

Rather Useful Seminars

3D Printing

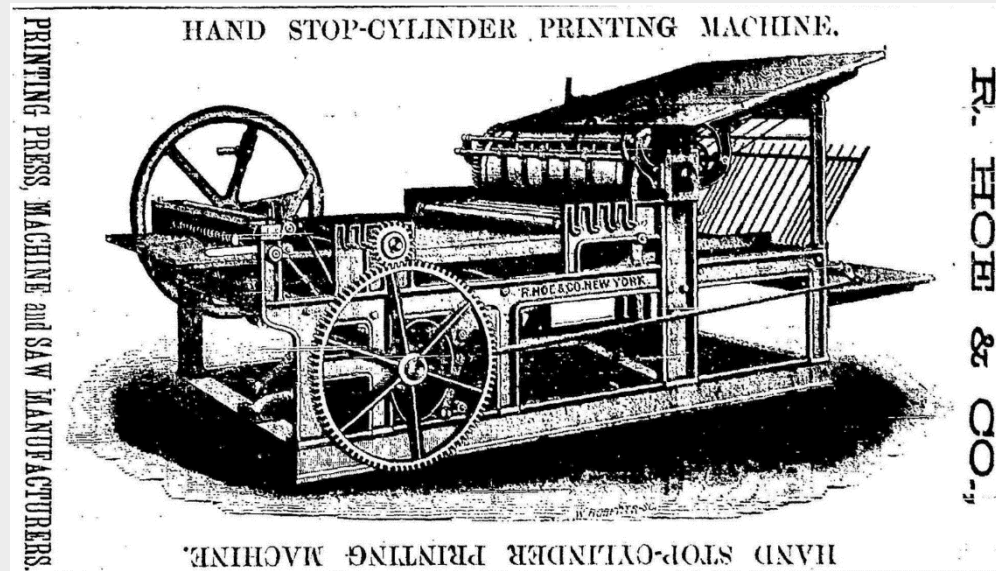
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Agenda

- 3D Printing Overview
- 3D Printing Workflow
- Design something and Print it
- The future of 3D Printing

Printing



- Not that many years ago having your own colour printer was the stuff of dreams
- Nowadays you can buy them for next to nothing
 - Although the ink is always very expensive

3D Printing

- Printing in 3D might seem as far fetched as everyone owning their own colour printer, or TV camera, did a few years ago
- The technology is now becoming almost mainstream
- We can print cheaply enough, and in sufficiently strong materials to make the technology viable



Uses for 3D Printing

- Rapid prototyping of designs
 - Prove that a physical design works as expected
- Short production runs of components
 - It may be uneconomical to mass produce the item
- Print things that can't be made any other way
 - Can print objects “inside” each other

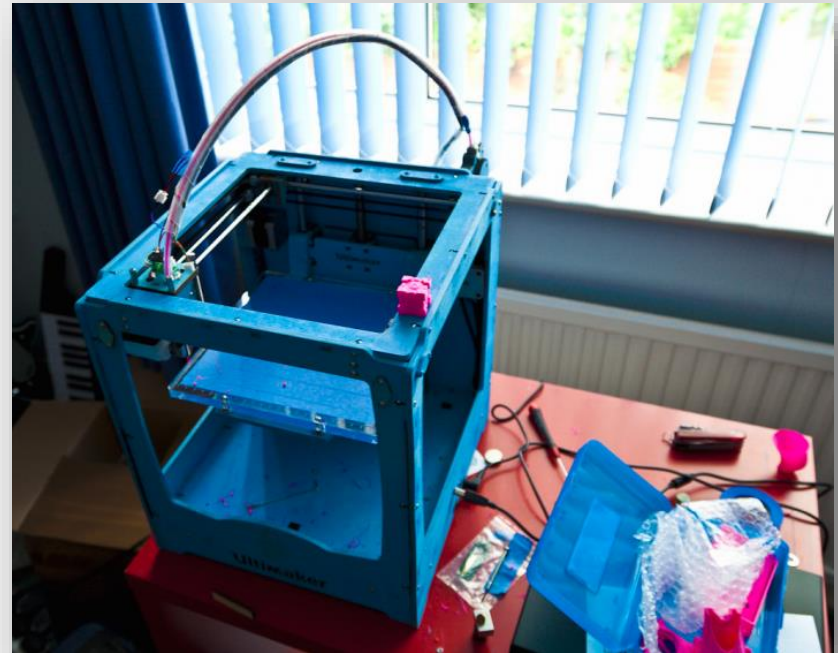


3D Printing Technologies

- There are lots of ways to print in 3:
 - Selective Heat Sintering
 - Heat up powdered plastic so it melts and fuses together and forms hard objects
 - Digital Light Processing
 - Shine a UV light onto liquid plastic which makes it harden
 - Fused Deposition Modelling
 - Lay down layers of material which is extruded onto a flat bed
- Each has its advantages and disadvantages
 - I don't think any of them are ready for prime time yet

