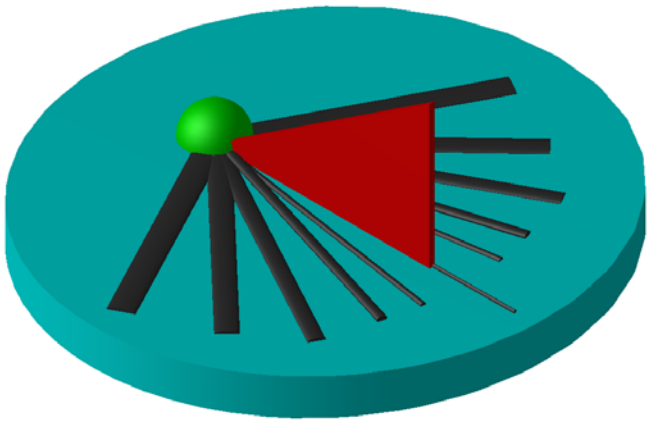
A 3D PRINTED SUNDIAL

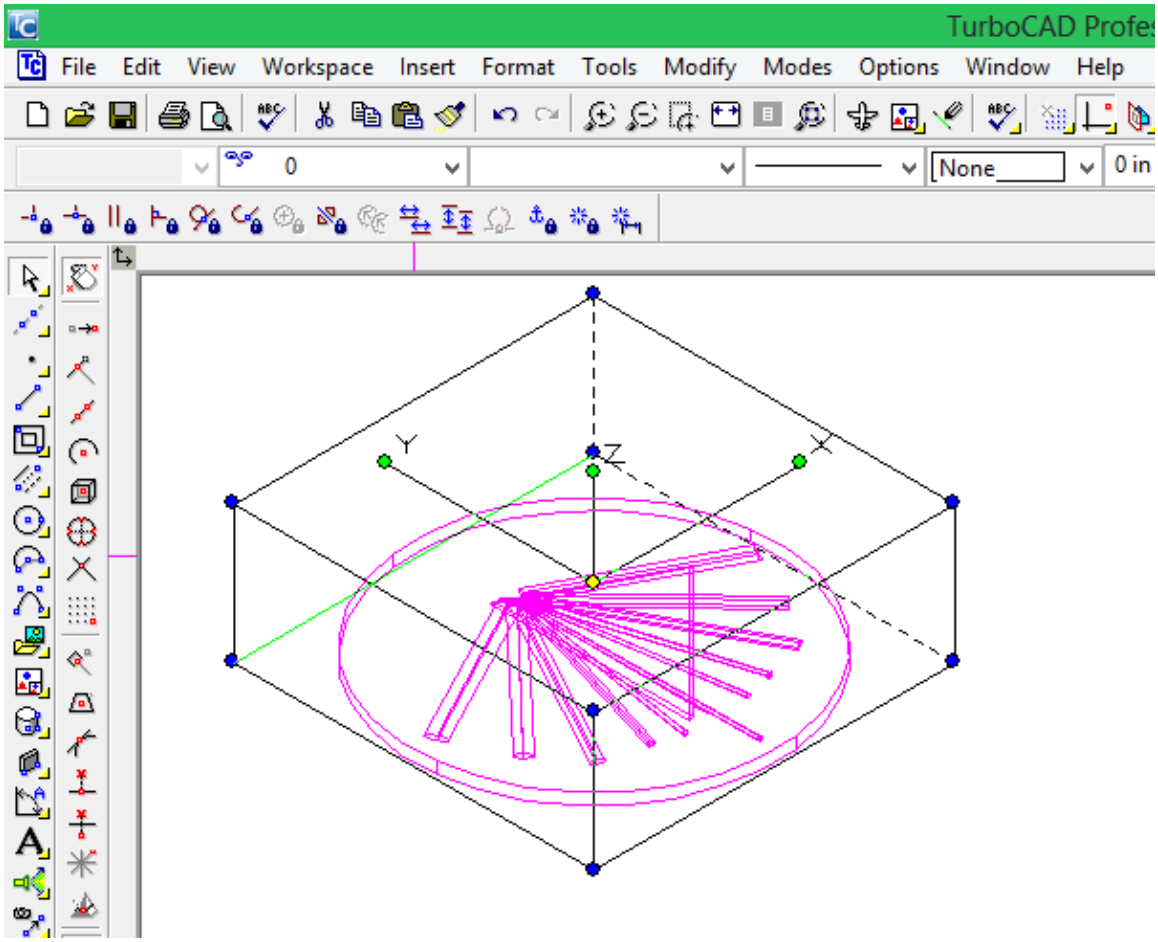


The objective was to 3d print a sundial correct for latitude. The selection of multiple colors involves extra steps, and this was not considered here.

