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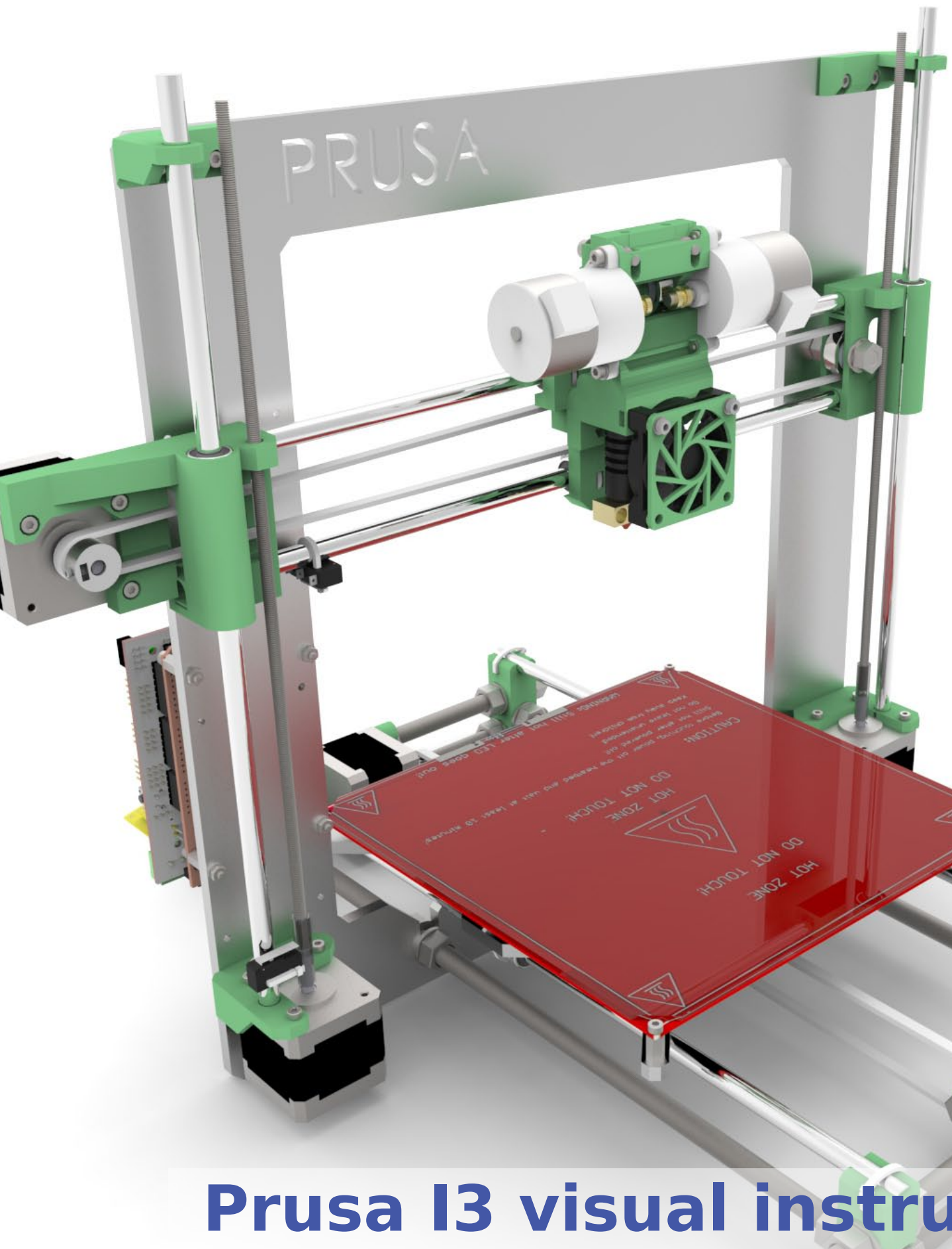
REPRAP MAGAZINE

Practical exploration of 3D printing



Print for life improvement design competition!

Prusa I3 visual instructions

Electronics board review - Interview with Nophead
Repetier 2: optimized workflow - Skeinforge tutorial
Laser introduction

June 2013

Interviews - Pro tips - Reviews

Issue 2

Diy projects - Tutorials - Galleries

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Practical exploration of 3D printing

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www.reprapmagazine.com

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RepRap Forums

Reprap Magazine

RepRap Magazine

Welcome back!

Let me just thank all who took the time to write to us just to say that you enjoyed our first issue. Now we are back with issue 2.

For the second issue our team has prepared a great mix of reviews and tutorials to help you upgrading your skills. We have an electronic boards review, Skeinforge tutorial, Prusa i3 (einstein version) assembly guide and some new sections.

Viktor has prepared a very good article in order to introduce everyone to the world of lasers.

A great event is being prepared in a new partnership with the TCT Show, and you can read all about it on page 10 of this issue.

And lastly, we are launching our first design and printing contest! The theme is “Print to improve life quality”, and we would like to thank the sponsors for the great prizes they are offering.

Paulo Gonçalves
Editor

Our mission

To the readers

We want to be have a close relationship with our readers. For that we encourage you to participate in this project. Send us photos of your best prints and your setup for possible publication to our dedicated email at general@reprapmagazine.com.

Also take part at the discussion at the http://forums.reprap.org/list.php?305.

To the contributors

This is an open magazine, and for that we encourage you to submit your articles for possible publications to our email at general@reprapmagazine.com. If you are also a developer of a tool that RepRap users use you can also send an email to be in our database for future contacts.

Independent

We are 100% independent. The manufacters of the products featured do not determine our content nor our opinions.

Contents

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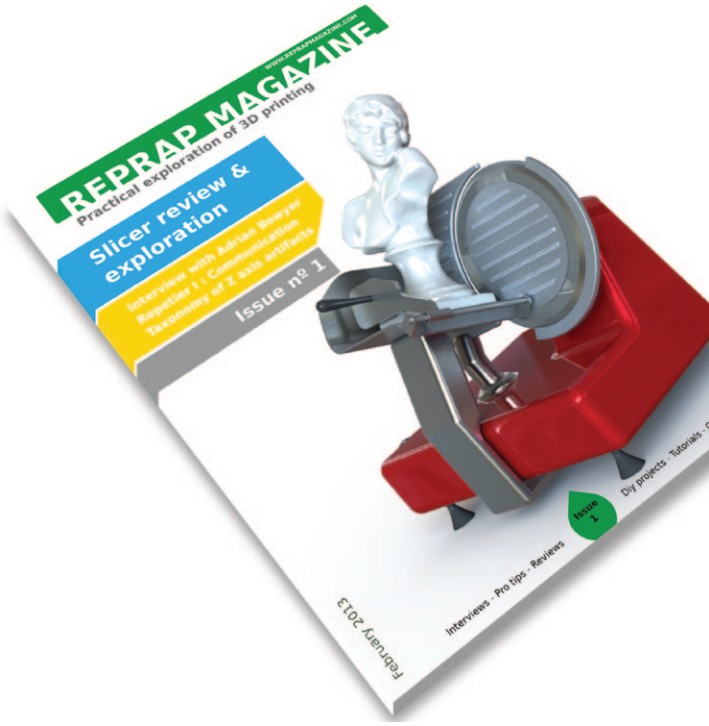

Previous issues available for download at www.reprapmagazine.com

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Kartik M. Gada Humanitarian Innovation Prize New Rules, New Deadline, and a New Name!

Readers who have been following RepRap for a few years may remember when the Kartik M. Gada Humanitarian Innovation Prize for Personal Manufacturing was announced in 2009. The prize was conceived by Kartik M. Gada to help develop a manufacturing technology that removes the fixed costs and volume necessities associated with heavy manufacturing, helping to reduce the barriers to entry for the manufacturing of many commodity goods. The RepRap project was a key inspiration for Kartik. On the prize's website he writes:

"A machine that could print just about any basic solid object of daily utility, and even print electrical circuits, is useful enough. If the same machine can also print 90% of the parts needed to build a copy of itself, then mass-distribution of this 'personal manufacturing' machine would be extremely easy."

"As an added bonus, the question of finding a suitable material for use in the personal manufacturing machine presents the opportunity to solve yet another pressing problem. Millions of tons of waste plastic currently reside in landfills, or are floating in the oceans.But remarkably, they can be recycled into a suitable material for 3-D printing, addressing a major ecological problem."

The prize got off to a great start in 2009, with an active subforum on *forums.reprap.org* and over thirty teams with registered entries on the RepRap wiki. A fully-funded $20,000 award was offered for the team that could meet the ambitious criteria for the Interim Personal Manufacturing Prize by December 2012. Unfortunately, the early teams dissipated, and no formal entries were received by the deadline. Kartik and the other organizers realized that the initial criteria may have been too restrictive given the changes that have happened in 3-D Printing between 2009 and the present. Despite this adjustment, the deadline has been extended and the prize is still alive and well.

The revised prize will be called the "Uplift Prize" when it is awarded. Here are the new guidelines:

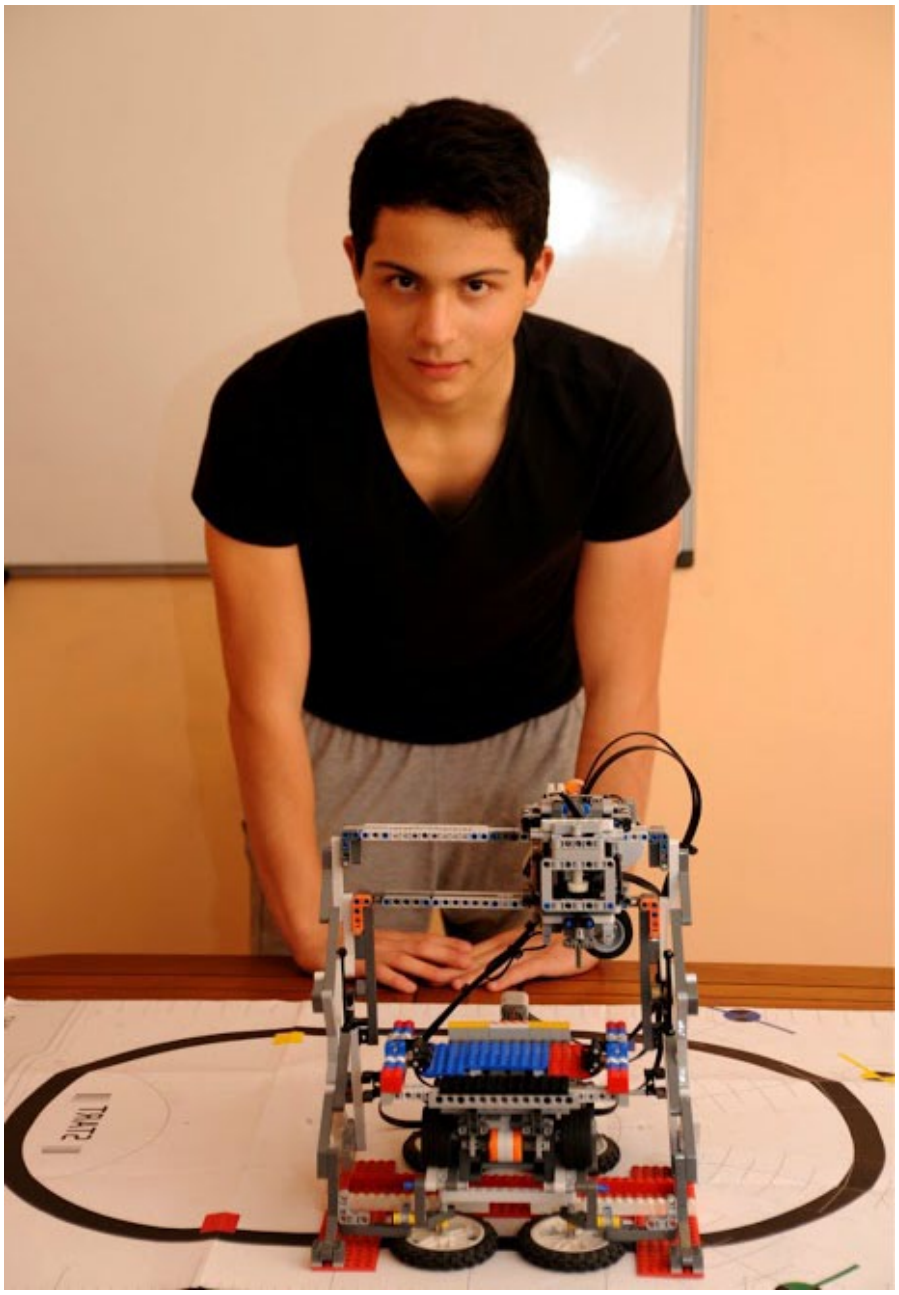
The $20,000 prize will be awarded to the inventor or team of inventors who create the 3D printer that can be assembled from its components to a fully working state most quickly by one person and that:

- Requires the least skill and experience from that assembly person,
- Has a low total one-off materials and parts cost,
- Has a high proportion of its own parts that it can print for itself,
- Requires a minimum of specialist parts that it doesn't make for itself,
- Has a low power requirement when running.
- Is completely open-source.

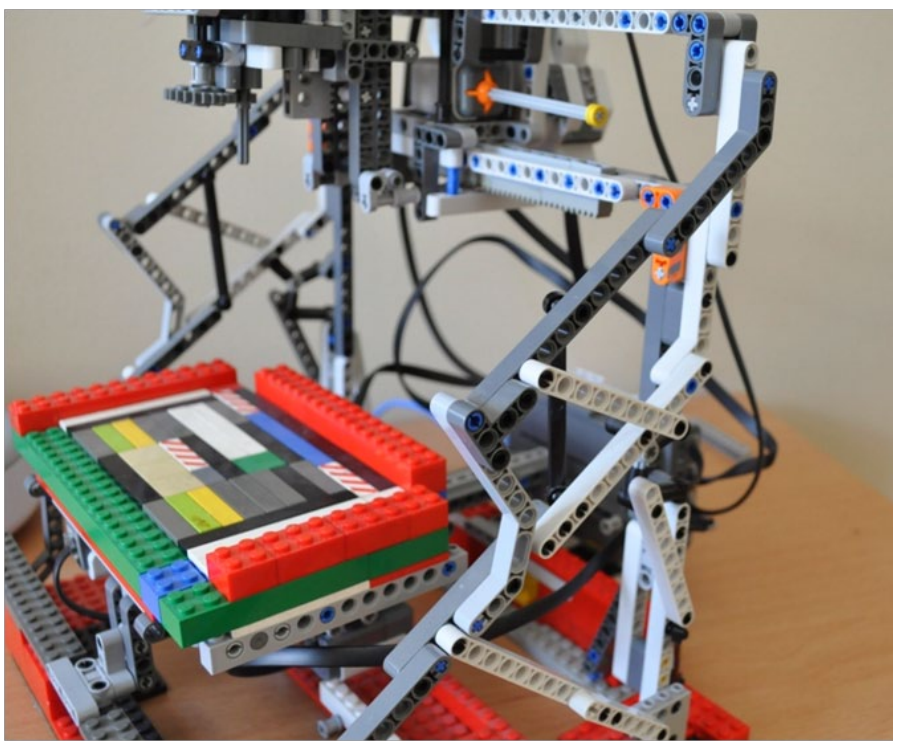
The *estimated* deadline for prize submission is May 31 2013, with a winner to be selected and announced on June 30, 2013.

Uplift Prize Announcement: http://kprize.wordpress.com/
Prize Criteria: http://humanityplus.org/projects/gadaprize/
Prize FAQ: http://kprize.wordpress.com/faqs/
Philosophical basis of the prize: http://kprize.wordpress.com/what-is-the-k-prize/
Official List of Entries on reprap.org: http://reprap.org/wiki/Gada_Prize
Forum dedicated to the Prize on reprap.org: http://forums.reprap.org/list.php?171

Lego milling machine by Marios Papachristou



Marios and his LEGO 3D Printing-Milling Machine



LEGO 3D Printing-Milling Machine

"The whole idea began a year before when I discovered the RepRap project, as well as a milling machine made out of LEGOs. I was amazed with the idea of desktop manufacturing, so I started building a 3D Printing-Milling Machine using LEGOs and inheriting RepRap open design and knowledge. The machine is (or will be) able to drill on floral foam and make three-dimensional sculptures, boosting, in its way, means of peer production. It consists of approximately 300 pieces of LEGO elements; like joints, beams, axes and so on.

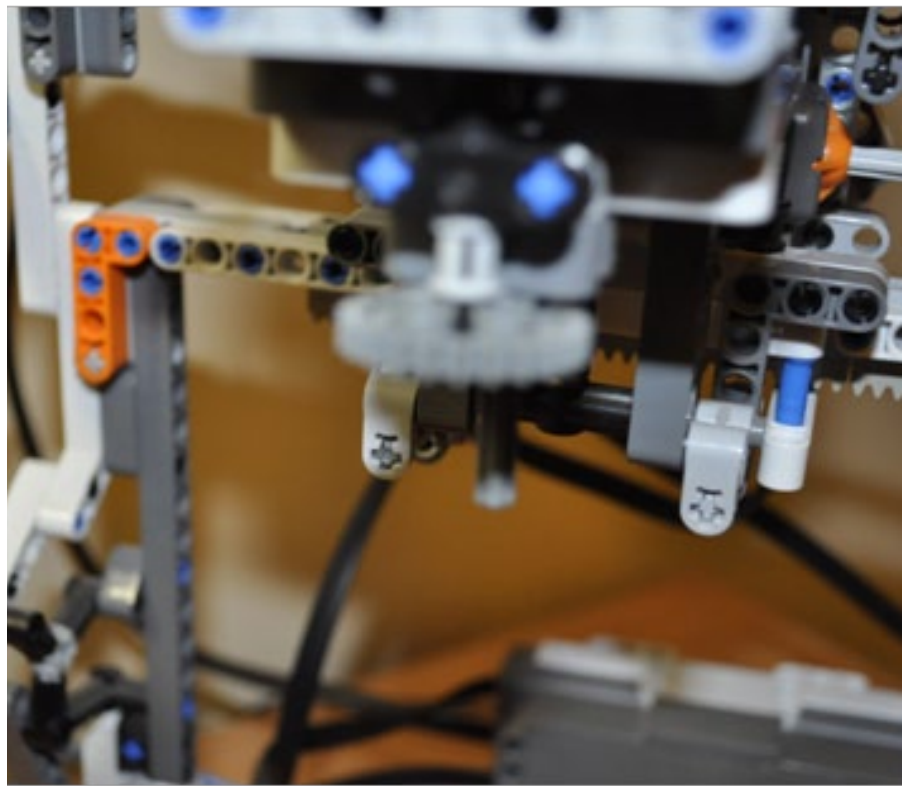
Besides this, I am an ardent open-source fan! So I decided to make my project open-source and distribute code and building instructions. The project is being developed using the LeJOS NXJ Java API (which is as well open-source based) . The machine itself manipulates G Code files in order to produce the desired results. During the (continuous) construction, many problems have arisen.

There were many stability issues in the beginning, which have, at the moment, been solved. For example, the top part of the machine oscillated due to inertia, viz the bulk mass of YZ Plane was moving back and forth on its driver (rack-and-pinion system), located at the top of the structure. This issued was manipulated by placing, at the bottom of the main frame, two "tendons" and two diagonal beams, one on each (rear) side.

Besides this, another arisen problem was NXT's power supply. Standard NXT Intelligent Bricks (which is also used so that the plenary of NXT's components are powered) are supplied via 6AA (1.5V) alkaline batteries which do provide scarce power as the time passes and, also, do damage the environment after their usage, which is, furthermore, non-productive and would make such

activities not plausible. In order to “dodge” this obstacle, NXT’s internal shell was modified so that it’s capable of having an AC/DC power transformer attached on it (by soldering each one of the dipole NXT’s poles with the poles of the transformer), making it competent to operate at a voltage of 9V and intensity of 0.8mA.

Moreover, this machine can be classified as a “subtractive desktop manufacturing machine”. Yet, the concept behind is absolutely the same, although the Z axis is moving downwards. My main aim is to have a machine with the fewest possible non-LEGO elements and that’s why I didn’t attach an extruder in order to make it an additive manufacturing machine



The YZ Plane (without the drill attached)

Finally, I want to thank you all for devoting your time to read this short article and I wish you happy reprapping!

Perspective view of the structure

ICTP SCIENTISTS PUBLISH FREE DOWNLOADABLE BOOK ON LOW-COST 3D PRINTING

The book, titled “Low-cost 3D Printing for Science, Education and Sustainable Development”, offers a practical guide to this rapidly evolving technology, giving an overview of current research on the topic and its uses in science education. It was compiled and edited by ICTP’s Science Dissemination Unit (SDU) and can be downloaded free of cost from the website *http://sdu.ictp.it/3D/book.html*

The affordable and easy-to-use technology is good news for developing countries, where 3D printing could open up exciting opportunities for research, education and humanitarian projects. As an institute dedicated to promoting sustainable science in the developing world, ICTP is prepared to advance the adoption of this technology in these regions. The book’s editors -Enrique Canessa, Carlo Fonda and Marco Zennaro- want readers to understand and explore the huge potential that 3D technology provides.