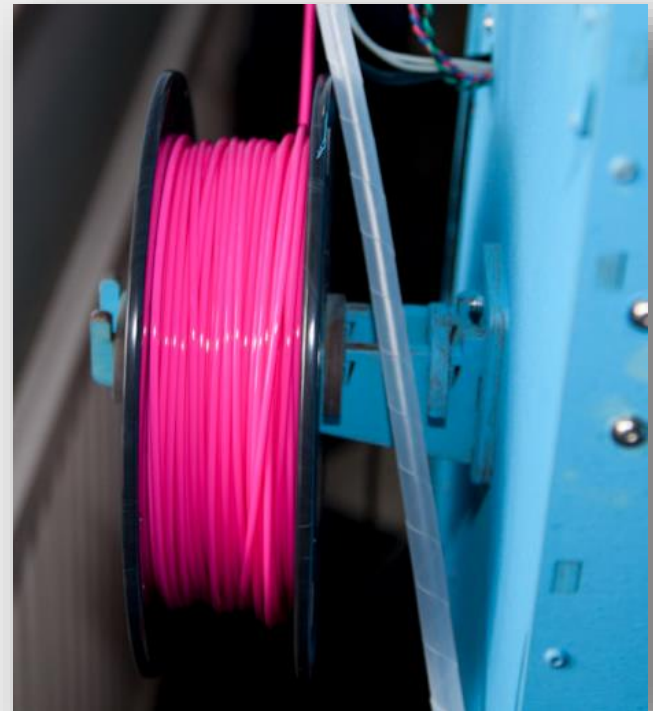
Introducing Una

- Una is an FDM 3D printer
- She prints by “knitting” together a continuous hot plastic fibre to make solid objects
- She is a bit temperamental, but when she is in a good mood she can print some amazing stuff



Raw Materials

- You can print on ABS or PLA types of plastic
- PLA is biodegradable and melts at a lower temperature
- It is supplied as a 3mm wide fibre strand which is fed into the machine from a roll



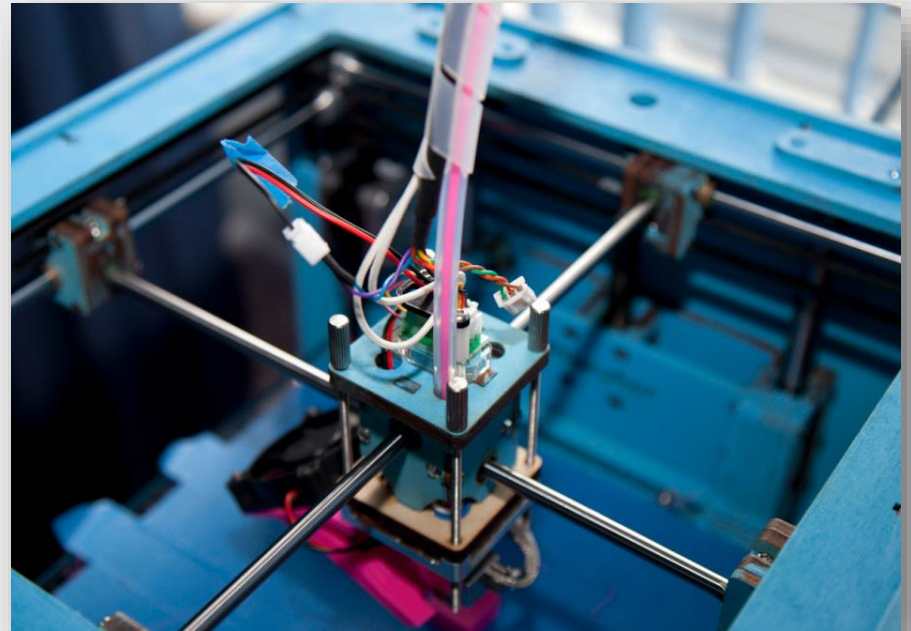
Feeding Plastic

- The drive motor pushes the plastic fibre into the clear tube towards the print head
 - This is called the “Bowden Tube”
- At this point the plastic is still solid
- Note that one of the gears is made of wood....