Simon Wheaton-Smith
www.illustratingshadows.com
June 26, 2013
July 2, 2013

A simple sundial was created in CAD software, in this case TurboCAD, and it wasn't the latest version.

- 3dSundialLat33.5Lng0gnomonLinesAndPlate.tcw




This was a small sundial, so it was NOT longitude corrected. My practice is not to correct for longitude if the dial is small or portable, and to only correct for longitude when the dial is large or permanent. Of course other facts may change that decision.

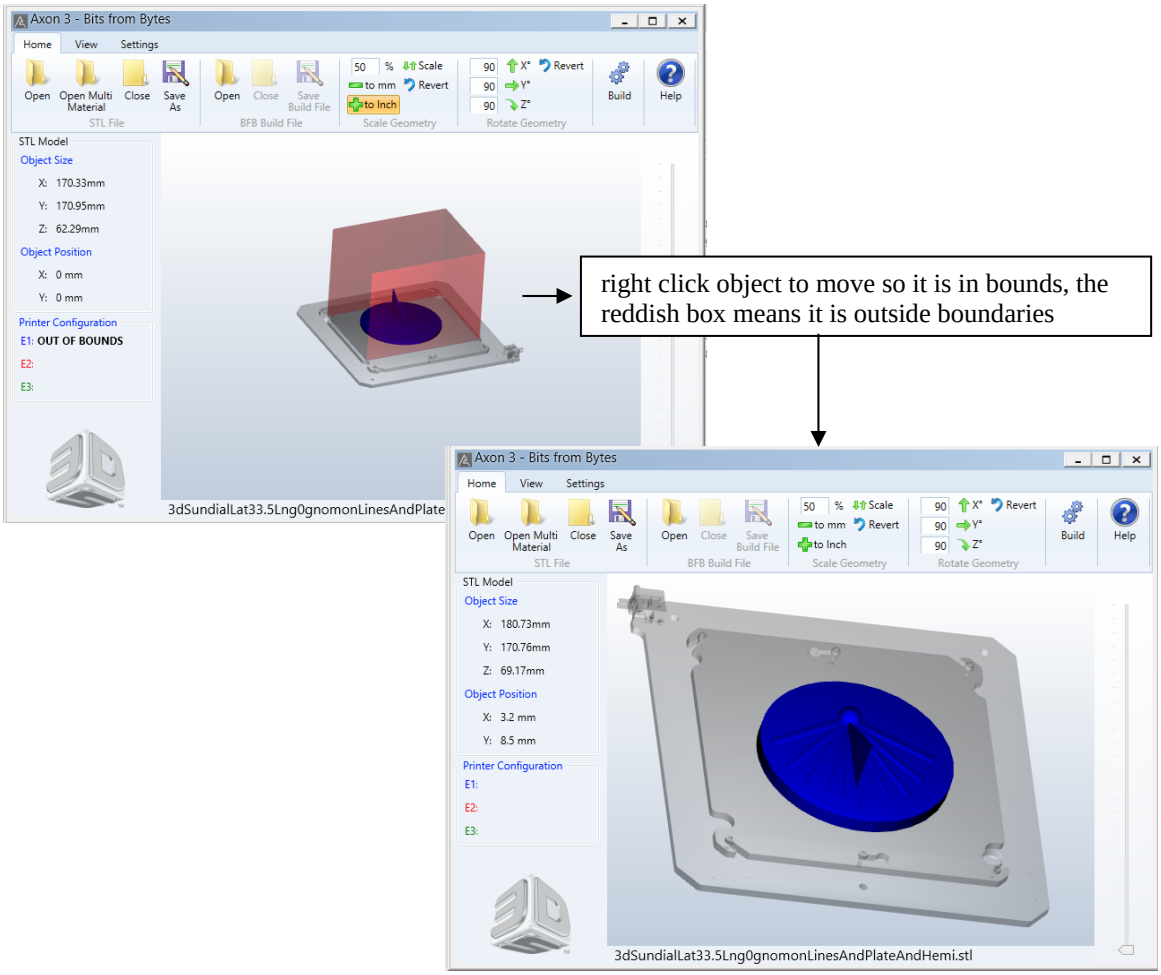
This dial was correct for latitude.