The book is divided into four main sections:

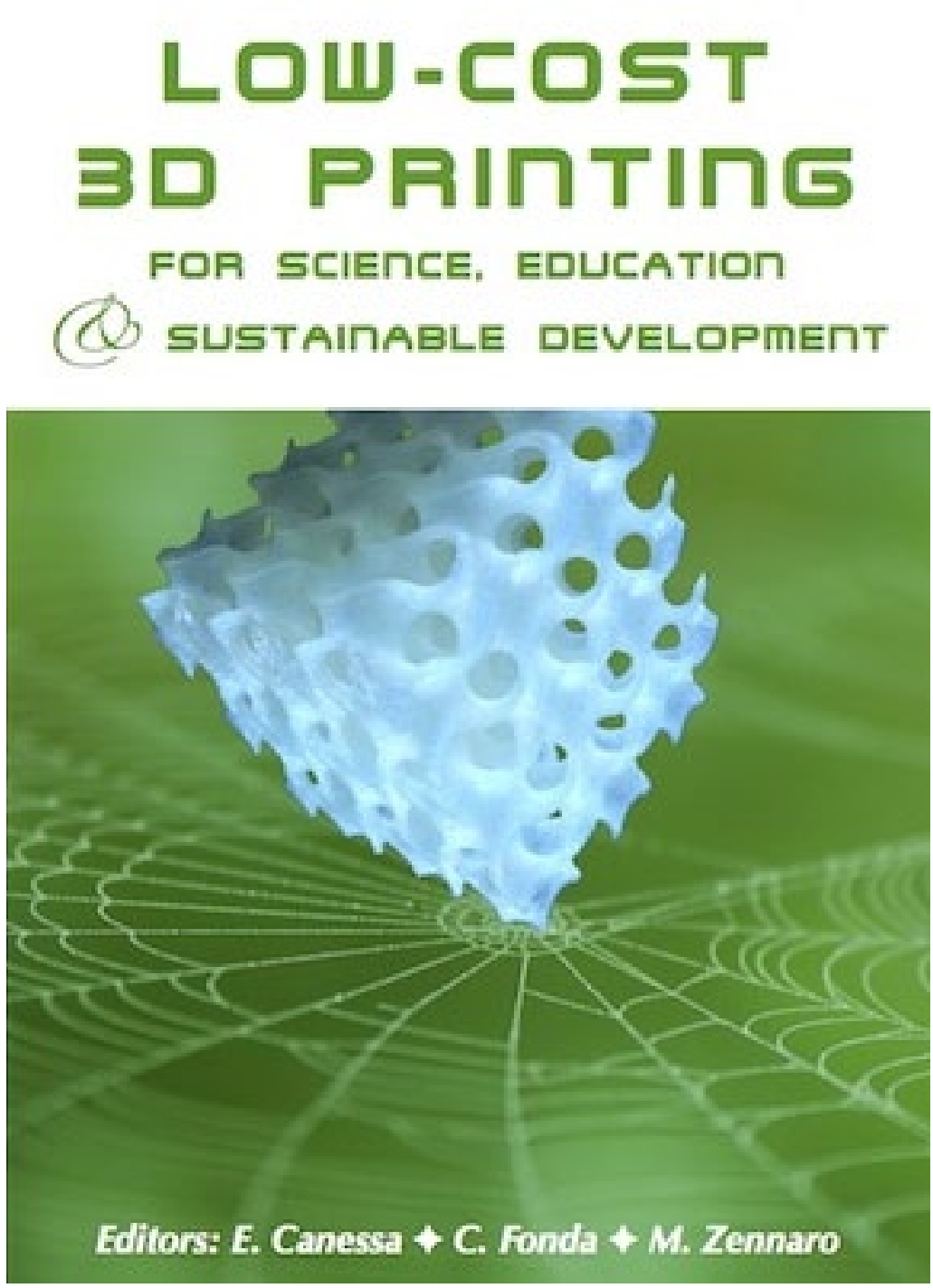
-A detailed view on the technology with information on how to create a 3D printed object, the related open source hardware and software, the kits available in the market today, and a glimpse at future projects.

-Applications of 3D printing in scientific fields ranging from mathematics, physics to archaeology, space science, and medicine.

-Innovative ways for the technology to be used in education.

-A glimpse of the immense potential the low-cost 3D technology can have on sustainable development including plastic recycling.

ICTP opened its own 3D printing facility on 27 February 2013, when it inaugurated its 3D Printing Lab. The Lab will take center stage at an international workshop organized by the book’s editors -with the participation of book’s authors and attendees from developing countries, to take place in Trieste from 6 to 8 May 2013 and aimed to create awareness about 3D printing and its applications to science, education and development.



Low-Cost 3D printing book front cover.

Michigan Tech: Win a Free 3-D Printer in 3-D Printers for Peace Contest! (US only)

3D printing is being condemned in the media because of the potential for printing guns. Engineers at Michigan Tech believe there is far more potential for 3D printers to make our lives better rather than killing one another.

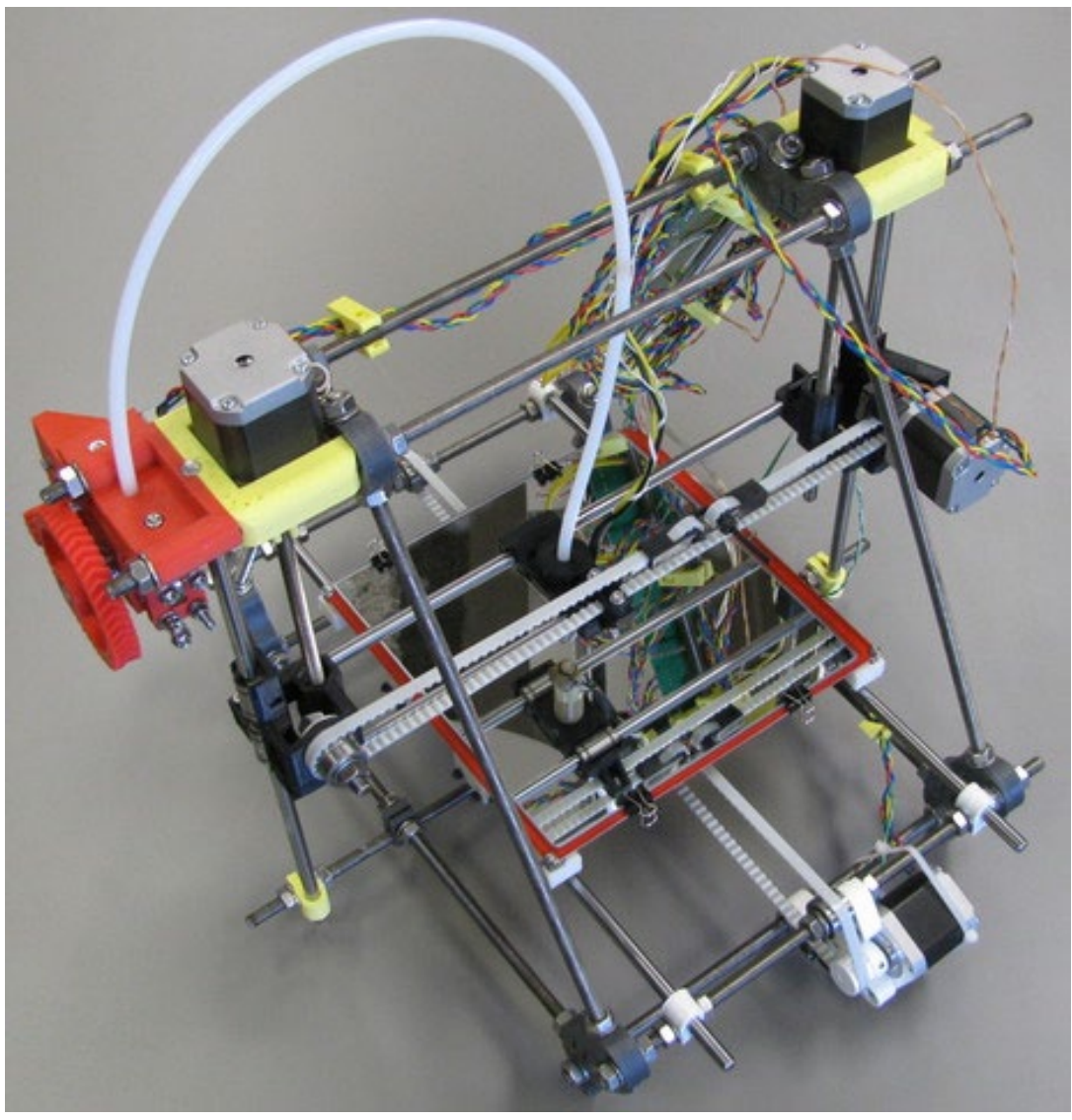
To encourage thinking about constructive uses of 3D printing technology Michigan Tech Open Sustainability Technology (MOST) Lab and Type A Machines is proud to sponsor the first 3-D Printers for Peace Contest.

A fully assembled Type A Machines Series 1 3D Printer goes to first place and a MOST RepRap 3D printer kit will go to the second prize winner who create designs that enable 3D printers to encourage peace. Winning open-source designs will discourage conflict (e.g. designs for appropriate technology in the developing world to reduce scarcity or designs that improve economic development).

Designers are encouraged to consider: If Mother Theresa of Ghandi had access to 3D printing what would they print? What kind of designs could help reduce military spending and conflict while making us all safer and more secure?

Michigan Tech has already saved tens of thousands of dollars using 3D printable scientific and engineering equipment and our labs have developed 3D printable tools to test water quality, recycle waste plastic and found that 3D printing consumer goods is better for the environment than shipping conventional goods from China. Joshua Pearce, a professor in the departments of materials science and engineering and electrical and computing engineering, points out that “The technological evolution of 3D printers, widespread Internet access, and inexpensive computing offer new opportunities for open design to enable peaceful and accelerate wealth creation for everyone.

We hope the contest facilitates an open exchange of 3D designs of technologies that benefit humanity.”



One MOST RepRap is the second prize.

Anyone in the United States may enter and there is no cost to enter. Entry Guidelines can be found at: *http://www.mtu.edu/materials/printersforpeace/*

Deadline for submitting entries: September 1, 2013

Under the product name X400 CE, the Jumbo 3D printer X400 is now available as an assembled device with CE certification according to DIN ISO 9001.

With 56 liters of printing volume, it meets the requirements of professional users. Especially medium-sized and large enterprises often stick to buying DIN ISO 9001 verified devices due to operational safety reasons. In this scale, the X400 CE is the first, readily assembled RepRap 3D printer with this test seal.

The CE verification of the assembled device certifies that the X400 CE 3D printer was manufactured, adjusted and tested in compliance with the DIN-ISO 9001 guidelines for quality management systems. The examination according to the relevant DIN guideline 10218-2 (robotic systems and integration) conduces to the operational safety. In many cases, the CE approval is required for the operational use.

With a layer thickness as little as 0.1mm and a printing space of about 400 x 400 x 350 mm, precise models with a volume up to 56 l may be printed. This may be product mock-ups, PCB drafts, design and architectural models, art objects or other items. It is also possible to print shapes, with polystyrene, for instance. Printed objects may be ground, painted or reworked in other ways.

The outer dimensions of the X400 CE are 66 x 66 x 77 cm (D/W/H) with a weight of about 40 kg and it is mounted on a stable aluminum frame. The whole printing space is protected by a case. A base with lots of storage space is available as an option. Moreover, if desired, the printer may be equipped with a deformation free ceramics heated bed.

German RepRap GmbH

The readily assembled Jumbo 3D printer X400 CE is available at the price of 3.499 EUR (excl. VAT) or 4.164.99 EUR incl. VAT.

X400 CE: Jumbo 3D printer X400 now available as CE certified assembled device.

Breaking NEWS!

RepRap news – RepRap Community Hub at the TCT show Birmingham, UK (NEC) September 25th – 26th 2013

The RepRap Magazine is very pleased to announce that in partnership with the TCT Magazine and Personalize we have organised a very exciting opportunity for the whole RepRap community.

In September this year the TCT magazine has its annual Additive manufacturing and 3D printing show at the NEC in Birmingham (UK). The TCTShow is in its 18th year and attracts big names from the industry, businesses and individual makers from all over the world.

The Show has an exciting exhibitor list and in recent years has embraced the Maker and RepRap communities with the Personalize sections of the show and the fantastic bright minds initiative. This attracted many maker based companies including Ultimaker, Makerbot, Leapfrog, Electrobloom and Mii-Craft along with many other open source and proprietary developers to last year's event.

Giving the maker community greater focus at TCT will also complement the TCT Bright Minds UK programme, which will be given a platform at the Show. In partnership with 3D Systems and Black Country Atelier, the scheme aims to introduce 3D printing to 300 school students over the two days.

TCT Show

3D printed mug

This year the TCT Show and Personalize have further collaborated with the RepRap and maker community, providing a significant and dedicated space for the two days of the exhibition.

This space will be a dedicated RepRap community hub, where makers, designers and developers from all over the world can come and talk about RepRap and all the many aspects of 3D Printing. We can share our passions and developments, 3D printing experiences and ideas with each other and visitors to the show.

The RepRap community hub will also be home to Faberdashery for the event - another favourite among the maker community around the world. UK-based Faberdashery provides the 3D printing community with material for 3D printing and will be on hand to offer expert advice.

We are also thrilled to announce that the father of RepRap, Dr Adrian Bowyer will be joining us for the show along with the amazing team from RepRapPro Ltd. It's going to be a real delight to have such accomplished RepRap developers at this event who will be able to answer questions and discuss the future of Home 3D printing and how this personal manufacturing revolution may evolve in years to come.

This is a globally recognised event and a great opportunity to get involved and spread the RepRap mission. And on that note here is where we need your help!

Richard Horne (RichRap) is helping coordinate efforts in the UK and needs to hear from anyone that wishes to contribute in making this a really fantastic hub for the RepRap community.

We will be releasing further information about what you can expect for the two day show on the RepRap Forum here - http://forums.reprap.org

3D scanning

Mcor parts

We have a lot to do and are looking for, individuals and companies who want to help make this a great resource for the RepRap community.

And if you can operate a 3D printer, or would like to print some awesome things for the event, please get in contact at the e-mail address below.

This will be what you help make it, so please do get in contact for more information and if you can assist or even just to let us know you are going to visit the show, we want to hear from you – let's make this a RepRap event to remember.

If you would like to help out in any way with the event or just want to show support, please e-mail us :

tctshow@reprapmagazine.com

For further information about the show and to register FREE which must be done in advance please go to - *http://www.tctshow.com*

Also on the show:

www.prsnlz.me
personalize.
the hub for the 3D printing and personal manufacturing community

Personalize - *http://www.prsnlz.me*

bright minds uk programme

Bright minds - *http://www.tctshow.com/bright-minds-uk.html*

Low cost 3D printers for the Dominican Republic.

Luis is a man on a RepRap mission, he is attempting to establish lower cost technology for 3D printing into the Caribbean. With his Blog 3DDominican and current indiegogo campaign Luis is attempting to raise funds to start-up 3D printing in Santo Domingo, at this point Luis has a long way to go. Please read below what Luis has to say about 3D Printed Equality, and if you wish to show some support or donate to his campaign you will be in good company.

Adrian Bowyer has already contributed and commented “Your campaign is one of the reasons I founded RepRap. Good luck!”

3D Printed Equality

All enthusiasts of 3D printing and RepRaps knows the countless applications that 3D printing have and the development that represents to be part of the Maker Culture as an individual. This technology and culture is widely spread worldwide thanks to the internet but mainly to the accessible materials needed to carry out its development, however this applies more to developed countries of the first world.

The Dominican Republic is a nation on the island of Hispaniola, part of the Greater Antilles archipelago in the Caribbean region, is the second largest Caribbean nation (after Cuba), With 48,445 square kilometers (18,705 sq mi) and an Estimated 10 million people, one million of which in the capital city, Santo Domingo. It is rich in resources but is poorly utilized mainly by the lack of education of the people and by the export of raw resources.

As a young student of Chemical Engineering and Business Administration I have tried to dabble in 3D printing as a way out of poverty, in the process which took more than two years i could not complete the project due to lack of resources both financial and materials, needed to assemble my first printer. Many over time have suggested me to make a RepStrap but even for that in my country it is difficult to impossible without the money to get the motors and other electronic parts.

With all the knowledge acquired as enthusiastic and being a Maker since birth. I proposed the idea to not only get 3D printing for me, but bring it to others that like me lack the resources to develop and give them the possibility of a change in their life, because that is all that is needed, at least one possibility.

My project is to bring this possibility, The first thing is to motivate and report on this technology in the country, which I have started with my blog *3ddominicana.org* I have reach lots of views and reactions, then assemble the first printer to make it known in a better way and show how it works and that you can profit with it, then bring in quantities of parts that are not available locally so they can be distributed at very low costs, in addition to offering 3D printing services and with the profits subsidize the parts and have lower costs.

Because the lack of resources, both personal and the lack of local support I have seen the need to appeal to the international community which has given me great support, as is the case of Richard Horne and Adrian Bowyer. I've done the feasibility study and everything necessary to see if the project is possible.

After an initial boost it will work without any additional resources. If I can get the necessary financing to bring this technology to my country, my greatest wish is to continue this work in other countries like mine that have the human resources but not the opportunities to develop them.

If you are interested in this project and wish that this technology that you will most likely already be using, I invite you to donate either financially or with parts.

To contact me you can email me:

luis.r.liriano@gmail.com

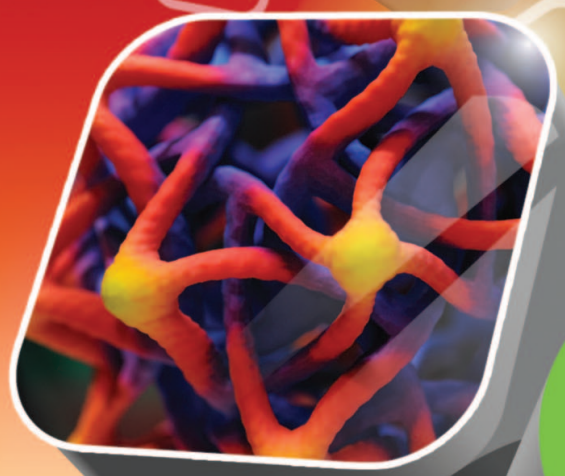
Donations directly on our website:

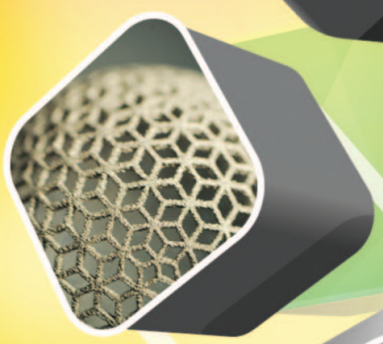
http://3ddominicana.org/

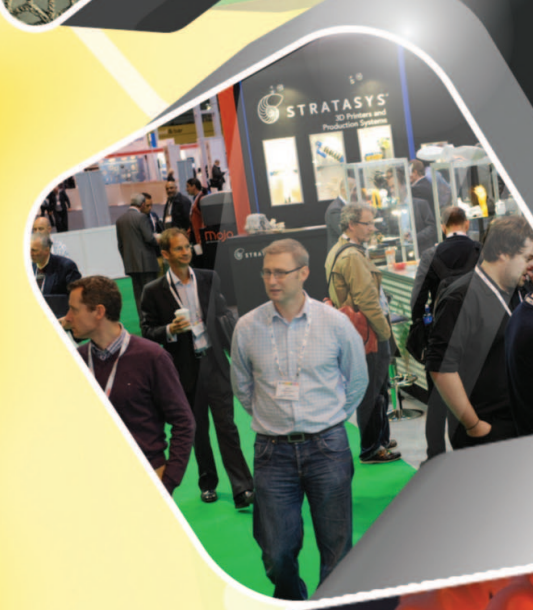
or at

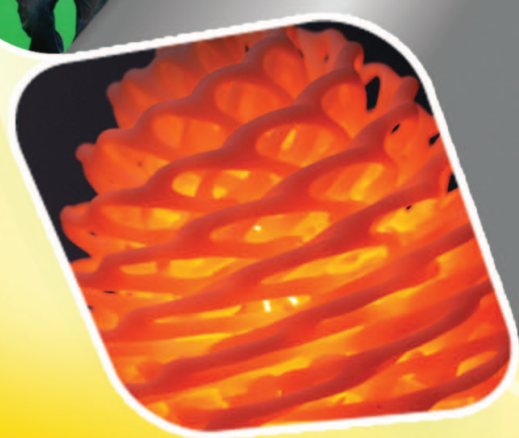
http://igg.me/at/3dprinting

Additive Manufacturing
3D Printing
Prototyping
Product Development
Software
Scanning
Digitising









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www.tctshow.com

In the works

Many in the Maker community are always looking for new and interesting projects to follow and perhaps take part in, and so this section gives a brief look at up-and-coming projects from in and around the RepRap community.

It should be noted that unless otherwise stated these projects are most definitely works in progress and not ready for general consumption.

If you like to live on the cutting edge then these projects might be for you.

by Gary Hodgson

Image: Morgan 1

OOML

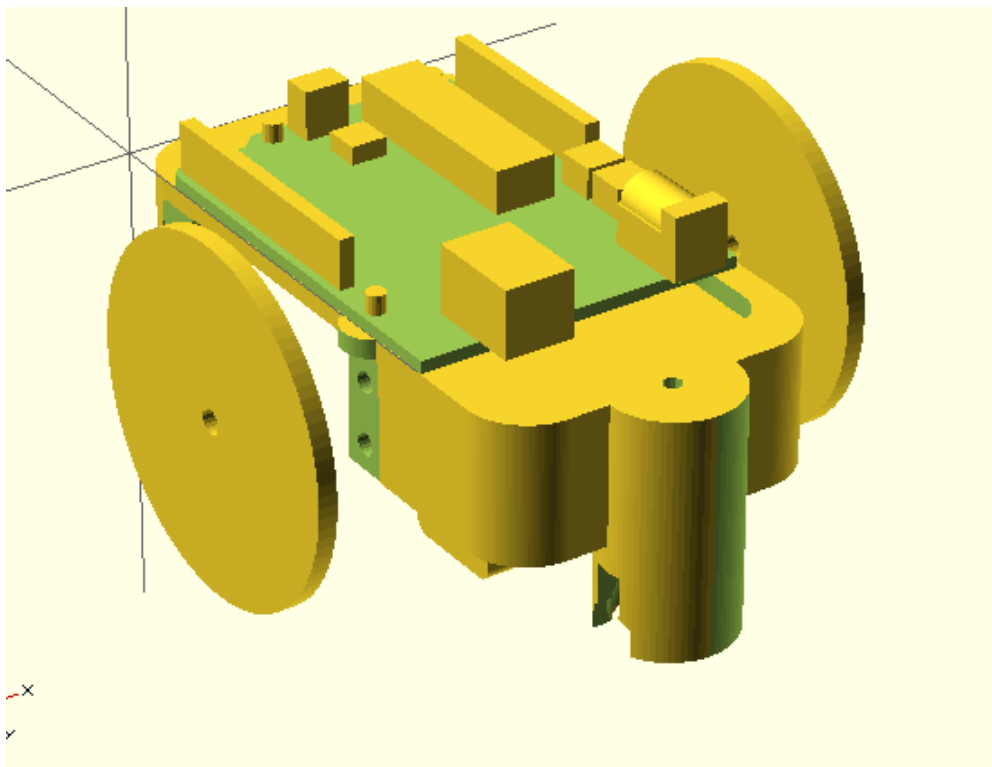
Alberto Valero Gomez et al.

http://iearobotics.com/oomlwiki

The Object Oriented Mechanics Library (OOML) is a set of tools for the C++ language which generates OpenSCAD code. It provides a set of reusable components for mechanical engineering, and effectively extends OpenSCAD by introducing the benefits of the C++ language, namely: programming constructs and object orientation.

