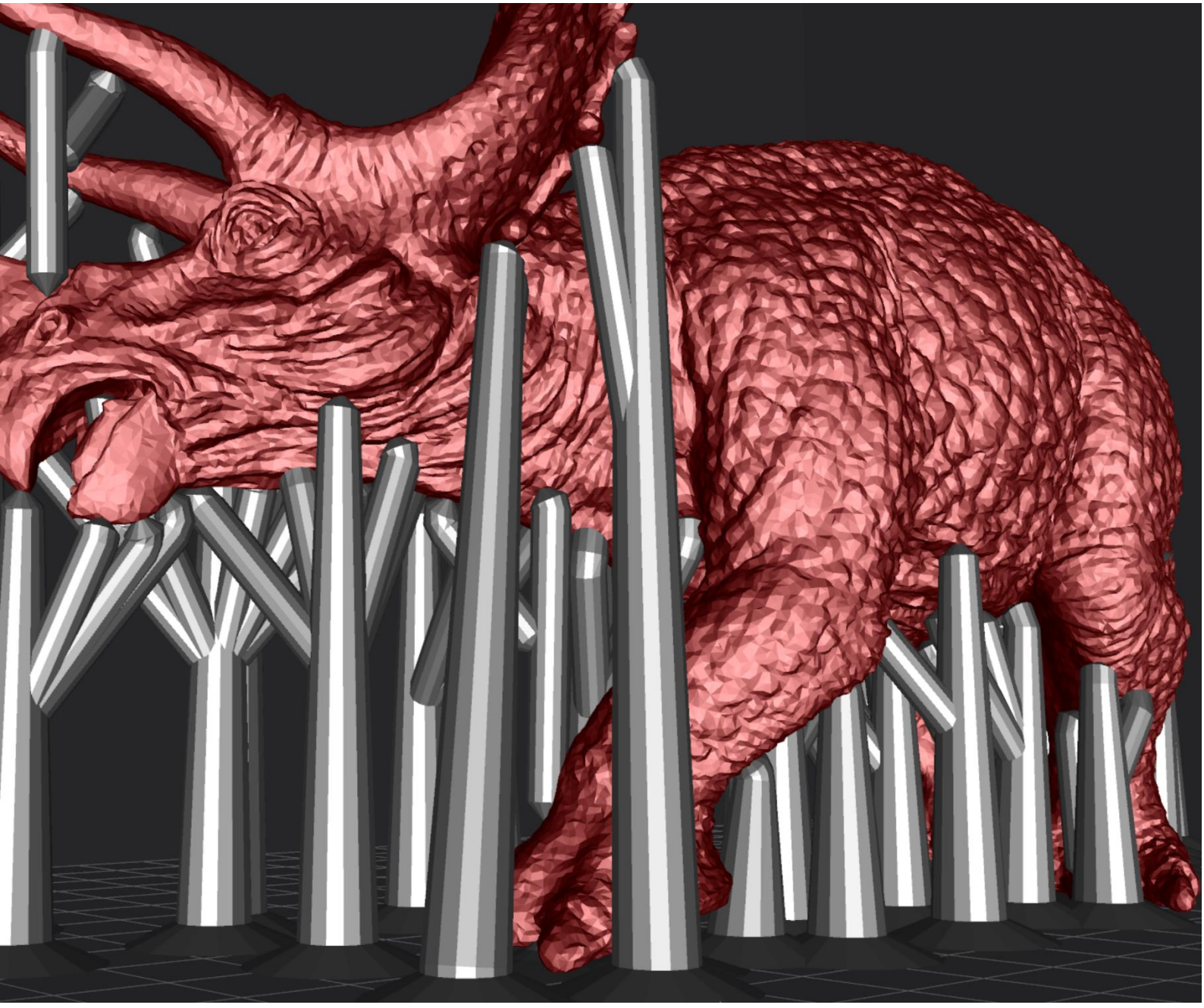
Tips to Improve the Output Quality of Cubicreator



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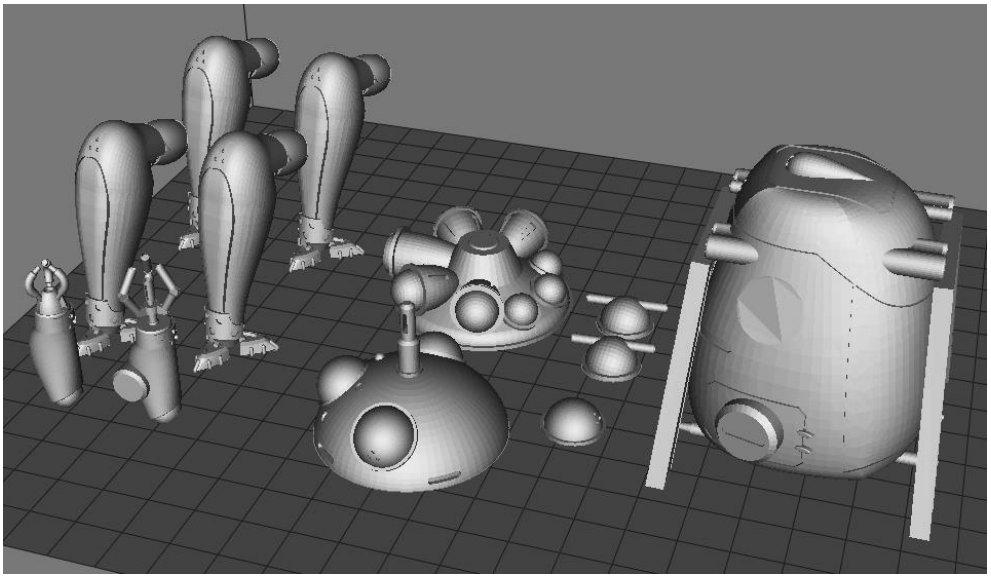
Start

Start

3D printers are attracting a lot of attention as a new technology industry for future, because it can change the way to produce an existing product in an innovative way. As printers for home use get widely spread, the number of 3D printer users is gradually increasing, and there are increasing cases of individual users who produce a model as a hobby or venture companies which produce a product mock-up. However, 3D printers are still unfamiliar to many people in general, and they are not easy to use. When it is used for the first time, there are many cases that the product is not printed correctly. Therefore, we decided to produce this document based on the know-how we have acquired during the development of a 3D printer in order for people who use the 3D printer for the first time to understand how to use the printer and its characteristics.

The contents were written based on the Cubicon, which is a 3D printer of our company. Some of options and method of the use may be valid only for Cubicon.



▲ Articles Printed by a Printer

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Chapter 1

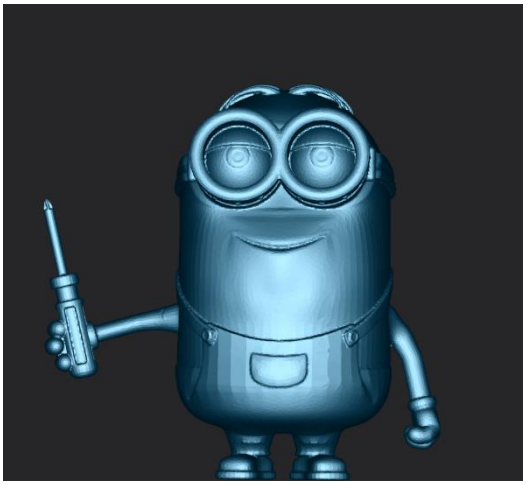
Chapter 1. Features and Characteristics of 3D Printer

1.1. Problems

Since a 3D printer produces an article by stacking layers of the model in 3 dimensional structure, some problems occur during printing out. Also, some cautions are required due to the characteristics of the material of the article printed.

1.1.1. In Case Some Parts Are Sticking Out

As a representative case, if an arm is horizontally sticking out from a character figure, output will not stack up since the printing has to start from the empty space in the air.



▲ The Character that Has an Arm

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1.1.2. Vibration Due to the Movement of Extruder

3D printers are highly precise equipment that can express 0.1mm in general. Since the layer of the model is created through physically moving a nozzle for **FFF** (**F**used **F**ilament **F**abrication or FDM) type, it gets affected by the slight vibration from the movement of the nozzle.

1.1.3. Problem of Filament Flow

Also, there are some cases that the filament naturally flows down from a nozzle due to the gravity, having a negative effect on the printing quality.

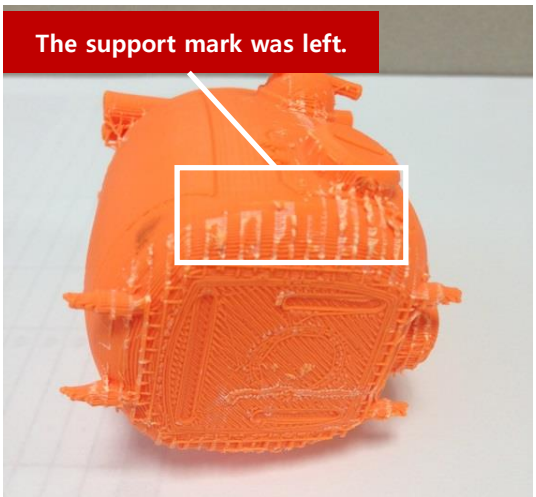
1.1.4. Problem Due to Materials

In general, ABS and PLA are frequently used for **FFF** (**F**used **F**ilament **F**abrication or FDM) type, but in case of ABS, the problem of the material is that the possibility of splitting or bending increases as an article gets bigger due to the contraction phenomenon according to the temperature. Since the edge of the article has higher difference in the temperature, the edge area is more vulnerable to the bending.

