

PRELIMINARY

 Roland



Cutting Tips



Table of Contents

Introduction	3
1 Plan the Cutting	3
2 Choosing the Workpiece	5
3 Choosing the Tool	5
4 Cutting Parameters	7
5 Trimming a Workpiece to the Required Size for Cutting ..	8
6 Securing the Workpiece in Place	9
7 2.5-dimensional Cutting and Three-dimensional Cutting	10
8 Dividing an Object	12
9 Changing the Orientation of an Object	15
10 Margin Cutting	15
11 Single-sided and Double-sided Cutting	16

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Introduction

This document describes some tips and tricks for cutting a wide variety shapes with a modeling machine from Roland DG Corp. It is assumed that data will be output to the modeling machine by MODELA Player or the Windows driver. The explanations in this document also assume that you already understand the basic operation of this software.

1 Plan the Cutting

When creating a shape by cutting, the most important matters the material and the shape being cut. These determine the method and procedure for cutting.

After you've performed cutting a few of times and familiarized yourself with the process, you'll find yourself planning the steps for a new cutting project in your head. Until then, you should plan out the steps for cutting first, before you start work. This is the best method for not wasting time and materials.

The secret to good planning is to consider the operation in reverse, starting from the finished item.

- 1 Decide on the size of the finished item.
- 2 Decide on the composition of the workpiece.
- 3 Break down the item into smaller parts.
- 4 Decide on the cutting method for each part.
- 5 Choose the tool.

■ Decide on the size of the finished item.

Decide on the size when finished.

If it is larger than the modeling machine's cutting area, you must divide it into portions of cuttable size.

■ Decide on the composition of the workpiece.

After making it, how will it be used? The composition to use differs according to the purpose of the item.

Because there are restrictions to the compositions that can be cut according to the modeling machine, choose the a composition from among those available that is suited to the item's purpose.

When deciding on the target purpose, give consideration to matters such as these:

- How much strength is required?
- How much durability is required?
- How much precision is required?
- After cutting, will further processing (such as coloring) be performed?

If there are no particular requirements, it's a good idea to choose a composition that is easy to cut.

■ Break down the item into smaller parts.

After deciding on the size and composition, divide the item into sizes and shapes that can be cut. Cut each of the component parts, then put them together.

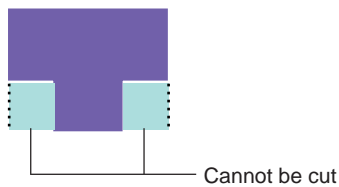
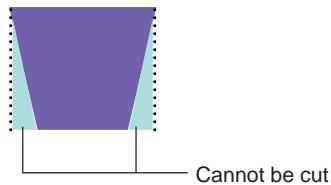
Depending on the item's size and shape, it may not be necessary to divide it into smaller parts.

Dividing an item into smaller parts is done to break it down into units that the modeling machine can cut.

When dividing an item into parts, follow the basic rules shown below.

- After dividing, the size must be smaller than the cutting area.
- There must be no overhang.

Because modeling machines from Roland DG Corp. employ an XYZ-axis rectangular coordinate system, you cannot cut underneath an overhanging shape.

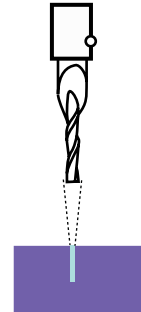


In some cases, however, you may wish to deliberately leave an overhang, then after cutting, work the portion underneath by hand.

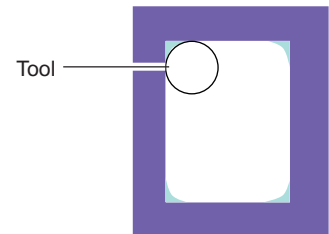


Because the tool is brought against the workpiece to perform cutting, cutting such as the following is physically impossible.

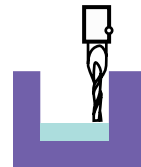
A hole narrower than tool diameter



Flat-drag cutting of a corner



A perpendicular wall higher than the length of the blade



■ Decide on the cutting method for each part.

For each component part, decide whether to perform single-sided or double-sided cutting.

For more information, see “11 Single-sided and Double-sided Cutting.”

■ Choose the tool.

Choose a tool suited to the composition of the workpiece, the shape to cut, and the cutting method.

For more information, see “3 Choosing the Tool.”

■ Relate topics

[Choosing the Workpiece](#)

[Choosing the Tool](#)

[Cutting Parameters](#)

[Changing the Orientation of an Object](#)

[Dividing an Object](#)

[Single-sided and Double-sided Cutting](#)

2 Choosing the Workpiece

The composition to use differs according to the purpose of the item.

Because there are restrictions to the compositions that can be cut according to the modeling machine, choose the a composition from among those available that is suited to the item's purpose. When deciding on the target purpose, give consideration to matters such as these:

- How much strength is required?
- How much durability is required?
- How much precision is required?
- After cutting, will further processing (such as coloring) be performed?

You may also wish to give thought to design factors such as whether you want to use wood grain.

If there are no particular requirements, it's a good idea to choose a composition that is easy to cut.

■ Relate topics

[Choosing the Tool](#)
[Cutting Parameters](#)

3 Choosing the Tool

Choose a tool suited to the composition of the workpiece, the shape to cut, and the cutting method.

The main specifications that are the decisive factors when choosing a tool are the shape of the tool tip and the composition (hardness) of the tool.

Shape of the Tool Tip

■ Tools suited to three-dimensional cutting (or 2.5-dimensional cutting)

Straight end mill



This is a tool for cutting with a flat tip.

It is suitable for cutting flat and stepped items.

Ball end mill



This is a tool for cutting with a rounded tip.

