USC Baum Family Maker Space
Standard Operating Procedure

Stratasys Fortus 250mc Standard Operating Procedure
The following classifications are used throughout this guide.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CAUTION</strong></td>
<td>Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.</td>
</tr>
<tr>
<td><strong>WARNING</strong></td>
<td>Indicates a potentially hazardous situation which, if not avoided, could result in serious injury.</td>
</tr>
<tr>
<td><strong>Hot Surface</strong></td>
<td>The hot surface sign indicates the presence of devices with high temperatures. Always use extra care, and wear safety gloves, when working around heated components.</td>
</tr>
<tr>
<td><strong>Gloves</strong></td>
<td>When performing some maintenance procedures, the machine may be hot and gloves will be required to avoid burns.</td>
</tr>
<tr>
<td><strong>Safety Glasses</strong></td>
<td>Wear safety glasses to avoid injury to your eyes.</td>
</tr>
<tr>
<td><strong>Recycle</strong></td>
<td>Use proper recycling techniques for materials and packaging.</td>
</tr>
<tr>
<td><strong>ESD Sensitive!</strong></td>
<td>ESD: Use standard electrostatic discharge (ESD) precautions when working on or near electrical components.</td>
</tr>
</tbody>
</table>
Overview

The Fortus 250mc system builds models, including internal features, from CAD STL files. Three-dimensional parts are built by extruding a bead of ABS plastic through a computer-controlled extrusion head, producing high quality parts that are ready to use immediately after completion. With three layer resolution settings, you can choose to build a part quickly for design verification, or you can choose a finer setting for higher quality surface detail.

The Fortus 250mc system consists of two primary components — the Fortus 250mc system and Insight. Insight is the preprocessing software that runs on a Windows Vista or Windows 7 platform.

The build envelope measures 254 x 254 x 305 mm (10 x 10 x 12 in). Each material cartridge contains 922 cc (56.3 cu. in.) of usable material.
Figure 1: Front view

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Extrusion Head</td>
</tr>
<tr>
<td>2</td>
<td>Extrusion Tips</td>
</tr>
<tr>
<td>3</td>
<td>Guide Rods</td>
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<tr>
<td>4</td>
<td>Lead Screw</td>
</tr>
<tr>
<td>5</td>
<td>Modeling Base</td>
</tr>
<tr>
<td>6</td>
<td>Model Material Cartridge</td>
</tr>
<tr>
<td>7</td>
<td>Support Material Cartridge</td>
</tr>
<tr>
<td>8</td>
<td>Display Panel</td>
</tr>
<tr>
<td>9</td>
<td>Tip Cleaning Assembly</td>
</tr>
<tr>
<td>10</td>
<td>Purge Container</td>
</tr>
<tr>
<td>11</td>
<td>Z stage platen</td>
</tr>
<tr>
<td>12</td>
<td>Modeling Base Retainers (2)</td>
</tr>
<tr>
<td>13</td>
<td>Power Switch</td>
</tr>
</tbody>
</table>
**Figure 3** Material cartridge

**Figure 4** Modeling base

**CAUTION:** DO NOT reuse modeling bases. If a modeling base is reused, calibration errors, poor part quality, and loss of extrusion may occur. Additional modeling bases are available from your reseller.
### Figure 5 Startup Supplies

