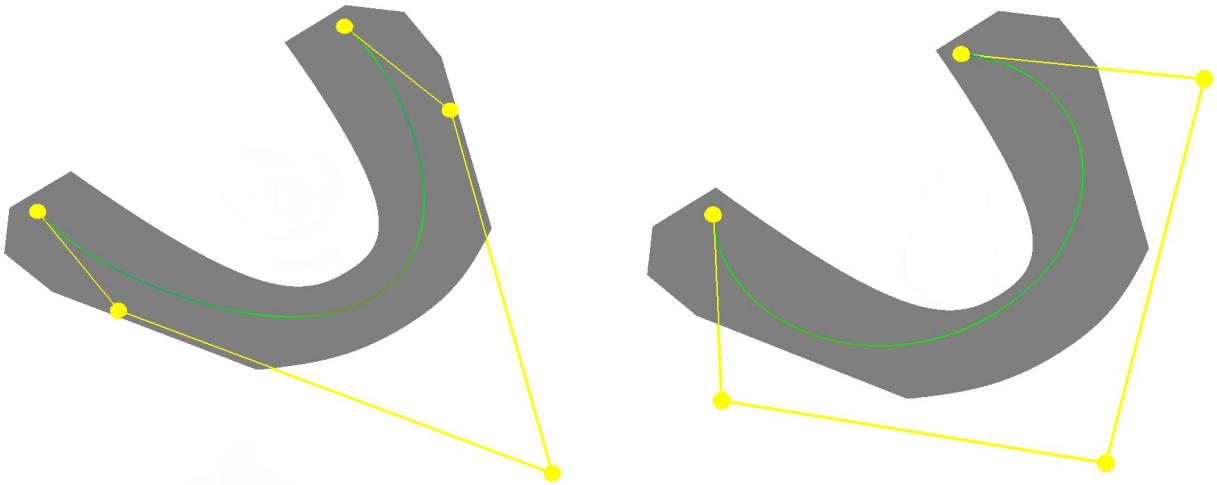
The jaw curve is used for several purposes:

For plate-type models it is the graph that the model segmentation planes are geared to. For that reason, the definition of the `JawCurveControlPoints` tag in the `config.xml` file is mandatory for plate-type models. Additionally, it is used during the automatic alignment process if the `JawCurveControlPoints` tag is defined. For plateless models, the definition of the `JawCurveControlPoints` tag is optional but highly recommended if there are special demands on automatic alignment, e.g. with respect to an articulator coordinate system.

It is defined as a polynomial function of degree 4, hence the interpolation uses five control points, which are the coefficients $p_0, \ldots, p_4 \in \mathbb{R}^3$ of the polynomial when expressed in the Bernstein basis:

$$p(t) = \sum_{i=0}^{n} \binom{4}{i} t^i (1-t)^{4-i} p_i, \quad t \in [0,1]$$

It follows from the formula that the first and the last point define starting point and end point of the curve, respectively. The three remaining points will in general not lie on the curve, but will affect how the curve bends. Figure 2.1 shows two sample arrangements of control points and their relating curves.



(a) (b)

Figure 2.1: Sample arrangements of control points and their relating curves

2.5 Creating a Plate-Type Model

This section contains the information needed for creating a plate-type model.

2.5.1 Composition of Plate Models

When creating a plate-type model type, the provided data needs to be in accordance with some guidelines. A model plate has to meet the following demands:

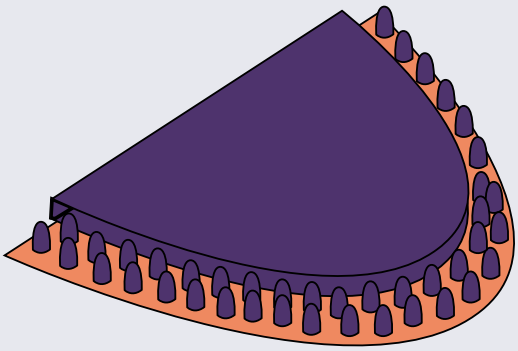
1. The elements of a model plate shall exist as meshes, not as a solid body. Every mesh shall have an open boundary.
2. The model shall be composed of two separate elements which are to be given as meshes: The model base plate and the model base pins (see Figure 2.2). Repeating the base plate in the pins mesh would lead to an inaccurate calculation of the model bottom at the conjunction of plate and pins and should be avoided.
3. The pins shall have a right angle where they touch the base plate (see Figure 2.3(a)).

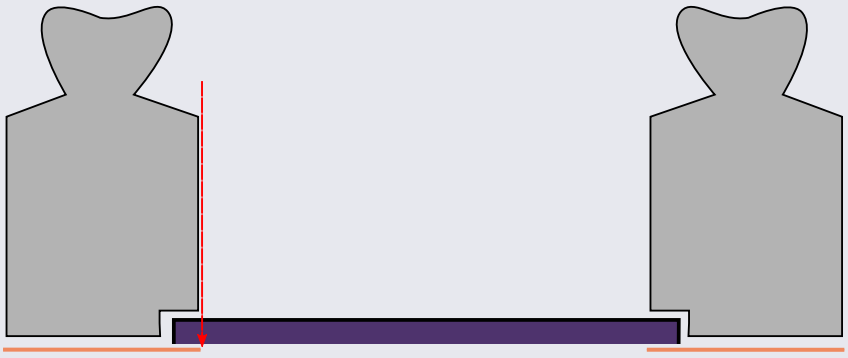
4. The model base plate must be perfectly flat as it represents the boundary of the model, i.e. there must not be mesh parts below the flat horizontal surface that will be the bottommost contact area with the model. All normals shall be facing upwards, i.e. they shall point in direction of the positive z-axis (see Figure 2.4).
5. The base plate mesh shall have a regular triangulation, i.e. shall consist of nearly equilateral triangles, with **edge lengths of between 0.25 mm and 0.5 mm** (see Figure 2.5). Equilateral triangles lead to best results in calculation. An edge length in the recommended range results in good accuracy with reasonable file size and computation time.
6. The model plate shall have the shape of a jaw arch. Model Creator will generate model geometry above the entire base plate mesh. Therefore, the base plate mesh must contain only those parts of the physical plate that Model Creator shall generate model geometry above (i.e. generally the base plate mesh will not match the physical plate geometry).

INFO

If your physical plate includes geometry in the palatinal area that shall be subtracted from the model, you may add this geometry to the pins mesh.

Note that the model geometry will only be generated above the base plate mesh. Pins mesh area that extends beyond the base plate mesh will be irrelevant for model generation. You may need to adapt the base plate mesh as shown below.

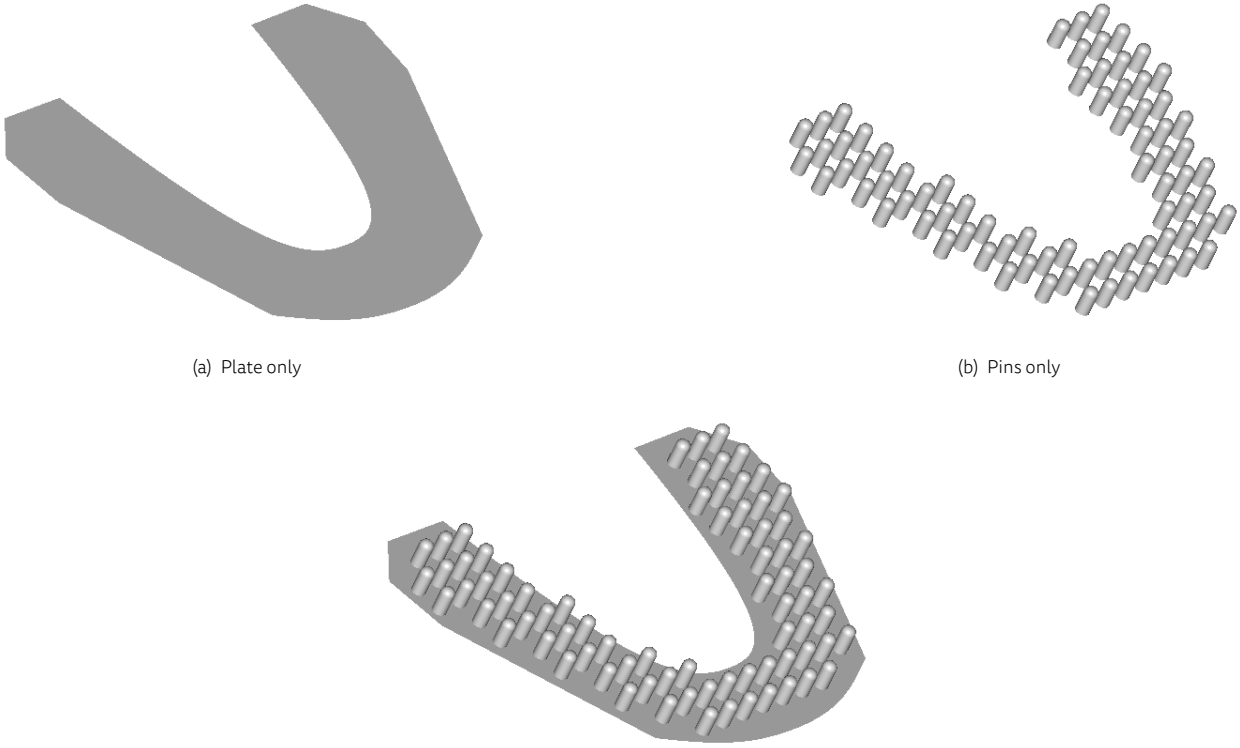




WARNING

Violation of these requirements will lead to malfunction of Model Creator!
It is indispensable that you avoid the mistakes described in Appendix B.1 and B.2!