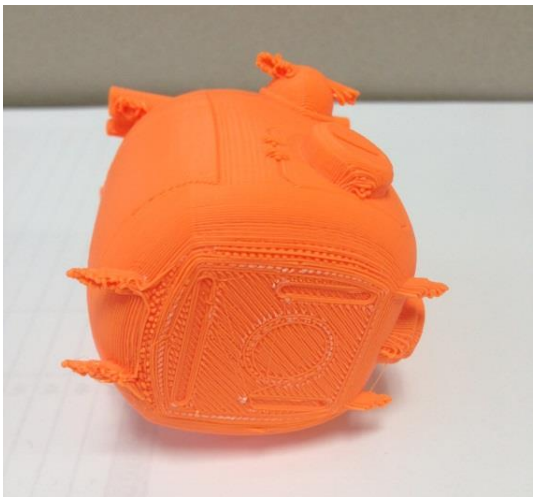
1.1.5. Problem of the Supplementary

Structure

Most of 3D printers have an important characteristic that it requires support structures to help the printing according to the model. Most representative ones are supports, brims, skirts, rafts, etc. Among them, supports and brims are the supplementary structures that help the printing, but they have a problem. In case of a support, as the support gets closer to the model and the density gets higher to sufficiently support the model, it gets harder to remove the support and it would leave a mark after the removal. In the other hand, if the density is lowered and the distance to the model gets far away, there would be a higher possibility of failing the printing because it would not be able to perform the proper role of supporting the model.



▲ Support Was Used



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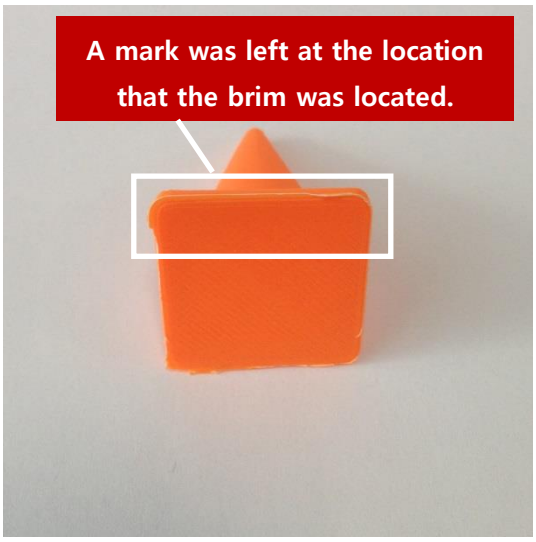
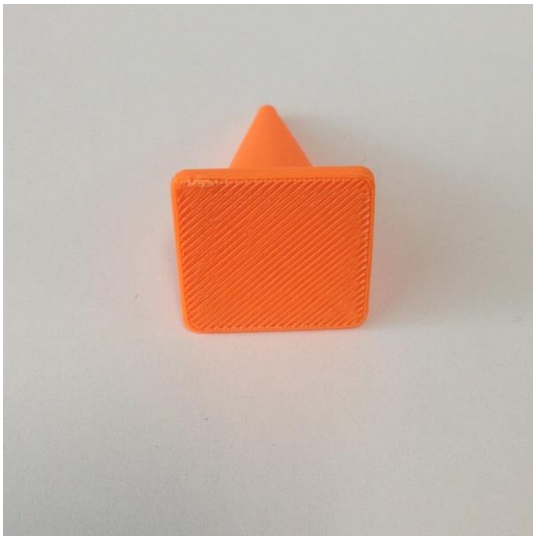


▲ Brim Was Used



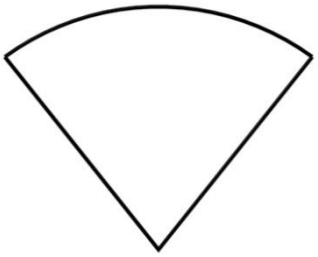
▲ Brim Was Not Used

1.2 The Way to Improve the Printing Quality

Due to the problems described above, 3D printer programs help the printing by creating supplementary structures such as supports through the software. However, although the supports are very useful, they are attached to the printed article and leave a mark when they are removed; if they are used in many places, they may make the printed surface messy. The best solution is not to use the supplementary structures such as the supports. To do so, the shape of the model needs to be changed. The easiest way to change the shape is to rotate the model or change the position.

1.2.1. Radial Shape

If the model is placed to be closer to radial shape as much as possible in the modeling stage, it can be printed without a supplementary structure such as a support.



▲ Radial Shape

Making into a radial shape by rotating or moving the model to minimize the supplementary structure is very effective. Even if it is already in a radial shape, it is important to find the most optimal location by moving the model. If you take a look at the baby model below, the printing quality would be improved when the baby model is lying down rather than standing because the lying down shape would reduce the area that requires the use of the support compare to the standing shape.

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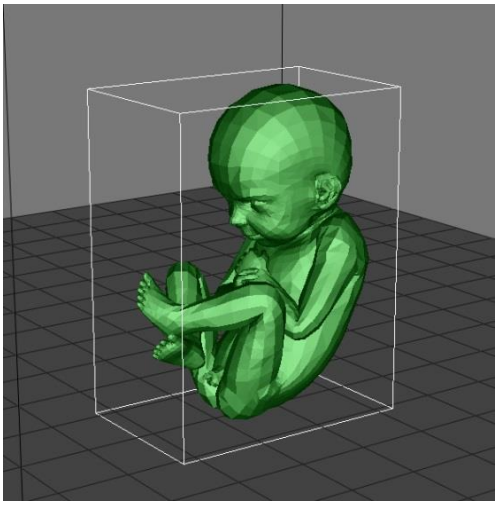
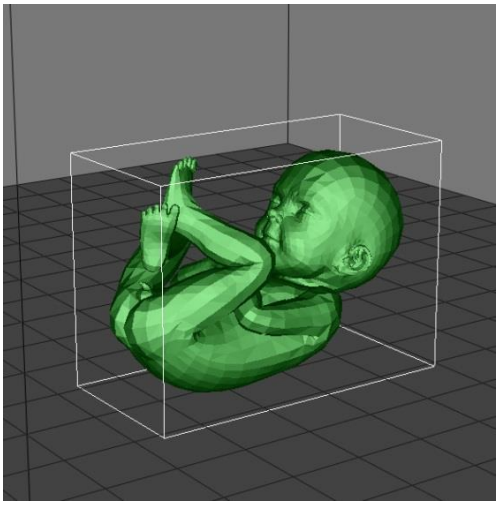


▲ Standing Shape



▲ Lying Shape

1.2.2. Model that Gets Contracted

There may be many factors for a model that is printed with ABS to crack, but the representative factor is the contraction phenomenon due to the difference in the temperature. To prevent this, the temperature must be maintained evenly and the temperature should be lowered slowly. But it can't be done easily. The easier way to do so is to design the part that can hold the contracting part thicker or design the shape in a way that it doesn't get exposed to the external air as much when designing the model. As for the other way, it is helpful to use PLA as a filament or use an enhanced low-contraction filament.

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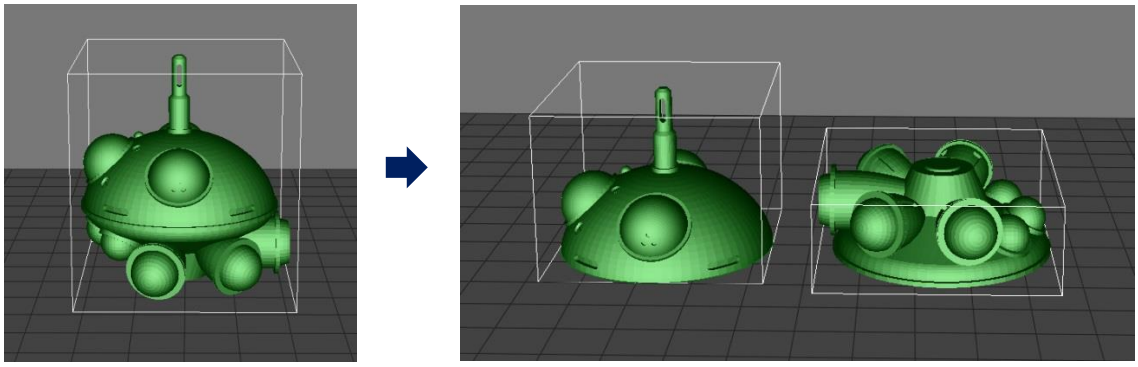
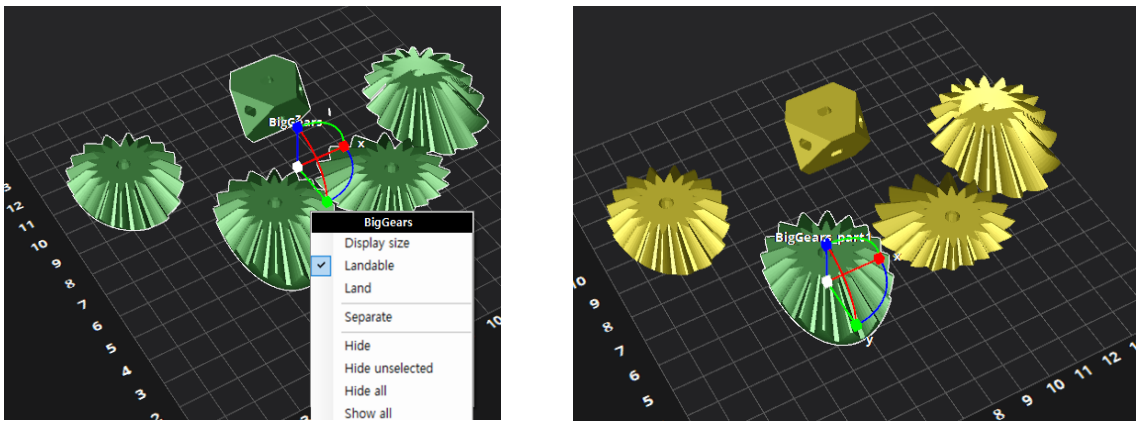
1.2.3. Splitting of a Model

In case of a complicated model such as a robot, the use of the supports can be reduced and the time taking for printing can also be reduced if the model can be split into parts to minimize the supports.