It is suitable for cutting curved surfaces and wavy shapes.

■ Tools suited to engraving

Engraving tool



This is a tool for engraving with a pointed tip.

It is suitable for engraving text and the like on nameplates and rating plates.

Flat tool



This is a tool for engraving with a flat tip.

It can perform cutting with a wide engraving cross-section, so it is suitable for large text and workpiece surfacing.

Tool Composition (Hardness)

Choose a tool suited to the hardness of the workpiece to cut. The following two types are optionally available from Roland DG Corp.

High-speed steel

This is the standard tool when performing cutting.

It is suitable for cutting resin, foamed material, balsa, and the like.

Cemented carbide

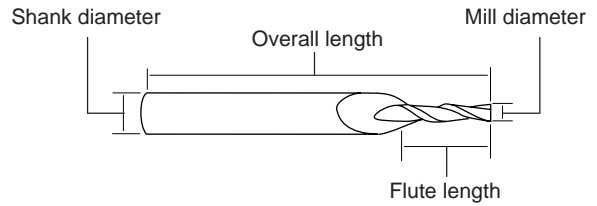
This features a long life compared with high-speed steel.

Besides resin, it is suitable for cutting aluminum, brass, and hard wood (such as magnolia).

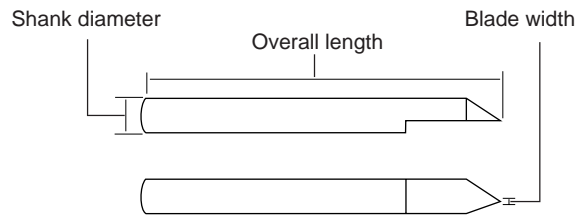
The tools you can use vary according to the modeling machine. Check the operator's manual for the modeling machine you're using, or a catalog from Roland DG Corp.

Other Specifications

End mill



Character cutter/flat tool



Shank diameter

Choose a diameter that can be mounted on the modeling machine.

Mill diameter

Choose an item that can cut detailed portions of objects.

Blade width

Make your choice according to the size of the text to engrave.

■ Related Topics

[Plan the Cutting](#)

[Choosing the Workpiece](#)

[Cutting Parameters](#)

4 Cutting Parameters

When you make the selections for workpiece composition and tool-blade diameter, MODELA Player automatically performs cutting using settings matched to these conditions. Note that these settings are general values, and depending on the hardness of the tool you're using and the usage environment of the modeling machine, they may not produce optimal cutting results.

In such cases, then MODELA Player's [Option] menu, display [Customer Parameters] and set the cutting parameters manually. For information on how to set the cutting parameters, refer to the help for MODELA Player. The setting ranges for these items vary according to the modeling machine you're using. For information on items that can be set, take a look at the operator's manual for the modeling machine you're using.

■ Relate topics

- [Choosing the Workpiece](#)
- [Choosing the Tool](#)

Cutting parameters	Setting item	Suggested setting
Tool diameter	This sets the diameter of the blade for the installed tool.	
Z speed	This sets the speed when the tool is lowered.	Generally, when the speed is too fast, cutting is coarse and it may not be possible to cut the surface of the object attractively. Depending on the composition of the workpiece, however, slower speeds may not necessarily produce a more attractive finish.
XY speed	This sets the tool's speed of movement in the along the X and Y axes.	
Path spacing	This sets the interval between adjacent path lines.	Set this to a value smaller than the diameter of the tool blade you're using.
Fine margin	This sets the cutting thickness for finishing.	During rough cutting, material of the thickness of the fine margin is allowed to remain around the object as it is cut.
Z step	This sets the cutting-in depth per cutting pass.	Deep cutting-in amounts result in correspondingly shorter cutting times. However, the cutting-in amount is limited by the composition of the workpiece. A cutting-in amount that is too deep may not only result in poor cutting, but may even shorten the useful life of the blade. You should generally reduce the cutting-in amount for harder materials of when using a narrow-diameter tool blade.
Spindle motor revolution speed	This sets the number of revolutions per minute of the spindle motor.	Increasing the speed results in faster cutting, but if raised too much the workpiece may melt or burn due to heat from friction. Conversely, lowering the speed results in longer cutting times. On some modeling machines, this setting is not available.

5 Trimming a Workpiece to the Required Size for Cutting

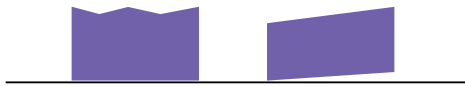
To prepare a workpiece of the necessary size for cutting, use a saw or the like to trim it to size.

The optimal size for a workpiece is usually the minimum dimensions required to cut the object, plus a margin of several millimeters.

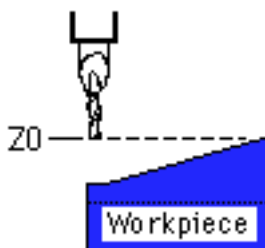
Cutting time is long if too large, and the solid object cannot be made if too small.

Note that when performing double-sided cutting, the size of the workpiece matched to the task is determined in advance. For more information, see “11 Single-sided and Double-sided Cutting.”

Also, when a workpiece has been cut to size with a saw, the cut surface is not level. If you then start cutting the object with the workpiece as it is, the dimensions may go out of true. Before cutting the object, be sure to perform surfacing.



1. Use a saw or the like to cut the workpiece to the required size.
2. Mount the workpiece on the modeling machine. For information on your mount the workpiece, see the operator’s manual for the modeling machine you’re using.
3. To make the cut surface of the workpiece level, perform surfacing with MODEL A Player.
If you have cut both the upper and lower surfaces, perform surfacing for both sides.
The Z-axis reference point when performing surfacing is set at the highest location on the workpiece.



