# Makerbot

From lab-wiki

This article is a guide on how to use the MakerBot (3D printer) that is available in **A6-215 (Contact Ben in A6-213 for access)**, there is a turbo guide available for getting the print done as quickly as possible, as well as a detailed guide explaining different ways to optimize the print.

Additive manufacturing or **3D printing** is a process of making three dimensional solid objects from a model-based digital model. 3D printing is achieved using *additive processes*, where an object is created by laying down successive layers of material. 3D printing is considered distinct from traditional machining techniques (*subtractive processes*) which mostly rely on the removal of material by drilling, cutting etc. *Source Wikipedia (http://en.wikipedia.org/wiki/3D_printing)*
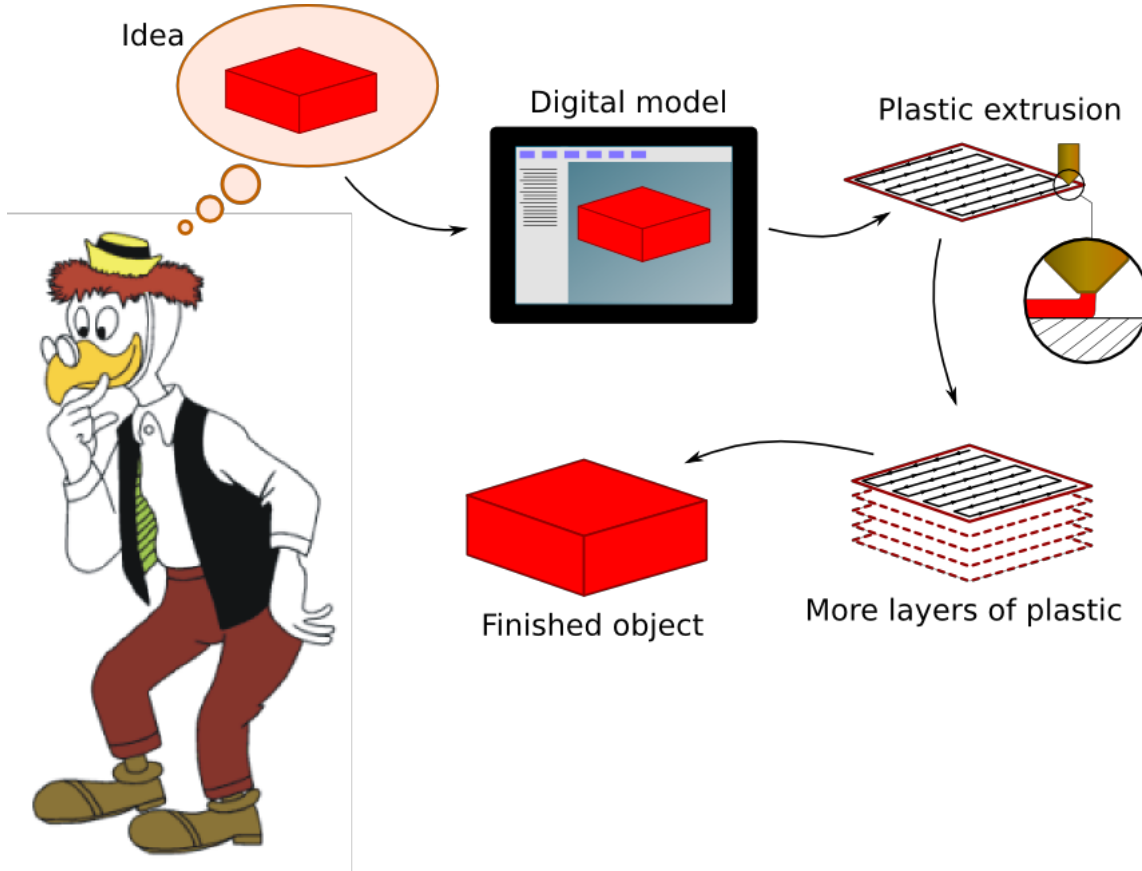
Contents