▲ Split of Complicated Model

3D editing program can split a model, and Cubicreator v3.5 or higher version supports the model split function; the model can be split as polygons using this function.



1.2.4. Printing Simulation

Since it would take excessive time to correct errors by printing every model, it is a good idea to simulate the G-Code in advance. Most of host programs of 3D printers offer a G-Code Preview function. As for the Cubicreator, the output can be checked in advance using the G-Code Printing Path Preview.

✓	Since the Output Path fuction draws the G-code path, it doesn't show the affect of the contraction or the gravity that may affect the actual printing.

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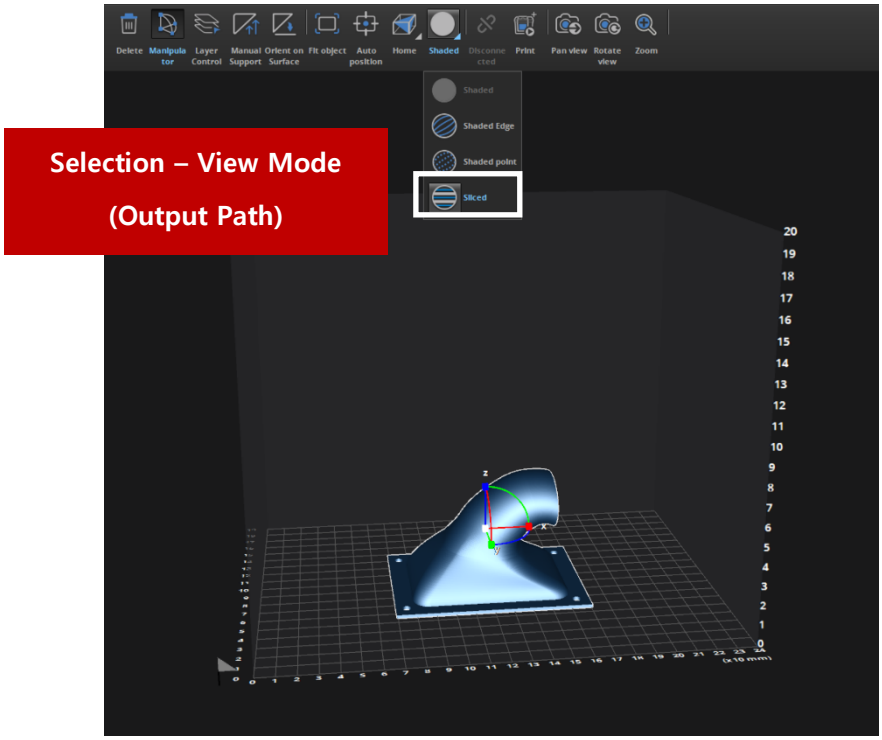
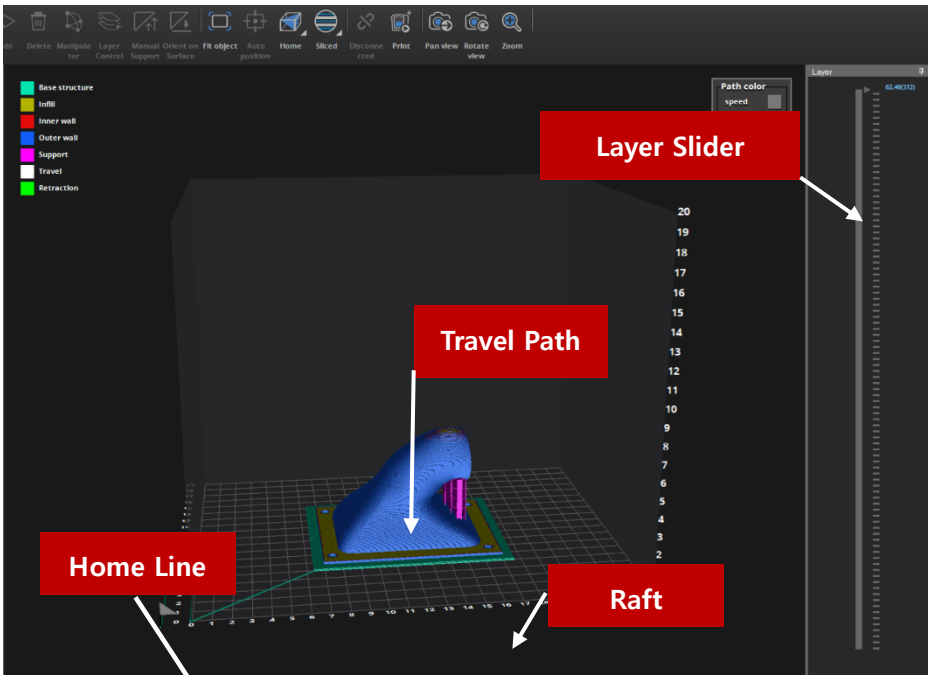


▲ View Mode – Use of the Output Path



▲ Output Path Simulation (Preview)

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Chapter 2

Chapter 2. Output by Options

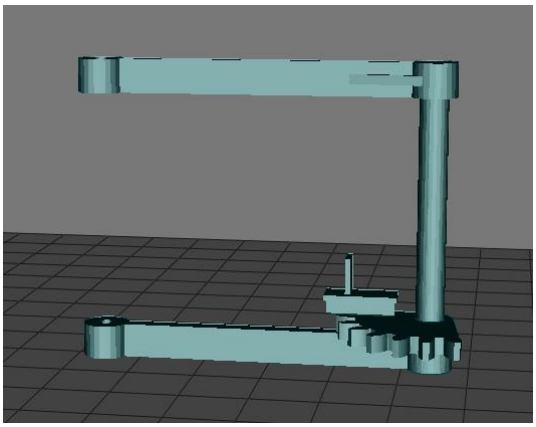
If the options are adjusted appropriately according to each model after understanding the characteristics of options in order to improve the printing quality, you can get the most optimal quality. Even though the printing options that are described in this chapter are based on the Cubicreator, most of them are general options that are used for 3D printers since the Cubicreator is based on Cura.

✓	Since the content that is described here is tested with the Cubicon, it may not work with printers from other company.

2.1. Use of Rafts and Supports

2.1.1 **Supplementary Structure to the Base**

A model that has a small bottom or that has a tall height has a higher risk of failing the printing as it falls down during printing, In this case, using a raft can help the printing by preventing the falling down of the model.



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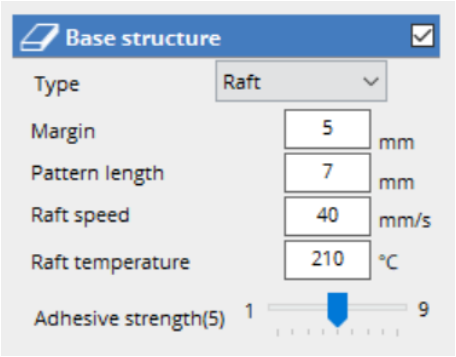
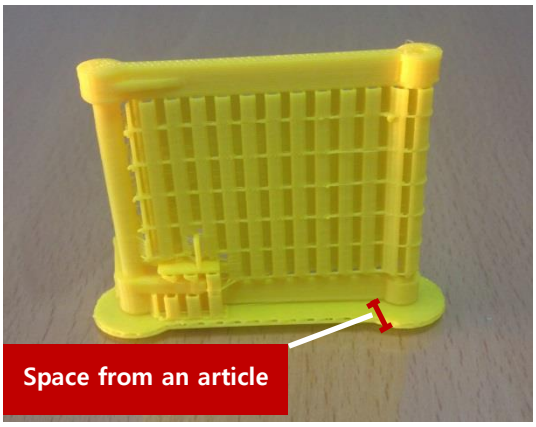
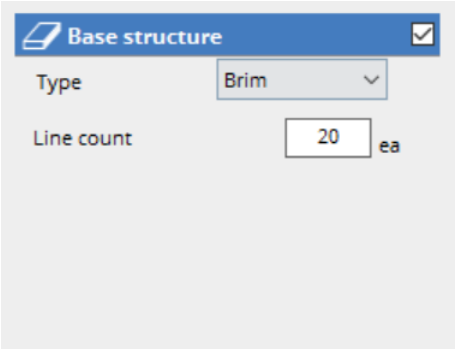