It was created in a very few simple steps as a 3d .TCW file, and then saved as a .STL file (stereo lithographic) which is a common method of feeding 3D printing systems. In essence, DeltaCAD was used to get the hour lines, that screen was inserted into TurboCAD, and then TurboCAD hour lines built over the copied DeltaCAD ones. Of course, the TurboCAD VBS scripts could have been used but that requires the Professional version. Then 3d hour lines were generated in TurboCAD, and the original 2d lines as well as the DeltaCAD depiction were removed. The gnomon was added as well as the dial plate, and an aesthetic dial center hemisphere.

The TurboCAD .TCW file was then saved as a .STL file:-

- 3dSundialLat33.5Lng0gnomonLinesAndPlate.stl

It was then viewed in an STL viewer such as Axon just to verify the conversion from TCW to STL.




This Axon viewer was downloaded from the web site:-

- http://www.bitsfrombytes.com/

The file was called:-

- Axon 3.0 Alpha 3 Setup.zip

There is a manual online at:-

- http://3dpedia.3dsystems.com/display/BFBAXON2/Axon+2+manual

This manual describes the above software and also describes how to BUILD the final file for actual printing on the final 3d printer, IF the file is to be 3d printed on your 3d printer. For using remote or cloud 3d printers, the .STL file is what is used as that is device independent.

At this point there were three choices.

1. To buy a 3d printer and install its software
2. To use a 3d printer that also does cloud printing of 3d objects, or
3. To select a local provider.

CHOICE 1:

A 3d printer can be acquired for around $1299, namely the “Cube”

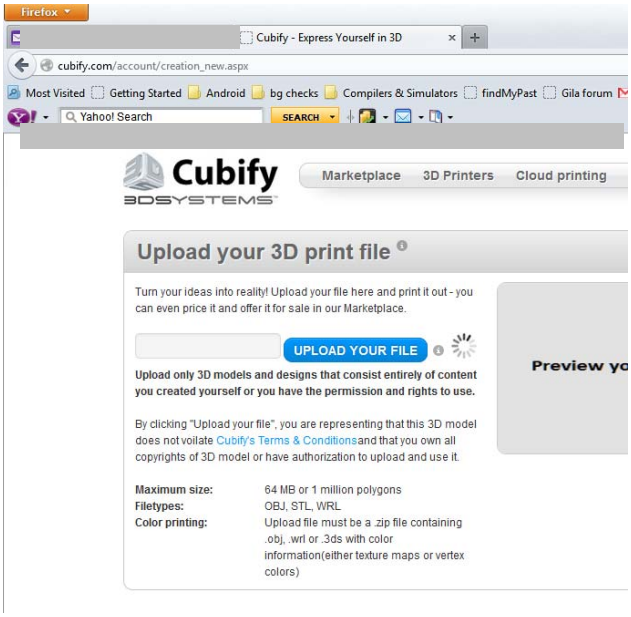
- http://cubify.com/cube/index.aspx

| | |
|---|---|
| **Print size** | 5.5" x 5.5" x 5.5" or 140 x 140 x 140mm |
| **Print resolution** | 200 microns (0.2mm)* |
| **Colors available** | 16 colors,<br>2 are glow in the dark |
| | Cube |
| **Colors per print** | ✔ (1) |
| **Prints in ABS plastic** | ✔ |
| **Prints in PLA plastic** | ✔ * |

Given the price, I decided to opt for choice 2, namely to use this vendor’s cloud printing service.