Before printing

What is needed to make a print
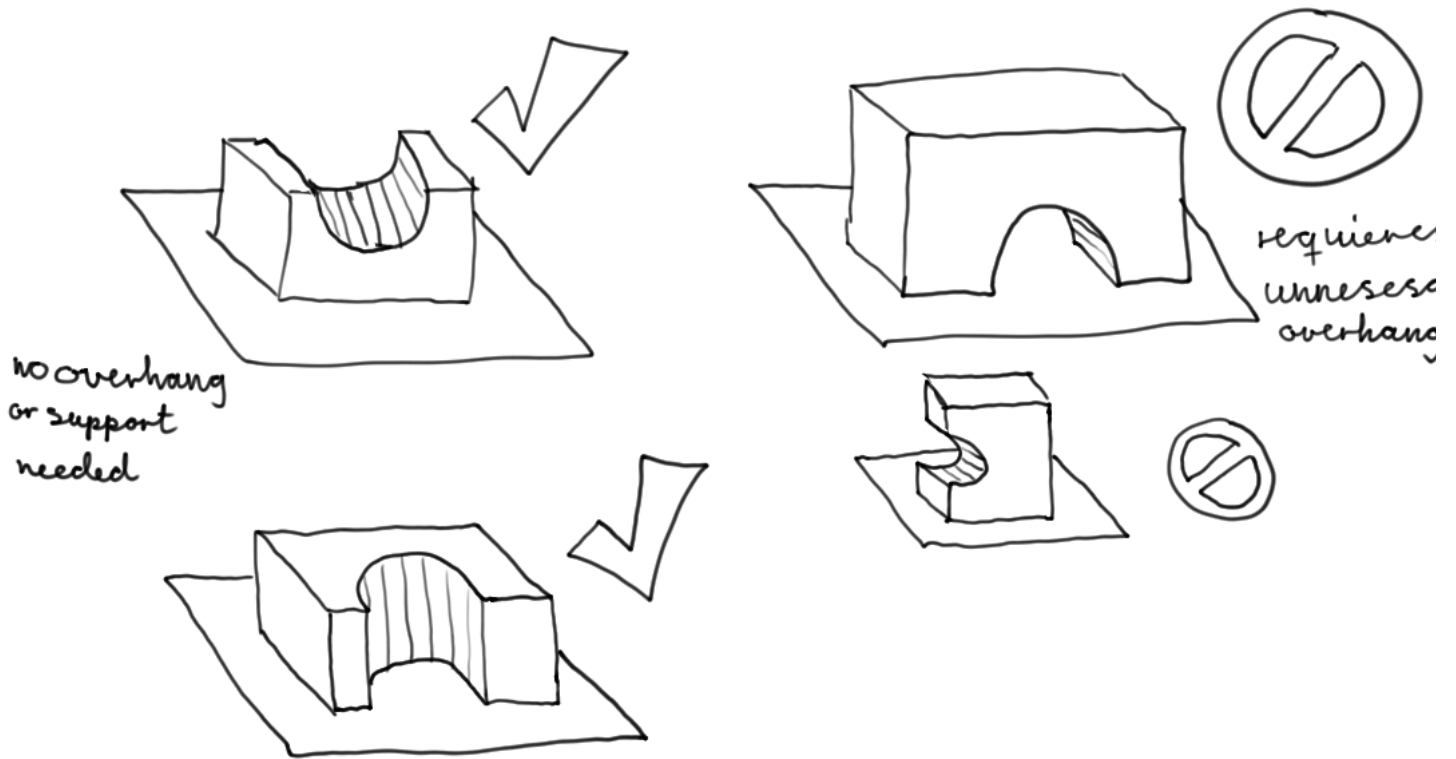
- A 3D model in STL format.

- A computer for converting the 3D model into S3G code that the Makerbot uses to make the print.
- An SD card to get the S3G from your computer into the MakerBot. An SD card can be borrowed from Komponenten (http://www.komponenten.es.aau.dk/) .

General advice regarding printable 3D models

When printing an object it is vital to orient it in the right way, to get the best print possible. The best results are obtained without using support, since the support has to be pealed or cut of the object afterwards, and this makes the surface of the object more rough.

To get the best possible result, getting the mass of the object as close to the print surface is a good idea. It is also a good idea to think about printability already when designing the digital model of the object, to avoid any unnecessarily complex structures that can be difficult to print.

Below can be seen a few examples on good and bad orientation of an object.

The example above shows how to orient an object to avoid the need for support.