The Print Head

- The print head is driven left and right by stepper motors
- These allow very precise positioning
- The plastic fibre is fed through the “Bowden Tube” into the print head at the top



The Print Head

- The shiny metal block in the middle contains a heater that melts the plastic
- It then comes out of the print nozzle at the bottom and lands on the thing Una is building
- Una builds each layer in turn



Printing in action

- Here Una is building the side of a box
- The hot plastic is coming out of the brass nozzle
- The fan on the left is cooling it down so that it sticks to the previous layer



FDM Printing

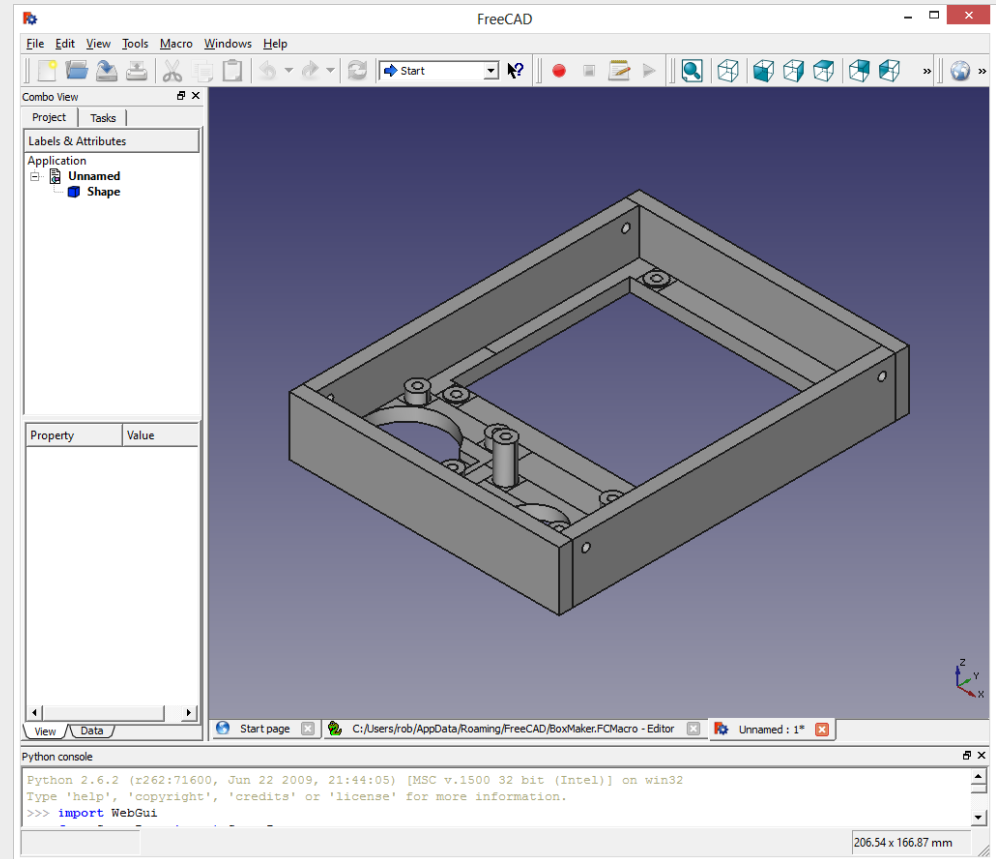
- The great thing about FDM printing is that it works
- There are a few less great things though
- Models are built up of layers, which means that things like overhangs are hard for printer to produce
 - You can print at an angle of up to around 45 degrees before things start to go badly
- The material itself is prone to shrink as it cools, leading to warping of flat surfaces
- You can only print in one colour at a time

3D Printing Workflow

- Create the design using a 3D package
 - FreeCad, Autodesk 123D, Sketchflow all work well
- Export to an STL file
 - This contains a mesh that describes the object to be printed
- Slice the mesh to produce a “GCode” file that describes the printer path
 - I use a program called Cura to do this
- Send the design to the printer