Pins Mesh Separated From Base Plate Mesh



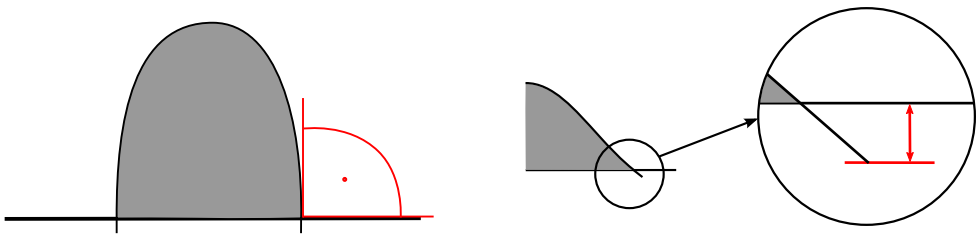
(a) Plate only

(b) Pins only

(c) Plate and pins displayed together — note that they are still separate meshes

Figure 2.2: Example for plate and pins as two separate elements

Pins: Intersection With Base Plate



(a) Rectangular intersection

(b) Different angle

Figure 2.3: Pins intersecting the base plate

INFO

We recommend to extend the pins to 0.5 mm below the base plate.

NOTE:

If your physical plate's geometry requires a different pins angle than 90°, we *highly recommend* to extend the pins to 0.5 mm below the base plate (see Figure 2.3(b)).

Base Plate: Direction of Normals

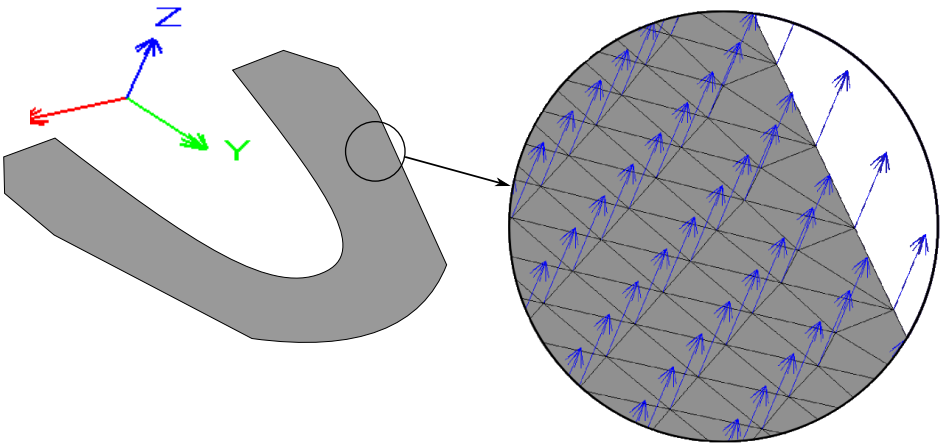


Figure 2.4: Detail of a mesh (direction of normals)

INFO

We recommend to place the base plate within the coordinate system such that the tongue would point in direction of the positive y-axis.

Triangulation: Edge Length

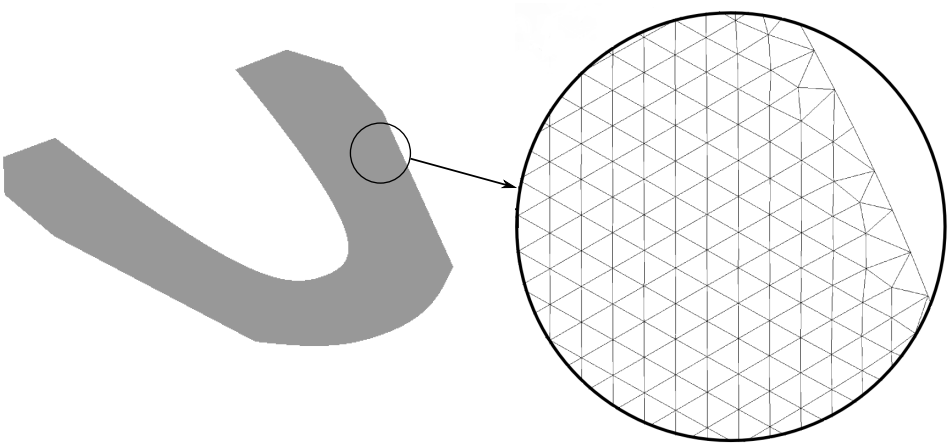


Figure 2.5: Detail of a mesh (triangulation)

INFO

Some tools do not allow to influence the triangulation. In order to check if your base plate triangulation meets the demands, please use a mesh editing tool.

2.5.2 Configuration Options for Plate-Type Models

Model types are configured in the `plates`-subdirectory of the Model Creator library. For each supplied model type there is a subdirectory containing the configuration file (`config.xml`) and possibly further files referenced in the configuration file (i.e. the baseplate and the pins mesh files in case of a plate-type model). For an explanation of the tags used in the following example see Table 2.1.

The configuration file has the following structure:

```
<?xml version="1.0"?>
<ModelBuilderLibraryEntry ...>

   <ModelHeight>40</ModelHeight>
   <ModelHeightMinimum>35</ModelHeightMinimum>
   <ModelHeightMaximum>45</ModelHeightMaximum>

   <BasePlateFilename>baseplate.eoff</BasePlateFilename>
   <PinsFilename>baseplate_pins.eoff</PinsFilename>

   <OcclusalPlane>
      <DistanceToOrigin>20</DistanceToOrigin>
      <Normal>
         <x>0</x>
         <y>0</y>
         <z>1</z>
      </Normal>
   </OcclusalPlane>

   <JawCurveControlPoints>
      <Vec3>
         <x>25.514404</x>
         <y>0.000000</y>
         </z>0<//z>
      </Vec3>
      <Vec3>
         <x>37.859695</x>
         <y>-22.754890</y>
         <z>0</z>
      </Vec3>
      <Vec3>
         <x>0.006076</x>
         <y>-89.689903</y>
         <z>0</z>
      </Vec3>
      <Vec3>
         <x>-37.864010</x>
         <y>-22.754753</y>
         <z>0</z>
      </Vec3>
      <Vec3>
         <x>-25.514404</x>
         <y>0.000000</y>
         <z>0</z>
      </Vec3>
   </JawCurveControlPoints>

   <MinRequiredPrepPlateDist>3</MinRequiredPrepPlateDist>

   <Supplier>ACME Inc.</Supplier>
   <DisplayInformation>ACME Model</DisplayInformation>
```

```
  <VisualizationMeshes>
    <VisualizationMesh>
      <FileName>vismesh.obj</FileName>
      <TextureFileName>vistexture.png</TextureFileName>
      <Material>
        <Color>#FF8080</Color>
        <Opacity>0.5</Opacity>
      </Material>
      <StippleTransparency>true</StippleTransparency>
    </VisualizationMesh>
    <VisualizationMesh>
      ...
    </VisualizationMesh>
  </VisualizationMeshes>

  <ConstructionParameters>
    <ConstructionParamValues>
      <Param>ModelCutWidth</Param>
      <DefaultValue>0.5</DefaultValue>
      <MinValue>0.3</MinValue>
      <MaxValue>0.6</MaxValue>
    </ConstructionParamValues>
    <ConstructionParamValues>
      <Param>ModelWallThickness</Param>
      <DefaultValue>2.0</DefaultValue>
      <MinValue>2.0</MinValue>
      <MaxValue>2.0</MaxValue>
    </ConstructionParamValues>
    <ConstructionParamValues>
      <Param>ModelPlateClearance</Param>
      <DefaultValue>0.12</DefaultValue>
    </ConstructionParamValues>
    <ConstructionParamValues>
      <Param>ModelConcavity</Param>
      <DefaultValue>1</DefaultValue>
      <MinValue>0</MinValue>
      <MaxValue>1</MaxValue>
    </ConstructionParamValues>
    <ConstructionParamValues>
      ...
    </ConstructionParamValues>
  </ConstructionParameters>

  <ArticulatorAlignmentType>acme-articulator</ArticulatorAlignmentType>
  <AntagonistType>acme-antagonist</AntagonistType>
</ModelBuilderLibraryEntry>
```

The meanings of the individual tags are explained in Table 2.1.