Setting an origin point that is lower than the surface to perform surfacing on causes the cutting-in amount of the first pass to be large, and may make it impossible for cutting to continue.



■ Relate topics

[Cutting Parameters](#)

[Single-sided and Double-sided Cutting](#)

6 Securing the Workpiece in Place

When you want to cut through a workpiece all the way to the bottom, or when securing a workpiece of complex shape, you can secure it in place reliably by using a base for securing a workpiece or a commercially available epoxy adhesive.

Mounting a Base for Securing a Workpiece

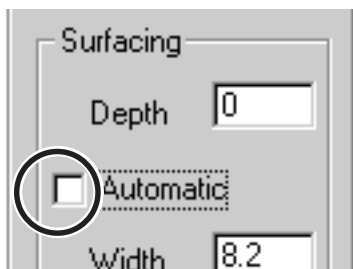
Composition

A base for securing a workpiece is made of plastic or wood. This is to prevent damage to the tool due to the hardness of the base if the tool should cut into the base. Note that materials which are prone to expansion and contraction due to changes in temperature are not suitable for use as a base.

Size

It may be a good idea to prepare an item that is a minimum of 10 mm (0.4 in.) wider than the workpiece area. Mounting an item that is wider than the size actually required eliminates the trouble of having to change the base many times according to the size of the workpiece. The suggested thickness is about 5 mm (0.2 in.). Note that the maximum cutting area in the Z direction is reduced by the thickness of the base for securing the workpiece.

1. Secure the base for securing the workpiece on the modeling machine. For information on how to secure it in place, see the operator's manual for the modeling machine you're using.
2. Perform surfacing to ensure that the base for securing the workpiece is level. With MODEL A Player, set the surfacing area to the size of the mounted base. To change the surfacing area, open the [Layout/Surfacing Settings] dialog box and unselect [Move Size/Position].



3. When surfacing finishes, remove any remaining cuttings on the top of the base.

Securing in Place with Commercially Available Epoxy Adhesive

* For information on the use and handling of the epoxy adhesive, refer to the documentation that came with the adhesive.

Epoxy adhesive can retain the workpiece securely even if its bottom surface is curved or uneven, making it handy for securing objects with a narrow bottom surface.

In addition to the workpiece and tool, have the following items on hand.

Base for Securing a Workpiece

(To mount a base, see the previous section, "Mounting a Base for Securing a Workpiece.")

Commercially Available Epoxy Adhesive

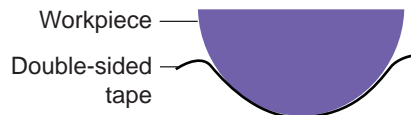
Commercially available double-sided tape

The double-sided tape prevents the epoxy from adhering to the workpiece.

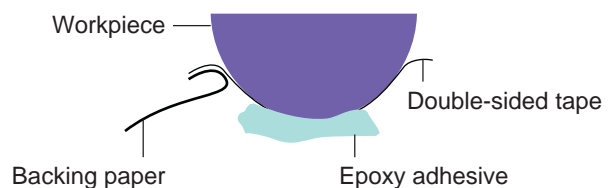
Commercially available ethyl alcohol

This is used when removing the workpiece from the base.

1. Apply double-sided tape to all surfaces of the workpiece that might come in contact with the epoxy.



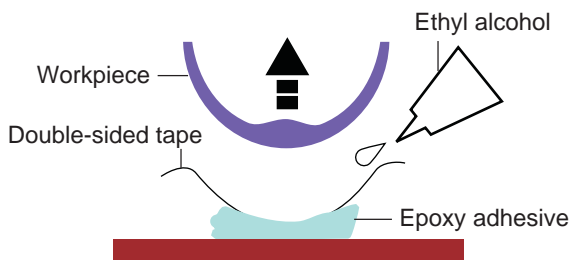
2. Peel off the backing paper from the double-sided tape and apply the epoxy evenly over the tape surface.



- Secure the workpiece in place on the base for securing the workpiece.
Allow the epoxy to harden, and when the workpiece is reliably secured in place, perform cutting.



- When cutting finishes, liberally moisten the borders between the double-sided tape and the workpiece with alcohol. Remove the workpiece from the base.



■ Relate topics

Single-sided and Double-sided Cutting

7 2.5-dimensional Cutting and Three-dimensional Cutting

With 2.5-dimensions, the X and Y axes are controlled simultaneously. You cannot move the X and Y axes while moving the Z axis, or move the Z axis while moving the X and Y axes. With three dimensions, the X, Y, and Z axes are controlled simultaneously. You can move all three axes at the same time, making it possible to cut curved surfaces such as spheres and ovoids.

Let's compare the cutting results with some cross-section illustrations.

2.5-dimensional Cutting



Three-dimensional Cutting



Flat data created with a commercially available 2D program can be used as 2.5-dimensional cutting data by using the 2.5 Driver included with the modeling machine.

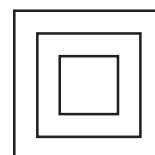
* The 2.5D Driver is for Windows 95/98 and Windows NT 4.0. The following explanation assumes you're using Windows 95/98 or Windows NT 4.0.

An Example of Creation of 2.5-dimensional Data

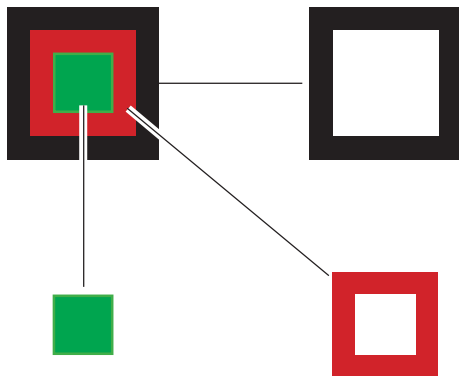
The settings for cutting depth are made by associating the colors specified when you created the data with the tool parameters of the 2.5 Driver. This section describes one example of creating data for cutting a step-shaped item.