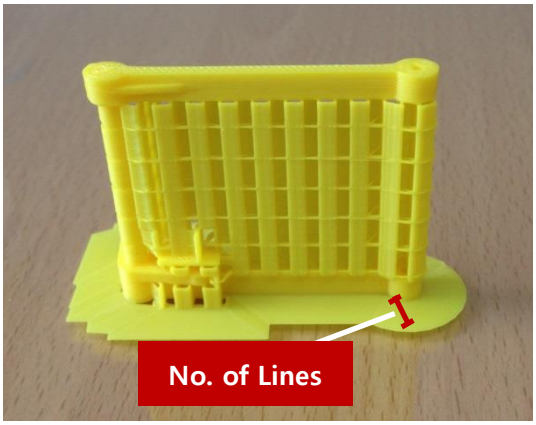
▲ Raft Option



▲ An Article Printed After Applying Raft

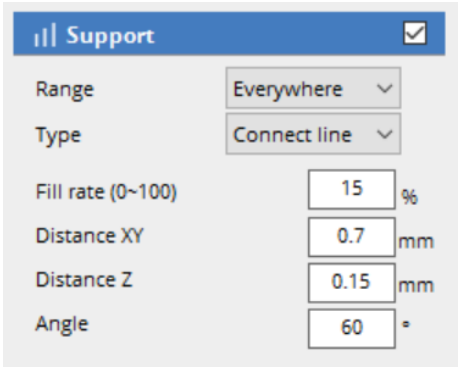


▲ Brim Option

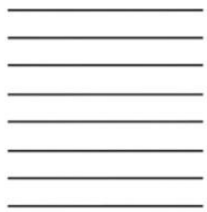


▲ An Article Printed After Applying Brim

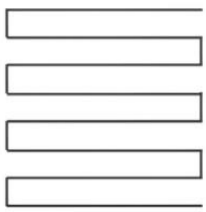
2.1.2. Support



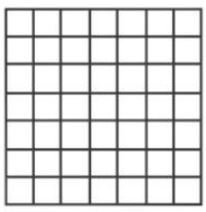
▲ Support



a. Single Direction Lines



b. End Point Connecting Line



c. Grid

▲ Support Pattern Types

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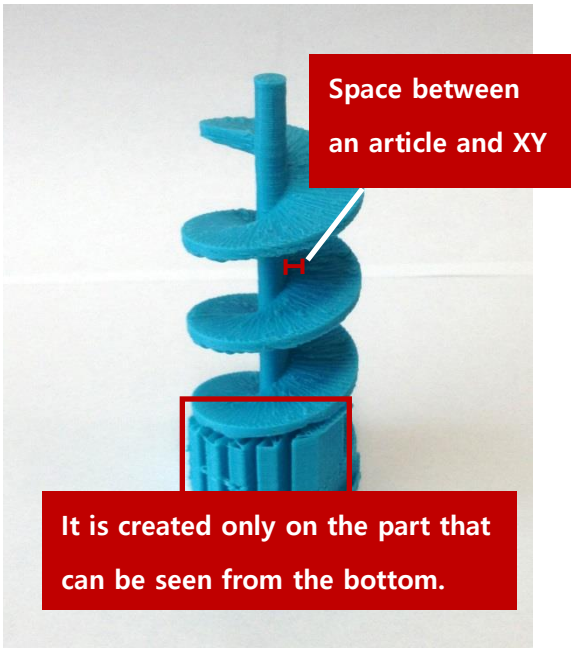
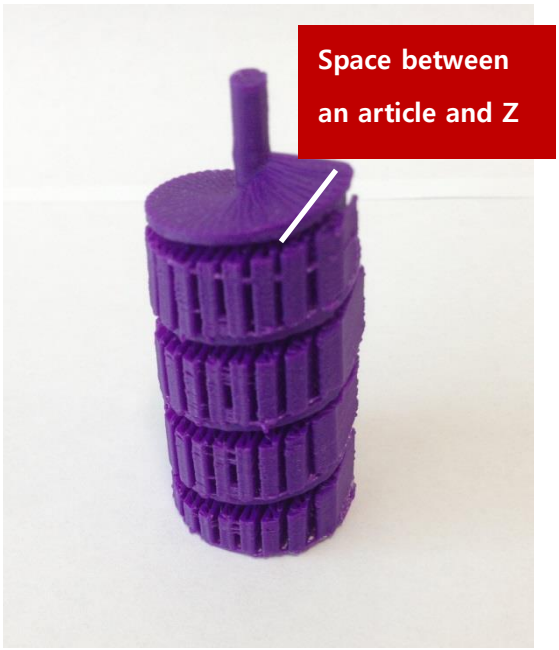
Options	Description
Single Direction Lines	The supports are stacked in the shape of straight lines. Even though they are easier to remove after printing, they may fall down if they are stacked too high.
End Point Connecting Line	The supports are stacked by connecting each end point of the straight lines. The supports are more stable and they are easier to remove after printing than the grid type.
Grid	The supports are stacked in the shape of a grid by crossing the straight lines perpendicular to each other. Even though they are very stable, they are hard to remove.



▲ Supports are applied to only the Selected Part of the Article



▲ Supports are applied to all Parts of the Article.

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2.2. Printing Speed

As for the printing speed, the quality basically gets lowered due to the vibration if the extruder moves faster. But if you take a look at the printing carefully, filling, stacking an inner wall, and stacking an outer wall are performed all distinctively. Since the part that is exposed to outside is an outer wall, we can find a compromising point between the quality and the printing speed by lowering the speed of only the outer wall. But since the inner wall printing speed also affects the printing quality slightly, the affect from the vibration can be minimized when the speed of all the parts are slowed.

▲ Printing at the Maximum Speed

▲ Printing by Setting Speed to 30 for the Outer Wall

2.3. Retraction

A typical filament that is used in **FFF** (**F**used **F**ilament **F**abrication or FDM) type is in the state between liquid and solid. This state is very special because it prevents a leak from the nozzle due to the gravity when it is not being discharged, and it stretches like a rubber band and stays connected like a spider web even during the movement. But since these characteristics may affect the quality by creating a spider web or a crumple on the article printed, a retraction is used to cut or prevent the flowing down. But if the retraction is used excessively, a layer of air may be created inside when the filament gets sucked up, and small holes may be created in the article printed. Therefore, the appropriate value should be applied.

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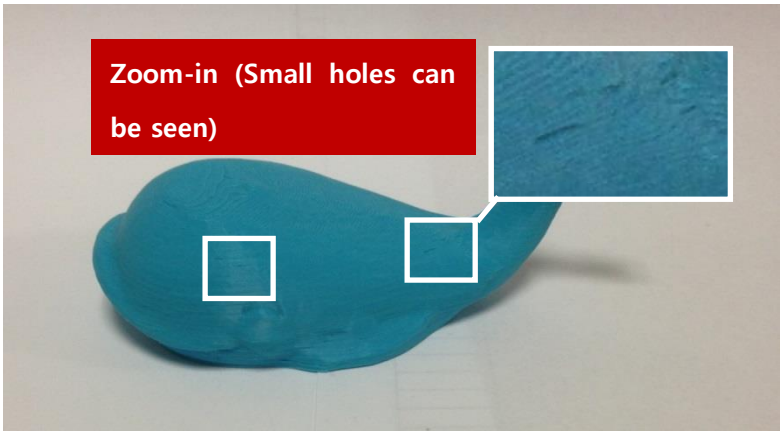
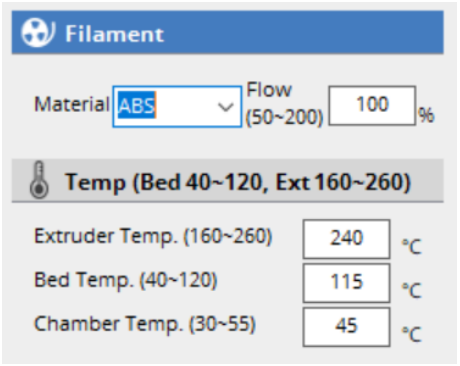


▲ When the Retraction is applied exceesively

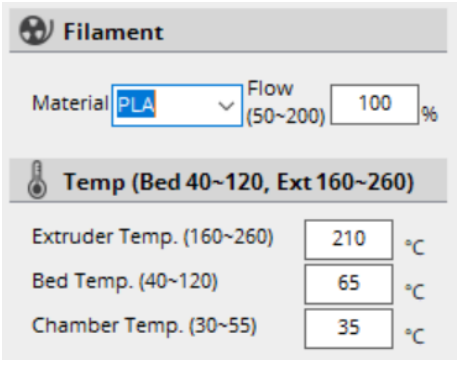
2.4. Temperature

The temperature differs by the types of the filament used, and the temperature that is recommended for each filament by its manufacturer should be used. If the temperature is too high or too low, it may not adhere to the bed, an article may melt down, or the nozzle may get clogged.

✓	If the temperature is too high, the filament may burn and clog the nozzle with its carbonized residue. If the nozzle is clogged, the nozzle needs to be either cleaned or replaced.



▲ ABS Temperature



▲ PLA Temperature

2.5. Model Modification

Model modification option is used to resolve the problem that may occur to the article printed in case of a certain model. For example, when the 3D model is sliced, the layer should be in a shape of a closed curve. In case it is not, that part may be skipped and continued. In such case, if you check on the checkbox that states "Maintain the Status of the Polygon as Being Opened", the part that is not a close curve can be printed. But this function that is offered can't solve all the problems, and it may cause some other problems; therefore, it is better to modify the model using an editing program if a certain problem occurs.

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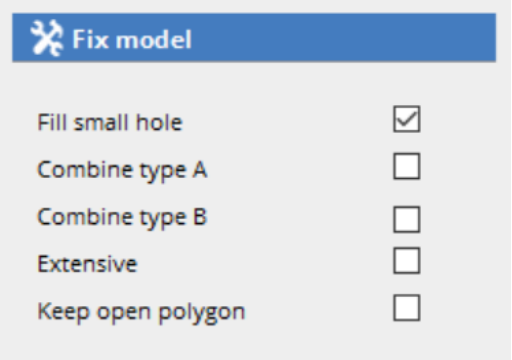


▲ Model Modification Options

2.5.1. Filling Up Minute Holes

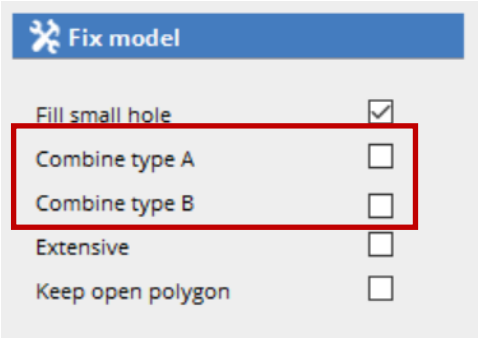
Printing is performed while ignoring (filling up) the minute holes on the wall.