Tag	Meaning
`ModelBuilderLibraryEntry`	Root element
`ModelHeight`	Default total height of the model, i.e. the distance between the base plates
`ModelHeightMinimum`	Minimum allowed total height of the model. If not defined it will be set to `ModelHeight`

Table 2.1: Explanation of the model type configuration file tags *(plate-type models)*

Tag	Meaning
`ModelHeightMaximum`	Maximum allowed total height of the model. If not defined it will be set to `ModelHeight`
`BasePlateFilename`	File name of the base plate mesh. If this tag is defined, the configuration file will be identified as for a plate-type model
`PinsFilename`	File name of the pins mesh
`OcclusalPlane`	Location of the occlusal plane. If defined the user can toggle the plane on and off
`JawCurveControlPoints`	Lists the five control points that define the jaw curve
`MinRequiredPrepPlateDist`	Minimum enforced distance between tooth preparations and the base plate. The default value is `0`
`Supplier`	Name of the supplier of this model type
`DisplayInformation`	Name to be displayed in the Model Alignment dialog
`VisualizationMeshes`	Meshes that are displayed during alignment. For the sub-tags of this section see Table 2.3. Can be left undefined
`ConstructionParameters`	This section can be used to overwrite the default values from `defaultparameters.xml`
`ArticulatorAlignmentType`	Articulator tag according to `articulatormappings.xml` if alignment is relative to an articulator, otherwise leave undefined
`AntagonistType`	Overwrite the `AntagonistType` during model alignment if defined

Table 2.1: *(continued)*

2.5.3 Construction Parameters for Plate-Type Models

The construction parameters for plate-type models can be used to (pre-)set the spacing between adjacent dies resulting from the cut and the spacing between plate and dies. Additionally, a flag can be set whether the model shall be solid or hollow, and in case of a hollow model, the material thickness can be defined. Furthermore, a flag can be set whether there should be a concavity below the preparation margin.

For plate-type models, the following construction parameters can be predefined (parameters marked with *( )* are shown in Figure 2.6):

`ModelCutWidth` *(a)*
The spacing between adjacent dies.

`ModelPlateClearance` *(b)*
The spacing between base plate (pins) and dies.

`ModelWallThickness` *(c)*
If 0, the model will be solid. A positive number means the model will be hollow and will define the material thickness. Negative values are invalid.

`ModelConcavity`
A boolean flag (`0` or `1`) whether there should be a concavity below the preparation margin.

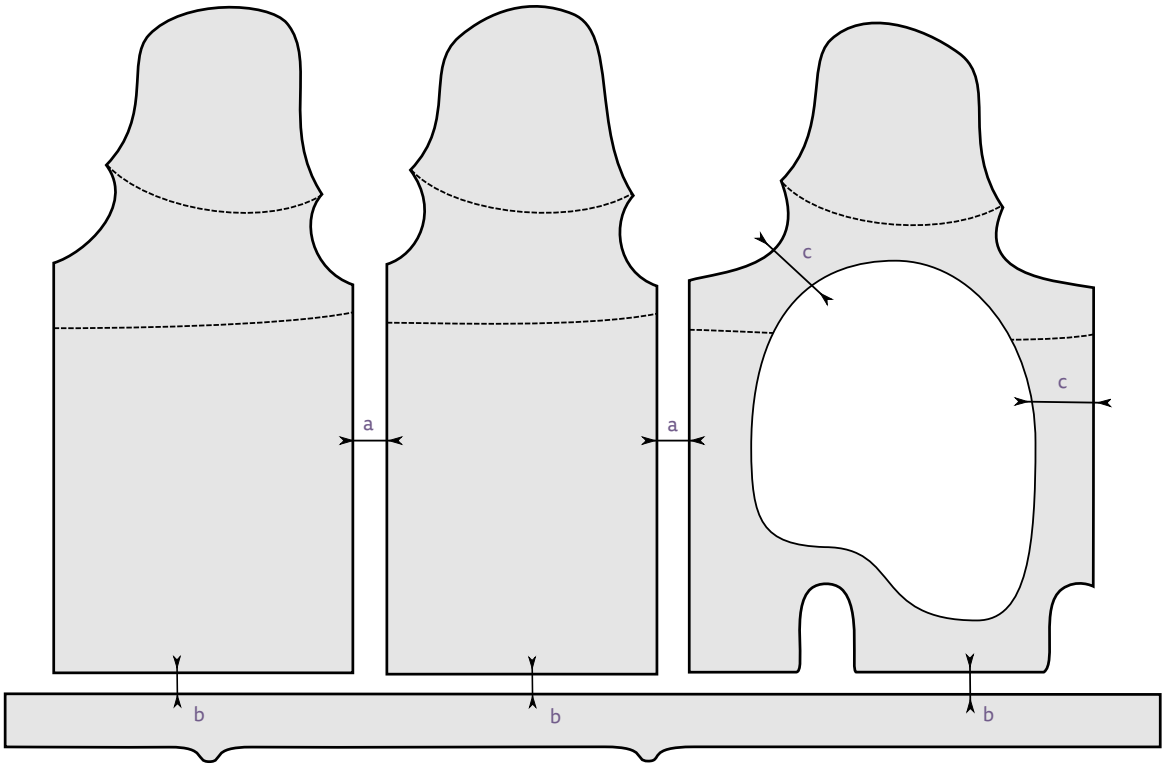


Figure 2.6: Construction parameters for plate-type models

2.6 Creating a Plateless Model

2.6.1 Configuration Options for Plateless Models

Model types are configured in the `plates`-subdirectory of the Model Creator library. For each supplied model type there is a subdirectory containing the configuration file (`config.xml`) and possibly further files referenced in the configuration file (i.e. the visualization mesh files in case of a plateless model). For an explanation of the identifiers used in the following example see Table 2.2.