- Use a commercially available 2D program to create data for engraving. Make the engraving data with a top-view perspective.



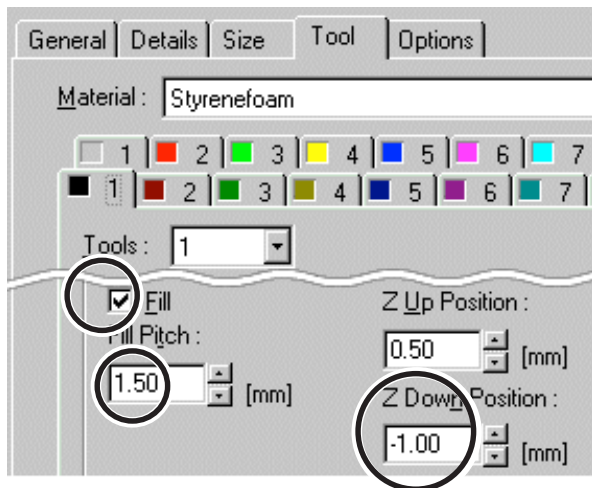
- To make the settings for depth, specify a color for each shape.
If a shallow plane overlaps a deep plane, specify the colors so that the color of the deep plane does not overlap the shallow plane.



- From the program, run the [Print] command.
- In the [Printing] dialog box, choose the 2.5 Driver to which the model name of the modeling machine to use is assigned, then click [Properties].
- Associate the colors you specified with the program with cutting depths.


• If You're Using Windows 95/98

- At the displayed screen, click the [Tool] tab.
Click the tab for the color used by the program.



Specify the depth to cut at [Z Down Position].
To cut the data used here in a stepwise fashion, specify progressively shallower values for [Z Down Position] in the sequence of black, then red, then green.

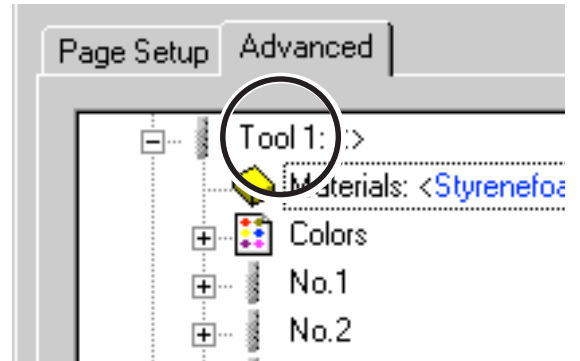
Example Settings

-  1 tab: -5 mm
-  2 tab: -3 mm
-  3 tab: 0 mm

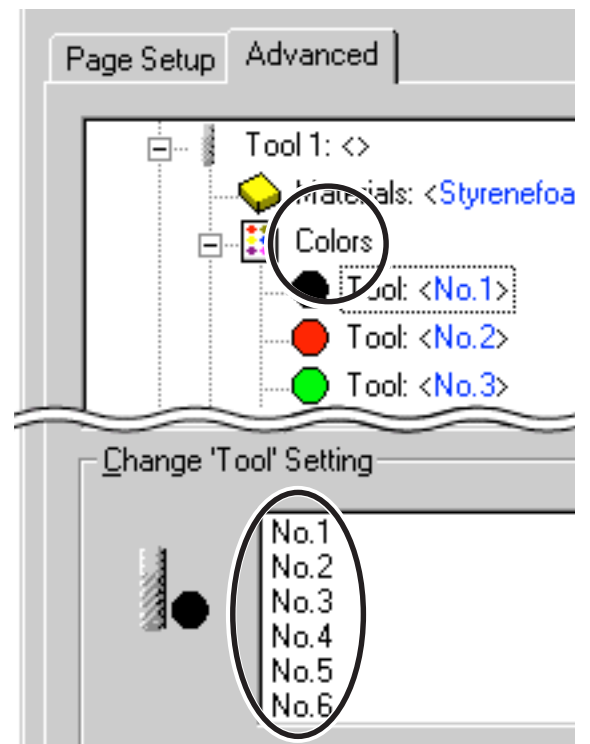
- Make sure [Fill] is selected, then specify the fill pitch.
Enter a value smaller than the blade width of the tool being used.

• If You're Using Windows NT 4.0

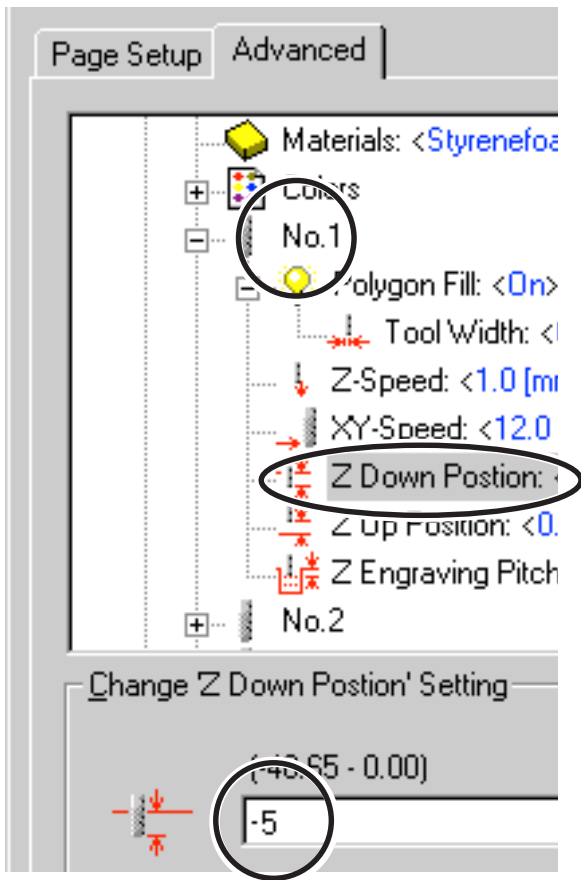
- From [Tool 1] through [Tool 4], double-click the parameters for the tool to use.