The project originates from the University Carlos III of Madrid, where a group of students, together with two professors (Juan González Gomez [0] and Alberto Valero Gomez [1]), combined to form a students interest group on robotics and 3D printing. This group would go on to develop the “Clone Wars Project” [2], a well-known effort in the RepRap community which to-date has produced over 150 RepRaps, plus many tutorials, videos and workshops - all aimed at spreading the RepRap message. OpenSCAD was the modelling tool of choice, but after several seminars the group began to desire a tool with the benefits of OpenSCAD but also the power of an object-oriented programming language, bringing with it a better IDE, improved code reuse, and the benefits of the object-oriented paradigm. C++ was chosen as this language was already widely use in the group, with both professors teaching it along with the courses on robotics.

Building a set of tools which outputs to OpenSCAD may appear slightly strange at first, considering the wealth of libraries available in C and C++, (OpenSCAD itself is written in C++). However this approach means that many tasks, such as rendering and STL generation, are already taken care of, and the focus can lie in creating the mechanical library itself. (It is worth remembering that the goal of the group is to develop robots, and not just create another piece of software). This means that the OOML project could produce useful results faster, and allow features which decouple the library from OpenSCAD to be planned in the future.



Render of the Masterbot

The library itself is divided into two categories: Components, which are basic geometric entities; and Parts, which have a mechanical aspect. The component library mirrors the primitives available in OpenSCAD (such as sphere, cylinder and cube), but has also been extended with additional forms, such as rounded cubes

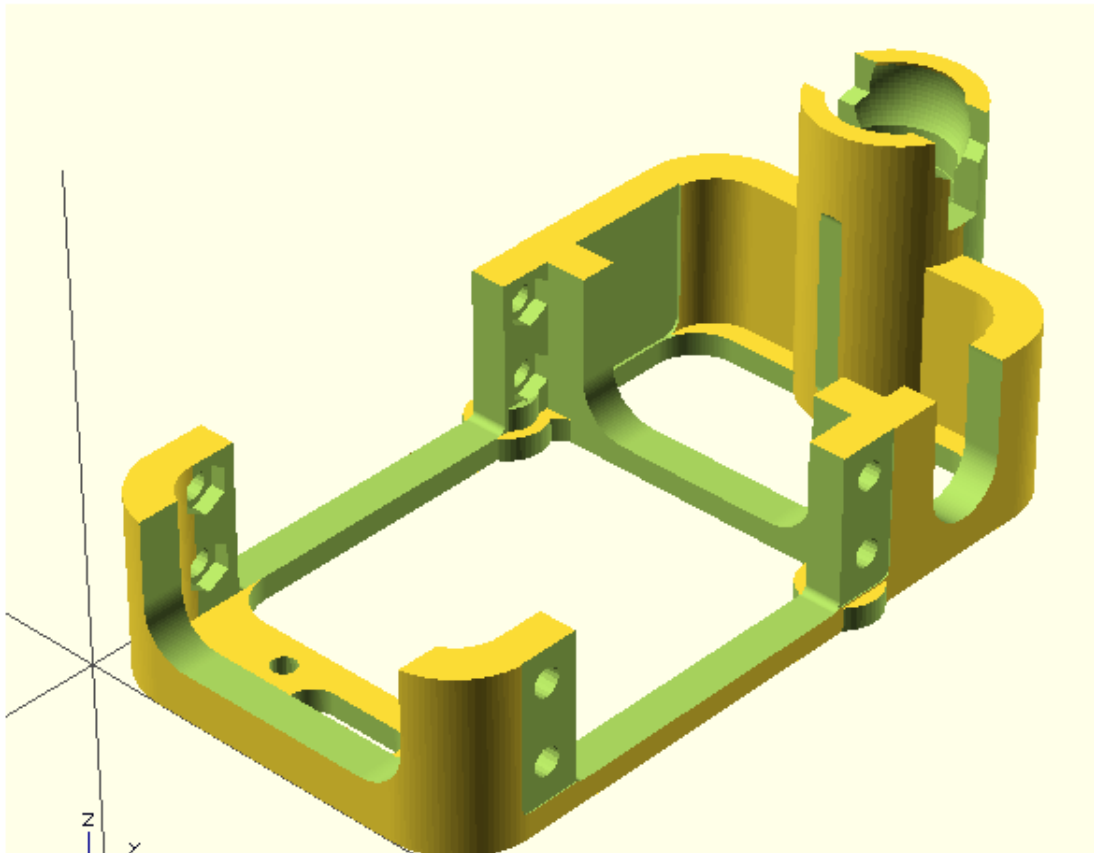
and toruses. This then provides the basis for the mechanical parts, which includes wheels, links and more complex models. Alongside the component and part models, the geometric operations found in OpenSCAD (translate, rotate, union, etc.) are available, and these too have been extended with other useful operations, such as Euler rotations and relative translations. The library also introduces new concepts such as the ability to define links and attachments, and use these as references in operations, such as the “moveToLink” and “attach” methods.

The project is ongoing and has many plans for the future. High on the list is to decouple from the OpenSCAD roots by developing an OpenGL viewer and an STL generator. Alternative output formats are also on the list, such as Collada [3] or CoffeeSCAD [4] (featured in the previous issue of RepRap Magazine), and possibly G-Code directly. Much of the future direction of the project will depend on the community, as current maintainer Alberto says: “... if community shows interest it will naturally grow, in an unexpected way. The project is hosted in gitHub and we will allow every developer to contribute. In the meantime we will continue developing and documenting as much as we can”. [5]

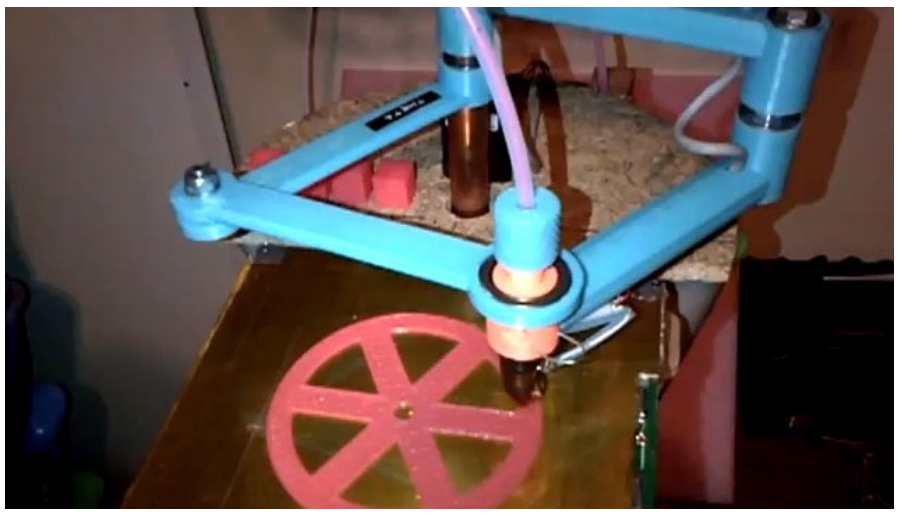
The main project website has all the details on how to install the library, many tutorials, and links to the complete API. The project is looking for feedback from the community, and contributors, should any programmers wish to get involved.

[0] http://iearobotics.com/juan
[1] http://iearobotics.com/alberto
[2] http://www.reprap.org/wiki/Proyecto_Clone_Wars
[3] https://collada.org
[4] http://coffeescad.net
[5] https://github.com/avalero/OOML

```
#include <components/Cube.h>
#include <components/Cylinder.h>
#include <core/IndentWriter.h>
#include <core/Difference.h>
#include <core/Union.h>
#include <core/Intersection.h>
#include <components/RoundedTablet.h>
#include <parts/FutabaS3003.h>
#include <parts/ArduinoUNO.h>
#include <parts/NineVoltBattery.h>
#include <parts/ServoWheel.h>
#include <parts/BallWheelHolder.h>

#include <parts/BatteryHolder.h>

#include <iostream>
#include <fstream>

using namespace std;

int main(int argc, char **argv)
{
        IndentWriter writer;

        //Output file which contains the OpenSCAD code.
        ofstream os("masterbot.scad");

//ARDUINO UNO

        // Use ArduinoUNO part.
        Component arduino = ArduinoUNO(true,10);
        arduino.rotate(0,180,90).translate(53.5,77,0);

//MAIN BODY

        os << writer;
        os.close();
}
```



OOML website_code screenshot



RepRap Morgan

Quentin Harley

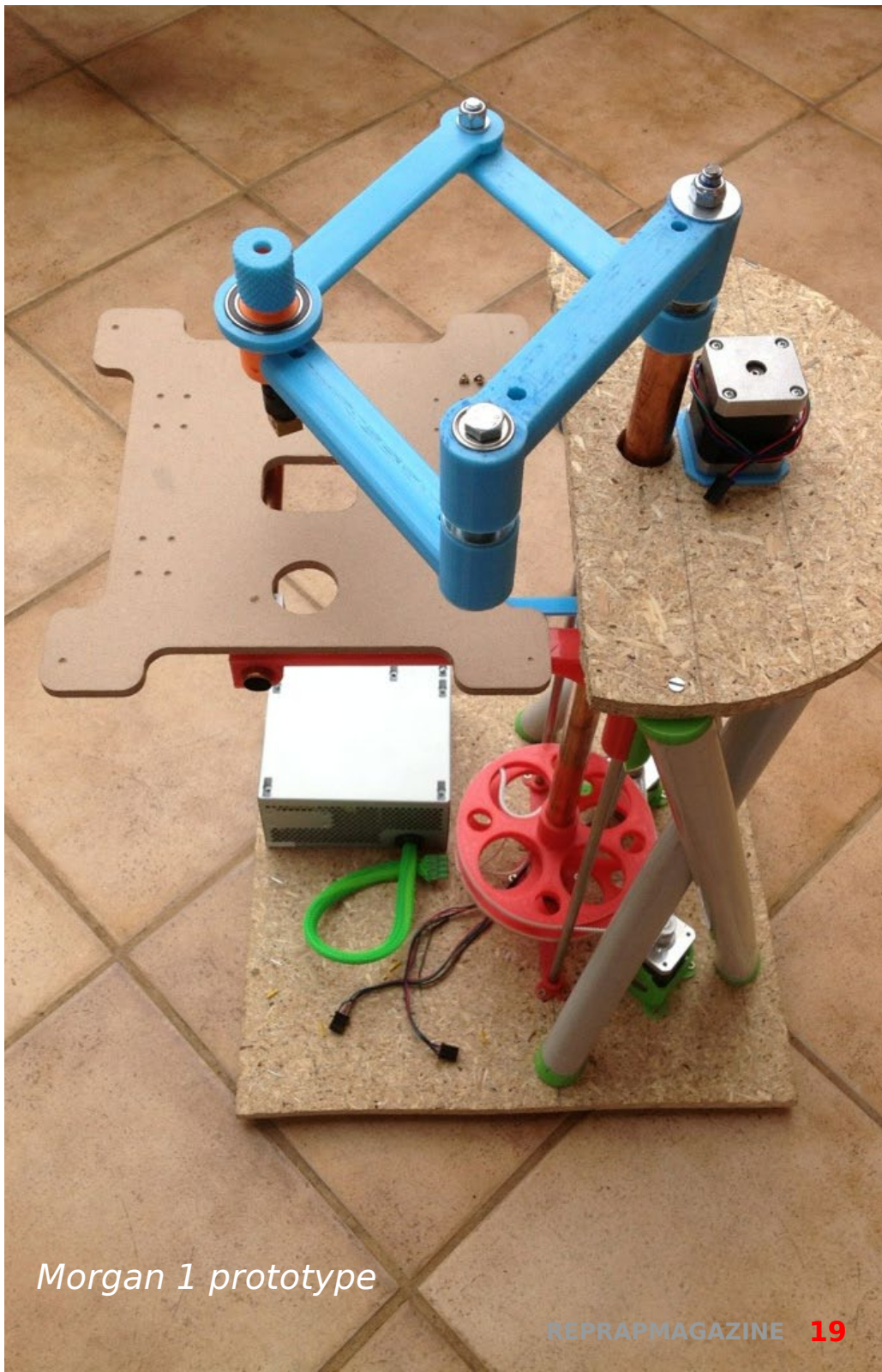
http://reprap.harleystudio.co.za/

Morgan printing

Since the inception of RepRap and the initial Darwin design there has always been a desire to try and develop a new way of printing things in three dimensions. Many different styles of printer have emerged, as can be witnessed in the RepRap family tree [0]. One of the more recent additions to the tree is the RepRap Morgan, designed and built by Quentin Harley who is based in South Africa.

The name stems from Thomas Hunt Morgan [1], an American geneticist who won the Nobel Prize for his discoveries in heredity, and follows the RepRap tradition of naming machines after famous deceased biologists. Quentin started the journey in 2011 when some on-line audio recording friends forwarded an April fools joke about reprapping vinyl records to the forums. His immediate thought: “I can do that!”. He then set about to build a repstrap, noting that, whilst South Africa is up-to-date with mainstream consumer electronic trends, it is a little behind when it comes to cutting-edge technology. This was to become one of the core goals of the project: making the printer easy to source parts for.

The first part built was a wooden “Greg’s extruder” which, although a lot of effort to produce, came together so nicely it was honoured by being used on the first Morgan prototype, until it was used to print it’s replacement upgrade. Choosing to build a repstrap, as opposed to building an established design, was a conscious decision and not only due to the difficulty of finding printed parts. Cobbling together a machine to bootstrap the first RepRap is a tried and tested rite of passage, and this proved to be the case for the Morgan. “This was both the biggest mistake, and the greatest fortune, since I managed to waste most part of a year hacking around different concepts,



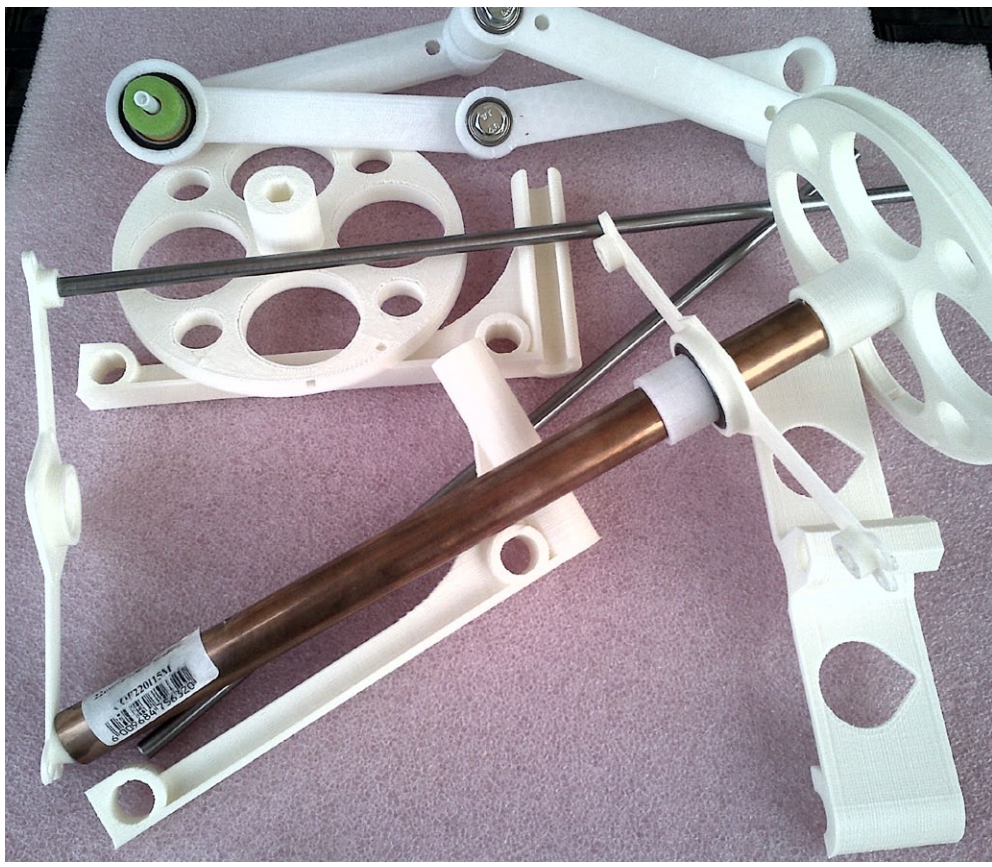
Morgan 1 prototype

proving to myself that it would not be easy, or in some cases, viable." explains Quentin.

Initial prototypes involved an aluminium frame, CORE XY mechanism [2], Sarrus linkages [3] for the Z axis, and "complete and utter failure". By the time February 2012 rolled around the idea that would become Morgan was starting to form. The key goals being how best to develop a robotic arm with the minimum number of vitamins, and the simplest way of building. "Tried and tested RAMPS" was chosen for the electronics after reviewing the alternatives, which brings "the right amount of power to make the prototype work".

Towards the end of 2012 a local hackerspace was discovered nearby (House for Hack [4]) who were in the process of building Printrbots. This led to the borrowing of a demo Ecksbot printer [5] and the start of printing Morgan. Designs collected over many notebooks were condensed into OpenSCAD models, iterating in the true rapid prototyping way. The current state of play is that the first prototype is now over a year old and has successfully produced functional items, including a preschool scooter wheel for his wife, as well as the parts for the second Morgan.

At the time of writing, the launch party for Morgan is planned for the 14th of May, where the files and plans will be released at the House for Hack meet, and online. A telling moment for the internet commentators of hack-a-Day who had told Quentin that the machine would never work [6]. His response? "Real Hackers are not limited to what is currently possible."

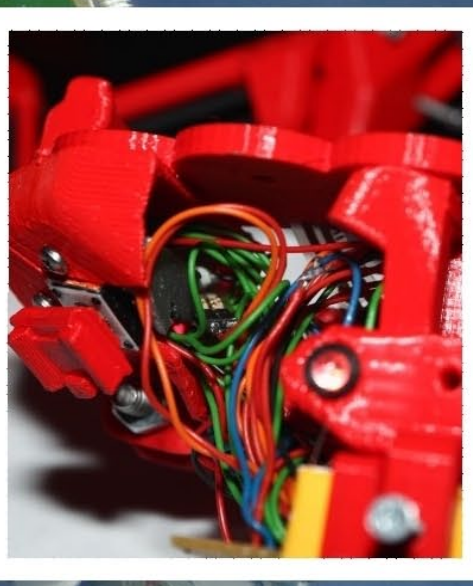


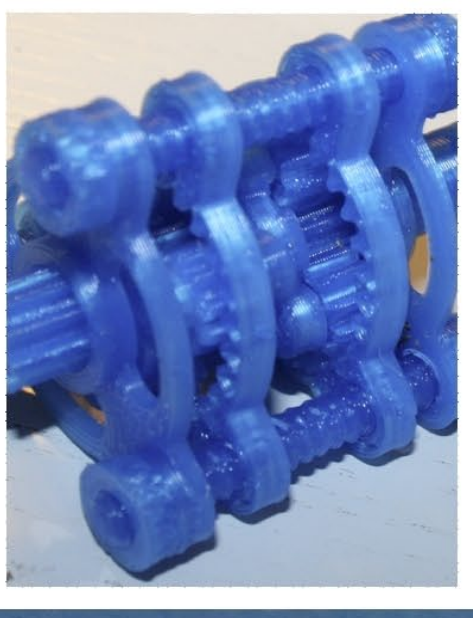
Morgan 1 parts

Morgan 2 in progress

[0] http://reprap.org/wiki/RepRap_Family_Tree
[1]http://en.wikipedia.org/wiki/Thomas_Hunt_Morgan
[2] http://corexy.com
[3] http://en.wikipedia.org/wiki/Sarrus_linkage
[4] http://www.house4hack.co.za
[5] http://www.eckertech.com/ecksbot/
[6]http://hackaday.com/2013/02/08/scara-

RepRap Kits Shipped Worldwide





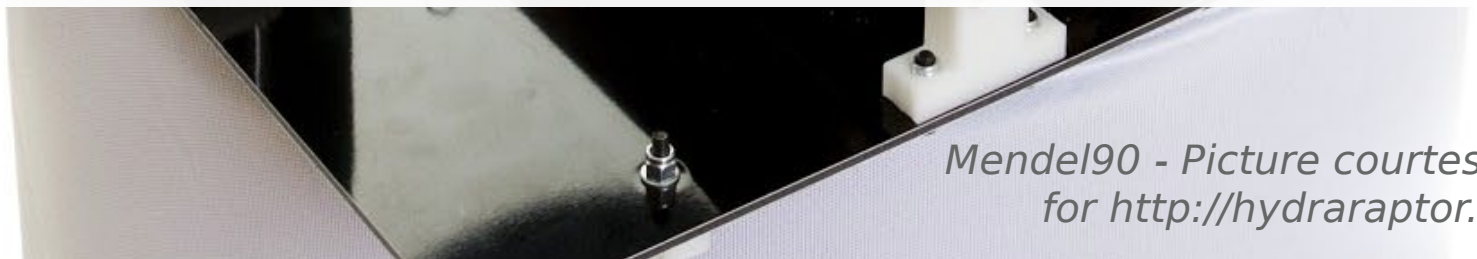
RepRap PRO

reprappro.com
RepRap Professional Ltd

Interview

Chris Palmer, better known by his alias Nophead, has been involved in the RepRap scene since 2007. Since that time he has written numerous informative posts on his blog, *hydraraptor.blogspot.co.uk*, contributing much to the RepRap project.