The configuration file has the following structure:

```
<?xml version="1.0"?>
<ModelBuilderLibraryEntry ...>
   <BoundingPlanesCenter>
      <x>0</x>
      <y>0</y>
      <z>0</z>
   </BoundingPlanesCenter>

   <ModelHeight>40</ModelHeight>
   <ModelHeightMinimum>35</ModelHeightMinimum>
   <ModelHeightMaximum>45</ModelHeightMaximum>

   <OcclusalPlane>
      <DistanceToOrigin>20</DistanceToOrigin>
      <Normal>
         <x>0</x>
         <y>0</y>
         <z>1</z>
      </Normal>
```

```
</OcclusalPlane>

<JawCurveControlPoints>
   <Vec3>
      <x>25.514404</x>
      <y>0.000000</y>
      </z>0</z>
   </Vec3>
   <Vec3>
      <x>37.859695</x>
      <y>-22.754890</y>
      <z>0</z>
   </Vec3>
   <Vec3>
      <x>0.006076</x>
      <y>-89.689903</y>
      <z>0</z>
   </Vec3>
   <Vec3>
      <x>-37.864010</x>
      <y>-22.754753</y>
      <z>0</z>
   </Vec3>
   <Vec3>
      <x>-25.514404</x>
      <y>0.000000</y>
      <z>0</z>
   </Vec3>
</JawCurveControlPoints>

<MinRequiredPrepPlateDist>3</MinRequiredPrepPlateDist>

<Supplier>ACME Dental Inc.</Supplier>
<DisplayInformation>ACME Model</DisplayInformation>

<EnforcedAttachments>
   <string>acme-attachment</string>
   ...
</EnforcedAttachments>

<AllowedAttachments>
   <string>acme-attachment</string>
   ...
</AllowedAttachments>

<VisualizationMeshes>
   <VisualizationMesh>
      <FileName>vismesh.obj</FileName>
      <TextureFileName>vistexture.png</TextureFileName>
      <Material>
         <Color>#FF8080</Color>
         <Opacity>0.5</Opacity>
      </Material>
      <StippleTransparency>true</StippleTransparency>
   </VisualizationMesh>
   <VisualizationMesh>
      ...
   </VisualizationMesh>
</VisualizationMeshes>

<HideBoundingPlanes>true</HideBoundingPlanes>
```

```
  <ConstructionParameters>
    <ConstructionParamValues>
      <Param>ModelCutWidth</Param>
      <DefaultValue>0.5</DefaultValue>
      <MinValue>0.3</MinValue>
      <MaxValue>0.6</MaxValue>
    </ConstructionParamValues>
    <ConstructionParamValues>
      <Param>ModelPinHeight</Param>
      <DefaultValue>2.0</DefaultValue>
      <MinValue>2.0</MinValue>
      <MaxValue>2.0</MaxValue>
    </ConstructionParamValues>
    <ConstructionParamValues>
      <Param>ModelWallThickness</Param>
      <DefaultValue>2.0</DefaultValue>
    </ConstructionParamValues>
    <ConstructionParamValues>
      <Param>ModelConcavity</Param>
      <DefaultValue>1</DefaultValue>
      <MinValue>0</MinValue>
      <MaxValue>1</MaxValue>
    </ConstructionParamValues>
    <ConstructionParamValues>
      <Param>ModelOmitDiePin</Param>
      <DefaultValue>0</DefaultValue>
      <MinValue>0</MinValue>
      <MaxValue>0</MaxValue>
    </ConstructionParamValues>
    <ConstructionParamValues>
      ...
    </ConstructionParamValues>
  </ConstructionParameters>

  <ArticulatorAlignmentType>acme-articulator</ArticulatorAlignmentType>
  <AntagonistType>acme-antagonist</AntagonistType>

  <SpecialCaseNoStumpHolesType1>false</SpecialCaseNoStumpHolesType1>
</ModelBuilderLibraryEntry>
```

The meanings of the individual tags are explained in Table 2.2.

Tag	Meaning
`ModelBuilderLibraryEntry`	Root element
`BoundingPlanesCenter`	Model Center
`ModelHeight`	Default total height of the model in mm, i.e. the distance from lower jaw bottom plane to upper jaw bottom plane. If not defined, it will be set to 40
`ModelHeightMinimum`	Minimum allowed total height of the model in mm. If not defined, it will be set to `ModelHeight`
`ModelHeightMaximum`	Maximum allowed total height of the model in mm. If not defined, it will be set to `ModelHeight`

Table 2.2: Explanation of the model type configuration file tags *(plateless models)*

Tag	Meaning
`OcclusalPlane`	Location of the occlusal plane. If defined the user can toggle the plane on and off
`JawCurveControlPoints`	Lists the five control points that define the jaw curve
`MinRequiredPrepPlateDist`	Minimum enforced distance between tooth preparations and the base plate or bounding plane. The default value is `0`
`Supplier`	Name of the supplier of this model type
`DisplayInformation`	Name to be displayed in the Model Alignment dialog
`EnforcedAttachments`	Keywords of attachment library entries that should be added automatically. The keyword is the name of the relating attachment folder in the `library/modelcreator/attachments` subdirectory
`AllowedAttachments`	Keywords of attachment library entries that are allowed to be added. If undefined no restrictions are applied. The keyword is the name of the relating attachment folder in the `library/modelcreator/attachments` subdirectory
`VisualizationMeshes`	Meshes that are displayed during alignment. For the sub-tags of this section see Table 2.3. Can be left undefined
`HideBoundingPlanes`	If `true` no bounding planes will be displayed for models without plate. The default value is `false`
`ConstructionParameters`	This section can be used to overwrite the default values from `defaultparameters.xml`
`ArticulatorAlignmentType`	Articulator tag according to `articulatormappings.xml` if alignment is relative to an articulator, otherwise leave undefined
`AntagonistType`	Overwrite the `AntagonistType` during model alignment if defined
`SpecialCaseNoStumpHolesType1`	If `true` a plateless model will consist of a model base including the stumps as one element (no stump holes) and the stumps as additional elements. The default value is `false`.

Table 2.2: *(continued)*

Tag	Meaning
`FileName`	File name of the mesh to be displayed
`TextureFileName`	If defined, the given texture is applied to the mesh
`Material`	Base color of mesh
`StippleTransparency`	If `true` use a stipple pattern instead of alpha blending for transparency. The default value is `false`.

Table 2.3: Sub-tags of `VisualizationMesh`

2.6.2 Construction Parameters for Plateless Models

The construction parameters for plateless models can be used to adjust the model geometry. This includes the tightness of fit (i.e. the spacing between a die and the model base), the specification whether or not a model shall be hollow, and the material thickness for a hollow model. There are also parameters regarding the geometry of the pin at the bottom of the die and the surrounding geometry on the bottom of the model base such as a depression intended to facilitate removal of the stump die.

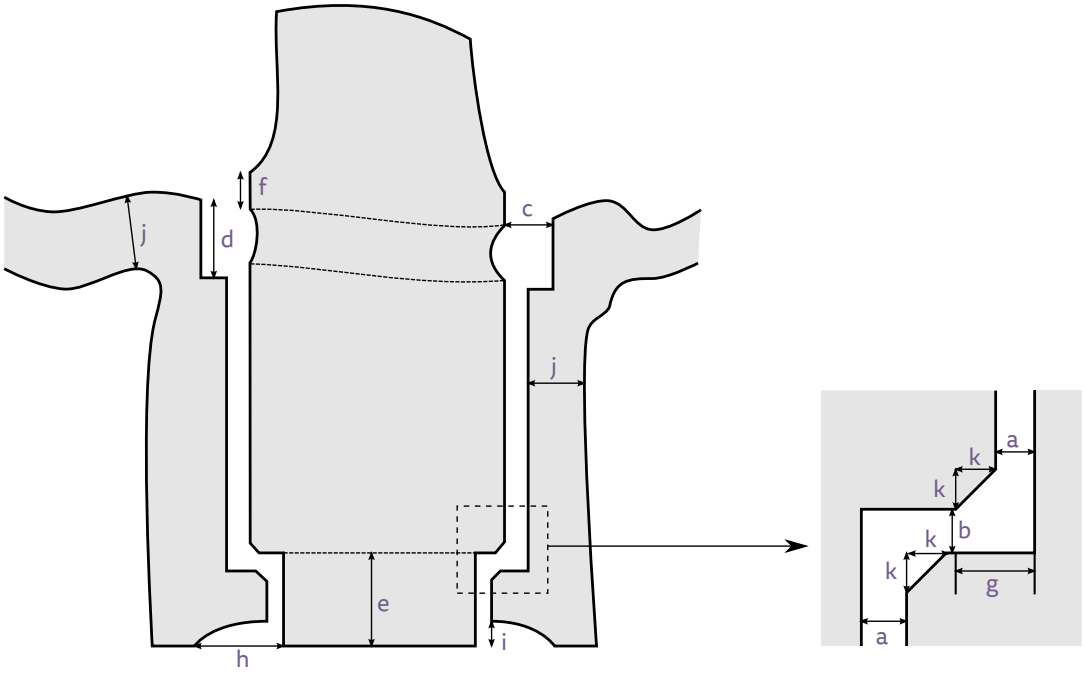


Figure 2.7: Construction parameters for plateless models

For plateless models, the following construction parameters can be predefined (parameters marked with *( )* are shown in Figure 2.7):

`ModelShaftGapHorizontal` *(a)*
Spacing between a die and the model base in horizontal (x and y) direction

`ModelShaftGapVertical` *(b)*
Spacing between a die and the model base in vertical (z) direction

`ModelDitchWidth` *(c)*
Determines the width (i.e. in x- and y-directions) of the ditch around stumps.

`ModelDitchDepthAvg` *(d)*
Determines the average depth (i.e. in z-direction) of the ditch around stumps. Since the bottom of the ditches is made almost flat, the depth cannot be met exactly everywhere.

`ModelPinHeight` *(e)*
The height of the key pin, i.e. the distance of the seating area to the bottom plane.

`ModelPreparationMarginExtrusion` *(f)*
Determines how far the preparation margin is extruded vertically towards the bottom plane above the concavity

area. This parameter is pointless if `ModelConcavity` is 0.

`ModelSeatingAreaWidth` *(g)*
Width of the bottom seating area of the dies, i.e. the distance between outer circumference and key pin.