- Double-click [Colors] and display the lower level. Click the color to set, then click the tool number.



- 3) Double-click the tool number and display the lower level.



To cut the data used here in a stepped shape, specify progressively shallower values for [Z Down Position] in the sequence of [Tool No. 1], then [Tool No. 2], then [Tool No. 3].

Example Settings

- [No.1]: -5 mm
- [No.2]: -3 mm
- [No.3]: 0 mm

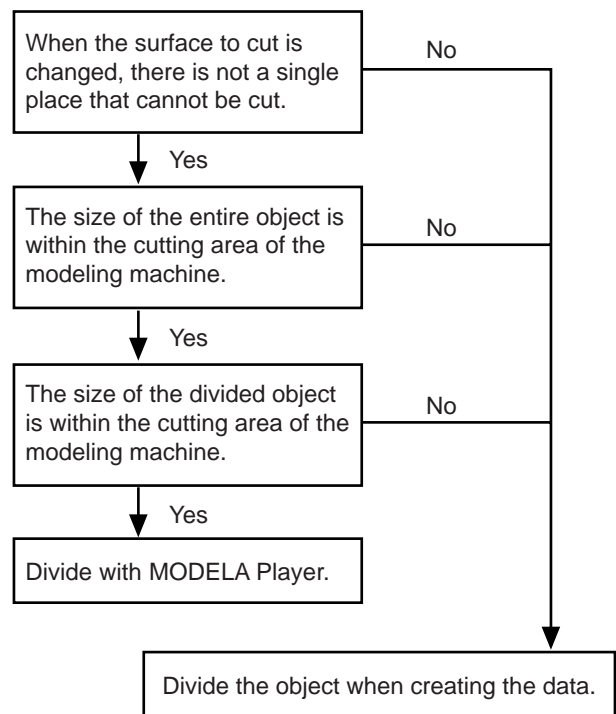
- 4) Make sure [Fill] is selected, then specify the fill pitch. Enter a value smaller than the blade width of the tool being used.
6. Make the settings for other cutting parameters, then click [OK].
At the [Printing] dialog box, click [OK], then output the cutting data to the modeling machine.

8 Dividing an Object

An object that includes shapes that the modeling machine cannot cut is first divided into a number of data sets, then cut.

There are two methods for dividing an object: changing the MODELA Player cutting parameters, and dividing the object into parts when you create the data.

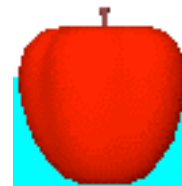
Once you've decided on the full image of the object to cut, give thought to what shapes the object includes. Refer to the figure below and decide which method to use.



Dividing with MODELA Player

This explanation takes the shape of an apple as an example.

The bottom portion of an apple is narrower than the top, so the light-blue portion remains without being cut.

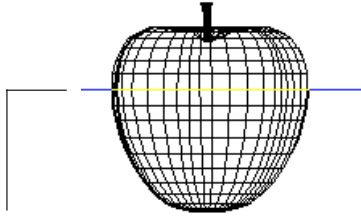


In cases like this, you should divide the apple into two parts, an upper and a lower, cut them separately, then join them together with adhesive.

1. In MODELA Player, set [Direction] to the upper surface.



2. Use [Cutting Depth] in MODELA Player to set the portion up to the widest part of the apple to the maximum depth, then perform cutting.

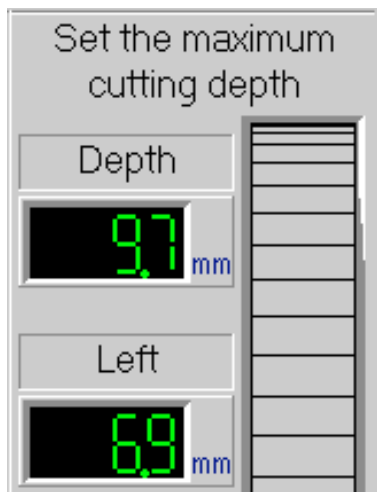
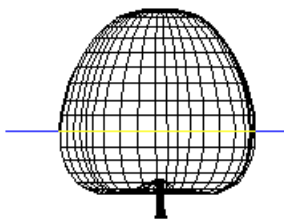


Set the portion up to the widest part of the apple to [Depth].

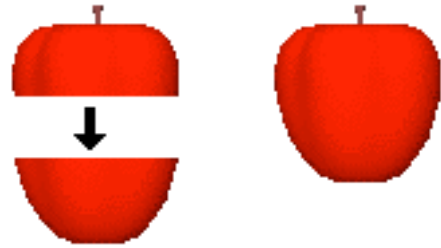
3. When the cutting of the top portion finishes, load the workpiece for the bottom portion.
4. Use [Direction] in MODELA Player to make the setting for the lower surface.



5. At the [Cutting Depth] screen, set the value displayed for [Left] to [Depth], then perform cutting.



6. When you're done cutting the top and bottom portions of the apple, join the two parts together with adhesive to finish the apple.



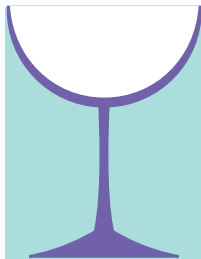
Dividing the Object When Creating the Data

This explanation takes the shape of a wine glass as an example.