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Insulated Leather Gloves (Pair)</td>
</tr>
<tr>
<td>2</td>
<td>Power Cord (Europe)</td>
</tr>
<tr>
<td>3</td>
<td>Power Cord (U.S.)</td>
</tr>
<tr>
<td>4</td>
<td>Crossover Cable (Orange)</td>
</tr>
<tr>
<td>5</td>
<td>Network Cable (Blue)</td>
</tr>
<tr>
<td>6</td>
<td>Model and support tips</td>
</tr>
<tr>
<td>7</td>
<td>Tip shield (8)</td>
</tr>
<tr>
<td>8</td>
<td>Tip Wipe assembly (4)</td>
</tr>
<tr>
<td>9</td>
<td>10x Magnifier Loupe</td>
</tr>
<tr>
<td>10</td>
<td>1/8&quot; T-Handle Allen wrench (red)</td>
</tr>
<tr>
<td>11</td>
<td>1/64&quot; T-Handle Allen wrench (yellow)</td>
</tr>
<tr>
<td>12</td>
<td>Bronze Brush</td>
</tr>
<tr>
<td>13</td>
<td>Needle Nose Pliers</td>
</tr>
<tr>
<td>14</td>
<td>Cutters</td>
</tr>
<tr>
<td>15</td>
<td>Fortus 250mc System Software CD</td>
</tr>
<tr>
<td>16</td>
<td>Fortus 250mc User Guide CD</td>
</tr>
<tr>
<td>17</td>
<td>Insight CD</td>
</tr>
<tr>
<td>18</td>
<td>P430 Model Material Cartridge (1)</td>
</tr>
<tr>
<td>19</td>
<td>SR-30 Soluble Support Material Cartridge (1)</td>
</tr>
</tbody>
</table>
Insert Modeling Base

Make sure retainers are turned ‘down’ - so as not to interfere with the modeling base installation. Set the modeling base on the Z Stage Platen aligning the tabs on the modeling base with the slots on the metal tray. Slide the modeling base toward the back of the unit until its front edge (with the handle) is flush with the front edge of the tray, see Figure 14. Secure the base with the two retainers by turning them up.

Note: When inserting and removing the modeling base, use the handle to avoid touching the top surface. Grease and oil that contact the top build surface could cause poor part adhesion. You can clean the build surface with isopropyl alcohol if necessary.

Figure 14 Inserting a modeling base
Operation

Display Panel and Keypad

The main User Interface to the system is the Display Panel and Keypad, see Figure 15.

![Diagram of Display Panel and Keypad](image)

Figure 15: Display panel and keypad

The display panel and keypad are very easy to use, consisting of a larger multiple-line LCD display on top, and four single-line context-sensitive displays, each with one button (or key) below. The top line in the large display always shows system status. The lower three lines of the large display show details related to the current operation.

At times there will be an item blinking in the lower (context-sensitive) displays. The blinking item is usually the most logical selection.
System software overview

- **Idle**: If there is no part being built and no part in the build queue, the display will show that the system is **Idle**.

- **Wait for Part or Start Part**: If the system is in Idle and the build queue is empty, you can set it to wait for a part. If the system has a part in the build queue, you can press **Start Part** to start a build.

- **Building**: If the system is building a part, you can choose to pause, set the lights either ON or OFF, view the print time or material remaining and set the system to auto power down.

- **Material**: From this section you can load material or unload material.

- **Standby**: From this section you can set the system to Standby mode.

- **Maintenance**: From this section you can make changes to the **System, Setup** or **Machine**.
Figure 16 Display panel hierarchy

- Idle status
  - Wait for Part
  - Start Part
  - Material
    - Load Material
    - Unload Material
  - Standby
  - Maintenance
    - System
      - Set Network
      - Test Parts
      - Load Upgrade
    - Setup
      - Lights Always On
      - Disable uPNP
    - Machine
      - Head
      - Gantry
      - Tips
  - Building status
    - Pause
    - Lights Off
    - Show Time
    - Auto Power Down
Control Center overview

• **Pack tab:** This section shows you which parts are in the pack for printing. You can add parts, arrange the parts for a better fit or clear the pack from this section.

• **Queue tab:** This section shows you the amount of material remaining (both model and support) as well as which parts are in the Build Queue.

• **Systems View tab:** This section shows you system information. The left side of the screen displays modeler information and the right side of the screen displays the job schedule.

• **Services tab:** From this section you can check the system history, set the system time, set the system password, update system software, get system info and export configuration files (files containing specific operating information regarding the system).

![Control Center hierarchy diagram](image)
**Processing your STL file for printing**

**Opening your STL file with Insight:**

- Create an STL file using your CAD software. Refer to your CAD software help section for more information about converting your CAD drawings into STL files.