His most recent achievement is the Mendel90, a popular progression of the Mendel design.



Mendel90 - Picture courtesy of Alzibiff for http://hydraraptor.blogspot.pt/

Interview with

Nophead

Blogging

Your very first blog post clearly states that you had decided to dedicate a good portion of your free time to the RepRap project. Was there a particular aspect which drew you to the project?

My hobby since being a child had been electronics and I had lots of tools and equipment but had run out of interesting things to make due to consumer electronics becoming cheaper to buy than make oneself. I had spent several years on a large project at work that took all of my time and was then scrapped so I suddenly had time for hobbies again.

As well as RepRap being interesting in its own right, it also was a way to use all my skills, tools and potentially some of the junk I had been collecting for years.

Does HydraRaptor still exist and is it being used, or is it retired from active duty?

It is gathering dust after developing a fault 18 months ago that I haven't had time to fix. It suddenly got backlash in the Y axis,

Gary Hodgson

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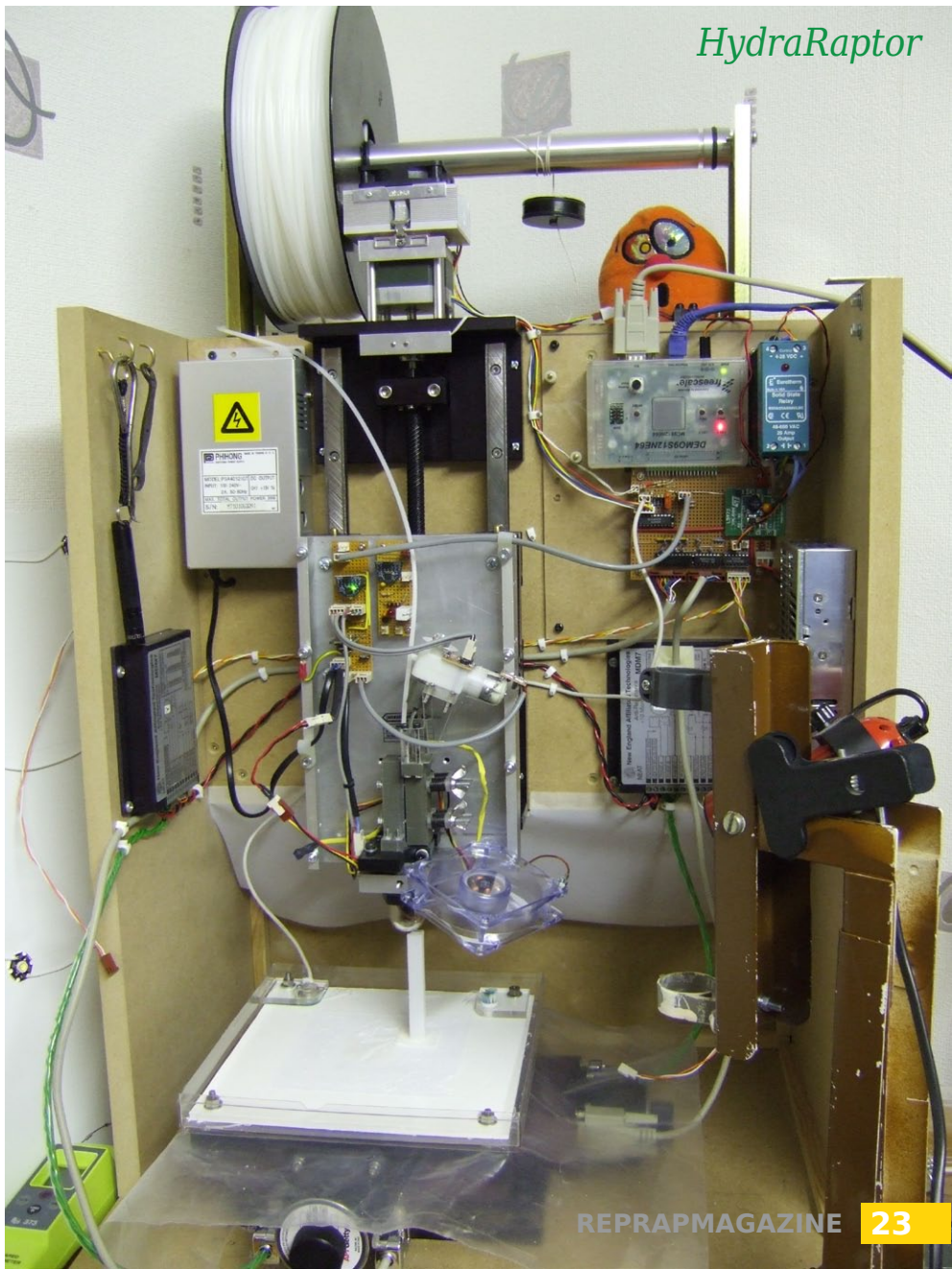
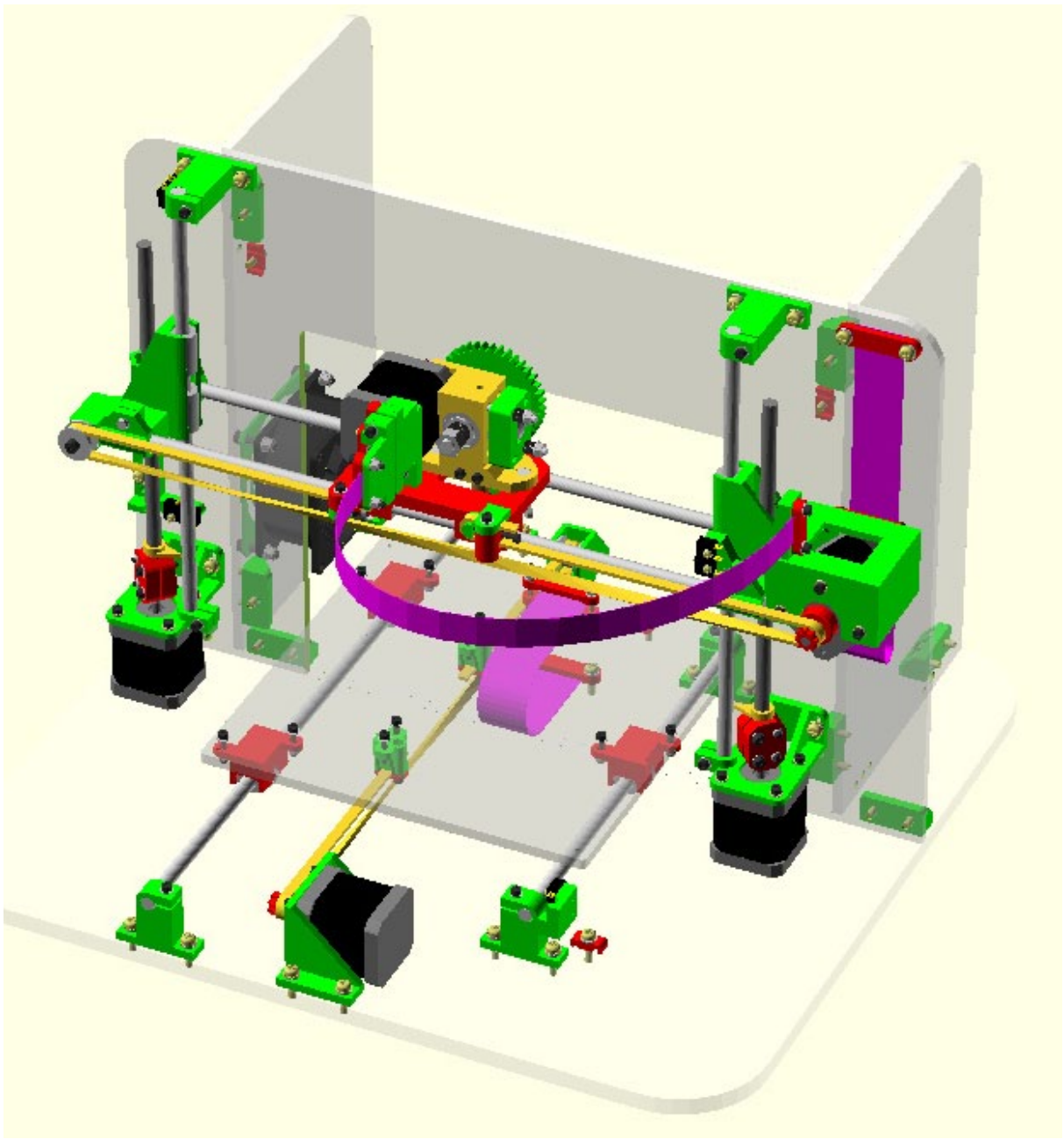
which I think is due to the ball nut becoming loose in its mounting. I can't see any way to get to it without dismantling the crossed roller slides and I am not confident I know how to put those back together again. If there are any experts reading this please get in touch!

The attention to detail in your blogging is an inspiration to many, but there seems to be ever fewer examples of such efforts. What drove you to share your experiences and results as you did? Do you feel that the GPL license of the RepRap project should extend to how people document their efforts, and not only the successful results?



HydraRaptor

I got my inspiration to start the blog from Forrest Higgs who was blogging all his experiments at the time, both the successes and failures and I found his work with HDPE very useful in getting HydraRaptor working. It seemed a very efficient way to share research information informally. I was also a bit frustrated by the lack of detail in the information coming from Bath. To some extent I think it



Mendel90 render with acrylic frame.

was due to it being Ed Sells' PHD project, so a lot got published in his excellent thesis at the end, rather than published on the RepRap blog in real time.

I don't think the GPL has anything to say on research documentation, does it?

The rate of posting on the blog has dropped in the last couple of years. Is that simply due to lack of time, or the fact there is fewer things to blog about? Do you consider the development of the Mendel90 to be a watershed moment in your RepRap "career", or do you have projects and experiments you still want to work on?

Yes it is simply because it took a lot of time to develop Mendel90 and subsequently we got so many orders for kits that despite giving up my full time job, I have almost zero time for experimenting. I still have lots of ideas I want to try.

Mendel90 was just supposed to be a temporary distraction but it turned into a monster! Adding VAT to the sale price in April approximately halved the sales and allowed us to clear the order backlog, so hopefully I can get back to development soon.

You have a reputation for thoroughness and quality in your work, and even had to respond to people badgering you to release Mendel90 before it was finished, telling them you would release it when it was tested and you were happy with it.

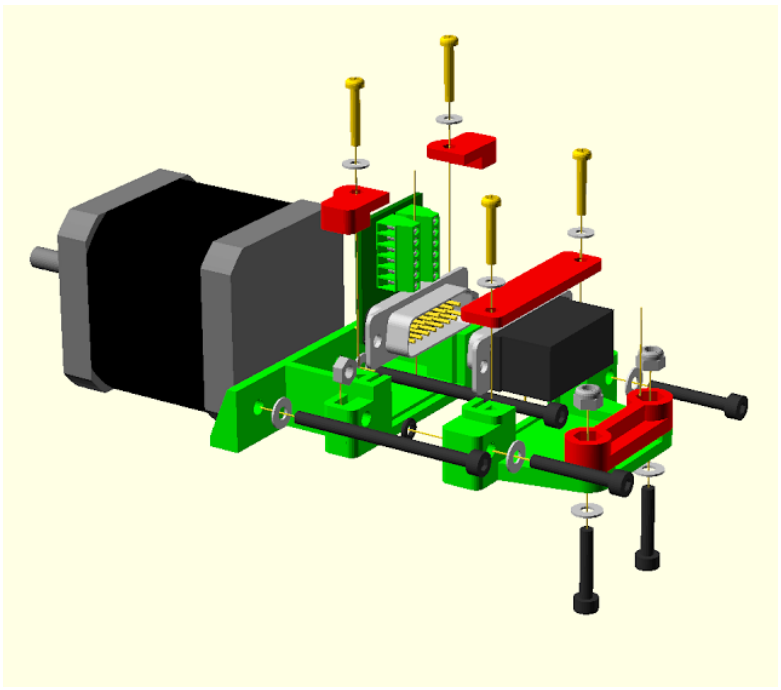
Do you feel that the "release early, release often" mantra, often brought across from software projects, is out of place in predominantly hardware projects?

At the start of building HydraRaptor you said you felt that more and more hardware is being released with bugs. Has this trend continued or have things improved since then?

Releasing free software early with bugs is not a big deal because it doesn't cost anybody anything but time to keep downloading

new versions. With an open hardware design it wastes other people's money if they build it and it doesn't work and if you sell hardware to people all over the world it becomes a big liability if it is not right.

Microchips and commercial consumer products have ever more bugs in them due to exponentially increasing complexity and massive cost and time to market pressures. I don't see how this will do anything but continue to get worse. My old analogue radio alarm clock, TV and video recorder had no noticeable defects. I now have a DAB radio alarm clock that sometimes crashes and so fails to wake me up, a digital TV that occasionally crashes and reboots itself mid program and a PVR that has quite a few immediately obvious minor bugs.



D connector assembly

You've mentioned not having enough time to try things out (1.75mm filament for example), or there being aspect of machining you have the tools for but not the time to try. If everything else could stop today and you had time to do anything - what would that be? (RepRap related or otherwise)

I would start by making all the Mendel90 kit production processes more efficient to free up some time for research. Then I think I would work on better understanding extruder flow rate dynamics. I think possibly the axes should be synchronised to the extruder output, rather than the other way round.

Tools

As you are more than capable of designing both electronics and software for RepRap, are you happy with the current available electronics and firmwares - are you planning your own hardware or firmware for Mendel90 or it's successor?

I find Marlin generally produces nicer looking prints and at higher speeds than my own simple software I wrote five years ago and has the big advantage I don't have to maintain and support it. It isn't a good platform for experimenting though, so I will continue to use my own hardware and software for that. I don't really have time to do anything else.

In "Fun with Python and G code" (http://hydraraptor.blogspot.com/2008/04/fun-with-python-and-g-code.html) you advocated separating G-Code slicing from the host controller (which is now prevalent), but also a further step of having the slicer just produce the paths, and the machine controller dictating speed, cooling, and presumably flow as well. The advantage being that the model mustn't be sliced for each small parameter change. Whilst acknowledging that flow and speed can often be modified at runtime via the host software, is such a separation still desirable with today's slicers and host programs?
Or would such a "real-time" approach be infeasible with such things as acceleration and volumetric flow calculations?

I certainly don't like re-slicing to change the filament diameter, speeds or temperatures. I think that should be separate from the geometric part of the slicing. And it definitely

is feasible to separate the real-time aspects of motor and heater control from the acceleration planning and flow rate calculations (I know because I did that). However, with the move to more powerful ARM based controllers the PC host program is no longer needed. I would still separate all these concerns into different layers of software if not separate programs.

Since the first time you had a reliable printer you seem to have been producing, non-stop, a considerable number of parts for people around the world. Do you still print things for yourself, or for fun, in between the orders? Are there any designers with whom you are particularly impressed with?

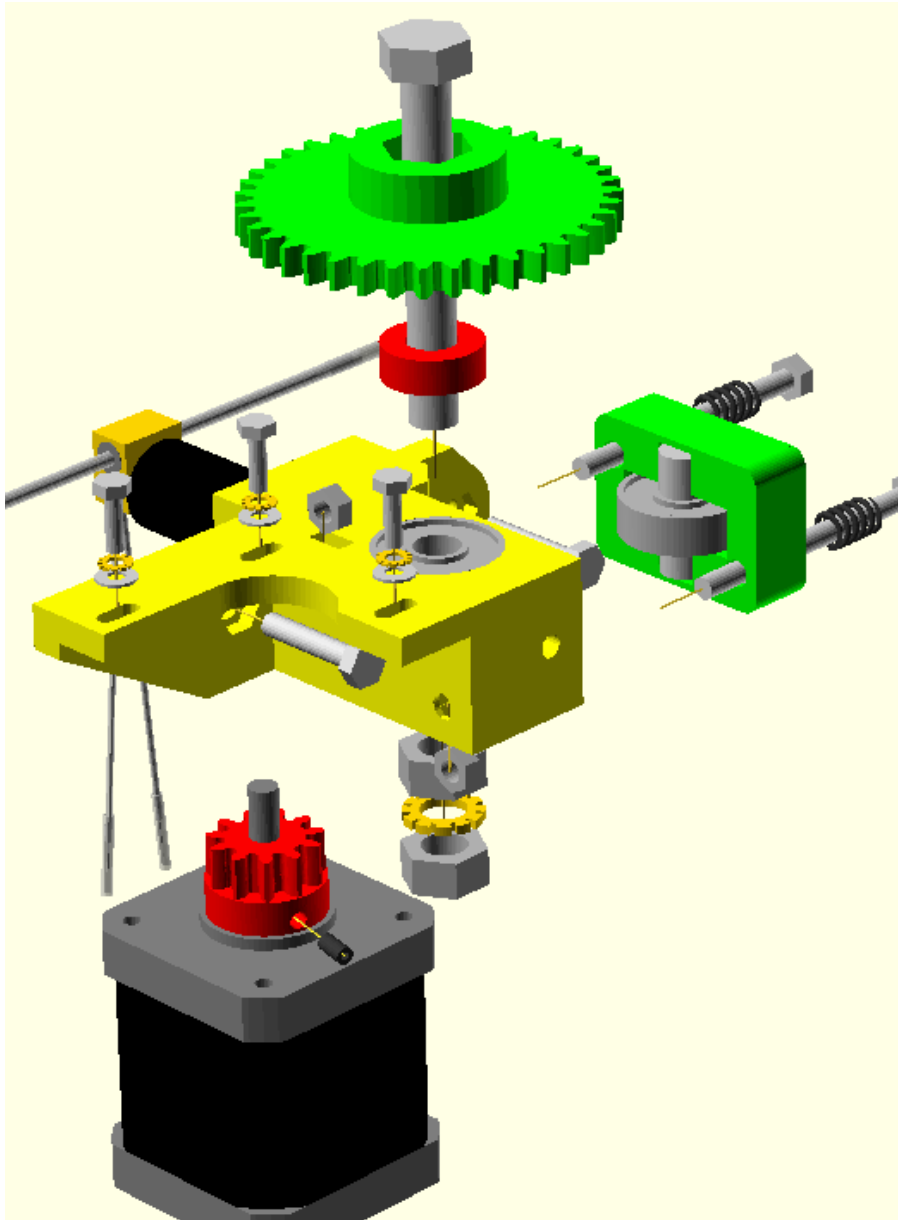
I print very little for myself nowadays other than jigs and tools for kit production. I never have any free machine time or personal time to print fun things. If I did have time I would print cool things like quadcopters and robotic humanoids, etc. I would also like to try out delta and scara printers.

Is there any area of self improvement you would like to focus on, any skill you would like to develop, with regards to 3D printing?

I would like to get an understanding of surface chemistry as I find what sticks to what is the most inconsistent and baffling aspect of 3D printing. I thought I had found the perfect bed material for ABS when I tried PCB solder resist film laminated onto glass. It gripped really well when hot and parts just lifted off when cold. It worked time after time without any cleaning. Fortunately I didn't have time to blog it because when I made two more beds exactly the same way, from the same pack of film, they did not work on the same machine. Also after about 6 months of continuous use the first one stopped sticking and I couldn't rejuvenate it with acetone.

There are lots of materials where the grip fades with use and can not be restored with acetone, such as Kapton and FR4.

With some materials the grip fades but can be restored with acetone, e.g. PET tape and recently I have discovered that glass with very dilute ABS juice has very little grip to start with but gets better and better with use. It would be nice to know why.