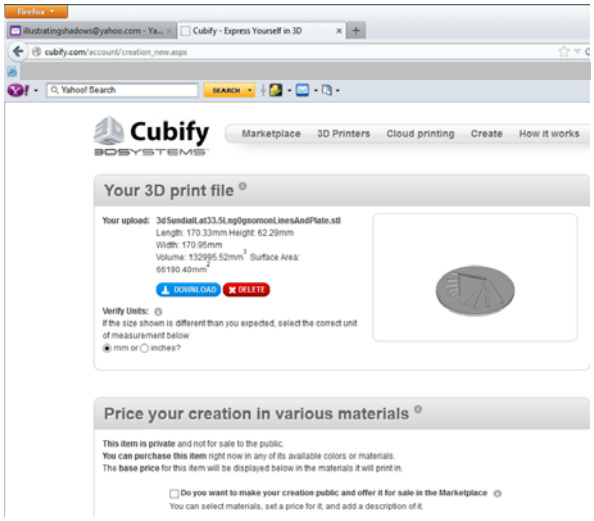
CHOICE 2:

I created an account on Cubify which was simple, and then selected cloud printing. This would help me decide whether I wanted my own 3d printer.



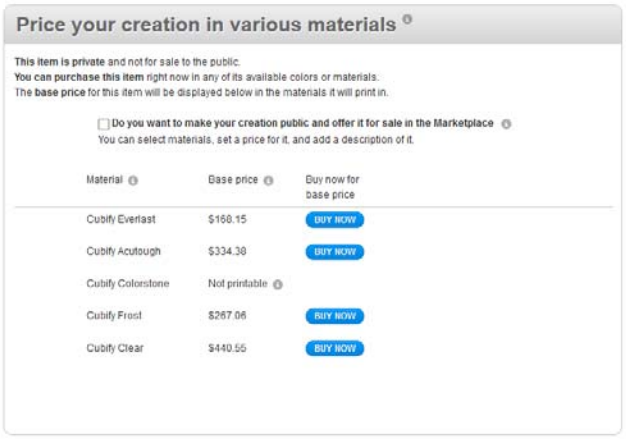

I selected a file to upload:

- 3dSundialLat33.5Lng0gnomonLinesAndPlate.stl

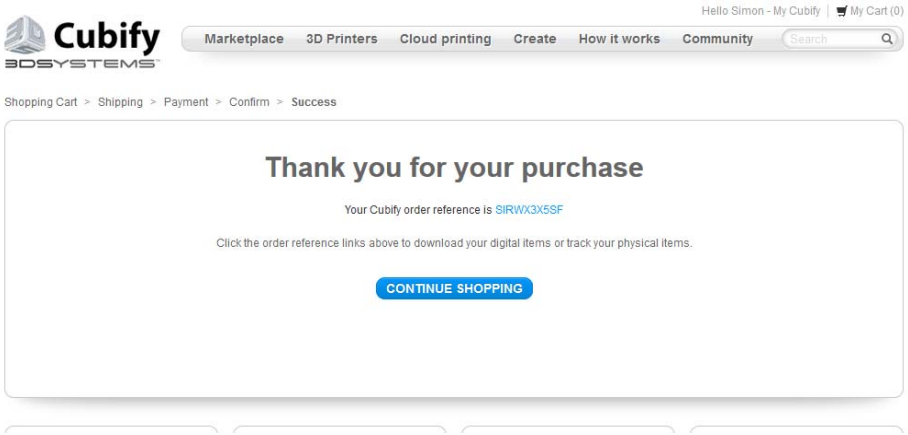



and it took a long time to process. Having no idea why, I went into Cubify and added a few, very few, profile details about me and tried the upload again. When I retried the upload, it worked quickly.

I had the option to print it on the cloud:-




So I followed the process and made the order:-




And then I waited for the sundial to arrive! They emailed me an invoice, and the shipping date was 15 days from the order.