`ModelBottomPinGrooveWidth` *(h)*
Determines the width (i.e. in x- and y-directions) of the pin grooves on the bottom of the model.

`ModelBottomPinGrooveDepth` *(i)*
Determines the depth (i.e. in z-direction) of the pin grooves on the bottom of the model.

`ModelWallThickness` *(j)*
If 0, the model will be solid. A positive number means the model will be hollow and will define the material thickness. Negative values are invalid.

`ModelWallMorphologicalClosureDiameter`
Determines the diameter of a ball that needs to fit into the cavity of a hollow model. Any region where such a ball would not fit is filled with material. Negative values are invalid. This parameter is pointless if `ModelWallThickness` is 0.

`ModelMillingHeadDiameter` *(k)*
Determines the size of the bevel at the bottom of the separate dies and the holes in the model base to allow for milling residue in the opposite part. Will be displayed as *Anticipate Milling*. (Note: Figure 2.7 shows the radius. However, the parameter is used to set the diameter.)

`ModelOmitDiePin`
A boolean flag (0 or 1) whether the key pin at the bottom of the dies should be omitted. The hole in the model base will remain in either case.

`ModelConcavity`
A boolean flag (0 or 1) whether there should be a concavity below the preparation margin.

`ModelMinimumPinCircumference`
If the key pin circumference is less than this value, the key pin is omitted (see also `ModelOmitDiePin`). This parameter will not be displayed in the CHANGE MODEL PARAMETERS section in the PLATELESS MODEL DESIGN dialog.

3 Model Attachments

Model Creator maintains an attachment library for a collection of attachments to be used when creating a plateless model. This chapter explains how attachments can be added to this library.

3.1 Overview

This section gives an overview of the steps and files that are necessary when adding a new attachment. For detailed information on creating a new attachment see 3.3.

In order to add an attachment to the library, a new folder needs to be created in the `library/modelcreator/attachments` subdirectory of your DentalCAD installation folder. The new directory must contain the following files:

- a configuration file that includes all information about the attachment as a `ModelAttachmentLibraryEntry` (see chapter 3.2.1)
- if the attachment is not a support pin: the attachment geometry information file(s) (see chapter 3.2.2)

3.2 Files

3.2.1 Configuration File

The configuration file (`config.xml`) defines the parameters of the attachment as a `ModelAttachmentLibraryEntry` (see 3.3.2 for an example). The given tags are explained in Table 3.1.

This file must include the following information:

- the name of the attachment (tags `Supplier` and `DisplayInformation`)
- if the attachment is not a support pin: the file name of the attachment mesh (tag `Attachment` or tag combination `AttachmentUpper` and `AttachmentLower`)

Optionally, the configurration file can also include the following information:

- color and material settings for visualization (tags `Material` and `RenderEffect`)
- a flag whether the attachment is positive or negative (attachment will be added to or subtracted from the model — tag `NegativeAttachment`)
- information about grouping restrictions (e.g. upper and lower jaw articulator interfaces — tag `GroupAll`)
- further configuration elements

3.2.2 Mesh Files for Attachments

There is one mesh file required for every seperate element of the attachment, i.e. two files if the attachment consists of separated upper and lower parts. A mesh may contain *either* the upper part *or* the lower part.

Support pins as a special kind of attachment will not require a seperate mesh file because the attachment may need to adjust to the model geometry and therefore will be generated by the software.

Any file format supported by the DentalCAD is also supported by Model Creator. For a recommended file format see 1.2.

3.3 Creating an Attachment

This chapter contains the information needed for creating an attachment.

3.3.1 Composition of Attachments

When creating an attachment, the provided data needs to be in accordance with some guidelines. An attachment has to meet the following demands:

1. Every mesh needs to have a closed surface without any open edges, and proper manifold topology.
2. All surface normals shall point outward.

3.3.2 Configuration Options for Attachments

Attachments are configured in the `attachments`-subdirectory of the Model Creator library. For each supplied attachment there is a subdirectory containing a configuration file (`config.xml`) and possibly further files referenced in the configuration file. For an explanation of the tags used in the following example see Table 3.1.

The configuration file has the following structure:

```
<?xml version="1.0"?>
<ModelAttachmentLibraryEntry ...>
   <Supplier>ACME Inc.</Supplier>
   <DisplayInformation>ACME connector</DisplayInformation>
   <Attachment>attachment.off</Attachment>

   <NegativeAttachment>false</NegativeAttachment>
   <CanOnlyBeAddedOnce>false</CanOnlyBeAddedOnce>
   <GroupAll>true</GroupAll>
   <NoPlacementValidityCheck>true</NoPlacementValidityCheck>
   <AutoOrientAttachment>false</AutoOrientAttachment>
   <MinDistBottom>0</MinDistBottom>
   <DistToBottom>1.0</DistToBottom>

   <TranslationRestriction>
      <DirectionType>GlobalPlaneNormal</DirectionType>
      <Direction>
         <x>0</x>
         <y>0</y>
         <z>1</z>
      </Direction>
   </TranslationRestriction>

   <RotationRestriction>
      <DirectionType>GlobalDirection</DirectionType>
      <Direction>
         <x>0</x>
         <y>0</y>
         <z>1</z>
      </Direction>
   </RotationRestriction>

   <Material>
      <Color>#FFe1c716</Color>
   </Material>

   <RenderEffect RenderEffectName="Metal">
      <ColorParameter Name="material_color" Value="#FFe1c716"/>
      <DoubleParameter Name="main_light" Value="0.51" />
      ...
   </RenderEffect RenderEffectName="Metal">
</ModelAttachmentLibraryEntry>
```

For more examples see Appendix A.

The meanings of the individual tags are explained in Table 3.1.

Tag	Meaning
`ModelAttachmentLibraryEntry`	Root element
`Supplier`	Name of the supplier of this attachment
`DisplayInformation`	Name to be displayed in the MODEL ATTACHMENT dialog
`Attachment`	File name containing the mesh for the attachment. If defined, `AttachmentLower` and `AttachmentUpper` are ignored
`AttachmentLower`	File name of the mesh for the upper jaw attachment part
`AttachmentUpper`	File name of the mesh for the lower jaw attachment part
`NegativeAttachment`	If `true`, the attachment will be subtracted from the model. The default value is `false`
`GroupAll`	If `true`, all attachments of this type will have the same orientation, upper and lower parts will share a common plane and upper (lower) parts will be on a common line. This parameter is pointless if `CanOnlyBeAddedOnce` is defined. The default value is `false`
`CanOnlyBeAddedOnce`	If `true`, the attachment can only be added once. The default value is `false`
`NoPlacementValidityCheck`	If `true`, there will be no check if the attachment placement is valid. The default value is `false`
`AutoOrientAttachment`	If `true`, the attachment will be added with it's z-axis facing in the same direction as the occlusal axis of the corresponding jaw. The default value is `false`
`FixUpperLower`	If `true`, the relative position between upper and lower parts is fixed. This parameter is pointless if `AttachmentUpper` and `AttachmentLower` are not defined. The default value is `false`
`MinDistUpperLower`	If defined, the distance between upper and lower part is kept greater than the given value. This parameter is pointless if `AttachmentUpper` and `AttachmentLower` are not defined
`MinDistBottom`	If defined, the distance between the attachment and the model bounding plane is kept greater than the given value
`DistToBottom`	If defined, the attachment will be initially placed with the given distance to the bounding plane
`TranslationRestriction`	Restricts the movement of the attachment. See Table 3.2
`RotationRestriction`	Restricts the rotation of the attachment. See Table 3.2
`Material`	Defines the surface appearance of the attachment
`RenderEffect`	If defined, the render effect with the given settings will be applied to the attachment

Table 3.1: Explanation of the attachment configuration file tags

Tag	Meaning
DirectionType	Defines how the Direction vector is interpreted. Possible values are Ignore, LocalDirection, GlobalDirection, LocalPlaneNormal, GlobalPlaneNormal
Direction	Direction of the restriction

Table 3.2: Sub-tags of TranslationRestriction and RotationRestriction

3.3.3 Support Pins

Support pins as a special kind of attachments require a different configuration file structure:

```
<?xml version="1.0"?>
<ModelAttachmentLibraryEntry ...>
   <Supplier>ACME Inc.</Supplier>
   <DisplayInformation>ACME support pin</DisplayInformation>
   <Type>SupportPin</Type>
</ModelAttachmentLibraryEntry>
```

The meanings of the tags are explained in Table 3.3.