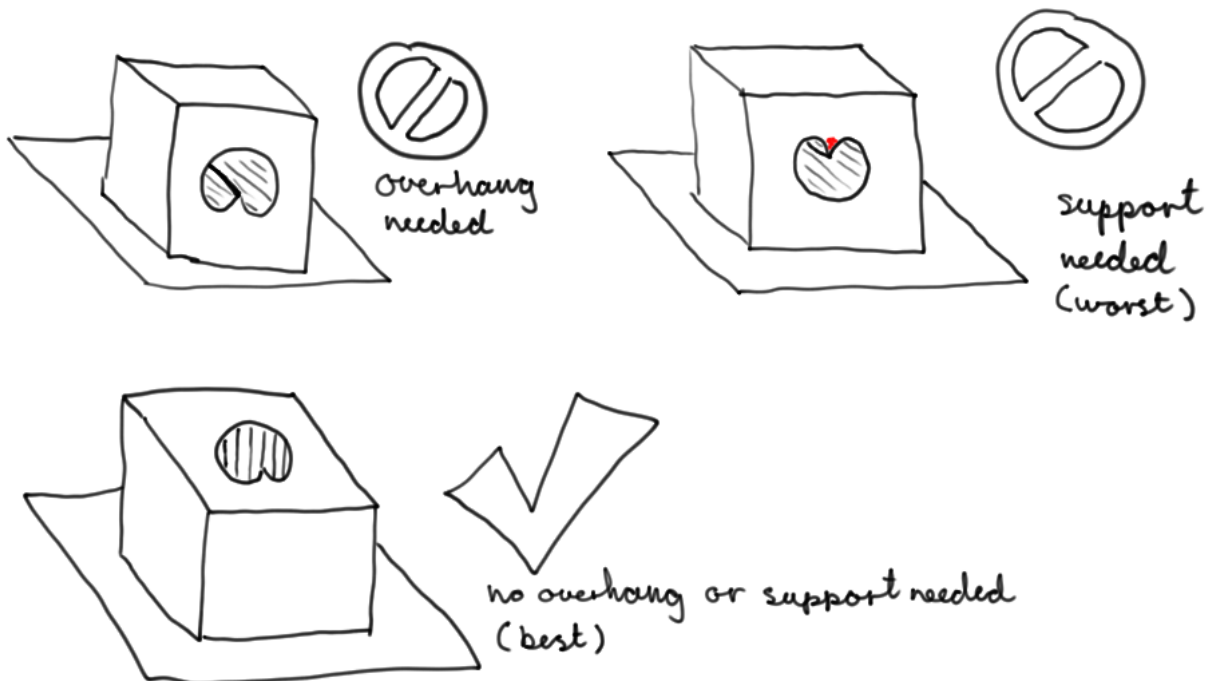doesn't fit on the build su

almost no contact area
unnessary overhang

taller than necessary
small contact area

good
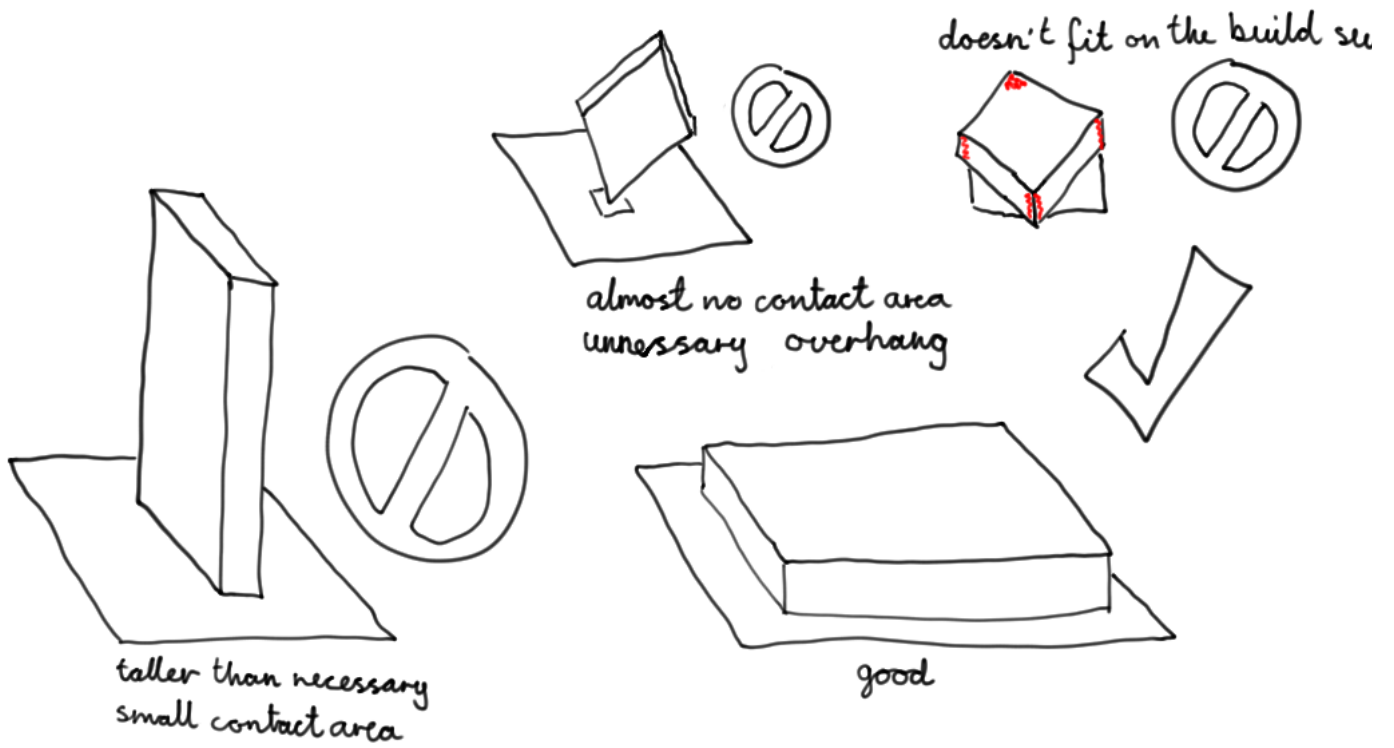
The example above shows how to orient a box, to get the best possible result.

overhang
needed

support
needed
(worst)

no overhang or support needed
(best)

This last example illustrates how some objects are impossible to build without support in some orientation, but perfectly possible in other orientations.

Inspiration can be found on Thingiverse (http://www.thingiverse.com) .

Usefull programs for making the 3D model

Beneath is listed useful programs for the whole process of creating a 3D model, and preparing it, to printing it on the printer, what program is used mainly rely on personal preferences and experience. For recommendations read the description of the programs, last in the description is a list of platforms the program runs on.

Creating a 3D model

Here are listed several 3D modelling programs that can be used to create 3D models that can be exported to STL files. Listed in no particular order.

Inventor (http://usa.autodesk.com/autodesk-inventor/)
> Inventor is an easy to use 3D modeling program widely used by professionals, Available through the university. Available Windows.

WINGS 3D (http://www.wings3d.com/wiki.php?title=Downloads)