Cubify 3DSYSTEMS

3D Systems, Inc
333 Three D Systems Circle, Rock Hill, SC 29730, US
E-Mail Cubify@Cubify.com

# INVOICE

**Order Reference:** [ ] **Date:** 24-Jun-2013

| Bill To | Ship To |
|---|---|
| Simon Wheaton-Smith<br><br>Phone:<br>Fax: | Simon Wheaton-Smith<br><br><br>Fax: |

**Items**

| No | | Item | Rate | Qty | Amount | Tax | Net Amount |
|---|---|---|---|---|---|---|---|
| 1 | | Untitled (3dSundialLat33.5Lng0gnomonLinesAndPlate.stl) by illustratingshadows<br>Color: White<br>Material: Cubify Everlast<br>This item is scheduled to be shipped on 08-Jul-2013. | $168.15 | 1 | $168.15 | $15.30 (9.10%) | $183.45 |
| | | | **Totals** | 1 | $168.15 | $15.30 | $183.45 |
| | | | | | | Shipping | $8.01 |
| | | | | | | **Total** | **$191.46** |

If you have any questions regarding your invoice, please contact Cubify at CubifyOrders@Cubify.com

CHOICE 3:

The other option was to use a local printer in my town. The local provider was just a few short miles away from me and was:

- http://www.padtinc.com/

Who asked for a .STL file which I sent. When converting .TCW to .STL files, sometimes scaling was a problem. However the aspect ratios were retained. A key point with TurboCAD is that ASPECT RATIO retention is NOT the default, so when rescaling anything, right click the objects, and turn on ASPECT RATIO. The printers needed to know the color, size, and purpose of the object. This affects the material to be used.

Same day I received a quote for a 4 to 5 day from receipt of order delivery date. It was actually ready the next day.

The final dial was ready the next day, so I picked it up and tested at 1031 mst. It shows, correctly, 1000 because this dial was designed for a longitude 28 minutes east and an EOT of about 3 minutes plus. So at 1031 mst the dial should shows 1000 local apparent time.

The material considerations consist of UV tolerance, and the like. The 3d print file is standardized to .STL and 3d printer vendors provide conversion software to convert it for the final print run to their internal formats. TurboCAD Deluxe for under $150 supports .STL files, as do some free programs.

A 3d printer printed dial could be intricate and used as the basis for a mold to cast a final dial.

ADDITIONAL NOTES:

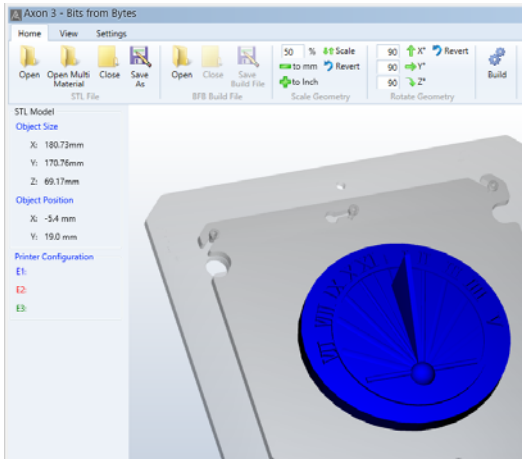
NOTES:-PLA Material ~ PLA (Polylactic Acid) may be the easiest material to work with, it is a biodegradable thermoplastic derived from renewable resources such as corn starch and sugar canes. This makes PLA environmentally friendly and very safe to work with.

ABS 3D Printing Material ~ ABS (Acrylonitrile butadiene styrene) may be the second easiest material to work, it is an engineering polymer commonly used to produce car bumpers due to its toughness and strength. It’s also the stuff that Lego blocks are made of…tough enough but safe enough for the kids to handle!