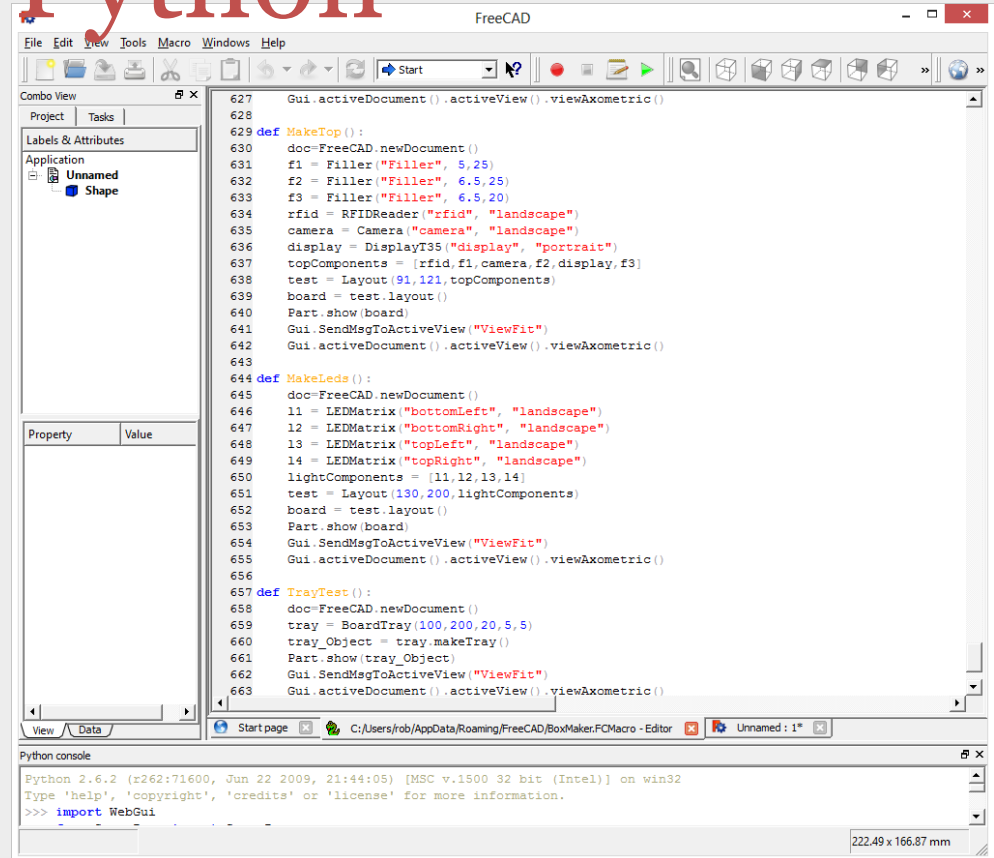
FreeCAD

- FreeCAD lets you design things in 3D
- This can be a bit painful
 - Visualising and manipulating things in 3D is hard



FreeCAD and Python

- One of the great things about FreeCAD is that it lets you generate objects using Python programs
- These run inside the tool and let you create objects programmatically