2.5.2. Combination Type A, B

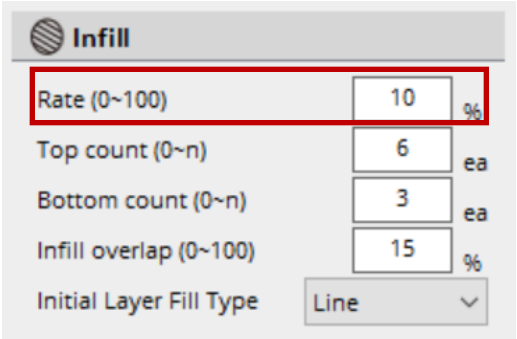
Following two functions are similar in function, but they are different in algorithm and they are very complicated to process.

Combination Type A - If the wall of the model is thin, the thin part may disappear when the model is sliced. The printer can print the walls by overlapping them to print the thin parts.

Combination Type B - Since it only slices the model using the outer line and inside is filled up automatically, the model that feels thick can be printed if the check is cleared in the checkmark stating "Fill up the Inside".



▲ Model Modificaiton Options



▲ Model Filling Options – Since it becomes too thin and inside is filled up, set it to 0.

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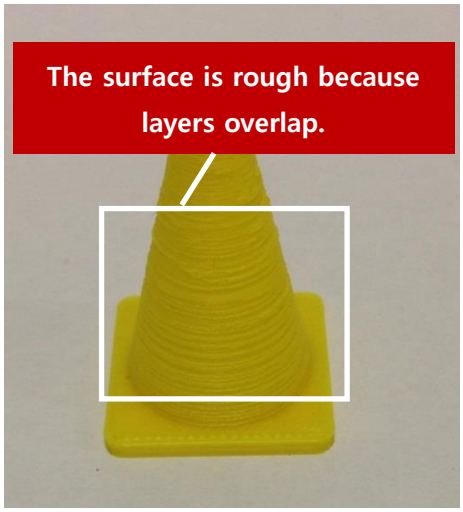
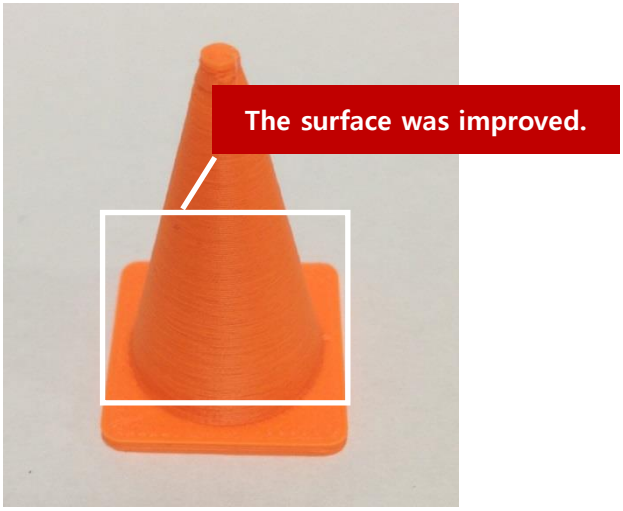


▲ Print with the Default Option



▲ Print after Applying the Option of Combining Thin Walls

2.5.3. Filling the Holes by Modifying the Polygon

Small holes in the model are filled up by adding polygons (a shape that is the basic unit to be used for expressing an object in the 3D graphic). Since this function requires a lot of processing time, and the unexpected result may come out, it must be used carefully.

2.5.4. Maintaining the Status of Polygon as Being Opened

When the model is sliced, and the outer line is not a closed curve, the part doesn't get printed. In such case, this option can be used to force the printing of the part.

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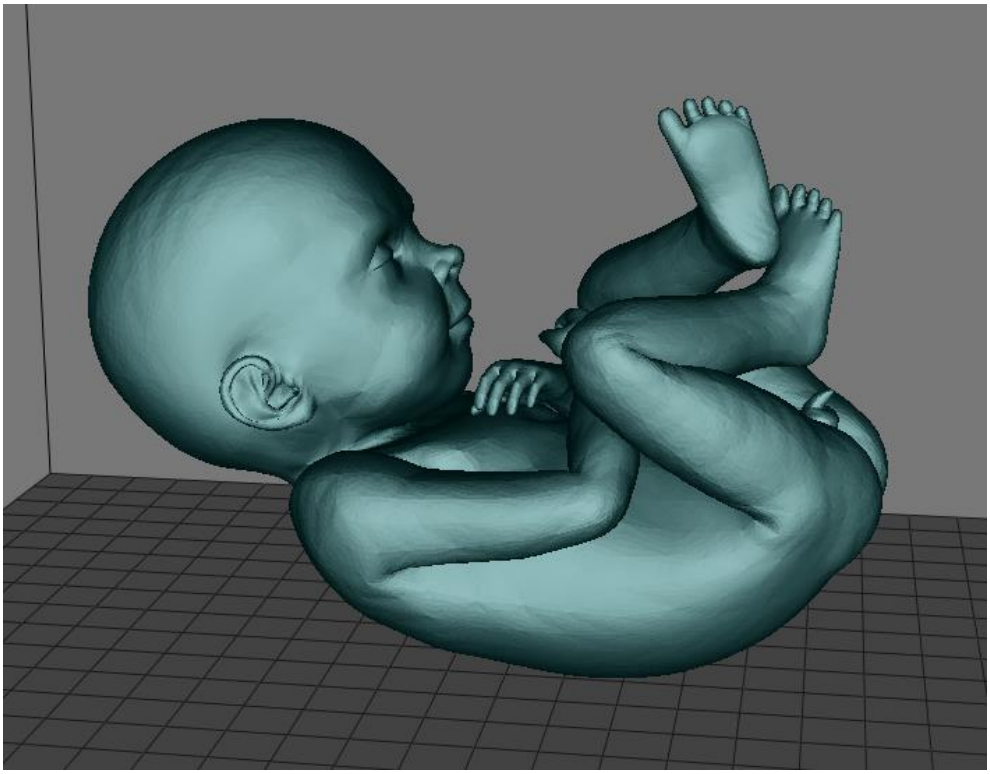
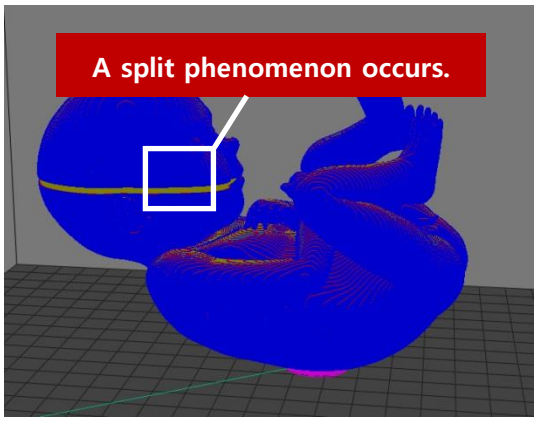


▲ Baby Model



◀ The model with a hole in the ear.
The problem of the disappearance of a whole layer.

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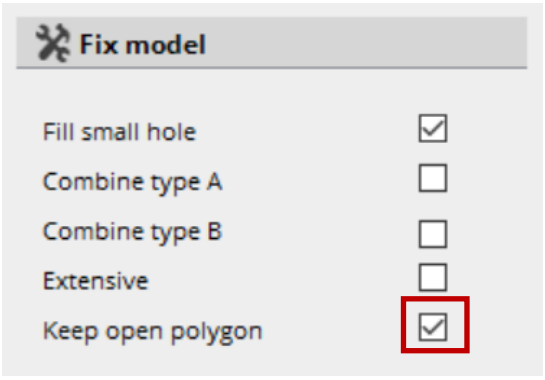
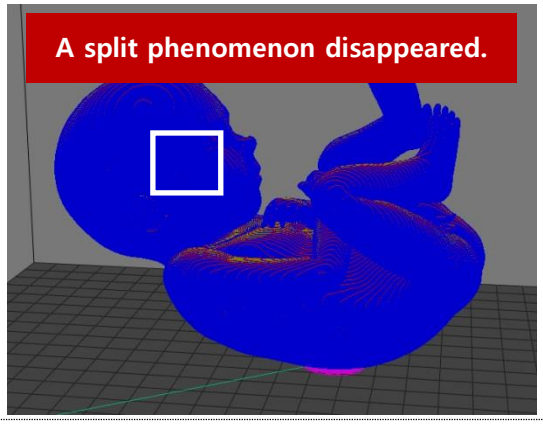


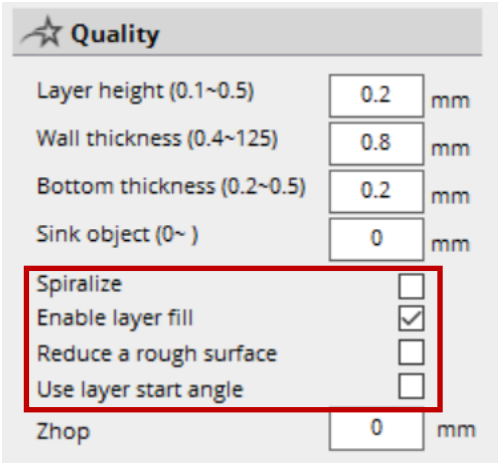
◀ Check the "Maintain the Open Status of Polygon" under the Model Modification.



◀ A split has disappeared.