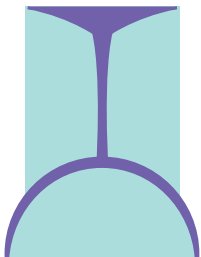


Let's look at the results when this shape is cut using just the MODELA Player settings.

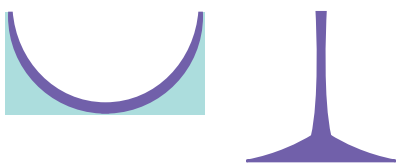
When cut from the upper surface



When cut from the lower surface



When divided vertically and cut



When divided laterally and cut



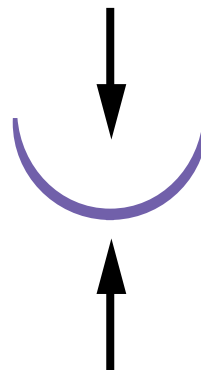
"  " indicates places that cannot be cut.

In this way, no matter how you change the cutting parameters with MODELA Player, a portion that cannot be cut always occurs somewhere.

When this happens, then instead of creating data for the entire object, break the object down into shapes that can be cut with MODELA Player settings as you create the data. In the case of the wine glass, create the data sets as shown below, then join the objects together afterward.

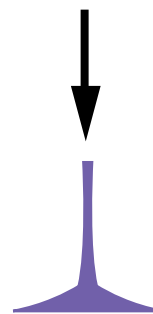
Data set 1

Perform cutting from both sides.



Data set 2

Perform cutting from the upper surface.



In the example described above, the object was completed simply by dividing it into two parts.

Note that with shapes that are even more complex (such as model parts or dolls), you must also take into account the points below and further divide the object.

- Match up the dimensions of the entire object with the dimensions of the object divided into its respective parts.
- Make sure the diameter of the tool to use can cut the intricate shapes when divided into parts.

Once you've decided on the object to create, proceed systematically with the task, such as by sketching the object on paper.

Relate topics

[Plan the Cutting](#)
[Single-sided and Double-sided Cutting](#)

9 Changing the Orientation of an Object

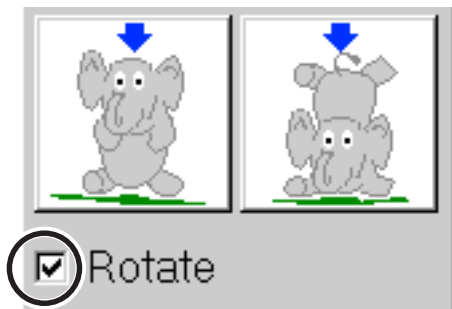
Depending on the orientation of the object data or the orientation of the mounted workpiece, an object may not fit in the modeling machine's cutting area.

<Example>



In such cases, you can perform cutting by rotating the object 90 degrees with MODELA Player.

1. At the MODELA Player [Direction] tab, select [Rotate].



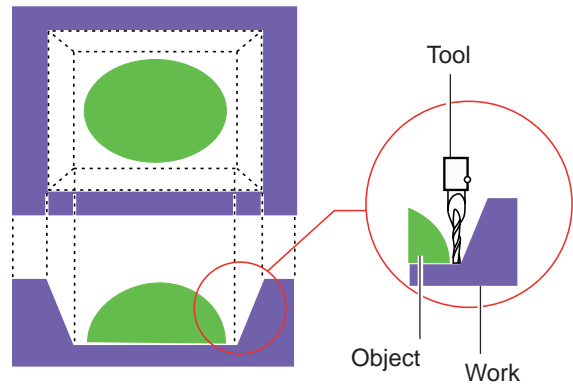
The object is rotated 90 degrees, and fits inside the cutting area of the modeling machine.



10 Margin Cutting

Margin cutting is a feature that ensures a cutting area with a margin equal to object depth plus tool diameter in the X and Y directions, and cuts the outer perimeter of the object's outer shape at an angle.

This means that even when cutting an object whose thickness is greater than the blade length of the tool being used, you can perform cutting without running up against a "wall" during cutting.



When cutting an object whose thickness is greater than the blade length of the tool being used, select [Abstract].

With MODELA Player, [Abstract] is active when the settings just after you set up the program are in effect.

Note that with margin cutting, an area more extensive than the actual object is cut, so cutting takes more time.

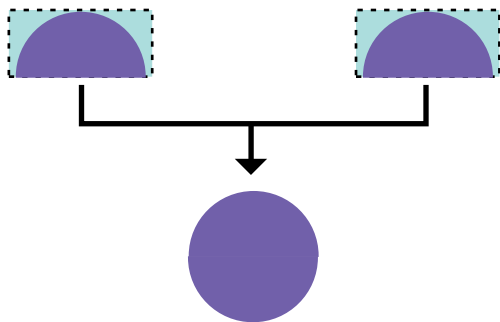
This means when cutting an object whose thickness is not greater than the blade length, you can shorten cutting time by deselecting [Abstract].

11 Single-sided and Double-sided Cutting

When dividing an object and performing cutting with MODELA Player, you can use either of two methods: single-sided cutting that cuts only one side of the block, or double-sided cutting which cuts both sides of the block.

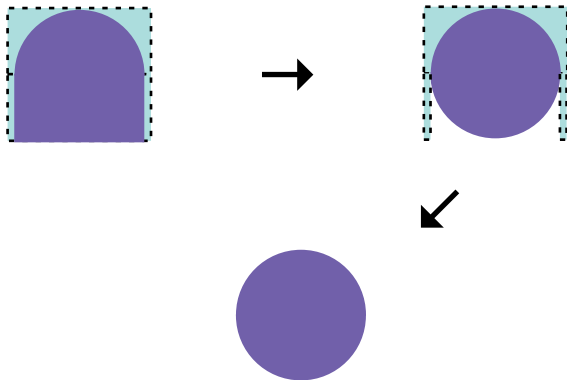
Single-sided Cutting

Prepare one block each for the upper and lower surfaces of the object, and cut only one side of each.