- Open the Insight software.

- From the **File** menu select **Open STL**...

- Navigate to and select the STL file that you have created.

**Selecting layer resolution:**

Layer resolution can be changed on the system. Changing layer resolution will affect surface finish and build times. Selecting a smaller layer resolution creates a smoother surface finish, but takes longer to build. Layer resolution also affects the minimum wall thickness. Minimum wall thickness applies to the horizontal (XY) plane of your part. If a feature in an STL is smaller than the limit, the modeler will increase the size of the feature to the minimum wall thickness.

<table>
<thead>
<tr>
<th>Available layer resolutions</th>
<th>Minimum Wall thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>.007 inch (.178 mm)</td>
<td>.025 inch (.635 mm)</td>
</tr>
<tr>
<td>.010 inch (.254 mm)</td>
<td>.036 inch (.914 mm)</td>
</tr>
<tr>
<td>.013 inch (.330 mm)</td>
<td>.047 inch (1.194 mm)</td>
</tr>
</tbody>
</table>
Selecting model interior fill style:

Minimum Wall thickness

.025 inch (.635 mm) .036 inch (.914 mm) .047 inch (1.194 mm)

This establishes the type of fill used for the interior areas of the part. There are three types of model interior that you can choose from.

- **Solid** - Used when a stronger, more durable part is desired. Build times will be longer and more material will be used.

- **Sparse High Density** - This is the default model interior style and is highly recommended. Build times will be shorter, less material will be used and the possibility of part curl for geometries with large mass will be greatly reduced.

- **Sparse Low Density** - The interior will be “honeycombed” or “hatched”. This style allows for the shortest build times and lowest material usage but will decrease the strength of the part.

- **Sparse Double Dense** - Minimizes the amount of model material used, but utilizes a crosshatch raster pattern (instead of uni-directional) for added strength. Top and bottom exposed layers are built with the solid raster pattern.

Selecting support style:

Support material is used to support the model during the build process. It is removed when the part is complete. Support styles will affect the support strength and build time of the print. SMART support is the default support setting.

- **Basic** - May be used for most parts. Basic support uses a consistent spacing between support toolpaths.
• **SMART** - minimizes the amount of support material used, reduces the build time, and improves support removal for many parts. SMART supports use a wide spacing between toolpath rasters and change the shape of the support region. As the supports descend from the underside of the part feature to the base of the supports, the support region shrinks and transforms to a simpler shape to reduce the amount of material used and the build time.

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  SMART supports are suitable for all parts, especially those with large support regions, and are the default style for builds using soluble supports.

• **Surround** - The entire model is surrounded by support material. Typically used for tall, thin models.

• **Sparse** supports will create supports that use less material than basic supports.
This is accomplished by creating a new raster fill pattern that has a much larger air gap. Like basic supports, the top layer of a support column is built with a solid pattern of rasters. The next several layers have the basic raster pattern that has a small air gap. Progressing downward, a new sparse support region is used below the several layers of basic support raster fill. The sparse support regions use a much larger air gap when building the toolpath rasters. In addition, the region is surrounded by a single closed toolpath-perimeter curve.

As the supports progress downward, it is possible to see all three support-fill types in a single layer: 1) top of support solid-filled, 2) basic supports with small air gap, and 3) sparse supports with large air gap. Sparse supports are suitable for all parts, especially tall parts and parts requiring large supports.

- **Break-away** supports are similar to sparse supports but consist of boxes instead of a continuous raster. There is no closed toolpath-perimeter curve around the break-away supports. They are easier to remove than other support styles for some materials but build slower than sparse supports. Break-away supports are not recommended for use with soluble support materials.

- **Selecting the scale of your STL file:**
  Before you process a part for printing, you can change the size of the part within the build envelope. Every part has a pre-defined size within the STL file. After you have opened the file you can change the size of the part produced from the STL file by changing the scale. The scale always relates to the original STL file size definition.