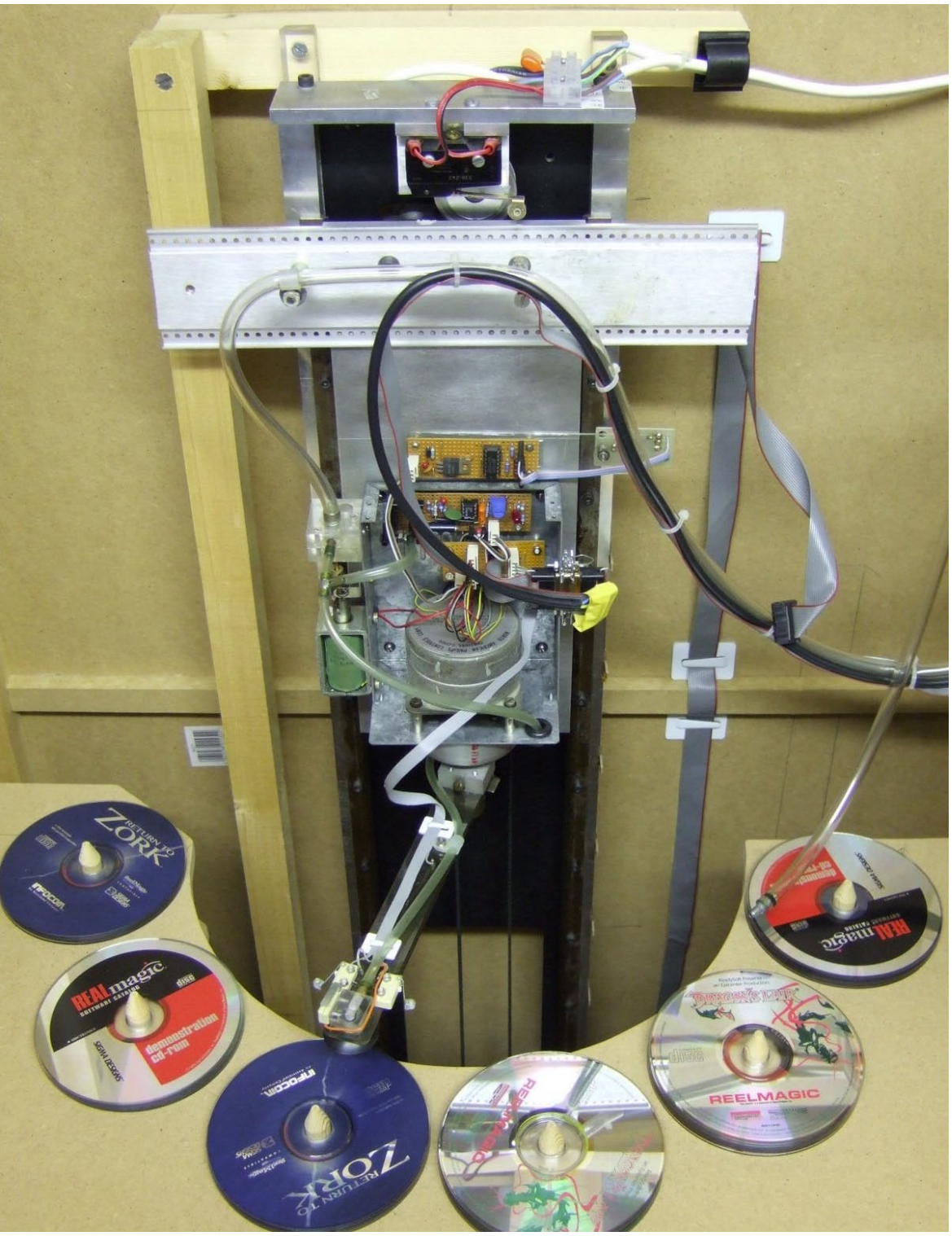


Mendel90 extruder assembly

DIY / maker movement

Recently there has been a lot made about the rise of the Maker Movement, with talk about the new industrial revolution and how it will completely disrupt current production chains. Do you feel there is such a movement happening, or is it simply more attention being drawn to a long-standing tradition of DIY, which happens to have a new set of tools made available to them, i.e. 3D printers?

I think the major change has been instead of individuals tinkering with their own stuff in isolation and perhaps sharing ideas in specialist magazines, the web has connected everybody with the same interests together. For example I designed and built a 400 CD jukebox in the early 1990's. The only people who got to know about it were my friends and family. Nowadays it would end up on-line and perhaps many people would have made and improved it. When I blogged its decommission in 2007 it got the highest number of hits of any of my blog pages.



CD Jukebox

The free information and software on the Web together with affordable CNC tools vastly increases what an individual can make in their own garage. Also, with the likes of eBay, individuals have a global marketplace that they can sell into making tiny niche businesses viable for the first time. I think this is indeed a revolution.

Design process for the Mendel90

You go into great detail about many of the decisions and compromises you made whilst designing both the HydraRaptor and the Mendel90. Do you have a particular method or way of working in order to produce robust and well-thought out designs?

Not really other than thinking deeply about things for a long time. I like to apply theory where I can and I am not afraid to do practical experiments where I can't.

Many of your designs and findings have been incorporated into the current state of the art within the RepRap project. What are your feelings about where the project is right now and where it might be heading?

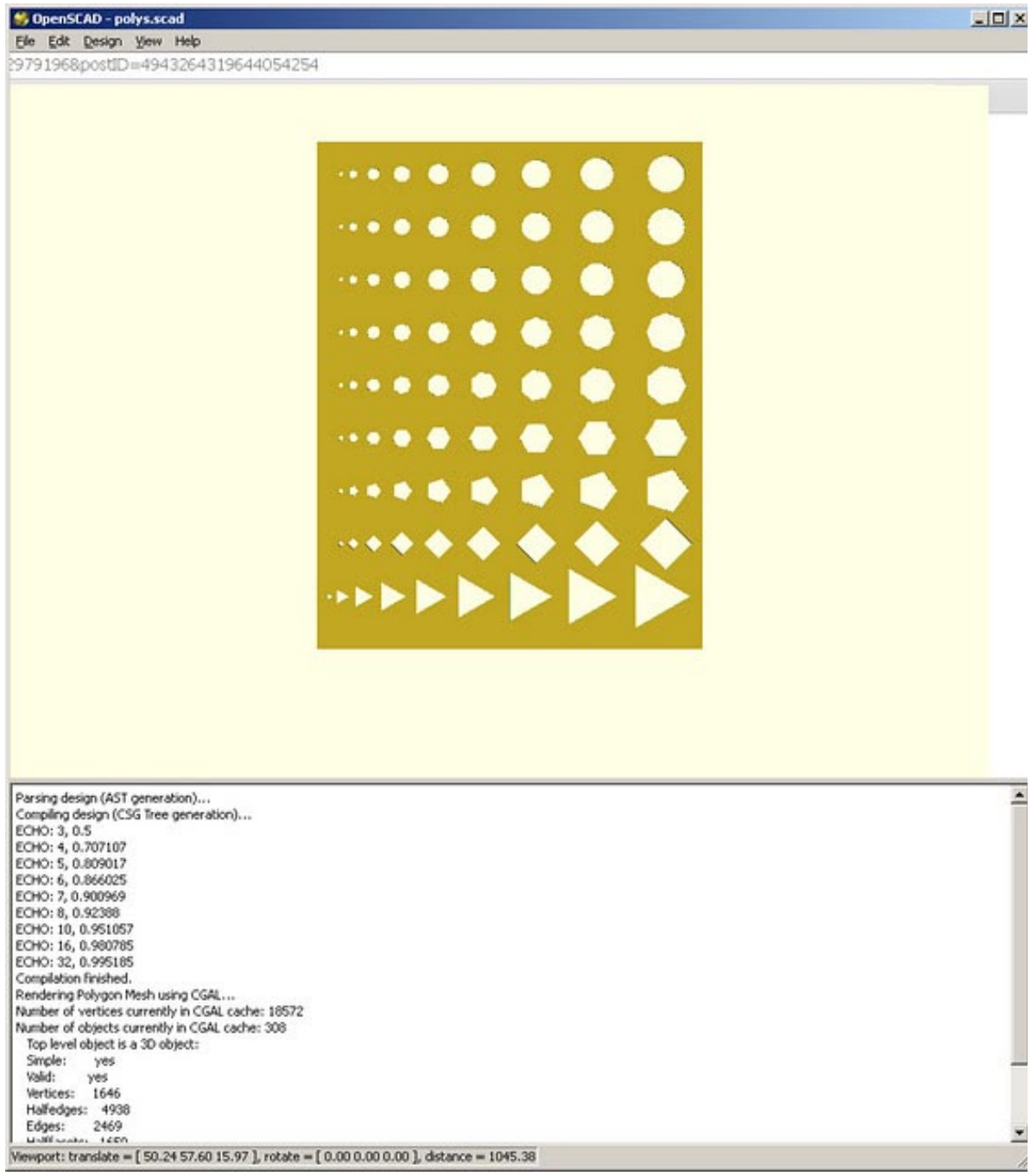
It is currently very fragmented with everybody doing their own thing. In some ways that is good as all possible avenues are being explored in parallel. I don't know if it will ever come back together again to make another generation official "RepRap" machine though.

Are there any tools or resources that you feel are especially useful or important, or have become useful or important, when designing such things as a new printer or part? Anything you would recommend to the budding layman engineer?

The main tool that has liberated my design abilities is OpenScad. It isn't for everybody as you have to think like a programmer to use it, and even a lot of programmers struggle with it being declarative rather than imperative. It isn't a quick process either but I find scripting far more powerful than a GUI in all applications, CAD being no exception.

For someone new to the project, and starting to build a RepRap from scratch, what aspect do you think is the most challenging? Have you any tips or advice on how to overcome it?

It is hard for me to put myself in the shoes of a beginner because I have been doing electronics since the age of 9, firmware since about 15 and I started on Reprap in 2007 before the first machine was released. I guess people have the most problems with firmware configuration and slicer configuration for good quality prints. Not sure what the answer to that is other than use Google and the RepRap forums or ask on IRC. Good quality photographs help with remote diagnosis, not out of focus ones from smart phones!

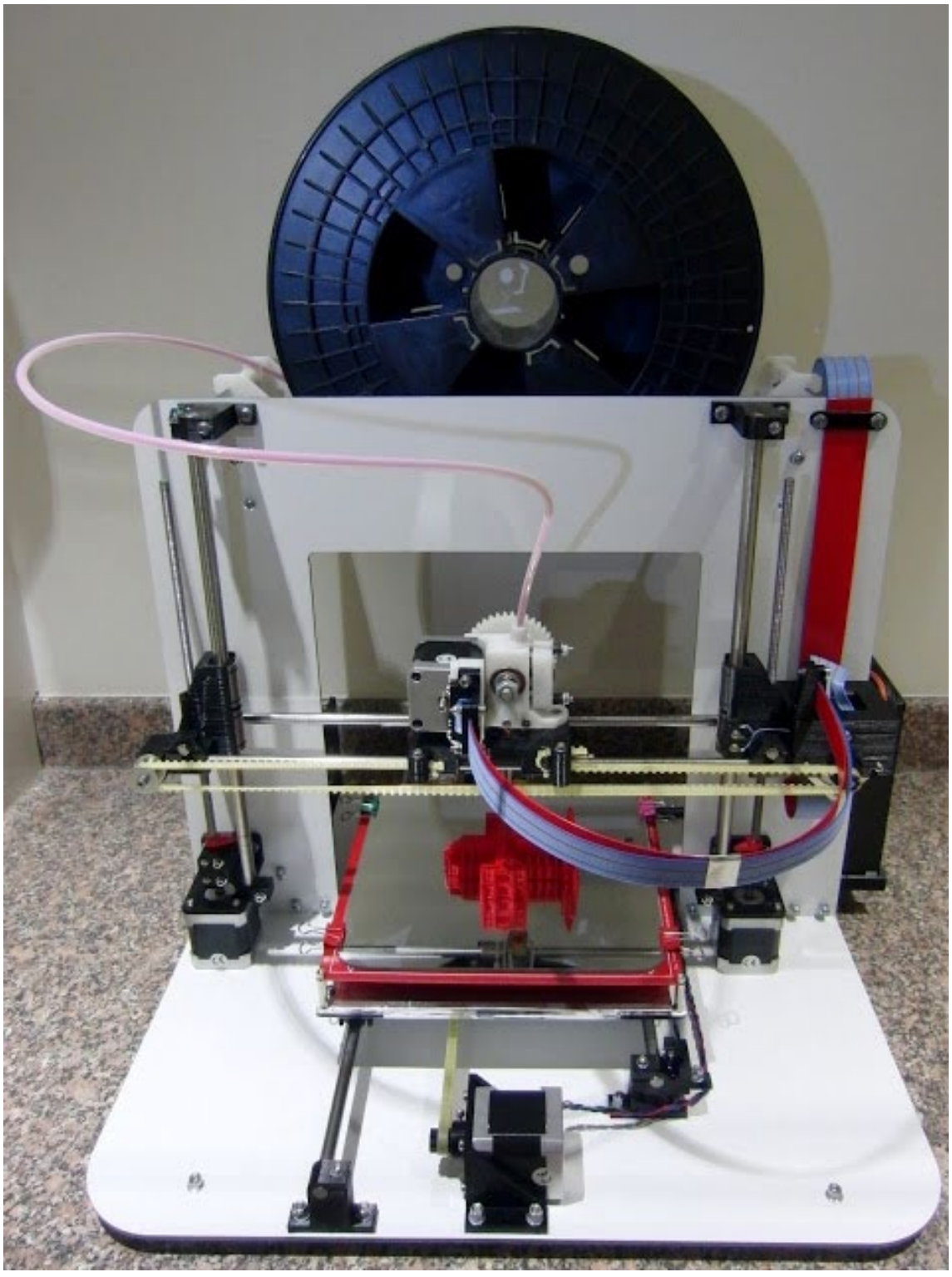


Nophead polyhole openscad function

Gada Prize

The Gada prize (now called Uplift Prize), was recently updated to have a new deadline and to relax the criteria. What are your thoughts on the prize? Are the criteria achievable? Are such challenges a good way to promote development in the RepRap community?

I didn't think the original goals were achievable, or the prize money big enough to be worth trying. The new one looks like it will be awarded to the entry judged the best so will definitely be achieved if somebody enters.



Polycarbonate Mendel90

I doubt it will have a significant effect on development in the Reprap community as the prize money is too small to compete against market forces.

Open-source businesses

The exponential growth of interest in 3D printing, including RepRap, has unsurprisingly led to an increase in attempts at commercial ventures. New printers are appearing on Kickstarter almost weekly, and physical stores are appearing around the world. Is the open-source nature of RepRap compatible with such commercialism? Can you foresee any RepRap, i.e. open-source, companies being ultimately successful, or are they, by their very nature, restricted to the hobby market?

Yes I think opensource can be compatible with making money and I don't consider being restricted to the hobby market as not successful. Whether many or any will be around in five years time remains to be seen.

Was it a big decision to start making kits for Mendel90? Has starting a RepRap business been a positive step? Are there any downsides?

I had always planned to give up working at 50 anyway but the government changed the law so I can't draw my pension until 55. Selling plastic parts made enough money to live on but after building a Prusa Mendel myself and struggling to get it to work properly I felt guilty selling them and decided to design something better. People started asking for kits so it seemed a natural next step. Originally the plan was to just make the plastic parts and the Dibond sheets with another company offering to do the rest but that fell through at the last minute so my wife and I were left doing it all.

It is positive in that I am my own boss. The downsides are it is repetitive work because demand has been so high that I don't have any spare time for development.

In your view, is the commercialisation of RepRap holding back any aspects of developments and do you think it's now more about 3D printers than the goals of a self replicating machine?

Yes I think the majority of people wanting a 3D printer want something cheap, easy

to build and operate with good print quality and care little about it being self replicating, so naturally there aren't many people working in that direction. However a few are. The Morgan by Quentin Harley seems a good step forward in reducing the quantity of vitamins and uGen has done some interesting work on printable nylon linear bearings. I don't think much more progress will be made until we can print hard metals.

Ohno

Future of RepRap and 3D printing

In 3D printing there are many exciting possibilities being explored around the world: biological tissue replication, printable architecture, new materials and techniques, amongst many others. Many of these use RepRap as their underlying technology. Is there any particular area which really interests you personally, or you feel has the potential to become exceptionally interesting in the near future?

Printable electronics interests me and I think printed graphene will have a big impact there.

Print to improve life quality!

We invite you to participate in our first competition envolving the design of objects to be printed with a RepRap.

With an ever growing number of RepRap based 3D printers out there we decided to challenge the community with our first competition.

We want you to came up with new designs to improve the life quality. You have the freedom to design things as complex as prosthesis or as simple as a anti-snoring device.

Think on how to improve an everyday task, minimize human body handicaps or how to improve your pet life quality.

Surprise us with your imagination!

We will pick 7 winners!

Prizes are:

1º RepRapPro Huxley hardware kit. Everything that's needed to build the Huxley 3D printer except the printed parts.
Shipping included.

2º Plastic2Print speciality plastics bundle (Flame retardant PLA, Crystal clear Natural PET, High temp ABS, Taulman Nylon 618, Flexible polyester and Ultra colored PLA). Diameters and quantities to the preference of the winner (max. of 250€).
Shipping included.

3º RepRapWorld bundle. The bundle includes Lcd, keypad, stepper motors nema17 (set of 4) and a minitronics board.
Shipping included.

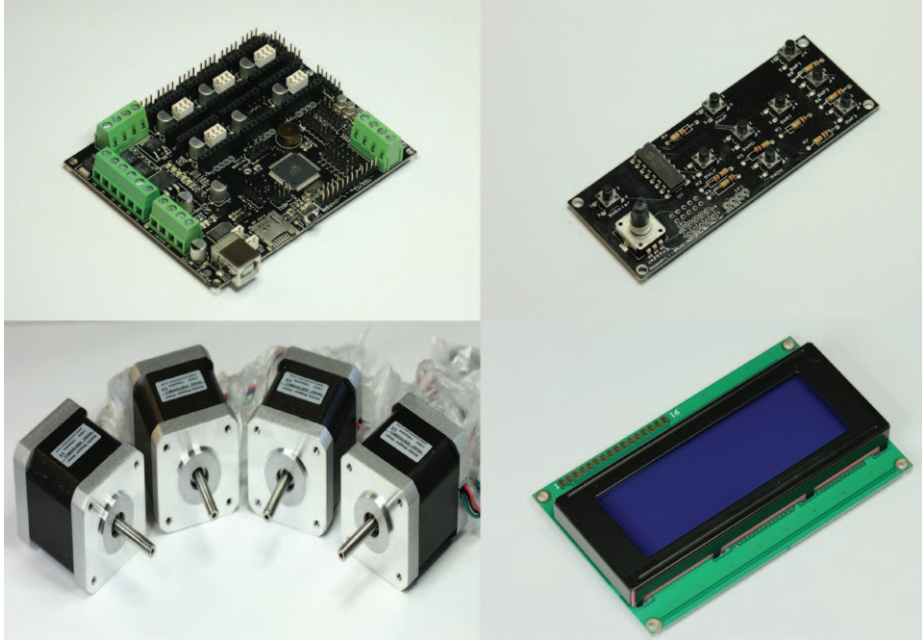
4º - 7º Faberdashery £50 voucher.

Each Voucher entitles the bearer up to £50 off a single transaction, excluding P&P, redeemable online during 'Check-Out'. Voucher is valid from 14th June 2013 - 14th of March 2014 (inclusive). Voucher is not valid in conjunction with any other offer or voucher and may only be used once. Voucher has no cash value. Faberdashery Ltd withhold the right to change or remove this offer at any time, and is not responsible for any voucher that is lost, stolen or otherwise unused by the expiry date.

Our Competition Sponsors Prizes:

RepRapPro Huxley hardware Kit. Shipping included.

Plastic2Print speciality plastics bundle. Shipping included.



RepRapWorld bundle. Shipping included.

Faberdashery four £50 vouchers worth of plastic.

RepRap Magazine competition winners will be announced on the TCT show Birmingham, UK (NEC) September 25th – 26th 2013

Print to improve life quality!

Rules:

-You can submit several entries.

-Team entries are welcome. In case of team win the prize will be given to the team leader.

- Contest is open to everyone except RepRap Magazine staff and our sponsor employees.

-By entering this competition, you:

1. Warrant that the work is your original work.

2. To the best of your knowledge, it is not, and has not been in production or otherwise previously published or exhibited.

3. Neither the work nor its use infringes the intellectual property rights (whether a patent, utility model, functional design right, aesthetic design right, trade mark, copyright or any other intellectual property right) of any other person.

-This competition is open until 15 August 2013

-Winners will be announced in our next issue.

-The contest sponsors and the RepRap Magazine have your permission to promote the winning entries.

-Only one prize per person and/or team.

4. Winner's info may be passed on to 3rd parties.

Requirements:

- Model should be able to be printed in printer with a building envelop of 200x200x200mm.

-It can be printed in sections. Assembly can be done using bolts, snap fit or glue.

- Entries will be selected based on creativity, feasibility, functionality and response to the competition theme.

-Post your entries at RepRap Forum competitions section, on the "RepRap Magazine - Print to improve life quality" topic.

-Name (or team members names).

-Link to the .STL file of the model, and one photo of the printed object. (use any file hosting site like Thingiverse, Grabcad, RepRap Wiki etc. Tag the model with RepRap Magazine).

Entries will be judged based on:

-Functionality (how complicated it is to use / assemble / how well does it solves the problem).

-Instructions and documentation on it's use and assembled.

-Proof that it works!

This competition is open until 25 August 2013.

Feature

RepRap electronics still have some way to go before becoming a universal standard for 3D printers, but we are at the point of having a choice of many compatible versions and firmwares to run on them with newer improvements happening all the time.

RepRap easy LCD shield

RepRap Electronics, past present and future. I'm not going all the way back to the early RepRap experiments with PIC's and early open source hardware, so I will start where I entered RepRap – with GEN 3 and the RepRap Makerbot split.