Double-sided Cutting

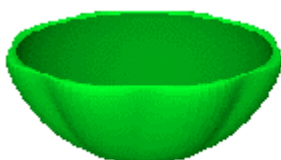
Prepare one block and cut both the upper and lower surfaces.



Because single-sided cutting uses two blocks, after cutting, in order to complete the object it's necessary to join the blocks together with adhesive. For an explanation of the cutting procedure, see "8 Dividing an Object - Dividing with MODELA Player."

Because double-sided cutting cuts a single block, it produces an attractive finished result, with no traces of joining remaining on the object.

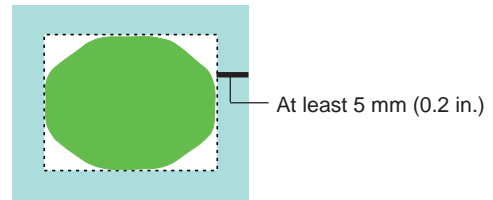
The shape shown below is used as an example to explain the steps of double-sided cutting.



Prepare a workpiece whose size is larger than the object's dimensions as the workpiece to use in this example.

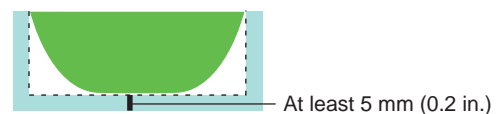
- X and Y directions

Use an item that is at least 5 mm (0.2 in.) larger to the left and right and to the front and back than the actual dimensions of the object.



- Z direction

Use an item that is at least 5 mm higher than the actual dimensions of the object.



These margins are necessary in order to place marks so that the X- and Y-direction cutting origin points on the front and back surfaces do not become misaligned.

In addition to the tool and workpiece, have the following items on hand.

- Base for securing the workpiece

For information on how to mount the base, see "Securing the Workpiece."

- Positioning pins

Prepare items that are the same diameter as the tool to use and about 10 mm (0.4 in.) longer than the height of the object.

If you're using a modeling machine that comes with positioning pins, use the included pins.

The dimensions of the included positioning pins are as follows.

Diameter	: 3 mm (0.118 in.)
Length	: 18 mm (0.709 in.)

- Epoxy adhesive

This is used to secure the workpiece in place when cutting the back surface (second pass).

When using positioning pins included with the modeling machine, the tool diameter and the height of the object that can be cut are subject to the following restrictions.

Tool diameter	: 3 mm (0.118 in.)
Object height	: Approx. 10 mm (0.4 in.)

1. Decide on the cutting sequence and cut the upper surface

When you finish the first cutting pass and start on the second cutting pass, the surface of the workpiece that was the upper surface in the first pass becomes the portion to secure in place for the second pass.

In the case of the object being cut in this example, cutting the side with the depression to hold things first would leave very little surface to support the object for the second cutting pass, so you should start by cutting the portion that will become the object's bottom surface first.

The first



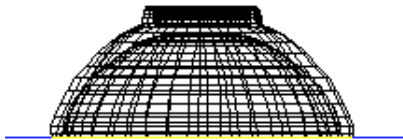
The second



1. Use double-sided tape to secure the workpiece in place on the base fixed securing the workpiece.
2. On the modeling machine, set the depth-direction reference point.
3. Use MODELA Player to perform surfacing.
4. Set [Direction] to the lower surface.



5. Make the setting for [Dimension]. If you're using positioning pins that came with the modeling machine, specify a height of 10 mm (0.4 in.) or less.
6. Make the setting for [Cutting Depth]. In the example used here, [Depth] (maximum cutting depth) is set to the lowest value.

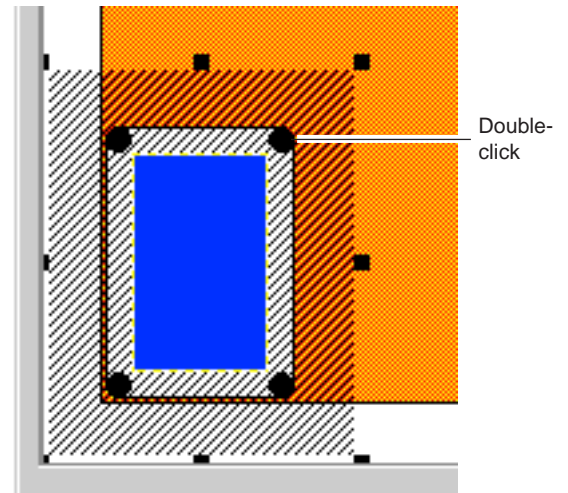


7. Select [Abstract].
8. Make the settings for other cutting parameters.
9. Cut the surface, performing rough cutting first, then finishing. When you finish cutting, do not remove the workpiece.