For example: a cube that is defined as 2 X 2 X 2 can be built to be 4 X 4 X 4 by simply changing the scale to 2.0. If after changing the scale to 2.0, you decide that a size of 3 X 3 X 3 would be preferred, change the scale to 1.5 - the scale relates to the original size of 2.0, NOT the resulting 4.0 from the first scale change.

Click within the scale input box to type a scale of your choice.
• Selecting the orientation of your STL file:
  How a part is oriented in the preview window will determine how the part is oriented when it prints.
  Orientation impacts build speed, part strength, surface finish and material consumption. Orientation can also affect the ability of Insight to repair any problems with the STL file.
  You can choose to auto orient your part, which allows Insight to determine the best orientation for the part for the fastest build time and least material usage, or you can manually change the orientation of your part.
  Orientation Considerations:

  • **Build Speed** - Closely related to material use. A lesser amount of supports will allow for a faster build speed.
  Another factor affecting build speed is the axis orientation. The system can build faster across the X-Y plane than it can along the Z axis. Orienting a part so that it is shorter within the modeling envelope will produce a quicker build.

  • **Part Strength** - A model is stronger within a layer than it is across layers.
  Depending upon what features you want your part to demonstrate, you may need to orient your part to have its greatest strength across a specific area. For example a tab that needs to be pressed would be weakest if you are applying pressure across layers.

  • **Surface Finish** - Much like orienting for strength, how the part is oriented will determine how the surface finish will look and allow the system to provide the smoothest finish for a specific area. For example, if building a cylinder, orienting the cylinder upright will have a smoother surface finish than building it on its side.

  • **STL File Repair** - It is possible for an STL file to have errors while appearing to be trouble free. If the STL file contains errors, Insight may have problems processing the file. Insight has the ability to automatically correct some STL file errors. How the part is oriented can impact this automated repair function.
• Selecting the visible surface style of your STL file:
  Choose Enhanced or Normal. The intent of this feature is to improve part appearance without negatively impacting build throughput.

**Normal** - No change from prior behavior.

**Enhanced** - The default choice is Enhanced; independent controls are used for the visible surface rasters and the non-visible, internal rasters. Use the Visible surface rasters option to control the raster width of the visible surface rasters. Use widths smaller than normal to improve the visible appearance. Internal non-visible regions are filled with Interior rasters, which can be assigned a wider toolpath width. Multiple output contours are optionally used on visible layers to hide the raster turn-arounds from view. Up to Surface max contours are used to hide the raster turn-arounds. On layers with a larger visible exposure, the default contour parameters are applied to the layer. The degree to which this feature affects build time also depends on the amount of internal raster fill that can now use wider rasters. For the ideal case of a cube, which is mostly filled with internal rasters, build time may reduced by almost one third. A complex shape or thin-walled part, where most regions are subdivided between visible surfaces and internal regions, may see little benefit. The faster build speed of wider internal rasters is offset by the inefficiency of using more individual toolpaths to fill the regions. The other Part interior style fill types, Double Wide and Sparse, can be used with visible surface detection - the features are independent and complementary.
Printing your CMB file:

The **Build Job** button is found on the Pack tab. Once build job settings have been accepted, the CMB file will open in the Control Center software.

Adding your CMB file to the pack:

The **Insert CMB** button is found on the Pack tab. When you click on the **Insert CMB** button, Control Center will add the file that you select to the pack preview window (Pack tab).

Opening your CMB file with Control Center:

• Open the Control Center.  

• From the **File** menu select **Open CMB...**

• Navigate to and select the CMB file that you have created.

**Inserting a Modeling Base**

Prior to inserting a modeling base into the tray, remove any material buildup on and behind the Z Platform and around the lead screw. Failure to do so could cause the modeling base to be unlevel or, if the amount of buildup is large enough, the Z Platform could jam at its upper limit.
Building a part

If a part has not been sent to your system for building, the build queue will be empty. If the build queue is empty the display panel will show \textit{Idle} or \textit{Ready to build}.