2.6. Special Functions

Spiral Printing and **Use the Layer Fill-up** that belong to the Quality Category under detailed setting in the printer setting are special options which should be used only in specific cases. Some functions are only offered in the Cubicreator.



▲ Options for Sepcial Functions

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2.6.1. Spiral Printing

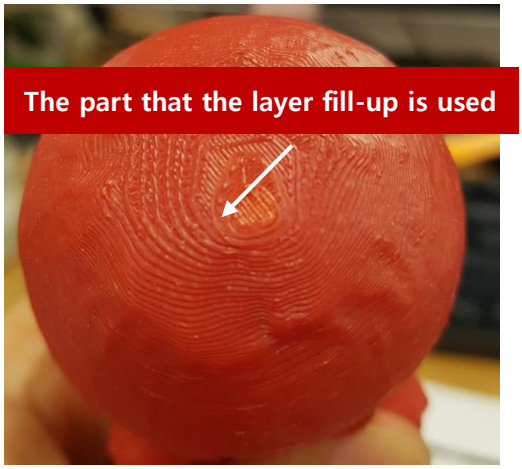
It is a mode for printing a cylindrical model such as a cup. It can express the surface smoothly since it prints by continuously stacking the z-axis little by little just like a spiral rather than the typical printing method of printing a layer, putting a z-axis, and then printing the next layer. Since this is a special function, it can't be applied to a complicated model, and its use is very limited since it is only useful for a certain model that has only one closed curve such as a cup.

▲ Default Printing

▲ Spiral Printing

2.6.2. Use the Layer Fill-up

This is a function to fill up the gaps between layers in the middle excluding the top and bottom part. If the check is cleared for the model that doesn't have a horizontal plane in the middle (such as a model in the shape of a cup), the printing quality can be improved and the printing time can be reduced. In all cases other than the special shape such as a cup that doesn't have a contour, it is recommended to turn on this function at all time.



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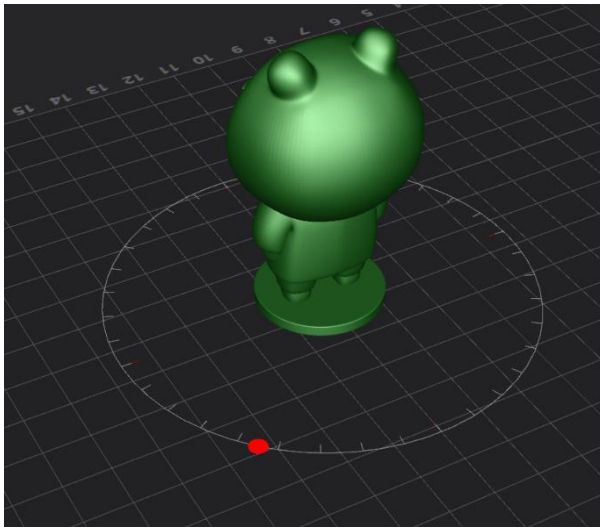
2.6.3 Use the Layer Starting Point Control

The starting point for the layer is changed to a certain point. Although a line like a sewing line appears in one place, the overall surface of a model can be printed smoothly. When this function is activated, a red dot that can change the starting point appears around the model. By adjusting the dot, the starting point of a layer can be configured. If there are multiple models, the center of each model is set as a configured angle.



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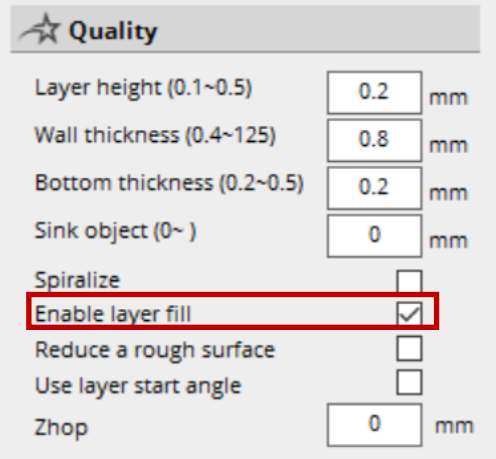
Chapter 3

Chapter 3. Output Examples by Models

The option setting and printing method for improving the printing quality would be described by classifying the 3D models into a few different types in a general situation.

3.1. Cylindrical Models

In case of a model that the layer is a single close curve such as a cup or a circle, the spiral printing can be used. However, it can't be applied to a cup with a handle, since the layer at the part of the handle is not one single close curve.



▲ Option Configuration for Cylindrial Model

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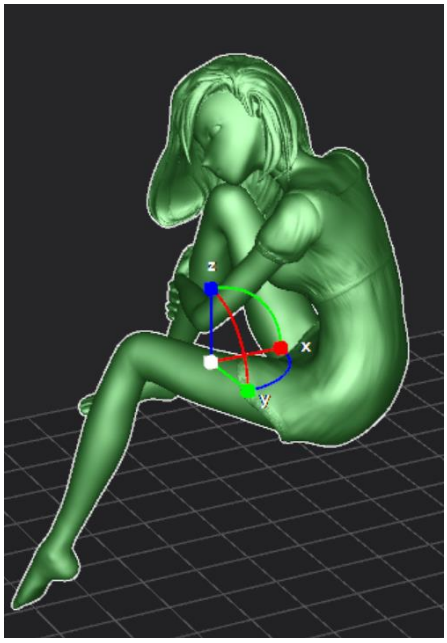
▲ Print with a Default Option

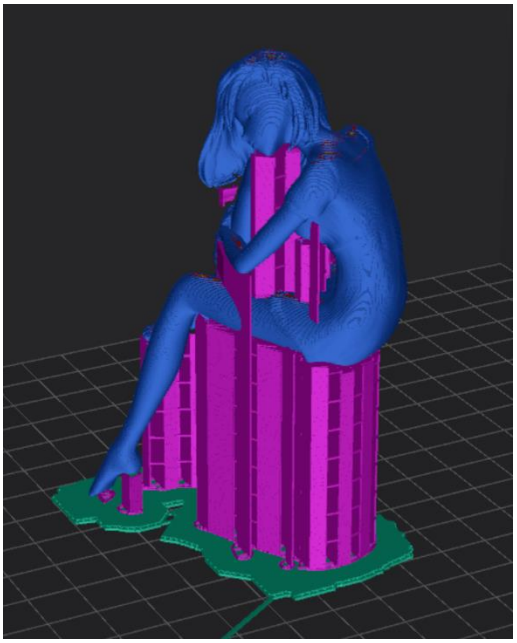
▲ Print after Checking "Layer Fill-up Is Not Used."

3.2. Character Models

Since the model such as a human or an animal has a complicated structure with a lot of curves, it requires a lot of supports. As for such model, it can be rotated to the position that is close to a radial shape as much as possible to minimize the use of the supports in order to improve the printing quality and the success rate.



▲ Character Model



▲ Print with a Default Option

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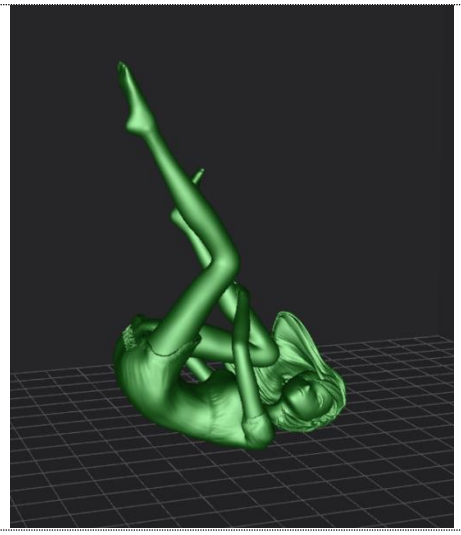
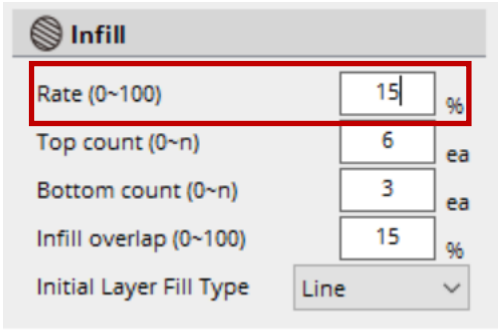
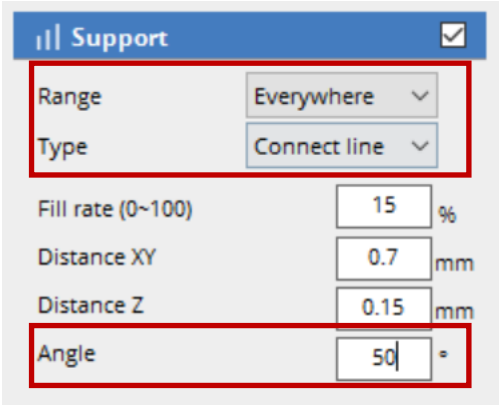


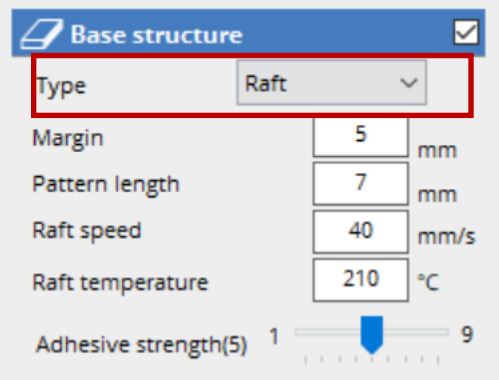
◀ Rotate the model so that the leg of the model is as close as the radial shape.



◀ Set the "Internal Fill-up Density" to approximately 15% so that the model doesn't get crushed easily.