> *Recommended for users with no 3D experience.*
> Easy to use 3D modeling software with a graphical approach. Available for Linux, Mac and Windows.

OpenSCAD (http://www.openscad.org/)
> *Recommended for designs using simple mathematical structures (like boxes, cylinders, cones and combinations of those.*
> Free CAD software using programming language to create three dimensional models. Easy to use for people familiar with programming and math, a guide to the language can be viewed here (http://en.wikibooks.org/wiki/OpenSCAD_User_Manual/The_OpenSCAD_Language) Available for Linux, Windows and Mac.

HeeksCAD (http://www.heeks.net/)
> Free CAD software using a more graphical approach than OpenSCAD. Available for Linux, Windows and Mac. Help can be found here (http://en.wikibooks.org/wiki/OpenSCAD_User_Manual/The_OpenSCAD_Language) .

SolidWorks (http://www.solidworks.com/)
> Solidworks professional tool used by many mechanical engineers, a students license can be obtained through the university. Available for Windows.

Rhino3D (http://www.rhino3d.com/)
> Comercial 3D modeller for Mac and Windows.

Trimble Sketchup (http://www.sketchup.com/)
> Formerly known as Google Sketchup for Windows and Mac, maybe through wine for Linux.

Tinkercad (https://tinkercad.com/)
> Online 3D modeller via your webbrowser.