Choose whether or not you want to start a build from a remote location or from the display panel at the system.

Starting a build from the display panel:

If \textit{Wait for Part} has not been activated, you can send the part to the system and start the part from the display panel after the part has been sent to the system.

- From your Control Center workstation, send a part to the system. The display will show \textit{Idle/ Ready to Build} and the name of the first file that is in the queue waiting to be built.

- Insert a modeling base.

- From the display panel press \textbf{Start Model} to start building the part.

Loading Material

Material cartridges are factory packaged in a box and an anti-static, moisture-proof bag to preserve shelf life. Material will stay humidity free inside the cartridge for at least 30 days after opening. Shelf life is more than one year if the cartridge package remains sealed.

Load material cartridges:

- Remove packaging.
• If present, remove the red sealing plug from the cartridge.

  a. Turn the plug a quarter turn counter clockwise.

  b. Lift up the plug to remove it from the cartridge - discard (or recycle) the plug.

  ![Figure 18: Remove red plug before loading](image)

  3. Find the end of the material taped with a “flag”.

  **CAUTION:** Be careful when touching the pinch roller on the side of the cartridge. See Figure 19 for the correct direction to move the cartridge roller. If you roll it backwards, you could draw the material into the cartridge. If this occurs, there is no way to retrieve the material without opening the cartridge and exposing the material to humidity, which reduces shelf life to a few days.
• Pull material out of cartridge to expose about 12 inches of material. You should easily be able to pull out the material.

**Note:** The above step makes sure that the material will feed freely from the spool.

• With the cutter from your Startup Kit, snip the material flush with the end of the cartridge, see Figure 20.
• If the system is in **Idle**, press the **Material...** button, which will be blinking.

• Display will prompt with **Material - Add/Remove** (flashing).

• Insert material cartridges into their appropriate slot from the front of the system (Model material cartridge goes in the Top slot; Support material goes in the Bottom slot).

• When the cartridges have been inserted, press **Load...** (flashing).

• Display will prompt with **Load Both..., Load Model...** or **Load Support...**
  Press **Load Both...**

• After material has been loaded to the head press **Done...**

**Unloading Material**

The model and support material cartridges may be replaced separately or at the same time. In idle-, load-, or build-related modes, the panel displays the percentage of material remaining in the cartridges. If the system will be operating unattended for a long period, and the material level is getting low, you may want
to replace the cartridges before starting a new part. Of course, you will also need to replace the cartridges when they are empty.

Unload material cartridges:

• From **Idle**, Press **Material ...**

  Press **Unload...**

  The panel displays **Material** and prompts with, **Unload Both...**, **Unload Model... or**
  **Unload Support...**

  After you have made the above choices, the panel displays **Unloading** for approximately 60 to 75 seconds (the selected materials will be unloaded from the extrusion head).

  When unloading is complete, the panel will prompt you to remove a cartridge based upon your choices - i.e., **Remove Model Cartridge, or**
  **Remove Support Cartridge**.

• Remove the material cartridge(s) by first pushing it forward gently, and then pulling it out of the slot.

• When you remove a cartridge there will be approximately 180 cm (6 feet) of material that will need to be pulled from the system. (This is normal. Material is only retracted from the extrusion head during ‘unloading’.)

• To store a partially used cartridge, place a small flag of tape on the material near the cartridge. Cut off and discard the remaining material. The tape flag ensures the material does not retract into the cartridge.
Building a Test Part

Factory test parts have been preloaded into your system. To familiarize yourself with the system, it is recommended that you build one of the test parts before attempting to build one of your own files.

Once the system has warmed up, material has been loaded, and a modeling base is in place, you can send a test part to the system.

Build a test part:

- Press Maintenance.

- Press System.

- Press Test Parts, and select one of the available sample parts. The system automatically starts building the part.

- When the part is finished, follow the steps under “Removing a Completed Part”

- The display panel during build
  
  - The top two lines of the display panel show system-status messages, see Figure 21. The bottom line of the panel shows the material amounts remaining in the cartridges.