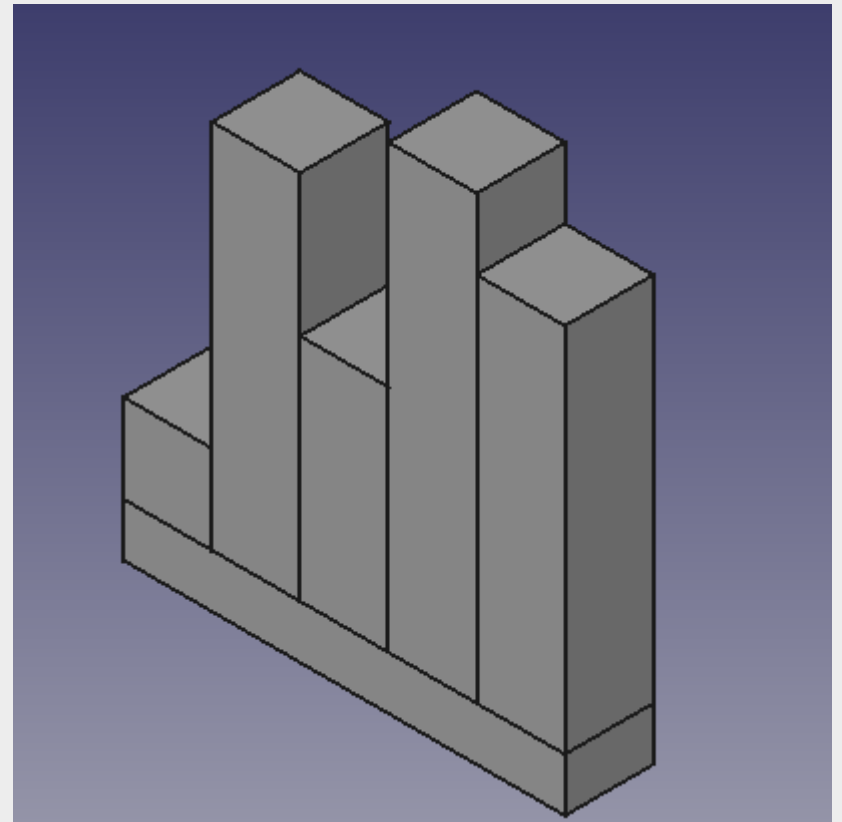


The screenshot shows the FreeCAD application window. The main area displays Python code for creating CAD objects. The code includes functions like `MakeTop()` and `MakeLeds()` which use FreeCAD's API to create fillers, cameras, displays, layouts, and LED matrices. A Python console at the bottom shows the execution of `import WebGui`.

```
FreeCAD
File Edit View Tools Macro Windows Help
Start
Combo View
Project Tasks
Labels & Attributes
Application
  Unnamed
    Shape
Property Value
627 Gui.activeDocument().activeView().viewAxometric()
628
629 def MakeTop():
630     doc=FreeCAD.newDocument()
631     f1 = Filler("Filler", 5.25)
632     f2 = Filler("Filler", 6.5 25)
633     f3 = Filler("Filler", 6.5 20)
634     rfid = RFIDReader("rfid", "landscape")
635     camera = Camera("camera", "landscape")
636     display = DisplayT35("display", "portrait")
637     topComponents = [rfid,f1,camera,f2,display,f3]
638     test = Layout(91,121,topComponents)
639     board = test.layout()
640     Part.show(board)
641     Gui.SendMsgToActiveView("ViewFit")
642     Gui.activeDocument().activeView().viewAxometric()
643
644 def MakeLeds():
645     doc=FreeCAD.newDocument()
646     l1 = LEDMatrix("bottomLeft", "landscape")
647     l2 = LEDMatrix("bottomRight", "landscape")
648     l3 = LEDMatrix("topLeft", "landscape")
649     l4 = LEDMatrix("topRight", "landscape")
650     lightComponents = [l1,l2,l3,l4]
651     test = Layout(130,200,lightComponents)
652     board = test.layout()
653     Part.show(board)
654     Gui.SendMsgToActiveView("ViewFit")
655     Gui.activeDocument().activeView().viewAxometric()
656
657 def TrayTest():
658     doc=FreeCAD.newDocument()
659     tray = BoardTray(100,200,20,5.5)
660     tray_Object = tray.makeTray()
661     Part.show(tray_Object)
662     Gui.SendMsgToActiveView("ViewFit")
663     Gui.activeDocument().activeView().viewAxometric()
View / Data
Start page C:/Users/rob/AppData/Roaming/FreeCAD/BoxMaker.FCMacro - Editor Unnamed: 1*
Python console
Python 2.6.2 (r262:71600, Jun 22 2009, 21:44:05) [MSC v.1500 32 bit (Intel)] on win32
Type 'help', 'copyright', 'credits' or 'license' for more information.
>>> import WebGui
222.49 x 166.87 mm
```


3D Weather Forecast

- I thought it might be fun to be able to print the weather forecast in 3D
- This is how we do it...