Richard Horne

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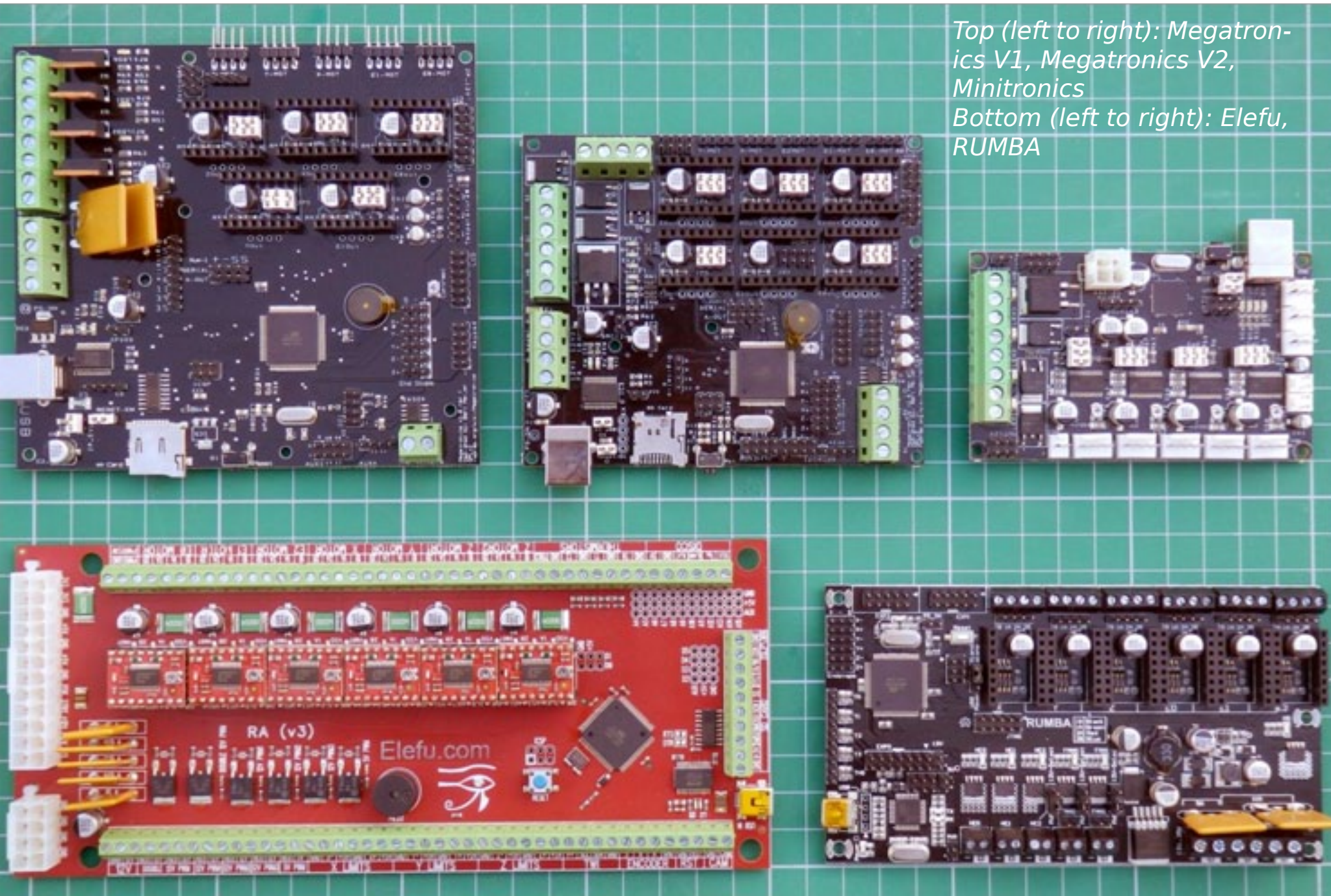
In the recent past (2009) RepRapper's had a choice of hacking together some electronics based on maybe Chinese stepper drivers and Arduino boards or if you were lucky buying a kit of parts.

Ready built versions of the official RepRap GEN3 electronics did get made in small batches for not an insignificant cost to the user and it was not an easy thing to build up yourself.

Gen 3 was in many ways ahead of it's time, you could expand the number of extruders with extra boards and if boasted some Surface mount components that while great for mass production mainly served to frustrate the average hobbyist trying to get their printer running.



Top (left to right): Megatronics V1, Megatronics V2, Minitronics
Bottom (left to right): Elefu, RUMBA

In those early days you could buy GEN3 with a RepRap or Makerbot build option – the main difference was choice of connector's and the fact RepRap had gone down the road of using a Stepper driver for the Extruder and Makerbot were still using a DC motor with optical position feedback – GEN3 handled both options. Just.

Most early Sells Mendel machines used GEN3 and so did all the Makerbot Cupcake's

GEN3 only had 2x micro-stepping drivers so everything was noisy and a little clunky, and the extruder boards blew up a lot of the time.

GEN3 mainly used a dedicated RepRap Arduino based firmware and a JAVA Host program developed by Adrian Bowyer to control the machine, it had no electrical noise protection and as you had to run from a serial port, often had issues with hanging up or generally going a bit wrong in the middle of a print.

Then a little while later after Adrian Bowyer and others experimented with some Pololu stepper drivers, we finally had a reasonable set of Electronics to expand and do some serious firmware development – RAMPS by Johnny Russell - https://ultimachine.com/ramps

RAMPS was originally a single sided (1.5 layer with a few wire links) design that required only conventional components to be soldered to a 'shield' PCB that fitted onto a standard Arduino MEGA controller.

RAMPS was one of the first designs to define a set of pinouts for various functions, this made it very easy to evolve more versions to have more options and capability. To keep a small form-factor some surface mount components are now used and it's fair to say it's probably the most used electronics at the moment.

The Gen6 board by Mendel-Parts was one of the first board sets to be developed as an all in one integrated board with 8x micro-stepper drivers directly soldered onboard, it's limiting issue was that it had no Heated bed control, but it sold very well and started a trend of many similar and compatible developments.

Sanguinololu and GEN 7 were both developed to continue the RAMPS style of easy to assemble using mostly conventional components and enough functions for most 3D printer users. GEN 7 was particularly suited to hobby assembly; even the PCB being single sided can be made at home and it is still a highly robust and reliable design.

Teensylu is a more integrated version of Sanguinololu using more surface mount components and removing the need for a separate FTDI Serial communication device. *(http://reprap.org/wiki/Teensylu)*

The Melzi and PrintRboard http://reprap.org/wiki/Printrboard are further examples giving somewhat easier to wire fully featured small electronics designed to be produced in volume manufacture at a low cost. (*http://reprap.org/wiki/Melzi*)

In the last few years we have seen a boom in available RepRap electronics. Many are repackaged versions of RAMPS which makes sense as so many of the firmware's can then use them with only simple modifications to pin out files or software modules. More recently ARM based control boards have started to surface along with dedicated firmware versions to make the most of the increased processing power available.

RepRap electronics still have some way to go before becoming a universal standard for 3D printers, but we are at the point of having a choice of many compatible versions and firmwares to run on them with newer improvements happening all the time.

RepRap present

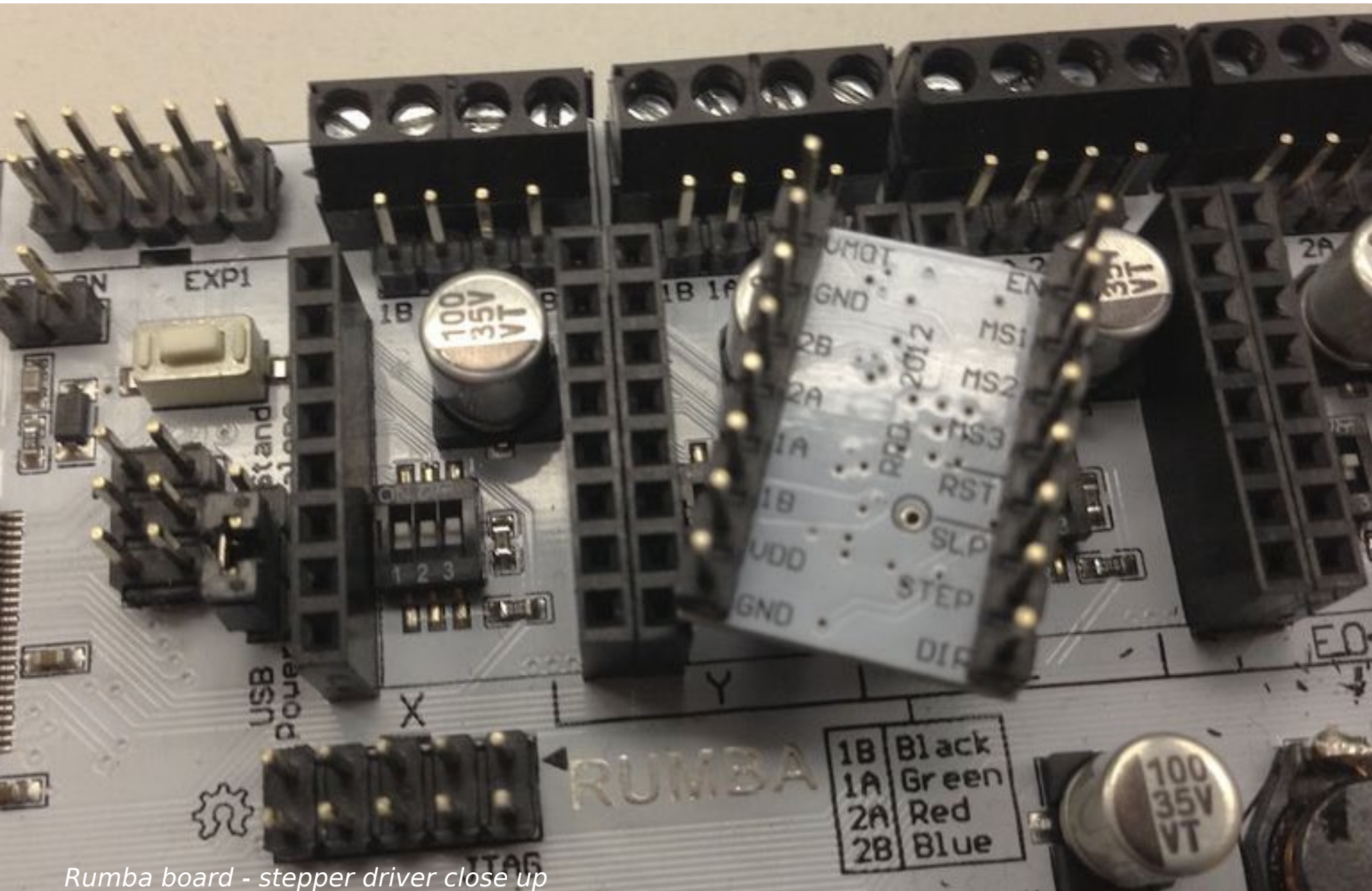
I'll dive right into some of the electronics you can safely choose today, some are still quite new, but most are still based on the Atmel MEGA or derivative parts used on the RAMPS setup.

These could all be called the safe and reliable options, as they have well established firmwares and many RepRap based machines are already setup to use them in one form or another.

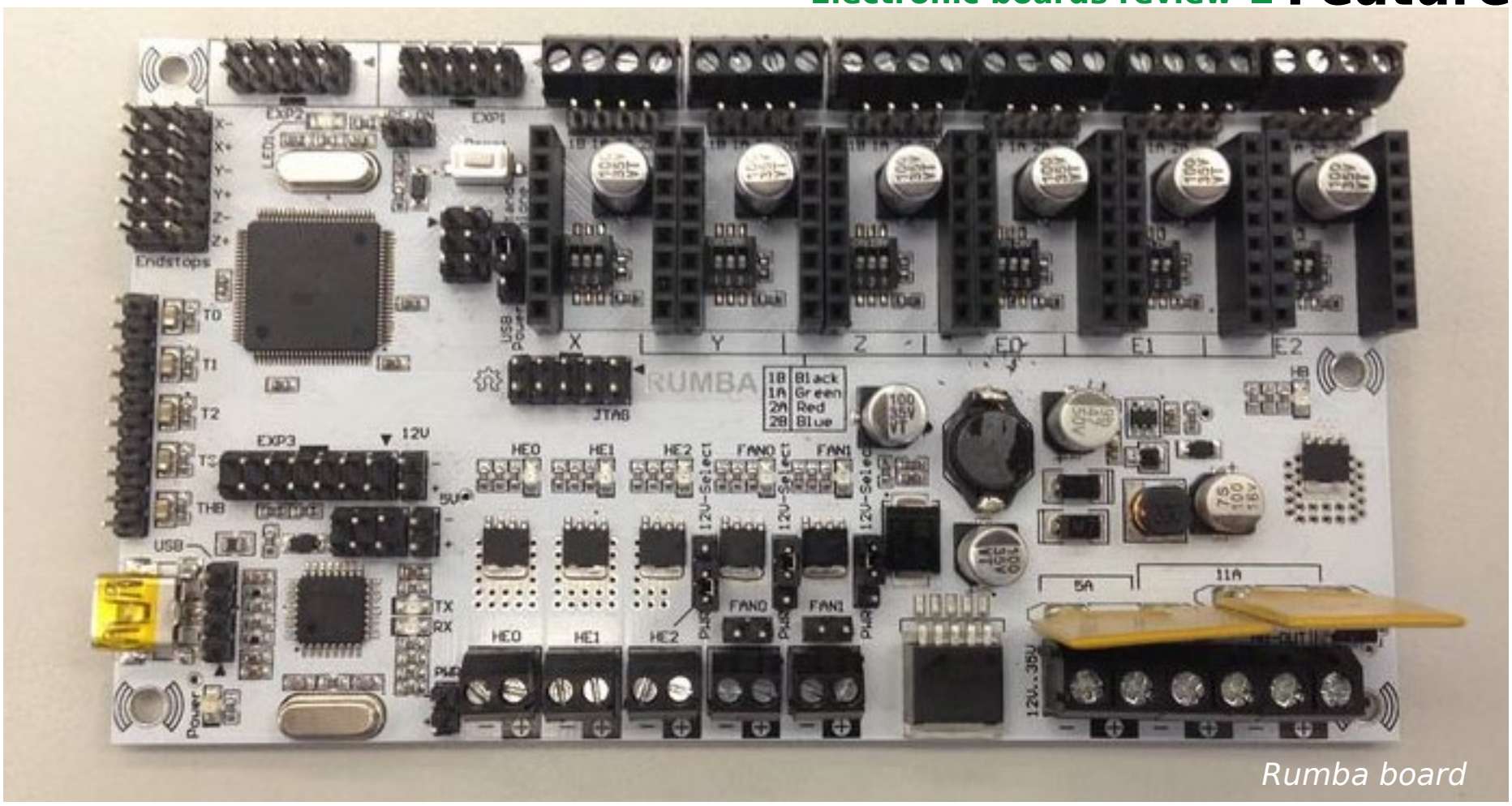
Most of them are running an Atmel 2560 MEGA at 16Mhz, but a few are starting to run at 20Mhz for a little more processing power as this mocrocontroller is forever being pushed harder and harder with new firmware revisions.

As a side note and printing tip here is that I would always recommend using an SD card for printing anything, you get a much better data transfer rate from SD card than any serial link, this will always lead to better prints and you will get less issues with reliability and generally less problems especially if you are starting to print at faster speeds.

Even with higher speed transfer from SD card you will reach a limit with how many steps the Atmel MEGA can clock out to your stepper motors and how much acceleration it can process, it's possible to experience slow-down and artifacts caused by only modest processing power and now quite complex firmware getting ever packed with features. Optomisation of firmware is also constant and continues to also improve the chances of more ports being done in the near future to higher powered microcontrollers.



Rumba board - stepper driver close up



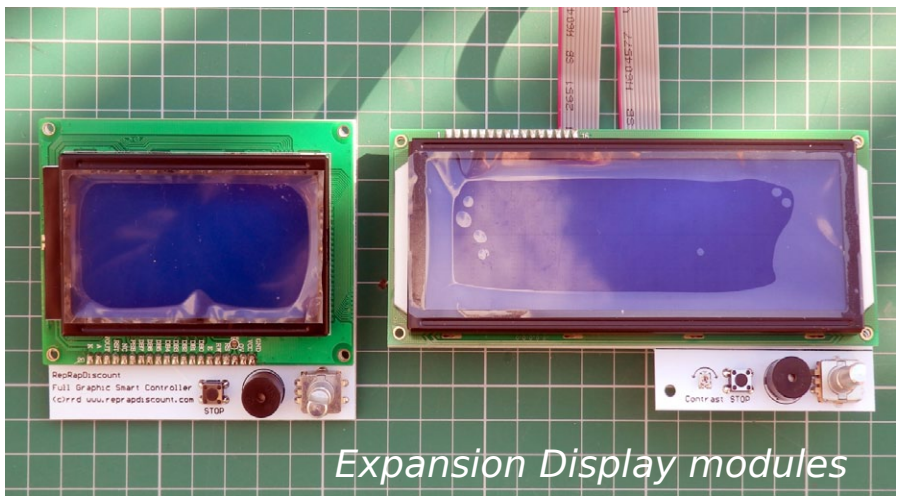
Rumba board

RUMBA

The RUMBA electronics set is a combined RAMPS board with dedicated remote LCD and SD Card expansion and future three channel thermocouple add-on module.

This board uses standard RAMPS style Stepper drivers, so you have options to use any of the Pololu modules, Stepstick or other open source drivers like Kliment's recent DRV 8825 x32 microstepper boards.

I have been using this board for a while and apart from a few annoying things it's proving a good design. It is a little sensitive to electrical noise, and can lock up or drop the USB connection in my experience running it with the USB serial connection active, but when run as stand-alone via the SD card and LCD screen it's been rock solid for weeks of use. I also had some issues with a few pads popping off the underside of the board on the motor 0.1" connections, this does not normally happen with double sided electronics, but seems a point of weakness so go careful when pushing in any connectors, the screw terminal connections proved a better option, it is nice that both are included.



Expansion Display modules

Note: If you do use the Full graphics module or the new XXL mega sized LCD screen please note that the two 10way connectors are labeled incorrectly so EXT1 and EXT2 are swapped on the display modules. When you connect to RAMPS or RUMBA make sure you check the connection.

It's possible RepRapdiscount or other suppliers may correct this error, so do check before powering up!

A dedicated USB driver is required for the RUMBA board, when installed it allows the onboard Atmel 16U2 to be seen as a USB to serial link. This implementation does not seem quite as reliable as a dedicated FTDI USB to serial device, and seems to be

the giving me the most cause for drop-out and electrical noise resulting in a non functioning serial link. There also seems to be a 80% chance of the serial port working after plugging in the USB cable, the rest of the time it simply does not seem to appear as a valid port usable by the Host software or the Arduino IDE. Removing and re-inserting the USB cable solves this issue.

It's very likely you will be running on external power rather than USB (is has an option link to choose this) and when you are be careful with pluging in the mini USB cable as bare pins for reading the analogue thermistors are exposed and could be shorted out if you slip with the USB plug.

The board also has 3 x separate extruder driver outputs and 3 x hot-end support.

RUMBA is supported in Marlin software and within just a few minutes I had added the relevant pin-out details to the Marlin Delta branch I'm using for Rostock. Do check the pin numbering with the firmware you use, I had a few issues with incorrect identification of the end stops on the version I was using.

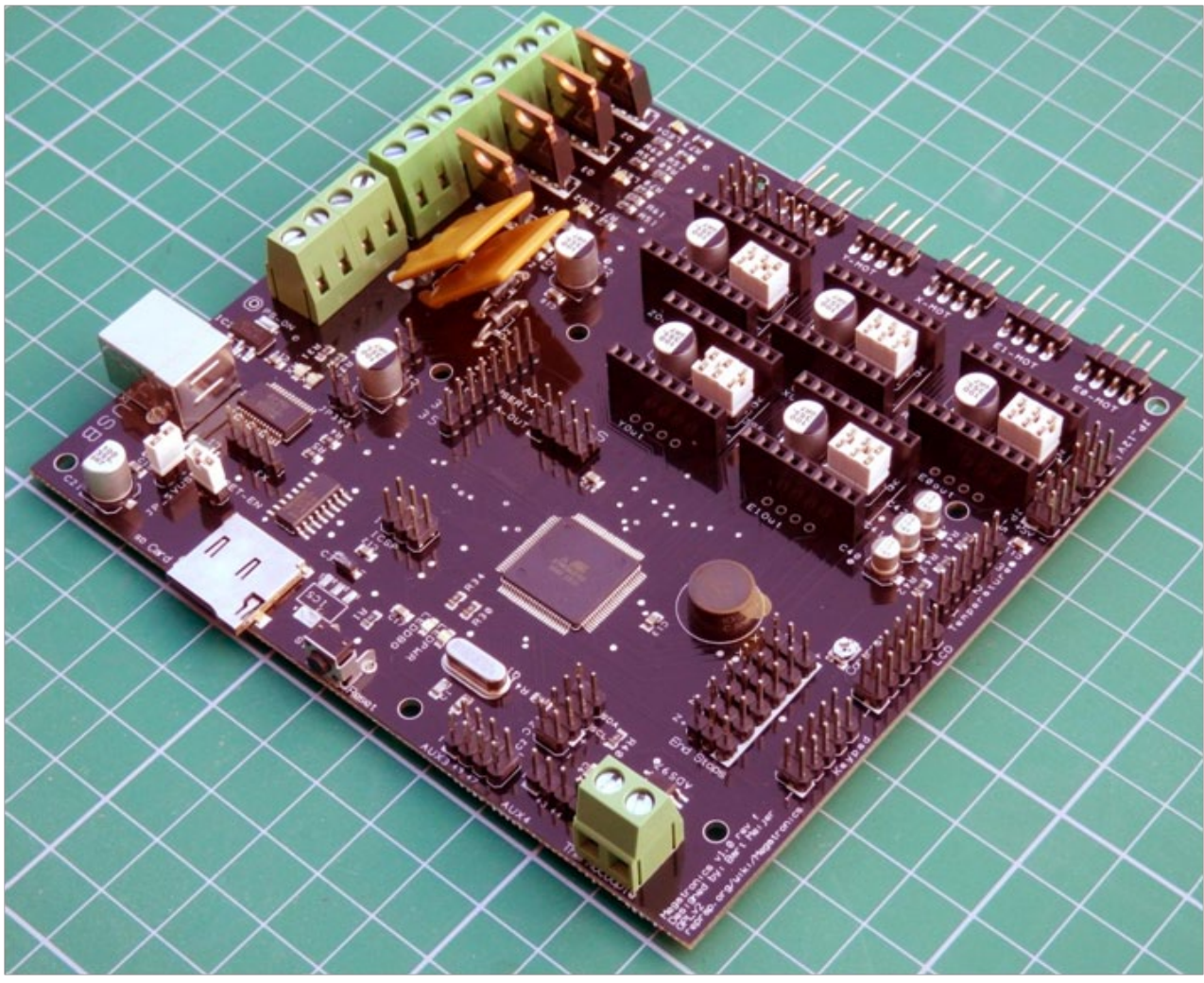
Summary:

A highlight for RUMBA is that it's very compatible with RAMPS so you can re-use your stepper drivers, SDCARD module and even the recent RAMPS Smart LCD controller modules also from reprapdiscount, this makes RUMBA a very good upgrade if you want to experiment with more extruders, or if your RAMPS electronics dies.

Being quite compact and a rectangular shape it should also fit into your machine design quite easily whilst giving plenty of expansion for the future.