Blender (http://www.blender.org/)
> 3D modelling program, used in everything from making 3D objects, to animated movies, (not usually used for designing mechanical designs)

There are many other alternatives out there, both free and payed.

Repairing STL files

Often when programs are producing STL files they make some complex geometry that ReplicatorG or MakerWare does not quite understand, it has to be simplified/repaired with a tool. There exists several options of which a few are listed below.

Netfabb cloud (http://cloud.netfabb.com/)
> Browser based solution to repair a single STL file.

Netfabb basic (http://www.netfabb.com/basic.php)
> Provides mesh edit, repair and analysis capabilities. Works on Mac, Windows and Linux.

MeshLab (http://meshlab.sourceforge.net/)
> Processing and editing of unstructured 3D triangular meshes. Works on Mac, Windows and Linux.

Other solutions are available.

Slicing software

Slicing software is used to convert an STL file into a set of paths for the printerhead, for the printer to realize the part. Beneath is listed the two programs recommended by MakerBot.

RepliocatorG (http://replicat.org/download)
> ReplicatorG is the default host software for the Makerbot Replicator 1. It can not be used for creating 3D models, only for converting them, to a file readable by the MakerBot. Available for Linux, Windows and Mac.

MakerWare (http://www.makerbot.com/makerware/)
> MakerWare is the program that is supposed to take over from ReplicatorG, it is simpler, but is still in beta, thus it is not completely ready yet, it has been tested successfully on Windows and Mac, the Linux version does not work properly yet. Available for Windows and Mac.

Other Slicing tools are available but not recommended at the moment.

FAQ

What can the Makerbot be used for?
> The Makerbot is used for making plastic items, theese items can have a size up to 225 mm x 145 mm x 150 mm.

What is the Makerbot usually used for?
> The Makerbot have previously been used to make everything from coat hangers to small mechanical systems as well as scale models of e.g. buildings, more examples can be seen on thingiverse.com (http://www.thingiverse.com/) .

Who can use this printer?
> All students and employees at AAU.

Where is it located?
> In A6-215.

What is the quality of the prints?

- Precision

  The prints are printed with a precision under 1 mm.

- Strength

  The items are typically printed in ABS which is the same material that LEGO bricks are made from, the strength is therefore comparable to that of LEGO bricks, though not quite as good, since the material is printed out in layers, thus making it a little weaker, the strength is also dependent on how thick your item is. Furthermore infill can be ajusted, saving weight, but sacrificing a little strength. Generally you should refrain from using more than the standard infill of 10 % unless you really need the strength.

An other issue regarding strength is the number of perimeters 2 is generally recommended, though really small details often works better with just one, if extra strength is

needed, it is generally recommended to use more infill rather than using more infill.

Materials

Two types of materials can be used in the same print, this can be done to utilize the different properties of different materials, or get a two coloured print. A special kind of water soluble plastic can be used for support material on complex prints.

- Types of plastic

Glossary

There are different terms in relation to 3D printing, hence a list of the most common words is described here for your convenience. The words may or may not be used in this documentation.

- Brim - Edge of matrial that helps the object stick on the printbed without warping.
- Infill - The inside structure of the object.
- ABS - Acrylonitrile butadiene styrene (http://en.wikipedia.org/wiki/Acrylonitrile_butadiene_styrene) . A flexible thermeplastic, used for e.g. LEGO bricks.
- PLA - Polylactic acid (http://en.wikipedia.org/wiki/Polylactic_acid) . A thermoplastic that is more stiff that ABS and is biodegradable.
- PVA - Polyvinyl alcohol (http://en.wikipedia.org/wiki/Polyvinyl_alcohol) . A water soluble plastic, which is used for removable support material.
- STL - The 3D file format used to generate S3G code for the printer with ReplicatorG or MakerWare.
- S3G - A simplified binary version of GCode used by MakerBot printers.
- GCode - A plaintext file format that describes the printer paths to make a 3D object using e.g. 3D printers and CNC machines.

Expected print time
On the following pictures items and their respective print times are shown

The detailed guide

This guide takes you through the process of making an item using the Makerbot, and gives you useful advice on how to get the best print quality for your specific object.

Step 1 - Slicing your model

Slicing your object means converting it from an STL file to a GCode (http://en.wikipedia.org/wiki/G-code) file, which the printer can read

Using ReplicatorG

ReplicatorG default program for slicing objects for the replicator.