◀ Use of Supports
Range: All Parts – (The leg above the body is supported)
Type: End Point Connecting Line (in order to easily remove the supports inside of the body.)
Applied Angle: 50 degrees (The number of supports gets increased if the value gets larger.)



◀ Make sure it adheres to the base tightly using Raft or Brim.

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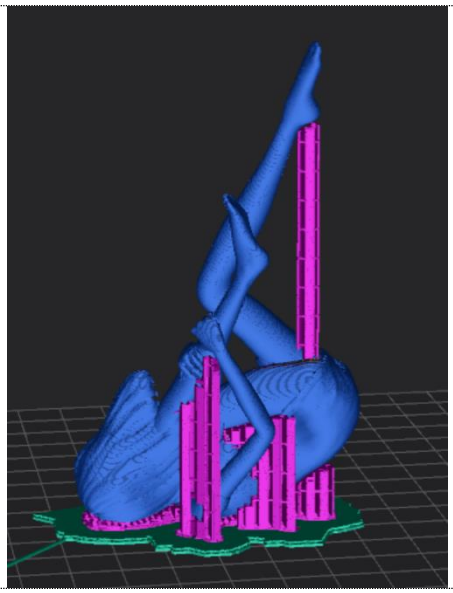
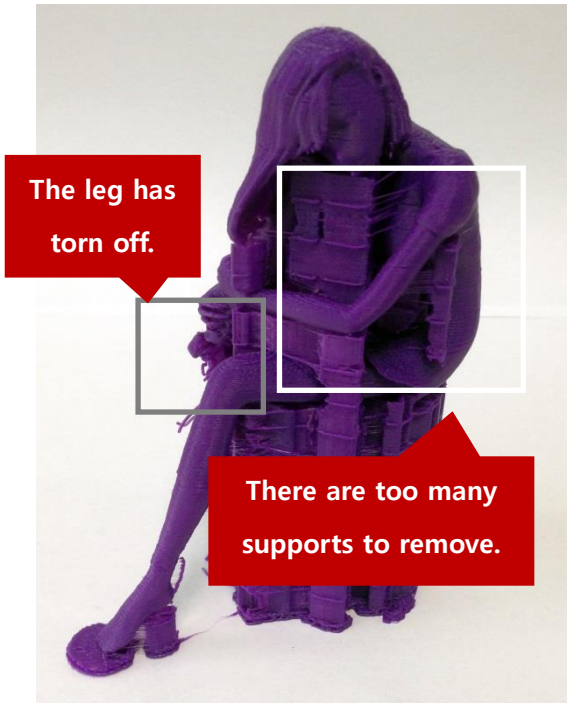
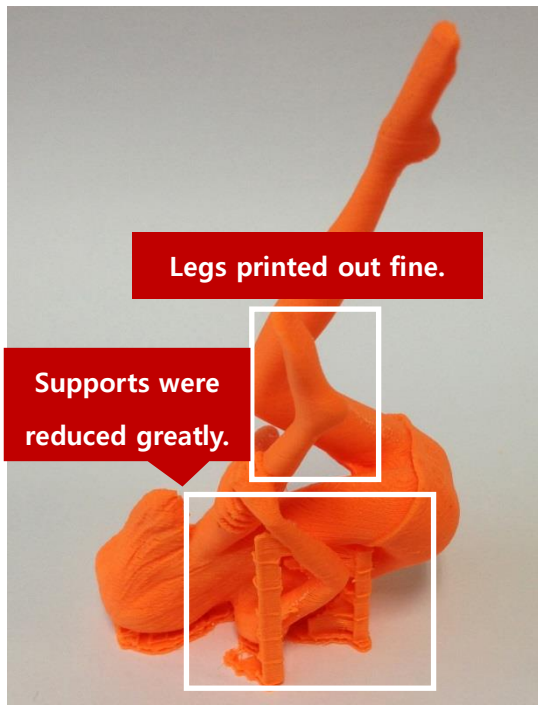


◀ The result of a simulation shows that the number of supports is decreased, and the bottom part is appropriately placed on the base.



▲ Printed in Default State



▲ Printed after Rotating

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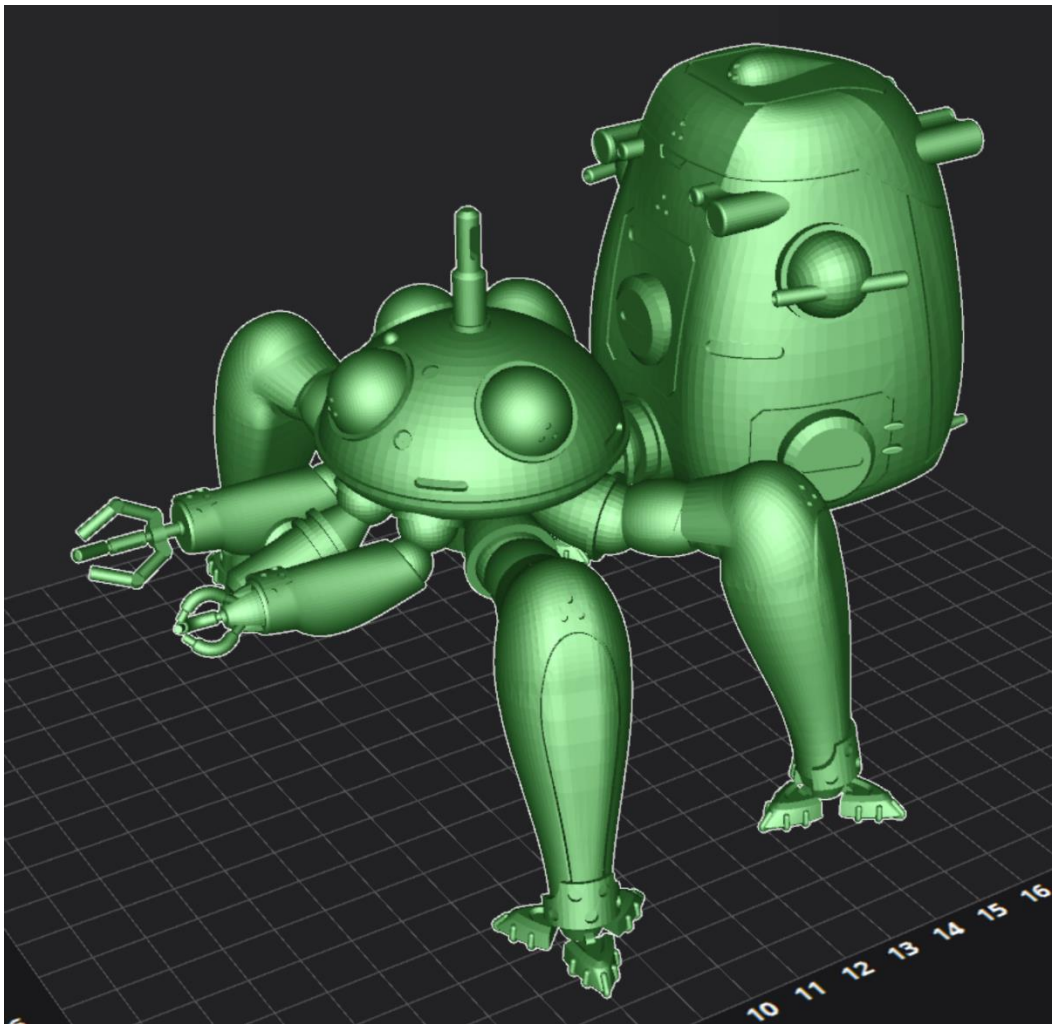
3.3. Complicated Models

As for a complicated model such as a robot, the success rate of the printing and the quality can be improved if the model is printed after splitting the parts compare to the printing at once. If the model is split by using the model split function (refer to 1.2.3 Model Split) which was added in the Cubicreator 3.5, the use of the supplementary structures can be minimized, which has the advantage of reducing the printing time and saving the filament.

In order to revise the printed model, the 3D Editing Program needs to be used, but typical 3D Editing Programs are very expensive and difficult to use. Therefore, beginners should choose a program that is easy to use. Popular products include 3D Max or Tinkercad of AUTODESK, and Sketch Up of Google. Most tools have the function of cutting and deleting the model.