Tag	Meaning
ModelAttachmentLibraryEntry	Root element
Supplier	Name of the supplier of this attachment
DisplayInformation	Name to be displayed in the ModelAttachmentDialog
Type	Defines this attachment as a support pin. The value must be set to SupportPin

Table 3.3: Explanation of the attachment configuration file tags for support pins

Construction Parameters for Support Pins

The construction parameters for support pins can be used to adjust the support pin geometry, e.g the diameter.

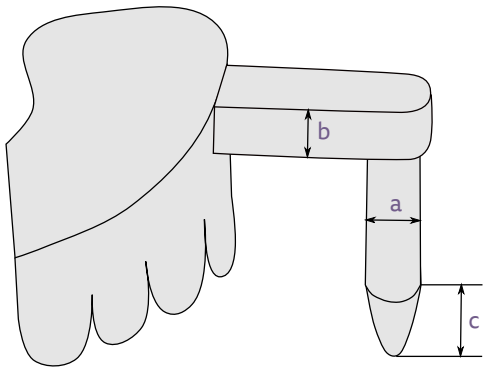


Figure 3.1: Construction parameters for support pins

For support pins, the following parameters can be predefined (parameters marked with *( )* are shown in Figure 3.1):

`ModelSupportPinDiameter` *(a)*
Defines the diameter of the support pin shaft

`ModelSupportPinLedgeHeight` *(b)*
Defines the height of the support pin ledge

`ModelSupportPinBulgeHeight` *(c)*
Defines the height of the support pin shaft bulge

IMPORTANT

Note that the construction parameters for support pins are *not* specified in the configuration file of the support pin, but in the configuration file of the plateless model type.

4 Implant Lab Analogs

Model Creator maintains an implant lab analog library for a collection of lab analog geometries. This chapter explains how lab analogs can be added to this library.

IMPORTANT

The implant lab analog library is not to be confused with the standard implant library:

- The standard implant library in the `library/implants` subdirectory of your DentalCAD installation folder is used application wide. It is not to be modified during configuration of Model Creator.
- The implant lab analog library in the `library/modelcreator/implants` subdirectory is used only by Model Creator and is subject of this chapter.

4.1 Overview

This section gives an overview of the steps and files that are necessary when adding a new lab analog. For detailed information on creating a new lab analog see 4.3.

A lab analog for Model Creator must refer to one or more implants from the standard implant library. Therefore the first step in providing a lab analog is to decide for which implants from the standard library the analog shall be applicable. Please note that the user will *not* choose the lab analog to use directly, but rather pick the correct implant from the standard library as usual (as when designing an abutment for example). Model Creator will then select the correct lab analog based on the list of compatible implants as given by the lab analog supplier, which currently has to be unique. Support for multiple compatible lab analogs for a given implant may be added in the future.

In order to add a lab analog to the library, a new folder needs to be created in the `library/modelcreator/implants` subdirectory of your DentalCAD installation folder. The new directory must contain the following files:

- a configuration file that includes all information about the lab analog as a `ModelLabAnalogEntry` (see chapter 4.2.1)
- mesh files that the `config.xml` refers to (see chapter 4.2.2)

4.2 Files

4.2.1 Configuration File

The configuration file (`config.xml`) defines the properties of the lab analog as a `ModelLabAnalogEntry` (see 4.3.2 for an example). The given tags are explained in Table 4.1.

This file must include the following information:

- the name of the lab analog (tags `Supplier` and `DisplayInformation`)
- a list of all compatible implants from the standard implant library (tag `CompatibleImplants`)
- the file name of the mesh that will define the cavity in which the lab analog will be inserted (tag `RetentionMeshType`)

Optionally, the configuration file may also include the following information:

- the file name of the mesh that represents the lab analog (tag `ModelLabAnalogFile`)
- the symmetry group order n that defines the allowed rotation angles (tag `RotationalSymmetry`)

4.2.2 Mesh Files for Lab Analogs

Model Creator uses the standard implant library for its scan abutment geometries that the lab analog will be aligned to. The retention mesh represents the geometry of the cavity within the model. In general, it will not match the geometry of the physical lab analog as the resulting channels (holes) need to be larger in diameter than the physical lab analog to facilitate insertion. A more or less exact replica of the lab analog may be added to the library as an additional mesh which will be used for visualization purposes only and may differ from the original geometry.

INFO

You may enlarge the lab analogs mesh in diameter to receive the retention mesh. Note that the retention mesh needs to contain exactly the geometry that is to be subtracted from the model. The retention mesh diameter may be varied to control the accuracy of fit.

For detailed information on the required characteristics of the retention mesh, see 4.3.1. Any file format supported by the DentalCAD is also supported by Model Creator.

For a recommended file format see 1.2.

4.3 Creating an Implant Lab Analog

This section contains the information needed for creating an implant lab analog.

Each implant lab analog library entry will come with a retention mesh and optionally with a mesh representing the lab analog for visualization purposes.

4.3.1 Composition of the Retention Mesh

When creating an implant lab analog, the provided data needs to be in accordance with some guidelines. A retention mesh has to meet the following demands:

1. It shall consist of one single mesh, i.e. as one single connected component, even if the physical lab analog consists of several separate elements.
2. The retention mesh in the Model Creator implant library and the scan abutment geometry in the standard implant library shall be in the same coordinate system and correctly aligned with respect to each other (see Figure 4.1).
3. It shall be oriented as in the final model, i.e. the surface normals must point into the implant channel.
4. It must be fully interconnected, i.e. it must not contain any open edges within the mesh except for the boundary curves.
5. Each boundary curve shall be planar and will correspond to a hole in the final model.

WARNING

Violation of these requirements will lead to malfunction of Model Creator! The supplier of the lab analog data will be responsible for ensuring that these requirements are met!

Extrusion of Boundary Curves

The hole will be created by extruding the boundary curve of the retention mesh in direction of the curve plane's normal. The following examples show some cases that may be realized:

- For an analog that will be inserted from above and fastened with glue, the retention mesh should have a single open boundary curve on top.

- For an analog consisting of two pieces, where one is inserted from above, the other from below, and which will be attached to each other (e.g. for an analog that is fastened with a screw from below), the retention mesh should have two open boundaries, one facing up and the other facing down.
- For an analog that will be fastened by inserting a pin or screw laterally, there should be an additional boundary facing sideways. There may be another boundary facing sideways (in the opposite direction) if that channel should extend to both sides of the lab analog.

Alignment of Retention Mesh and Scan Abutment

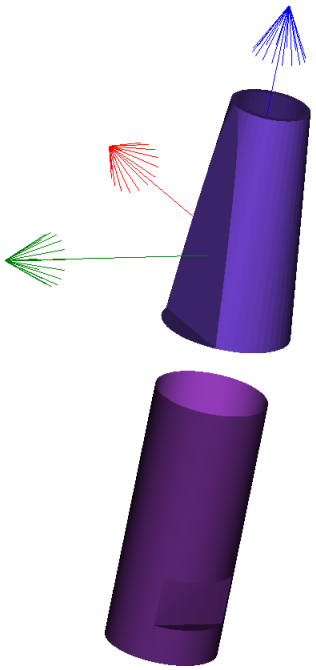


Figure 4.1: Retention mesh and scan abutment in the same coordinate system

4.3.2 Configuration Options for Implants

Implant lab analogs are configured in the `implants`-subdirectory of the Model Creator library. For each supplied lab analog there is a subdirectory containing the configuration file (`config.xml`) and possibly further files referenced in the configuration file (i.e. the retention mesh file and optionally the lab analog file). For an explanation of the tags used in the following example see Table 4.1.

The configuration file has the following structure:

```
<?xml version="1.0"?>
<ModelLabAnalogEntry ...>
   <Supplier>ACME Dental Inc.</Supplier>
   <DisplayInformation>ACME Implant</DisplayInformation>

   <RetentionMeshType>
      <ModelLabAnalogRetentionFile>retention-kx.stl</ModelLabAnalogRetentionFile>
   </RetentionMeshType>

   <CompatibleImplants>
      <string>ACME : KX : default</string>
      <string>The_Other_Company : * : *</string>
   </CompatibleImplants>
```

```
    <ModelLabAnalogFile>labanalog-kx.stl</ModelLabAnalogFile>

    <RotationalSymmetry>4</RotationalSymmetry>
</ModelLabAnalogEntry>
```

The meanings of the individual tags are explained in Table 4.1.