2. Get ready to perform positioning

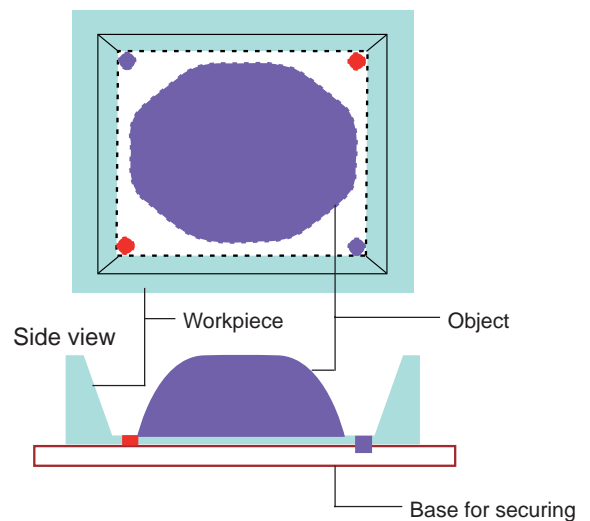
When you finish cutting the upper surface, cut positioning marks in the workpiece and base.

1. From the MODELA Player [Option] menu, display [Layout...]. Black circles are displayed at the four corners of the cutting position. Double-click one of these black circles to lower the tool on the modeling machine to the Z-axis reference point.



2. In step 1, the tool descends only as far as the upper surface of the workpiece. To apply positioning marks, it is necessary to cut through the four corners of the workpiece, and to cut the base for securing the workpiece as well. Then continue by using the modeling machine to lower the tool to the location shown in the figure below.

Front view



- ◆ Cut through only the workpiece.
- ◆ Cut through the workpiece, and cut into the base for securing the workpiece by 2 or 3 mm.

3. Remove the workpiece.

3. Measure the excess thickness of the workpiece

Before mounting the workpiece, measure and make a note of the dimensions described below.

The values you measure here are required in the steps described in “5. Cut away excess portions of the workpiece.”

1. Orient the workpiece as shown below, and place it on a level base.

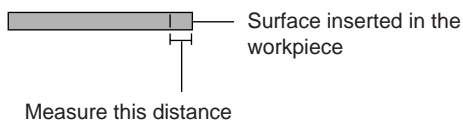


2. Insert the positioning pins at the places you cut in “2. Get ready to perform positioning.”
Use an indelible marker or the like to mark the portions of the positioning pins shown in the figure.



Mark with an indelible marker.

3. Pull out the positioning pins, measure the following dimension with a ruler or the like, and write down the measured value.



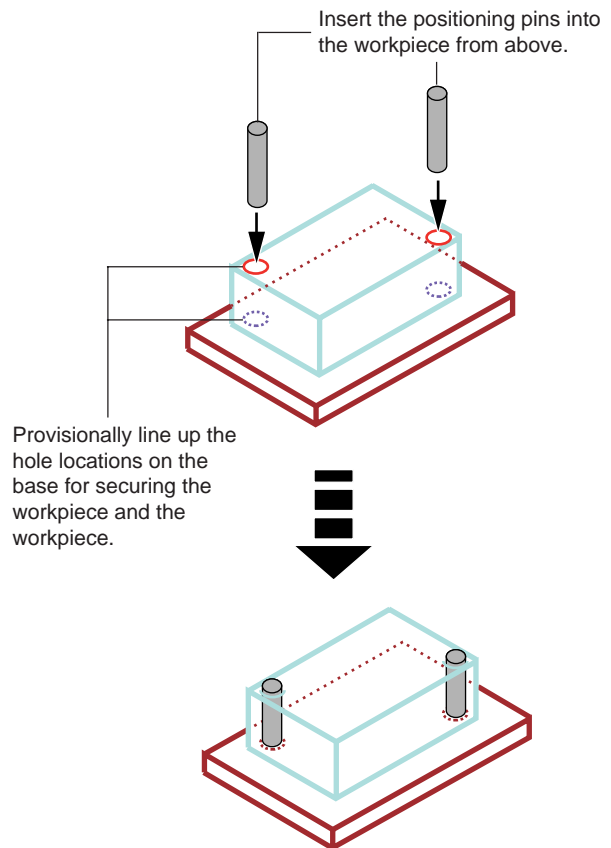
Surface inserted in the workpiece

Measure this distance

4. Change the workpiece surface

Mount the workpiece, using the marks you cut in “2. Get ready to perform positioning.”

1. Apply double-sided tape to the entire surface of the workpiece to be mounted on the base for securing the workpiece.
Remove the backing paper and apply epoxy adhesive.
2. Using the positioning pins, mount the workpiece on the base for securing the workpiece as shown in the figure.



Provisionally line up the hole locations on the base for securing the workpiece and the workpiece.

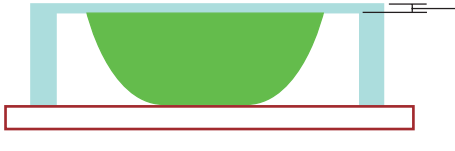
When you fit the positioning pins into the holes in the base, the hole locations in the workpiece and the base are secured in place, and the workpiece is mounted at the same position as the first cutting pass.

3. Allow the epoxy to harden, and when the workpiece is secured in place, pull out the positioning pins.
If you cannot easily grasp the positioning pins by hand, use pliers or the like to grip them and pull them out.

5. Cut away excess portions of the workpiece

In order to make positioning marks on the workpiece, you use a workpiece whose height is greater than the thickness of the object. In the second cutting pass, this thickness (the value you made a note of in “3. Measure the excess thickness of the workpiece”) remains on the upper surface.

Perform surfacing to cut away this excess portion of the workpiece.



Eliminate this thickness by surfacing.

1. On the modeling machine, set the depth-direction reference point on the surface.
2. From the MODELA Player [Option] menu, click [Layout...]. The [Layout/Surfacing] dialog box appears.
3. For [Depth], enter the value made a note of in “3. Measure the excess thickness of the workpiece,” then click [Start].

6. Cut the back surface of the workpiece

1. Use MODELA Player to change the cutting surface.



2. Check the other cutting parameters, then output the data to the modeling machine.

■ Relate topics

[Securing the Workpiece in Place](#)