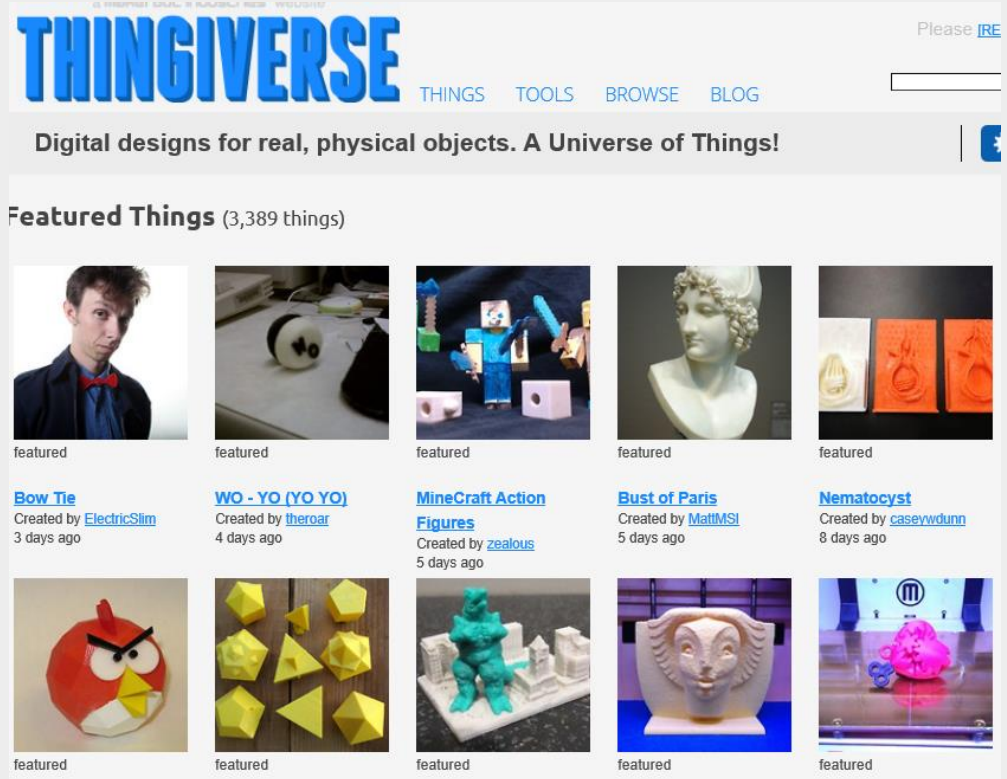


demo

“Printing the Weather
Forecast”

What can you print

- You can print anything
 - within reason..
- There is quite a community of people who make and share object designs
- I use thingiverse.com as a good starting point

A screenshot of the Thingiverse website homepage. The header features the "THINGIVERSE" logo in large blue letters, with navigation links for "THINGS", "TOOLS", "BROWSE", and "BLOG". Below the header is the tagline "Digital designs for real, physical objects. A Universe of Things!". The main content area is titled "Featured Things (3,389 things)" and displays a grid of ten featured items. Each item includes a thumbnail image, a "featured" label, a title, the creator's name, and the time since creation. The items shown are: "Bow Tie" by ElectricSlim (3 days ago), "WO - YO (YO YO)" by theoror (4 days ago), "MineCraft Action Figures" by zealous (5 days ago), "Bust of Paris" by MattMSJ (5 days ago), "Nematocyst" by caseyrdunn (8 days ago), and five other items including a red Angry Bird, yellow geometric shapes, a green Minecraft character, a white bust, and a pink object.

3D Scanning

- There is an iPhone app called 123D Catch from Autodesk which will take 40 pictures and make a 3D model from them
- You can use the new Microsoft Kinect SDK to scan in 3D

3D Printing and Fun

- You can generate the designs (and even the GCode files) programmatically
- The printer firmware can also be reprogrammed
- Many printer designs and control software are open source, so you can fiddle with them
- You can also use a 3D printer to print parts to make another 3D Printer
 - You can also print extra parts for your printer

3D Printing and the Future

- Selling 3D printing technology as something which is here now is being wildly optimistic
 - Although they are great fun to tinker with and for prototyping at a very low cost
- It is pretty much certain that our future will contain 3D printers of some kind
 - Although I'm not convinced that the current generation of technology will be how they end up working
 - They need to get a lot cheaper
 - They need to be able to print in colour
 - They raise a whole new set of copyright issues

Useful Stuff

- 3D Printers and Cura
 - <http://www.ultimaker.com/>
- Free 3D Design and Scanning Tools
 - <http://www.sketchup.com>
 - <http://sourceforge.net/projects/free-cad/>
 - <http://www.123dapp.com/>
- Things
 - <http://www.thingiverse.com/>
- My Blog
 - <http://www.robmiles.com>

The Imagine Cup

- The Imagine Cup is a student competition that has been running for 10 years
- It is open to students from anywhere in the world
- At Hull we have the best track record in the competition of any UK University

Some History...

- A team of Hull University First Year Students won the first ever UK Imagine Cup Finals and went on to come third in the World Finals in Barcelona
- I was the mentor for that team



Some More History...

- In 2006 teams from Hull came First, Second and Third in the UK finals
- No other university has ever managed this



Last Bit of History...