Tag	Meaning
`ModelBuilderLibraryEntry`	Root element
`Supplier`	Name of the supplier of this model type
`DisplayInformation`	This information is currently not used by Model Creator, but this may change in the future. Therefore implant providers are encouraged to properly fill in this information at this time already
`RetentionMeshType`	File name of the retention mesh
`CompatibleImplants`	Keywords of implant entries of the standard implant library that the lab analog is compatible with. See Keywords of Implant Entries
`ModelLabAnalogFile`	File name of the optional lab analog mesh
`RotationalSymmetry`	Defines the allowed rotation, which will be available to the user while either the Model Segmentation or the Plateless Model Design dialog, depending on the chosen model type, is active. For possible values and meanings, see Table 4.2. The default value is 1

Table 4.1: Explanation of the implant lab analog configuration file tags

Value	Meaning
$n = 0$	Allows arbitrary rotations about the lab analog's z-axis
$n > 0$	Allows rotations in steps of $360/n$ degrees about the lab analog's z-axis
$n = 1$	No rotation allowed

Table 4.2: Values of `RotationalSymmetry`

Keywords of Implant Entries

Each entry in the list of compatible implant types refers to either one single standard implant library entry or a group of standard implant library entries that differ e.g. in numeration by using the `´?'` (matches exactly one character) or `´*'` (matches zero or more characters) character. An implant may be listed only in one single lab analog entry. It cannot be referred to in more than one lab analog entry.

The keyword syntax is `xy : yz` or `xy : yz : zx`, where `xy` is the folder name of the implant and `yz` the implant type keyword. `zx` is the implant subtype keyword.

See the following example:

```
<?xml version="1.0"?>
<ModelLabAnalogEntry ...>
   ...
   <CompatibleImplants>
      <string>ACME : Implant1</string>
      <string>ACME : A-Series : big_1</string>
      <string>ACME : ?-Series : big</string>
      ...
      <string>The_Other_Company : Implant1</string>
      <string>The_Other_Company : Y-Series : *</string>
      ...
      <string>Company_XY : *</string>
      <string>Company_XY : * : *</string>
   </CompatibleImplants>
</ModelLabAnalogEntry>
```

See the following pages for the relating standard implant library entries.

Folder name: ACME

```
<?xml version="1.0"?>
<ImplantLibraryEntry ...>
   ...
   <TypeConfig>
      <ImplantTypeConfig>
         ...
         <Keyword>Implant1</Keyword>
      </ImplantTypeConfig>
   </TypeConfig>
   ...
   <TypeConfig>
      <ImplantTypeConfig>
         ...
         <Keyword>A-Series</Keyword>
         <SubtypeConfig>
            <ImplantSubtypeConfig>
               <keyword>big</keyword>
               ...
            </ImplantSubtypeConfig>
            <ImplantSubtypeConfig>
               <keyword>small</keyword>
               ...
            </ImplantSubtypeConfig>
            <ImplantSubtypeConfig>
               <keyword>big_1</keyword>
               ...
            </ImplantSubtypeConfig>
         </SubtypeConfig>
      </ImplantTypeConfig>
   </TypeConfig>
   ...
   <TypeConfig>
      <ImplantTypeConfig>
         ...
         <Keyword>B-Series</Keyword>
         <SubtypeConfig>
            <ImplantSubtypeConfig>
               <keyword>big</keyword>
               ...
            </ImplantSubtypeConfig>
         </SubtypeConfig>
      </ImplantTypeConfig>
   </TypeConfig>
   ...
   <TypeConfig>
      <ImplantTypeConfig>
         ...
         <Keyword>C-Series</Keyword>
         <SubtypeConfig>
            <ImplantSubtypeConfig>
               <keyword>big</keyword>
               ...
            </ImplantSubtypeConfig>
         </SubtypeConfig>
      </ImplantTypeConfig>
   </TypeConfig>
</ImplantLibraryEntry>
```

Folder name: The_Other_Company

```
<?xml version="1.0"?>
<ImplantLibraryEntry ...>
   ...
   <TypeConfig>
      <ImplantTypeConfig>
         ...
         <Keyword>Implant1</Keyword>
      </ImplantTypeConfig>
   </TypeConfig>
   ...
   <TypeConfig>
      <ImplantTypeConfig>
         ...
         <Keyword>Y-Series</Keyword>
         <SubtypeConfig>
            <ImplantSubtypeConfig>
               <keyword>X1</keyword>
               ...
            </ImplantSubtypeConfig>
            <ImplantSubtypeConfig>
               <keyword>X2</keyword>
               ...
            </ImplantSubtypeConfig>
            <ImplantSubtypeConfig>
               <keyword>X3</keyword>
               ...
            </ImplantSubtypeConfig>
         </SubtypeConfig>
      </ImplantTypeConfig>
   </TypeConfig>
</ImplantLibraryEntry>
```

INFO

Note that with

`Y-Series : *`

all subtypes of `Y-Series` are reserved for this lab analog. They must not be listed in the configuration file of any other lab analog.

Folder name: **Company_XY**

```
<?xml version="1.0"?>
<ImplantLibraryEntry ...>
   ...
   <TypeConfig>
      <ImplantTypeConfig>
         ...
         <Keyword>Implant1</Keyword>
      </ImplantTypeConfig>
   </TypeConfig>
   ...
   <TypeConfig>
      <ImplantTypeConfig>
         ...
         <Keyword>Implant2</Keyword>
      </ImplantTypeConfig>
   </TypeConfig>
   ...
   <TypeConfig>
      <ImplantTypeConfig>
         ...
         <Keyword>A-Series</Keyword>
         <SubtypeConfig>
            <ImplantSubtypeConfig>
               <keyword>X2</keyword>
               ...
            </ImplantSubtypeConfig>
            <ImplantSubtypeConfig>
               <keyword>X1</keyword>
               ...
            </ImplantSubtypeConfig>
         </SubtypeConfig>
      </ImplantTypeConfig>
   </TypeConfig>
   ...
   <TypeConfig>
      <ImplantTypeConfig>
         ...
         <Keyword>B-Series</Keyword>
         <SubtypeConfig>
            <ImplantSubtypeConfig>
               <keyword>X1</keyword>
               ...
            </ImplantSubtypeConfig>
            <ImplantSubtypeConfig>
               <keyword>X2</keyword>
               ...
            </ImplantSubtypeConfig>
         </SubtypeConfig>
      </ImplantTypeConfig>
   </TypeConfig>
</ImplantLibraryEntry>
```

INFO

Note that

`Company_XY : * : *`

includes all implant types that contain subtypes. To cover the implant types without subtypes, `Company_XY : *` needs to bee added.

A Common Tasks

This chapter contains instructions for common tasks.

A.1 How to Make Hollow Models

Hollow models can be designed for both plate-type and plateless models. In order to make a hollow model, do the following:

Step 1: Open the `config.xml` file of your model type (in the `library/modelcreator/plates` subdirectory of your DentalCAD installation folder).

Step 2: Add a `<ConstructionParamValues>` entry for the `ModelWallThickness` parameter within the `<ConstructionParameters>` section if it does not already exist.

```
<?xml version="1.0"?>
<ModelBuilderLibraryEntry ...>
   ...
   <ConstructionParameters>
      ...
      <ConstructionParamValues>
         <Param>ModelWallThickness</Param>
         <DefaultValue>2.0</DefaultValue>
      </ConstructionParamValues>
      ...
   </ConstructionParameters>
   ...
</ModelBuilderLibraryEntry>
```

Step 3: Set the desired default value of `ModelWallThickness` within the `DefaultValue` tag. If it is set to 0, the model will be solid.

Step 4: Optionally, the minimum and maximum allowed values can be specified:

```
<?xml version="1.0"?>
...
<ConstructionParamValues>
   <Param>ModelWallThickness</Param>
   <DefaultValue>2.0</DefaultValue>
   <MinValue>1.0</MinValue>
   <MaxValue>3.0</MaxValue>
</ConstructionParamValues>
...
```

Step 5: If you prefer the `ModelWallThickness` value to be invisible to the user, set `MinValue` and `MaxValue` to the same value. The `ModelWallThickness` parameter will then be omitted from the SETTINGS tab within the MODELSEGMENTATION dialog for plate-type models and the CHANGE MODEL PARAMETERS section in the PLATELESS MODEL DESIGN dialog for plateless models.

Step 6: For a smoother surface within the hollow bottom cavity adjust the `ModelWallMorphologicalClosure-Diameter`. A larger value will cause a smoother surface, a smaller value may cause small cavities to be filled.

Step 7: Save the file. Your changes will be applied the next time you start the software.