For this process you need to install the program ReliocatorG (http://replicat.org/download) .

Choose "open" from the "File" menu and locate your stl file. (File\Open\Your_file.stl)

Make sure that "The Replicator Dual" is chosen from "Machine Type (Driver)" Under "Machine" (Machine\Machine Type\The Replicator Dual)

Choose the "generate GCode" button and make sure the settings match the following.

in ReplicatorG press the "build to file with SD card", third button from the top right. (Not the generate GCode button.)

Using MakerWare

MakerWare is the program that is supposed to take over from ReplicatorG, it is simpler, but is still in beta, thus it is not completely ready yet

For this process you need to install the program MakerWare (http://www.makerbot.com/makerware/)

Open the program and press the "**Add**" button, choose your STL file.

Press the "**Make it**" button and make sure the settings are as follows:

- Export file to: **S3G**
- For: **The Replicator Dual**
- Material: **ABS**
- Quality: **Medium** or **Low** (high does not work well)
- "**Raft**" and "**support**" should be **unchecked** unless you are sure you need it

Press the "**Export**" button and save the file on your SD card.

Step 2 - Before you start the print

- Make sure the build surface is clean, if not wipe it with a paper towel before the print is started.

Step 3 - Starting the Printer

Insert the SD card into the SD card slot in the right side of the printer

On the front panel press "Print from SD" and select your file.

The Printer should now starts heating up, and begin printing when it has reach the right temperature.

Observe the nozzle when the print starts, it should just above the build surface without touching, if the nozzle touches the surface or it is printing in the air, cancel the print and contact Ben.

Step 4 - When the print is done

When the print is done the item will stick to the build surface, when this cools, the item will come loose, and can be removed without force. Avoid using sharp tools to pry of the print, since this can damage the tape on the build surface.

Remove any excess material still stuck to the build surface.

Post processing of the item is not necessary, though drilling holes that need high precision might be a good idea, as well as clipping of any excess material that has stuck the print. The print can be smoothed by wiping it with acetone to dissolve the outer layer slightly. The plastic can be painted as well.

Relevant links

Makerbot.com (http://www.makerbot.com/) - the company that produces and sells the makerbot.

Reprap.org (http://www.reprap.org/wiki/Main_Page) - The open source project that the makerbot is based upon.

thingiverse.com (http://www.thingiverse.com/) - Online community page sharing 3D designs for printing.

3dcontentcentral.com (http://www.3dcontentcentral.com/default.aspx) - Free 2D and 3D CAD Models of User-Contributed and Supplier-Certified Parts & Assemblies, 2D Blocks, Library Features, Macros, and more.

Quick guide

This quick guide takes you through all the steps without explaining anything, it will get you an item fast, but if you want to optimize your print read the full article.

1. Download ReliocatorG (http://replicat.org/download)
2. Load your stl file into the program
3. Press the "generate GCode" button
4. Uncheck the "generate raft" option
5. Press "build to file for use with SD card" button.
6. Copy the gcode file you just generated to a standard size SD card
7. Insert the SD card into the right side of the Bakerbot machine
8. Using the front display and buttons of the Makerbot, select the "print from SD", then choose the file you just generated. The makerbot should now start moving, the print will not start right away, since it has to heat up first.
9. When the print is done, wait until the heatbed is somewhat cold and remove your print, if the print does not come of using only a little force, wait until the print has cooled down further.
10. Make sure to remove any residue from the build surface.
11. Congratulations on your new print :-)

Trouble shooting

This section deals with common issues, and their solutions.

Problem The object does not stick to the print surface.

Solution This problem generally occur for three reasons:

1. The buildsurface is not clean, this can be solved by wiping the build surface with a paper towel, if this is not enough try using a little ethanol on the paper towel.
2. The build surface is not level. This is revealed by the plastic lines on the lowest layer not the same width in opposite ends of the print. If this occurs, contact Ben in A6-213. [TODO add image]
3. The print can also come loose simply because it is large (covering most of the build surface, length or width wise), this problem mostly occurs with ABS plastic, if possible try to print the object in PLA (contact Ben in A6-213 for help exchanging materials in the printer). If you still have problems, consider redesigning the print, or contact Ben for pro-tips on how to get the print to stick, like printing with brim or raft.

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