![Figure 21: Display panel during build](image)
Chamber Lights

When a part starts to build, the chamber lights are automatically ON. You can toggle lights ON or OFF through the Display Panel.

You can also turn the light on continuously. Go to the Idle or Ready to Build mode. Press Maintenance and then press Setup. Press Lights Always On. The light will remain ON until the system is powered OFF.

Pausing Build

While building a part, you may want to pause the operation - e.g., to allow for replacement of a material cartridge. To pause the build operation at any time, press Pause.

Note: When the build process is paused, the system completes the current tool path before pausing.

Resuming Build from Pause Mode

If you have pressed Pause, and are ready to resume building the part, press Resume. The system resumes modeling.

Resuming Operations from Standby Mode

After several minutes of inactivity, the system enters Standby mode. During Standby, the head temperature will decrease to save energy.

Continue operation from Standby mode:

- Press Resume.

  The panel displays Ready to Build and your part’s name (if there is a part in the queue). It also shows the amount of material remaining in the model material cartridge and the support material cartridge (e.g. *Model 90%, *Support 85%).

  Start Model begins blinking.
• Press **Start Model** to begin modeling.
  (The system may require a few minutes to warm up to proper build temperatures. You can view the temperature values in the display.)

**Canceling a Job**

You can cancel a job at any time while the part is building.

Cancel a job:

• Press **Pause**.

• Once the system stops building, press **Cancel Build**. The panel displays **Are you Sure?**

• Press **Yes**. The panel displays **Build Stopped** followed by the part name.

• The panel prompts you to remove the part and replace the modeling base. See “Inserting a Modeling Base” on page 27. Once the chamber door has been opened and closed, the panel asks: **Part Removed?**

• Press **Yes only after** removing the part - refer to “Removing a Completed Part”

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**CAUTION:** If you press **Yes** before removing the part, the system can be damaged, and a service call will be required.
Auto power down

You can set the system to automatically power down when a build is complete. This option will save energy usage.

• While the system is building, press the **Auto Power Down** button.

• Turn the power switch, located on the left side of the system, to the OFF position.

The system will display **Auto Power Down Mode** and the system will power down as soon as the build is complete.

Cancelling auto power down:

1. Turn the power switch back to the ON position.

Powering Off

To power-off the system, move the power switch to the OFF position. You can do this at any time without harming the system. No other steps are necessary. If this is done while the system is building a part, the current build will be lost. System cooling fans will continue to operate for several minutes. This ensures a safe, systematic power down.

**Note:** For extended non-use periods greater than 72 hours, unload the material cartridges and power off the system.

Removing a Completed Part

When the part has completed, the panel displays **Completed Build**, and the file’s name. It also shows **Remove Part and Replace Modeling Base**.

Remove a completed part:

• Open the modeling chamber door.
• Release the modeling base retainers and pull the modeling base towards you, out of the tray guides.

• Insert a new modeling base.

• Close the modeling chamber door.

• After you have opened and closed the door, the panel displays **Part Removed?** only after removing the part, press **Yes**.

---

**CAUTION:** The system can be damaged if you answer **Yes** and the part has not been removed!

After you press **Yes**, the panel displays the status as **Ready to Build** for the next part in the queue.

**Remove a completed part from the modeling base:**

After removing the base from the system, firmly flex the modeling base back and forth with your hands to loosen the part. For best results, flex the modeling base front-right to back-left.

Pull the part off the base.

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**Note:** Supports are much easier to remove when the modeling base is still warm.
Removing Support Material

Soluble Supports

WARNING: When removing soluble supports by hand, wear LEATHER gloves and safety glasses.

Fortus 250mc uses soluble supports - designed to allow you to simply wash away the support material in a water-based solution. Your part is left smooth and clean with the fine details intact. The soluble support material can be removed by hand with relative ease, but is designed to be dissolved off of your parts for hands-free part finishing. Contact your Reseller for information regarding support removal equipment.

Well, that’s about all there is to shrimpin’.