A.2 How to Design a Plateless Model Without Holes

Models without holes will consist of a model base including the stumps as one element (no stump holes) and the stumps as additional elements. In order to design a plateless model without holes, do the following:

Step 1: Open the `config.xml` file of your model type (in the `library/modelcreator/plates` subdirectory of your DentalCAD installation folder).

Step 2: Add the `<SpecialCaseNoStumpHolesType1>` entry if it does not already exist.

```
<?xml version="1.0"?>
<ModelBuilderLibraryEntry ...>
   ...
   <SpecialCaseNoStumpHolesType1>true</SpecialCaseNoStumpHolesType1>
   ...
</ModelBuilderLibraryEntry>
```

Step 3: Set the value to `true`.

Step 4: Save the file. Your changes will be applied the next time you start the software.

A.3 How to Design Models With or Without Concavity Below the Preparation Margin

In order to set the flag for a concavity, do the following:

Step 1: Open the `config.xml` file of your model type (in the `library/modelcreator/plates` subdirectory of your DentalCAD installation folder).

Step 2: Add the `<ModelConcavity>` entry if it does not already exist.

```
<?xml version="1.0"?>
<ModelBuilderLibraryEntry ...>
   ...
   <ConstructionParameters>
      ...
      <ConstructionParamValues>
         <Param>ModelConcavity</Param>
         <DefaultValue>0</DefaultValue>
      </ConstructionParamValues>
      ...
   </ConstructionParameters>
   ...
</ModelBuilderLibraryEntry>
```

Step 3: Set the value to `1` if Model Creator shall generate a concavity or to `0` if it shall not generate a concavity below a preparation margin.

Step 4: Optionally, the minimum and maximum allowed values can be specified:

```
<?xml version="1.0"?>
...
<ConstructionParamValues>
   <Param>ModelConcavity</Param>
   <DefaultValue>0</DefaultValue>
   <MinValue>0</MinValue>
   <MaxValue>1</MaxValue>
</ConstructionParamValues>
...
```

Step 5: If you prefer the `ModelConcavity` value to be invisible to the user, set `MinValue` and `MaxValue` to the

same value. The `ModelConcavity` parameter will then be omitted from the SETTINGS tab within the MODELSEGMENTATION dialog for plate-type models and the CHANGE MODEL PARAMETERS section in the PLATELESS MODEL DESIGN dialog for plateless models.

Step 6: For an extrusion of the preparation margin above the concavity area adjust the `ModelPreparationMarginExtrusion`.

```
<?xml version="1.0"?>
...
<ConstructionParamValues>
  <Param>ModelPreparationMarginExtrusion</Param>
  <DefaultValue>0.5</DefaultValue>
</ConstructionParamValues>
...
```

Step 7: Save the file. Your changes will be applied the next time you start the software.

A.4 How to Design a Model Containing a Support Pin

Support pins can be added to plateless models. In order to predefine the construction parameters of the support pin for your plateless model, do the following:

Step 1: Open the `config.xml` file of your plateless model type (in the `library/modelcreator/plates` subdirectory of your DentalCAD installation folder).

Step 2: Add `<ConstructionParamValues>` entries for `ModelSupportPinDiameter`, `ModelSupportPinLedgeHeight` and `ModelSupportPinBulgeHeight` within the `<ConstructionParameters>` section and set the desired values.

```
<?xml version="1.0"?>
<ModelBuilderLibraryEntry ...>
  ...
  <ConstructionParameters>
    ...
    <ConstructionParamValues>
      <Param>ModelSupportPinDiameter</Param>
      <DefaultValue>5.0</DefaultValue>
    </ConstructionParamValues>
    ...
  </ConstructionParameters>
  ...
</ModelBuilderLibraryEntry>
```

Step 3: Save the file. Your changes will be applied the next time you start the software.

A.5 How to Set the Colors of the Model Alignment Rotation Controls

The rotation controls are displayed during the model alignment. In order to set their colors (distinguished by their rotation axis), do the following:

Step 1: Open the `defaultcolors.xml` file in the `config` subdirectory of your DentalCAD installation folder.

Step 2: Find the `<ColorDefinition>` entries for `ModelBuilder.RotationControlX`, `ModelBuilder.RotationControlY` and `ModelBuilder.RotationControlZ`:

```
<?xml version="1.0"?>
<ArrayOfColorDefinition ...>
  ...
```

```
    <ColorDefinition>
      <Type>ModelBuilder.RotationControlX</Type>
      <Color>#00FF00</Color>
    </ColorDefinition>
    ...
  </ArrayOfColorDefinition>
```

Step 3: Set the color for each desired rotation control as an RGB value within the `<Color>` tag (i.e. `<Color>#0000FF</Color>`).

Step 4: Save the file. Your changes will be applied the next time you start the software.

B Common Problems

This chapter gives information concerning common problems.

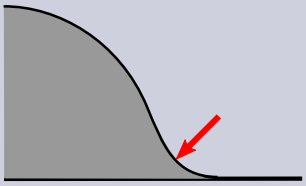
B.1 Common Mistakes During Pins Design

For a good result, it is essential that the pins mesh satisfies the requirements stated in 2.5.1.

Pin with tangential intersection

This picture shows a pin that touches the base plate mesh tangentially. The pin should intersect the base plate and the intersection should result in a distinct edge.

IMPORTANT:
This is an example of how not to design the pins mesh!
Do not use a pins mesh designed as shown!



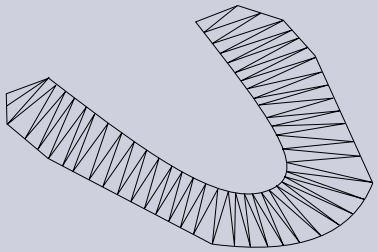
B.2 Common Mistakes During Base Plate Design

For a good result, it is essential that the base plate mesh satisfies the requirements stated in 2.5.1.

Mesh with unacceptable edge length

This picture shows a mesh with unacceptable triangulation. The mesh should have an edge length of between 0.25 mm and 0.5 mm.

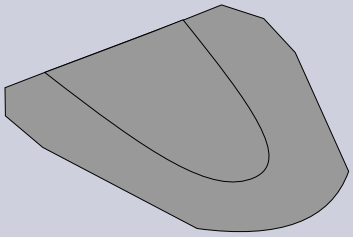
IMPORTANT:
This is an example of how not to design a base plate!
Do not use a base plate designed as shown!



Mesh including palatinal area

This picture shows the mesh of a base plate that includes the palatinal area. As Model Creator generates model geometry above the complete base plate mesh, the mesh should not include the palatinal area.

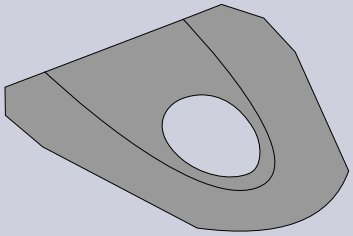
IMPORTANT:
This is an example of how not to design a base plate!
Do not use a base plate designed as shown!



Mesh including parts of palatinal area

This picture shows the mesh of a base plate that includes parts of the palatinal area. As Model Creator generates model geometry above the complete base plate mesh, the mesh should not include parts of the palatinal area.

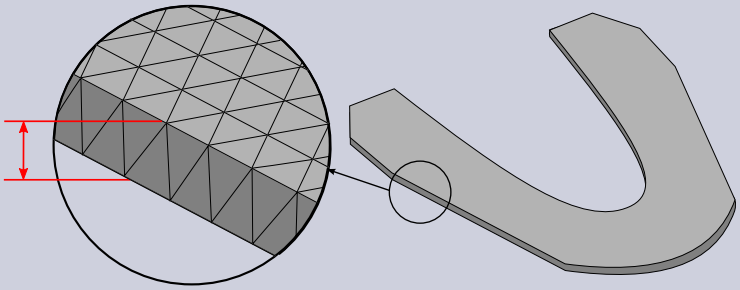
IMPORTANT:
This is an example of how not to design a base plate!
Do not use a base plate designed as shown!



Base plate as solid body

This picture shows the mesh of a base plate as a solid body. The base plate should have no thickness but be a perfectly flat mesh.

It does not help to reduce the thickness to *almost* 0.



IMPORTANT:
This is an example of how not to design a base plate!
Do not use a base plate designed as shown!

B.2.1 Why does my plate-type model come out bogus?

Most likely you did not strictly follow the rules stated in 2.5.1 — see also B.2.

B.2.2 Why does a cut on one side of the jaw extend all the way to the other side?

A cut will end whenever it reaches the boundary of the base plate. Thus if you have included the palatinal area (see B.2), your cuts probably will not turn out as expected.