MEGATRONICS V1

Version 1 of Megatronics was a big board, with a lot of conventional components, ideal if you blow some parts up and needed to do a quick fix. A really good all in one board, great for experimentation and future stepper upgrades with on-board support for a thermo couple , but now superseded by Version 2.



Megatronics V1

MEGATRONICS V2

Version 2 is smaller, and has more functionality; it's the only board in this review to have two thermocouple inputs, meaning you could have dual high temperature hot-ends extruding at hotter temperatures than thermistors can withstand which is usually around 290 Degrees C. You can also run standard thermistors if you prefer. You can add an LCD and Keypad to allow this board to run without a computer.

It has an official FTDI USB to Serial converter on-board, and I didn't experience any issues with drop-out of communications or any other electrical interference causing problems.Like many new board designs this also has 6 channels for stepper drivers and multiple extruders and choices of step rates from full to 32x.

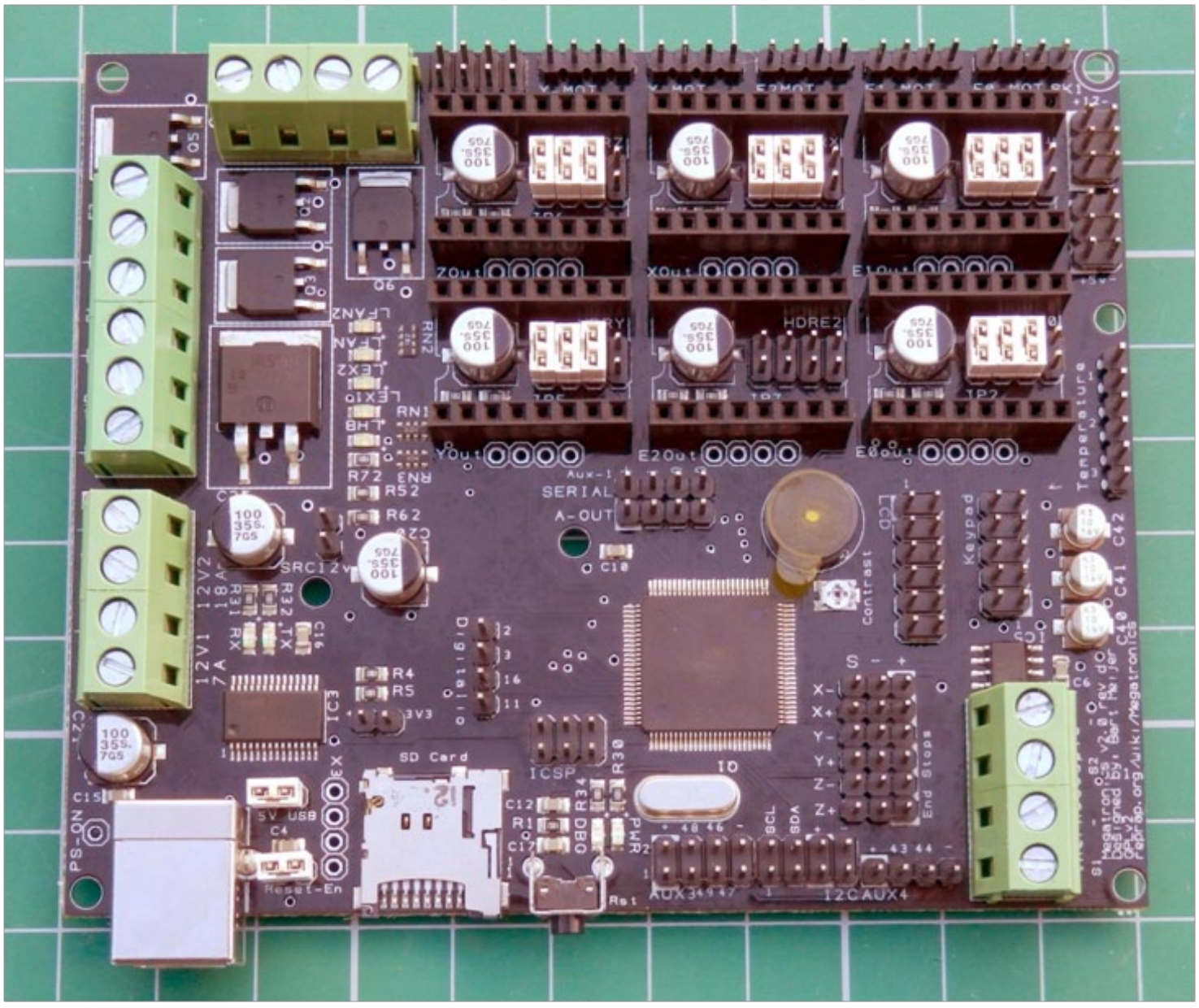
Unfortunately almost all of the current electronics suffer from a slow upload connection to the SD card as you are limited to a slow serial link. It's always a better and faster option to simply remove the card and use an adapter or USB reader on your computer to transfer the files for printing.

The micro SD card slot is a little fiddly to use compared to a full sized SD card but it works well. As it's only a few pins it would have been nice to be able to connect a remote SD card on a cable as quite often the electronics are hidden away and it's not so easy to get access, especially when you may choose to mount the keypad and LCD as a more convenient point on your machine.

I'm not that keen on electronics using 0.1" connectors for the motor connections, these have limited current capacity and can become unreliable due to vibration, thermal, tarnishing and are easy to misalign. It would have been nice to have screw terminals but I can understand why these connectors were kept as they are used on RAMPS and many similar board designs.

Summary

If you are looking for a compact board with a lot of future expansion this is a very good choice and will allow all sorts of further RepRap experimentation.



Megatronics V2

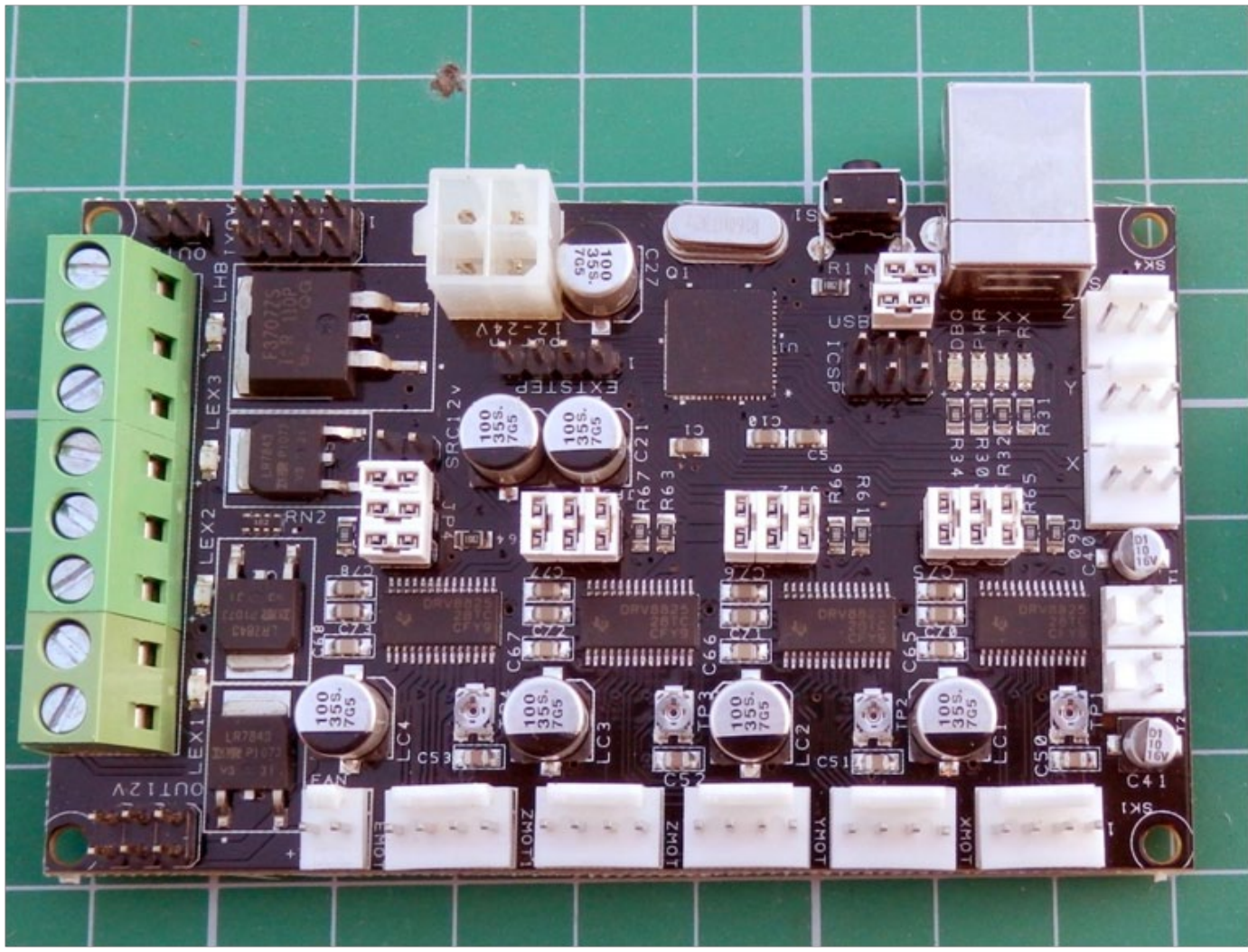
Minitronics

Minitronics is a very compact all in one RepRap control board, with four stepper drivers and an option for a fifth via expansion.

The processor is an Atmega1281 processor with 128 KB memory, running at 16Mhz, this looks like a normal FTDI RS232 port after power on so can be controlled via most host programs and upgraded via the Arduino IDE.

It's running the DRV 8825 stepper drivers so can achieve high current capacity. The PCB is used as a heatsink and must be cooled from the underside with a 40mm fan or bigger, this is important to do with such a compact board.

This is a highly compact all in one board, more than capable of running almost all single extruder machines along with a heated bed, powered from just a simple +12V connection via a Molex 4Way PC ATX style connector



Minitronics

Interesting to note the use of latching polarised connections for the Motors, end stops and thermistors, these have a bonus of being a little more secure than the standard 0.1" pin headers normally found. This should be encouraged and as long as the matching leads have the same style of connector should not cause issues. The only thing it does stop is the customer switching the motor direction easily by reversing the connector, but it's also easy to miss-align with the simple pin headers, so again the locking tab will help with reliable assembly.

It only has three end-stop connections rather than the normal six (that most people don't actually use) it has just two thermistor inputs if you did want to take the option for a fifth stepper driver for a second extruder, you would have to do this without a heated bed fitted or without temperature feedback of a heated bed if you did still want one, not a big problem.

It should also be possible to add a remote mounted SD card interface which is a great option that I hope people will use, my only disappointment is a lack of an expansion for LCD or Keypad so you will still require a PC connected to this controller to start the print, but not everyone will mind this.

The board has plenty of indicator LED's and is very easy to use, it should become highly popular in the market, if I can add a suggestion for Revision 2 to allow an a 'standard' expansion connector for LCD, full sized SD card and rotary encoder maybe by expanding the I/O pins with a simple shift register on-board it would really be my ideal set of off-the-shelf electronics for entry RepRap.

And as it's open source anyone reading this could do just that, me included.

Summary

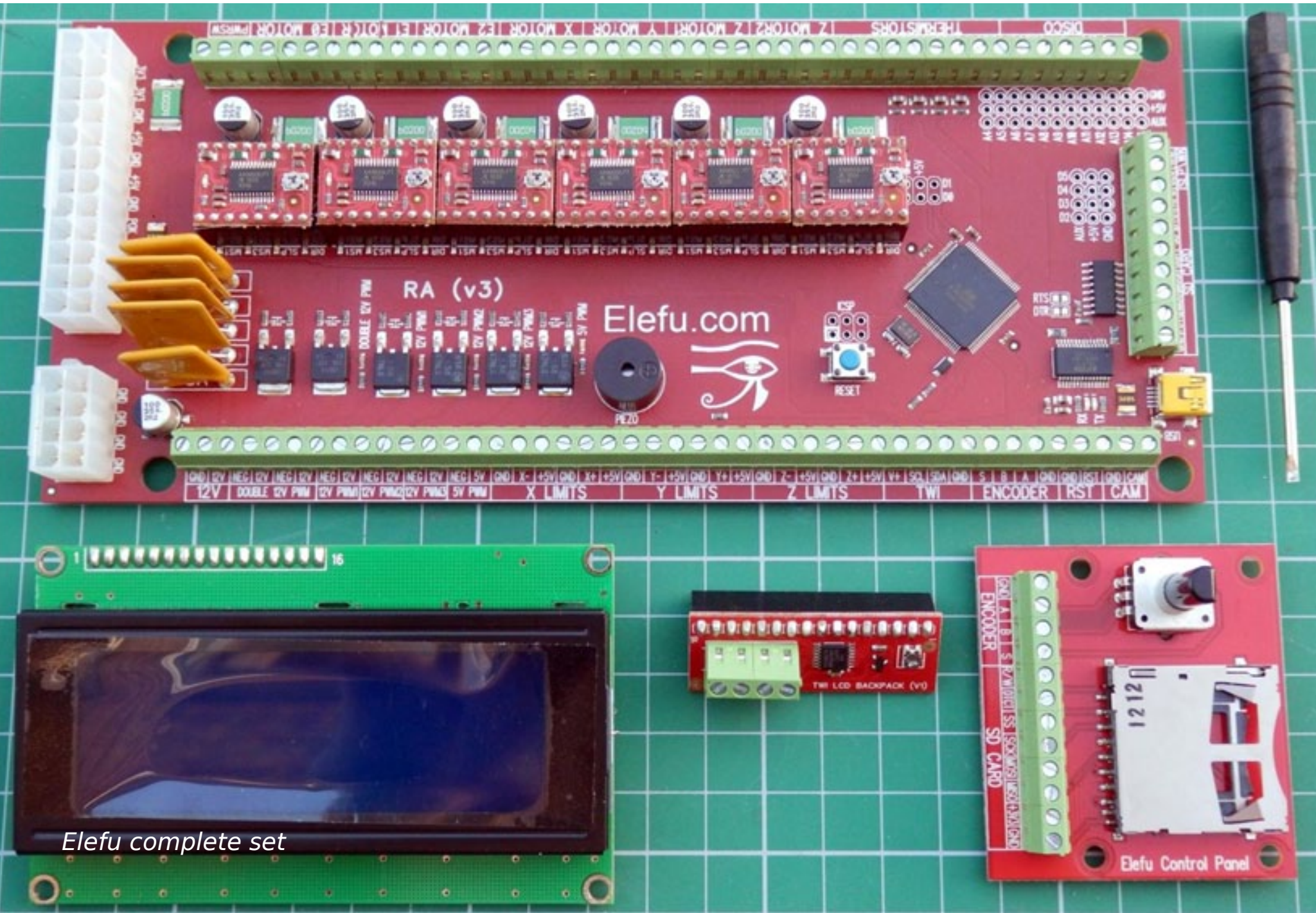
This board is going to be ideal for most people starting off in RepRap, it's also the lowest cost solution available at this moment with great stepper drivers and very easy connection and setup.

I can't stress enough how important it is for people to try running the Gcode from a SD Card, for most users it will make a really big difference to the quality of their finished prints.

Elefu - RA V3 Electronics

The Elefu electronics set is designed to be very easy to use and wire up, most things can be connected using screw terminals and wires, while this makes the board modules a little bigger than needed, it does make it accessible for everyone, as long as you do wire it up as per the instructions.

A complete set of parts can be bought from Elefu, the team is working hard to get full integration into common firmware releases so it's easy to select this as a standard option, you can even build up you own



Elefu complete set

board with these instructions http://blog.elefu.com/ra-assembly-instructions/

It uses screw-terminal connections all around, so it's very easy to wire up and has clear marking all around the PCB.

The development team have gone that step further to make it much easier for the customer, one aspect is in the LCD expansion, to save on pins and make wiring easy a serial to parallel adapter is used on the back of a any industry standard LCD module, the 16way plug allows just four connections to be required to the main-board. It's this sort of good design that could also be used on other minimal electronics like the minitronics above to allow LCD or other expansion options with only a few microcontroller pins and minor changes to firmware.

SD card and rotrary encoder have a few more wires, but top marks for making them on a separate board so it can be mounted away from the main controller when you choose on your machine.

Power comes from a standard PC ATX power supply, I'm not personally a big fan of using ATX power supplies with RepRap, but it does make a lot of sense for most users and anyone thinking about building up machine kits for sale, as most PC power supplies already come with CE approval and it's a very easy way to get high power and a lot of voltages.

Another nice feature is that being a PC supply you can shut down the power in software after a print is completed, something that the very early GEN 3 electronics could do, but not any I can recall since then apart from this Elefu set, quite a useful feature.

There is no power supply or power conversion used onboard as the ATX supplies all the required voltages, this makes the board look very clean and minimal, but does put all the emphasis on selecting a good ATX supply and relying that it stays in regulation.

Five polyfuses are fitted for any major over-current situations, note that these thermally resettable fuses can act quite slowly and still allow very high currents to flow, so will not always protect your electronics from all misuse or failure conditions.

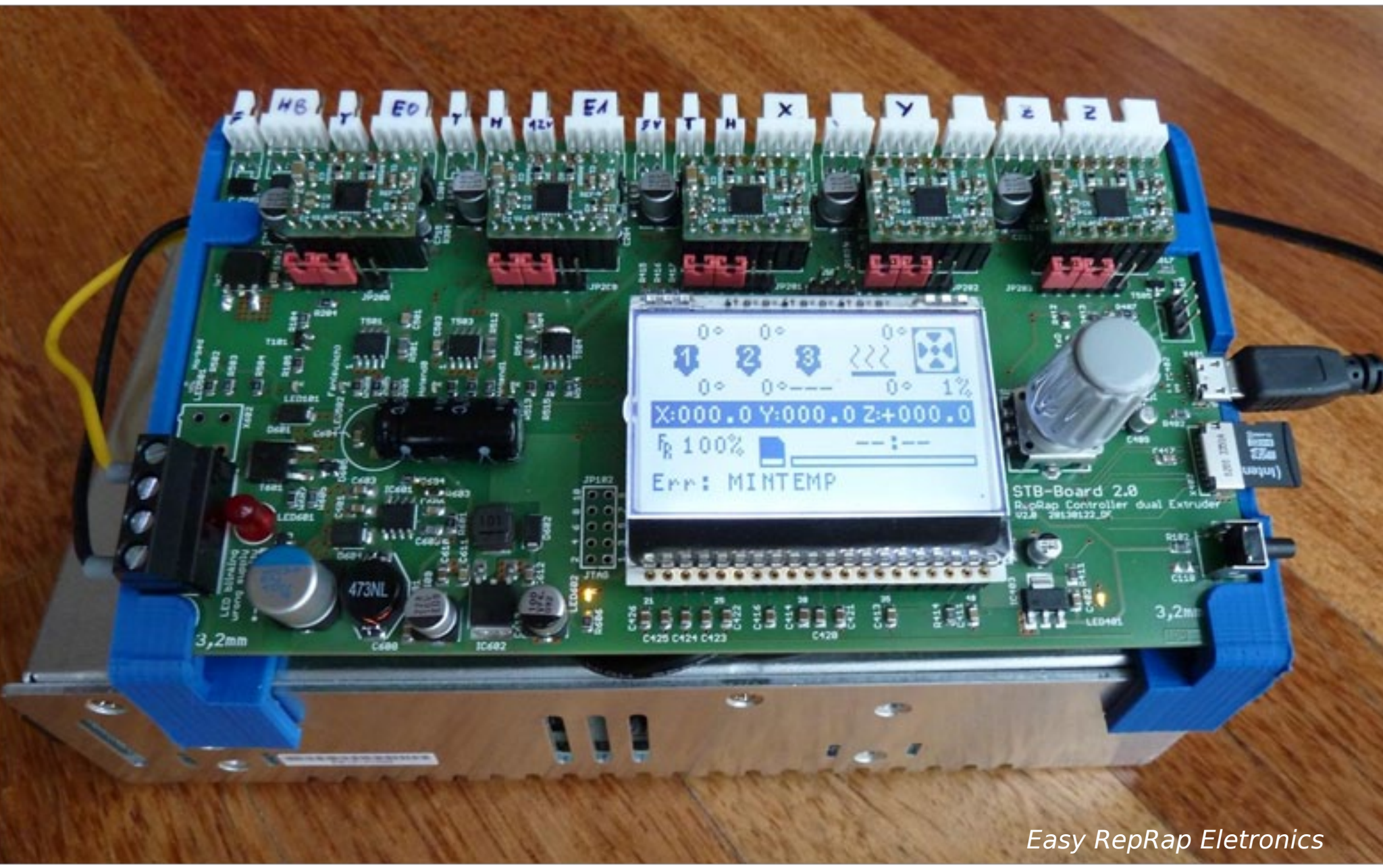
Three hot-ends can be driven and sensed and two heated beds or multi-zoned heating, maybe a chamber heater can be configured as required.

This electronics set was the first in the market to have six stepper motor driver options and has plenty of expansion outputs for adding lighting, camera trigger, even a sound control module so your machine can talk to you or play noises and tunes for different events or actions.

Summary

It's by far the biggest board set, but has some real thought and does not limit options or take any cuts on quality. A rock solid design that works very well, in many ways addresses all the issues you are likely to have integrating and wiring electronics into a machine. It has a lot of expansion options and the straightforward wiring will suit a lot of users and developers alike.

Elefu stepper drive close up



Easy RepRap Eletronics

Easy RepRap Electronics

This set is still running it's Kickstarter campaign so I could not buy a set to actually try out for this review, but I still wanted to include it as it offers some quite unique features.

It's probably the most integrated electronics set available. That does not make it ideal for everyone, but some will like the fact it's all on one board.

As mentioned above my only real issue with having everything all integrated is that it limits the design of the printer to some degree.

With many electronics sets for applications like this, it usually makes sense to have a power and control board all integrated and then a user interface, display and storage as a separate module connected via a simple cable, this way the power electronics can be integrated into the heart of the machine, often along with power supplies and motors and the user interface can be located at a convenient place for the user.