- Since 2007 I've been a judge on the Imagine Cup and since 2009 I've been Software Development Challenge Competition Captain

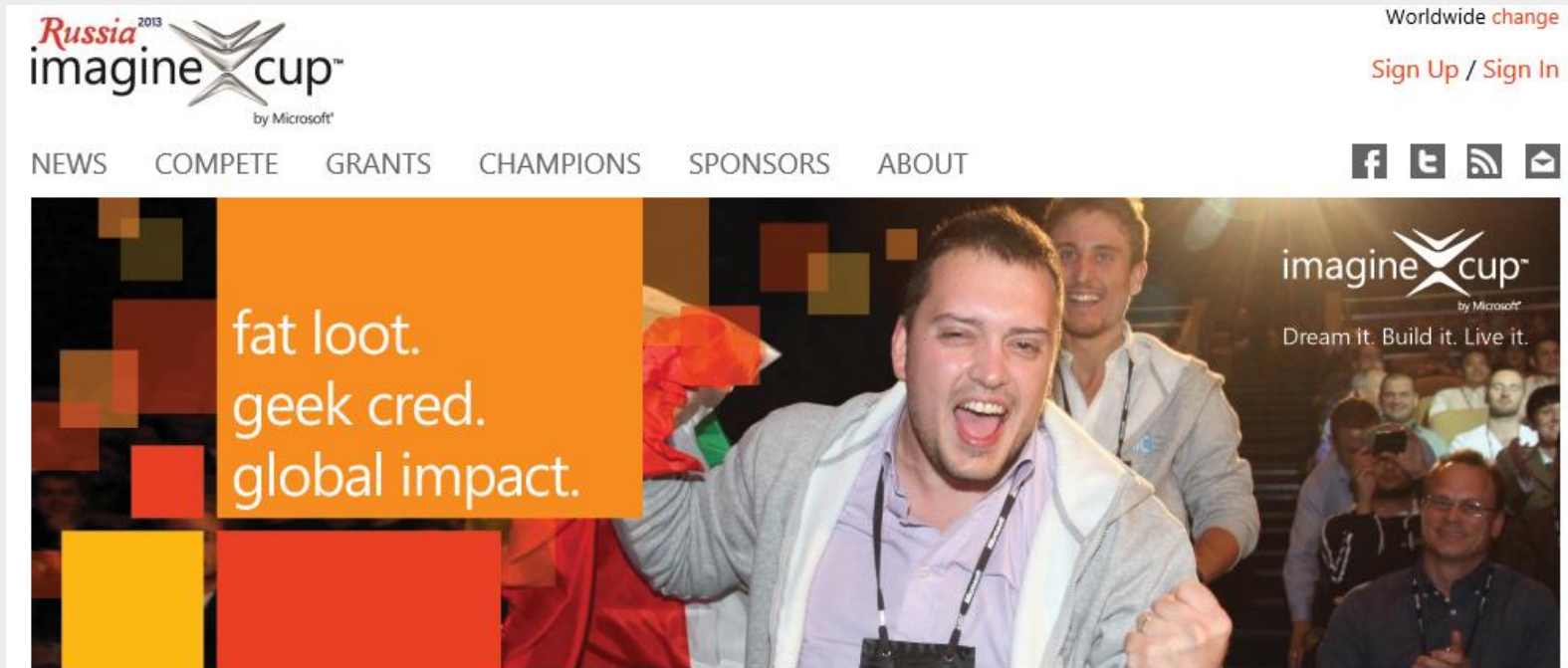
The Imagine Cup Competition

- There are a number of different competition categories
- You can enter as many (or as few) as you like
 - You need to enter a different project for each category though
- Many of the categories are team based

How the competition works

- Each strand has a slightly different way of working
- All of the categories have a number of different rounds
- Teams progress from one round to another

A Tour of the Imagine Cup Site



www.imaginecup.com

What do you need to win?

- An idea
 - Good ones are best
- A team
 - Mixed range of skills are best (either bring them in or acquire them)
- Persistence
 - It is hard work, but very rewarding

What do you win?

- There are some really nice cash prizes
 - \$50,000 first prize for each competition
- But you might get something even more valuable
 - Three of the first Imagine Cup team are now working at Redmond for Microsoft
 - All of the students that have taken part in the competition have gained from it

What to do next

- Register on the web site
- Take a look at the categories and start working on ideas
- See about building a team
- Keep in touch with me