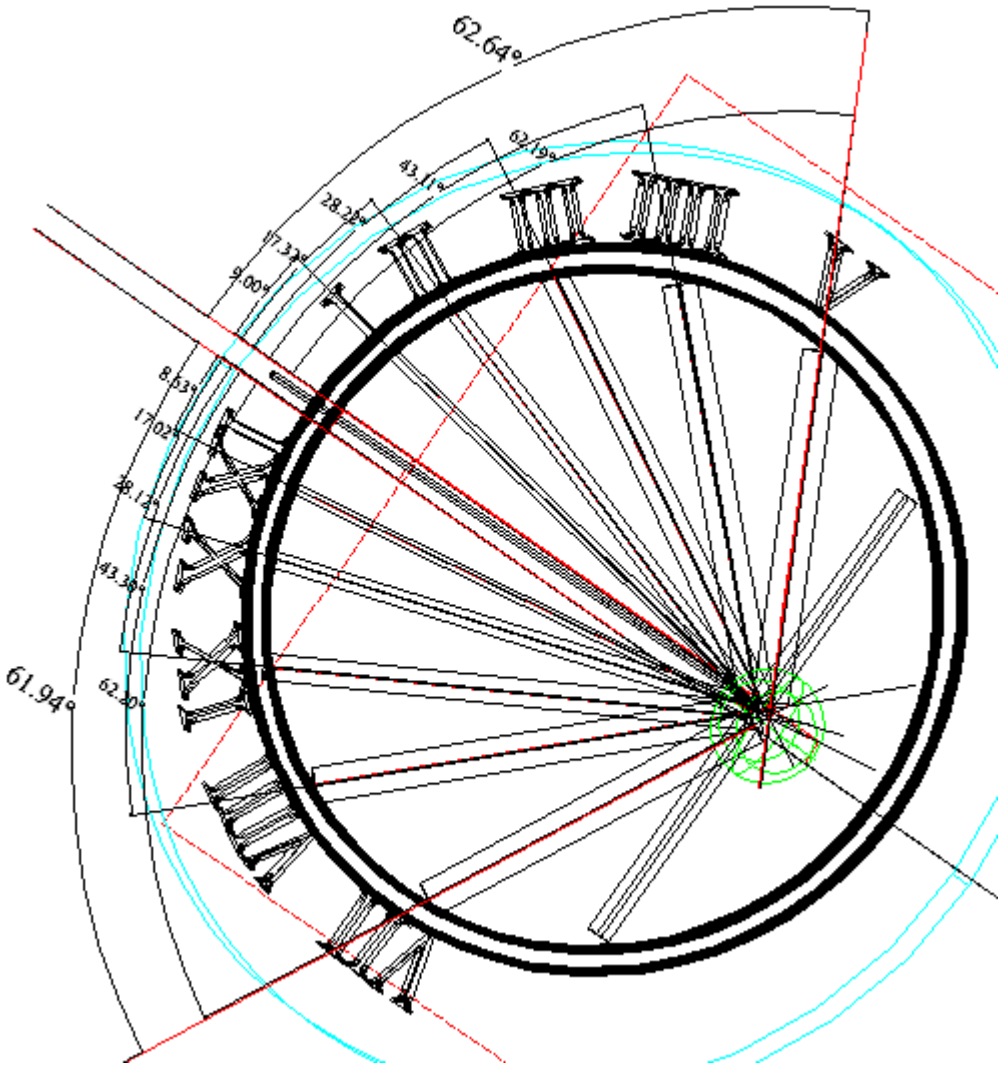
Some cloud 3d printer organizations have their own special materials.

Simple printers such as the CUBE available for around $1300 have one print head and thus multiple colors are done after the fact, requiring you to assemble the items. Some printers such as the CubeX  available for around $2500 have additional options for color.

Another dial was designed with lettering and a boundary circle and then printed, see below.



3dSundialLat33.5Lng0v3circle.tcw
3dSundialLat33.5Lng0v3circle.stl




| 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -90.0 | -64.1 | -43.7 | -28.9 | -17.7 | -08.4 | 00.0 | 08.4 | 17.7 | 28.9 | 43.7 | 64.1 | -90.0 |

| | | MEASURED | | ERROR | |
|---|---|---|---|---|---|
| | Calculated | AM | PM | AM | PM |
| 12 | 0 | | | | |
| 11~1 | 8.4 | 8.63 | 9 | 0.23 | 0.6 |
| 10~2 | 17.1 | 17.02 | 17.32 | 0.08 | 0.22 |
| 9~3 | 28.9 | 28.12 | 28.22 | 0.78 | 0.68 |
| 8~4 | 43.7 | 43.3 | 43.11 | 0.4 | 0.59 |
| 7~5 | 64.1 | 61.94 | 62.64 | 2.16 | 1.46 |
| 6 | 90 | | | | |

The error rates between the calculated design hour line angle and the final hour line angle were all within 1° except for 0700 and 1700 which was around 2°