▲ Complicated Model

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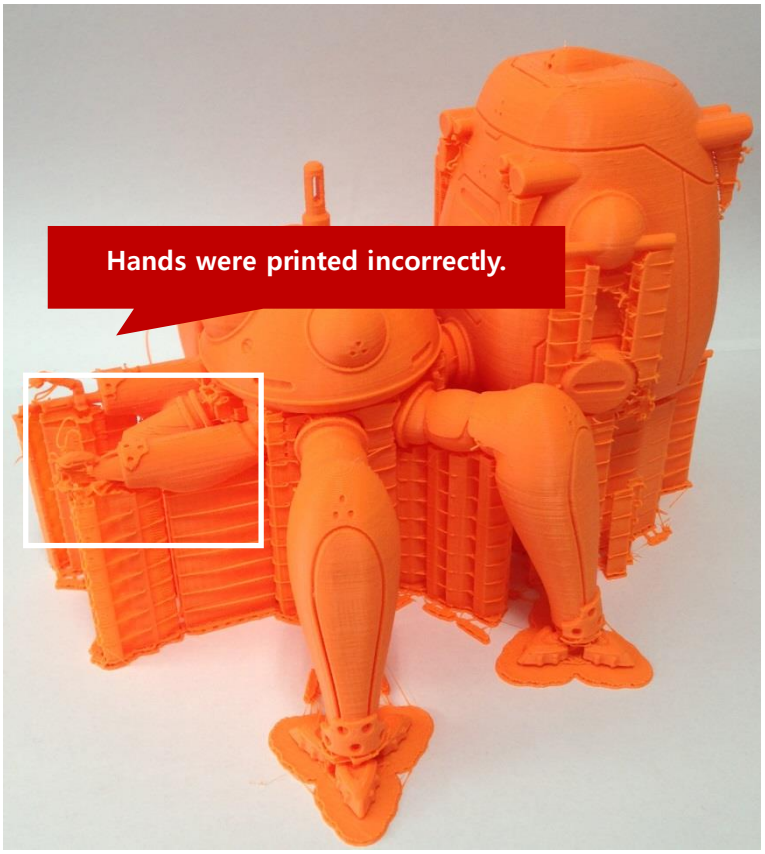
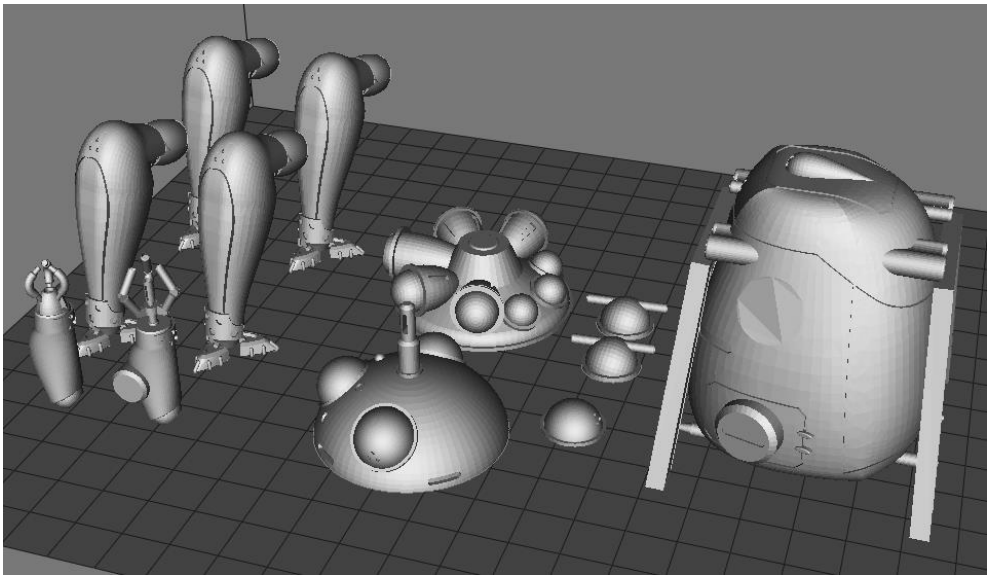


▲ Printing with Default Option



▲ Split of the Complicated Model

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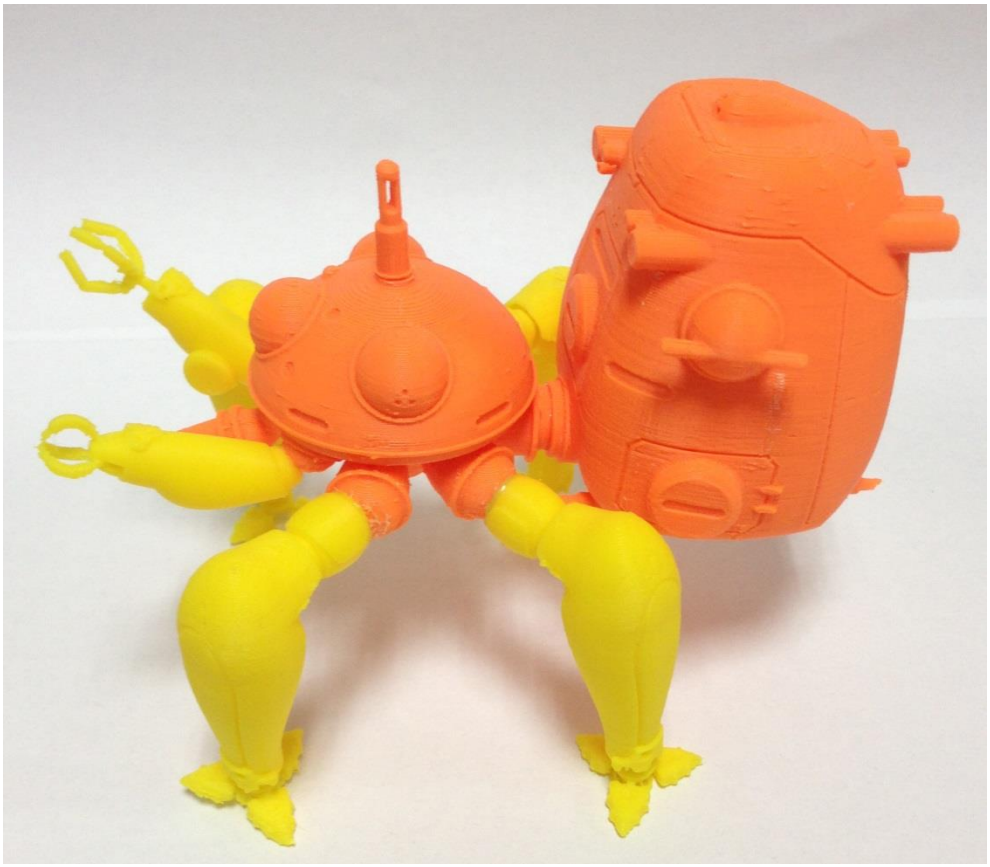
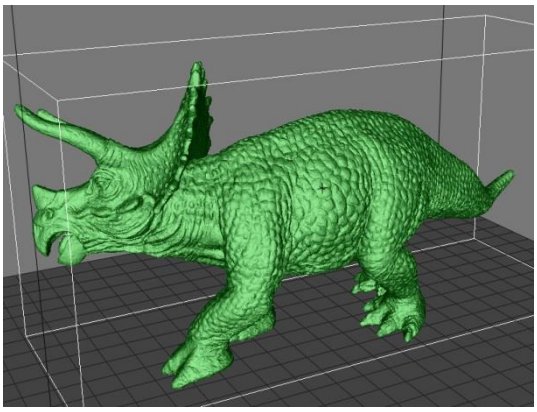


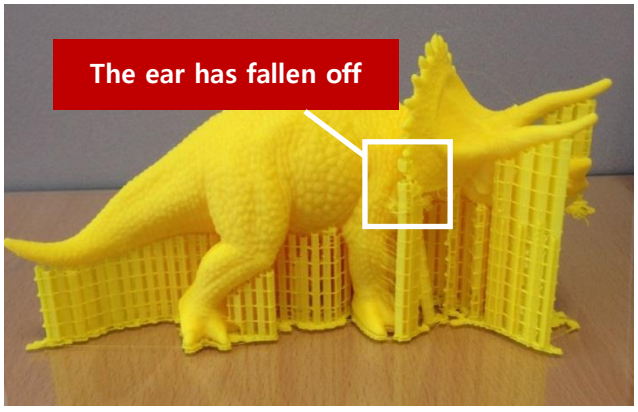
▲ Assembled after Printing Separately

3.4. Models that Require Manual Supports

Since the supports that are automatically created by the software are not perfect, the time taking for printing can be reduced and the printing quality can be raised if the supports are added only in the necessary locations by a user rather than applying the same supports to all the models uniformly.



▲ Dinosaur Model



▲ Dinosaur that Was Printed Incorrectly

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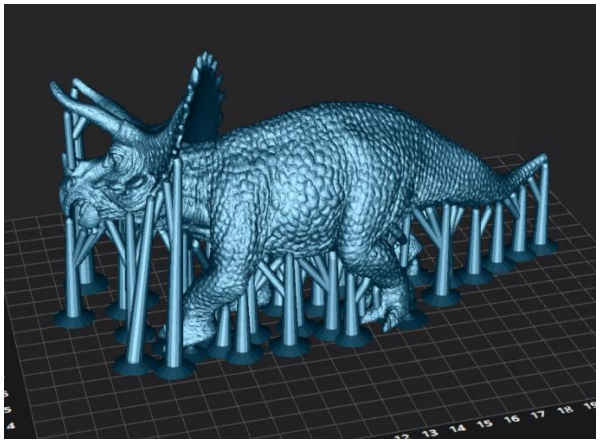
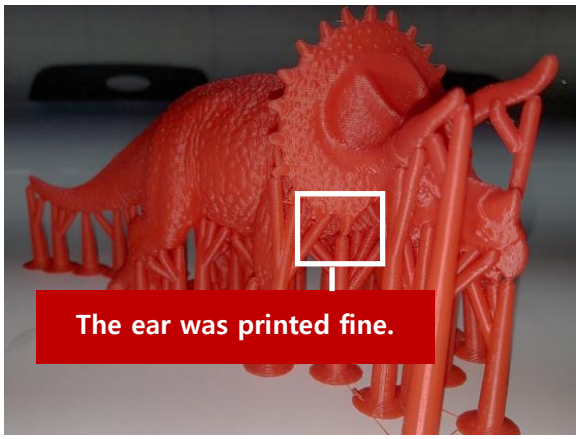


▲ Manual Supports Were Applied



▲ Supports by a User Were Applied

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Conclusion

Conclusion

3D printers have just started to be known to general public. But it can't print out an article just like a paper printer that prints texts or pictures on the paper just by pressing a print button yet. Although the software, materials and mechatronic technologies need to be developed further, we can still get a better quality of output even in current printing environment that is available now by appropriately configuring the printing options and putting the effort to create a model that is appropriate for the 3D printer. Cubicon Inc. will put our best effort for a user to get a printed article that is good enough to be used immediately after printing it by continuing the extensive research and development in the future.

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