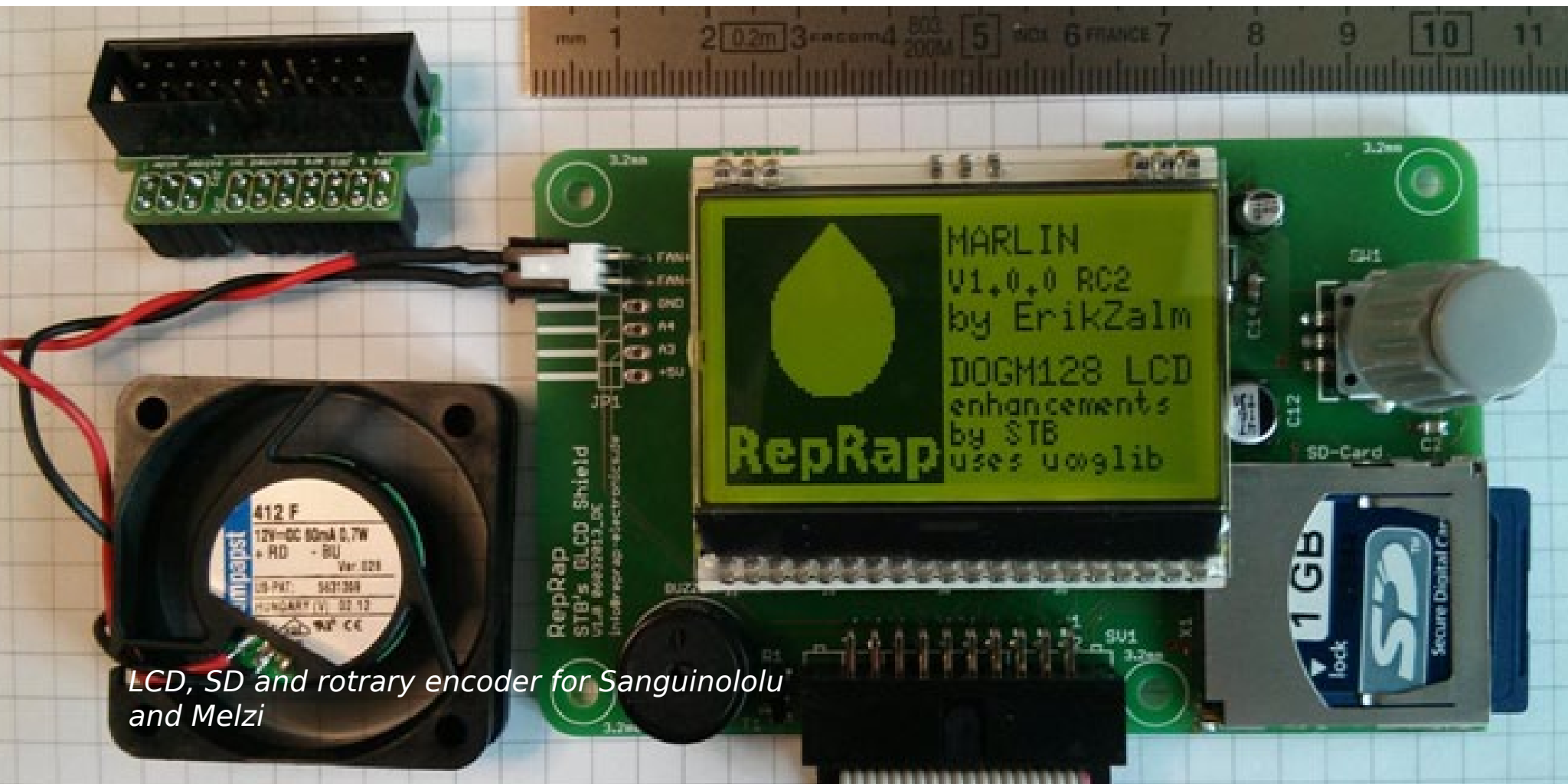
Because this board also uses a slow serial connection to talk to the SD Card that's another reason to have the memory card easily assessable to the user, so Gcode can be copied directly onto the card instead of very long and slow serial downloads.

This electronics set is very well designed, having a single voltage input and onboard switch-mode power supply with protection and even reversed polarity connection alert.

Easy RepRap Eletronics full graphic LCD

Easy RepRap Eletronics Switch-mode power supply.

Another campaign running at the moment from the same developer as the Easy Electronics aims to give Sanguinololu and Melzi users a very easy user interface option for LCD, SD and rotrary encoder on a seperate board. This is a really neat and compact board using a graphical LCD module, for me this would have been a great expansion option for the Easy electronics rather than having it all in one.



LCD, SD and rotrary encoder for Sanguinololu and Melzi

Comparison table 1

Board	RAMPS	Megatronics v2	Minitronics
License	GPL	GPLv2	GPL
Dimensions	100mm x 60mm	110mm x 95mm	95mm x 55mm
Power supply	.+12v .+24v	.+12v	.+12v
Processor	Atmega2560/Atmega1280	Atmega2560	Atmega1281
Speed	16Mhz	16Mhz	16Mhz
Memory	128KB/256KB	256KB	128KB
Mosfet Outputs	3	5	4
Stepper drivers	Module / A4988	Module / A4988	
Max Extruders	2	3	1 (2 with add-on board)
Max stepper microsteps	x16	x16	x32
Endstops	6	6	3
Thermistor inputs	2	3	2
Thermocouple	0 (+2 externally)	2 (+2 externally)	0
Programming IDE	Arduino	Arduino	Arduino
LCD option	yes	yes	no
Click Encoder or Keypad option	yes	yes	no
SD Card	yes (add-on board)	yes (built in)	no (external possible)

Comparison table 2

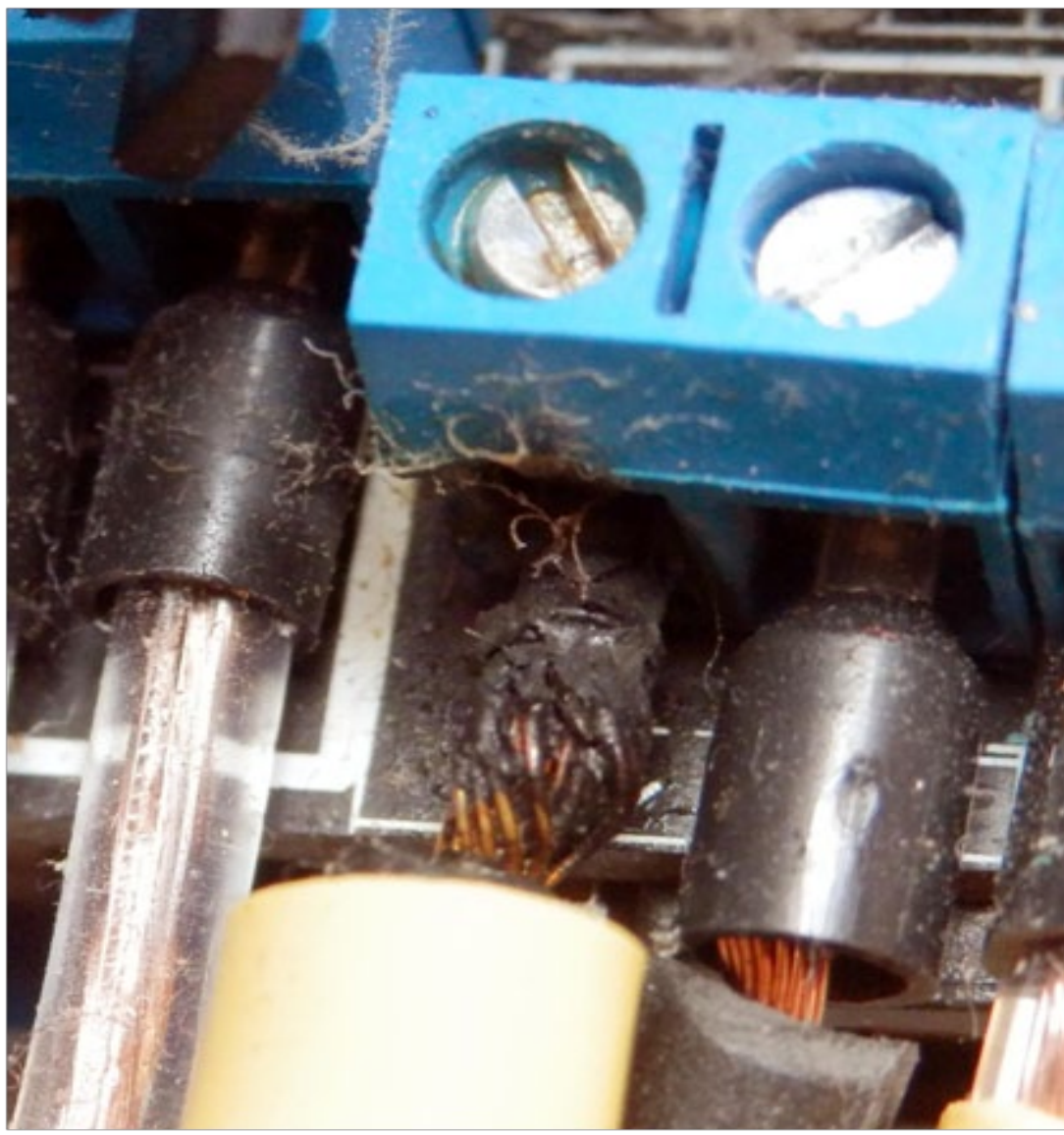
Board	RUMBA	Elefu RA V3	RepRap easy Electronics
License	GPL	GPL	GPLv2
Dimensions	135mm x 75mm	204mmx90mm	170mm x 90mm
Power supply	.+12v .+24v.+35v	ATX PSU	.+12v to .+24v
Processor	Atmega2560	Atmega2560	ATmega1284P
Speed	16Mhz	16Mhz	20Mhz
Memory	256KB	256KB	256KB
Mosfet Outputs	5	6	5
Stepper drivers	Module / A4988	Module / A4988	Module / A4988
Max Extruders	3	3	2
Max stepper microsteps	x16	x16	x16
Endstops	6	6	3
Thermistor inputs	4	4	6
Thermocouple	up to 3 (add-on board)	0	0
Programming IDE	Arduino	Arduino	Arduino
LCD option	yes - Various modules	yes	Graphic fitted onboard
Click Encoder or Keypad option	yes	yes	yes
SD Card	yes (add-on board)	yes (add-on board)	yes, built in

Electronics safety

I have had minimal failures over the last three years using RepRap electronics, most of the time it is a user mistake with incorrect wiring on initial setup or over current stepper drivers, inadequate cooling or just damage from shorting out things by accident. But I wanted to share one recent failure as something to watch out for and as a safety warning for using these machines.

The heated bed is one of the most frequent areas for failure, it handles the most current and is usually moving about potentially stressing cables and connections.

I had a slow failure on my oldest MendelMax machine and it turned out to be from the way the pre-built electronics had been manufactured, but this sort of failure is relevant for many other reasons.



Crimp terminal melted wiring

The first signs of this problem was the occasional printed object warping up or poping off the heated bed after an extended period of printing of a few hours.

Over time I noticed a very slight smell of burning, this was very faint as my electronics were all being cooled by a 60mm fan constantly, but it was starting to get noticeable as I came back into the room running the printer.

I decided to investigate the wiring and electronics, I’m very glad I did.

The visual indication something was wrong was the above photo, this was showing local heating at the heated bed connection to the board, the crimp terminal for the bed wiring was melted. This sort of thing usually occurs with a poor connection, faulty crimp or even a loose screw terminal.

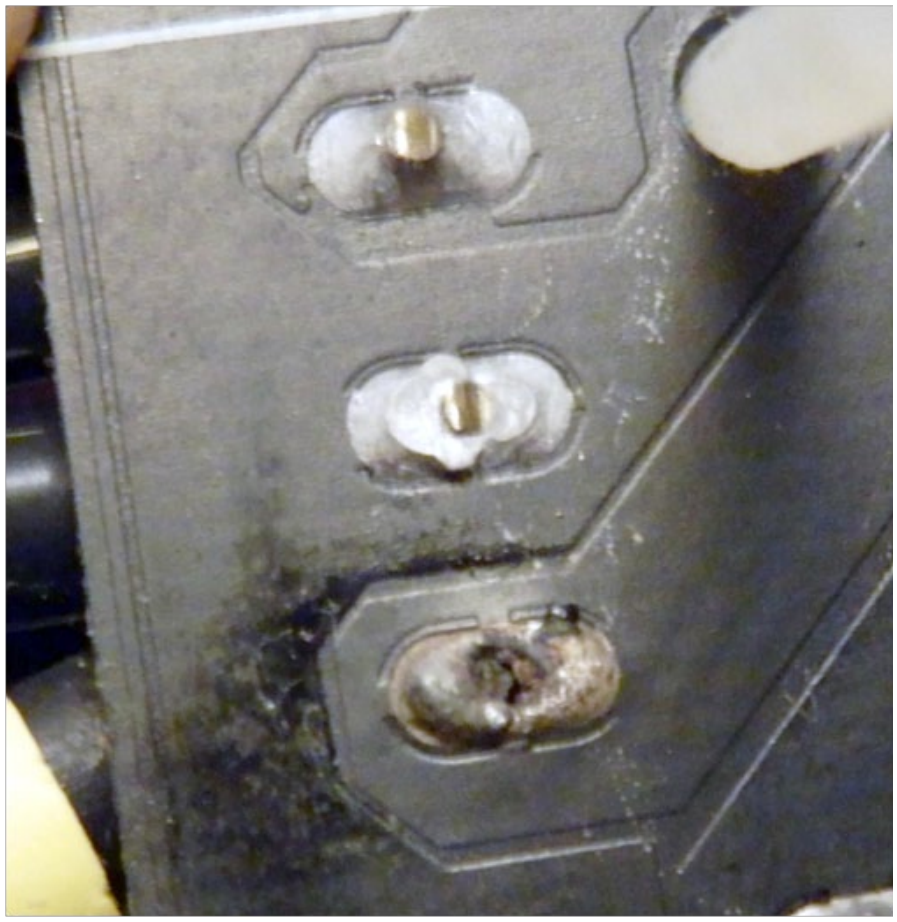
It’s always a good idea to use these sorts of ferrule crimps to terminate wires before going into screw terminals, they help make a good connection and ensure good conductivity.

ConducI was a little puzzled as the screw was very tight and the crimp seemed solid, so why was the insulation melted and the connector overheated? Time to take it apart and take a closer look.

Top pin shows a ‘good’ connection and correct pin cropping, middle pin has been badly cropped and is a poor connection, the bottom pin and pad shows our failure, most likely started off in a similar state to the middle pin.

After removal from the machine and turning over the board I could immediately see what the problem was. I had bought this as RAMPS 1.4 Electronics as a fully

built board set and when the board had been manufactured, the pins are normally cropped short, but on this board they had been cut way too short and even some of the solder was cropped off. This makes for a



Bad pin connection

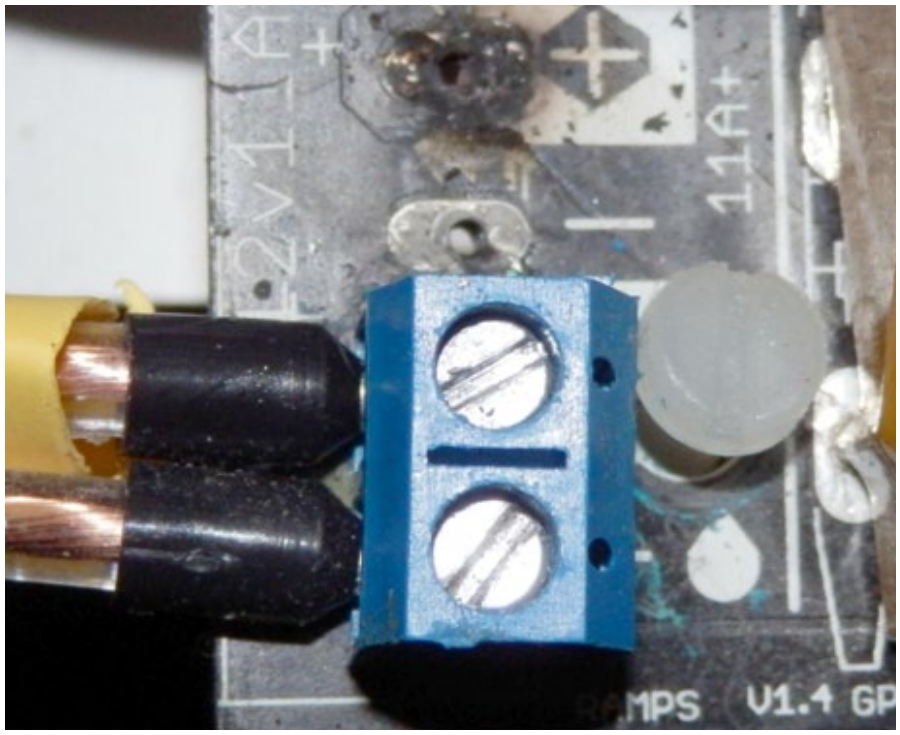
weak electrical and mechanical connection and only a thin layer of solder is holding the pin in the hole and making a connection.

Over time the thermal heating, current flow and a little bit of movement this joint starts to break down and fail, the pin arc's and has a poor connection, this generates local heat and makes the problem much worse, more time pases and the heat starts to affect the connector, crimp and wiring insulation.
Looking at the solder it also seems it has semi remelted (300+ degrees C) and further weakened the joint.

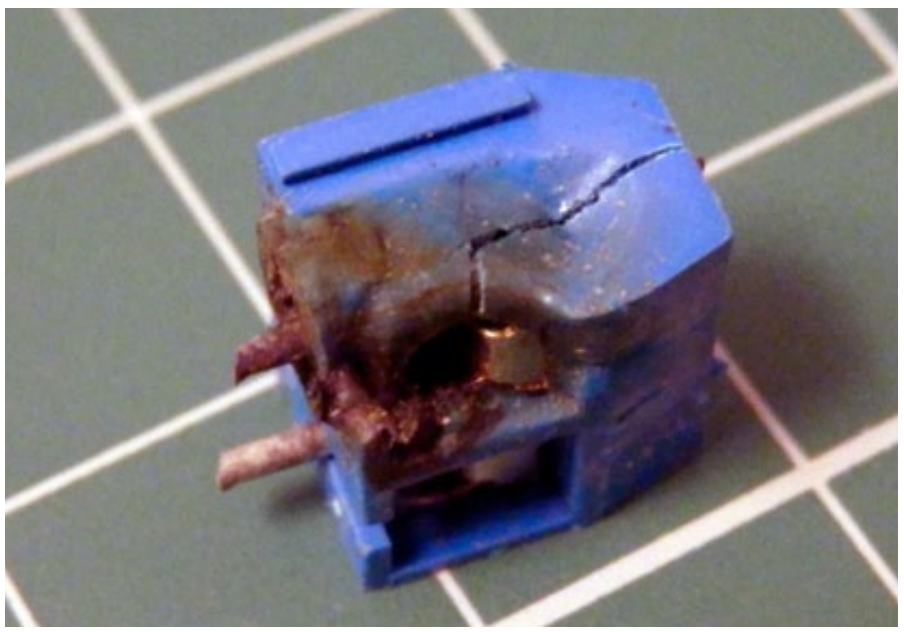
I had very big wires fitted and the ferrule slowed down the nature of this failure, it could have been a lot worse, quicker and more serious. You can see the way the PCB material has slowly burnt and the electrical pad has melted and 'eroded' away.

The big tracking, connector and PCB pads are all very good on the RAMPS design, so this was simply a bad manufacturing decision to crop the pin way too short and maybe the connections were also a little under-soldered.

It's not rust, but burnt materials. You can see that the pin has half melted to a point and the connector housing has had excess heating also conducting heat down the cable and across the PCB.



PCB pad has melted and 'eroded'



Burnt materials

For further information about use of electronics in RepRap, do take a good look in the Wiki first, there is already a lot of good information and advice on offer, and any further questions can always be asked on the Forum.

A good example is a recent article about Load switching with MOSFETS by STB *http://www.reprap.org/wiki/Basics_about_switching_loads_with_MOSFETs*

RepRap Future

RepRap Firmware

I had planned to go more into the firmware for RepRap, but that really requires an article in itself, Many new firmware ports are happening at the moment, with various ARM core based processors including the newer Atmel devices and even Beaglebone and Parallax Propeller. Raspberry Pi's are also being used as print servers and electronics interfaces. Things are getting very interesting and opening up another level of performance, operation and sophistication to our machines. So we will aim to do a further review in a future issue.

For the Adventurous

Many more electronics systems are also available, some harder to get hold of or still relatively new. Electronics well worth looking into include the following:

RAMBO board - An all in one Ramps style board with control of motor current limit settings configured in firmware and plenty of future expansion options.

Azteeg x3 - Another Ramps all in one board, this time with an optional 12v to 24V boost circuit for running your motors at the higher voltage. Fast acting blade fused instead of the slower polyfuse types.

And for ARM based options take a look at the 4Pi by Kliment, this is an all in one dual extruder design with a 32bit ARM processor and a custom port of the ever popular Sprinter firmware. Other developers are porting Marlin to this exciting new electronics platform.

Another ARM based controller is the Smoothieboard, firmware is being developed and can be found here

And we can only speculate on the the new ARM board and firmware design by ErikZalm:

"I am already working on the next version. It is for the STM32F4 and my own hardware design.

Porting Marlin is not dificult. But if you use a fast mcu there are more possibilities.

The grbl motion part is a nice start but I want to have better algorithms. A fast mcu makes it possible. "

Easy RepRap Eletronics full graphic LCD

Get started with Skeinforge

Pro-tips

Cameron MacLachlan

Author

Alias:
NewPerfection
Country:
USA
Website:
www.cameronmaclachlan.com

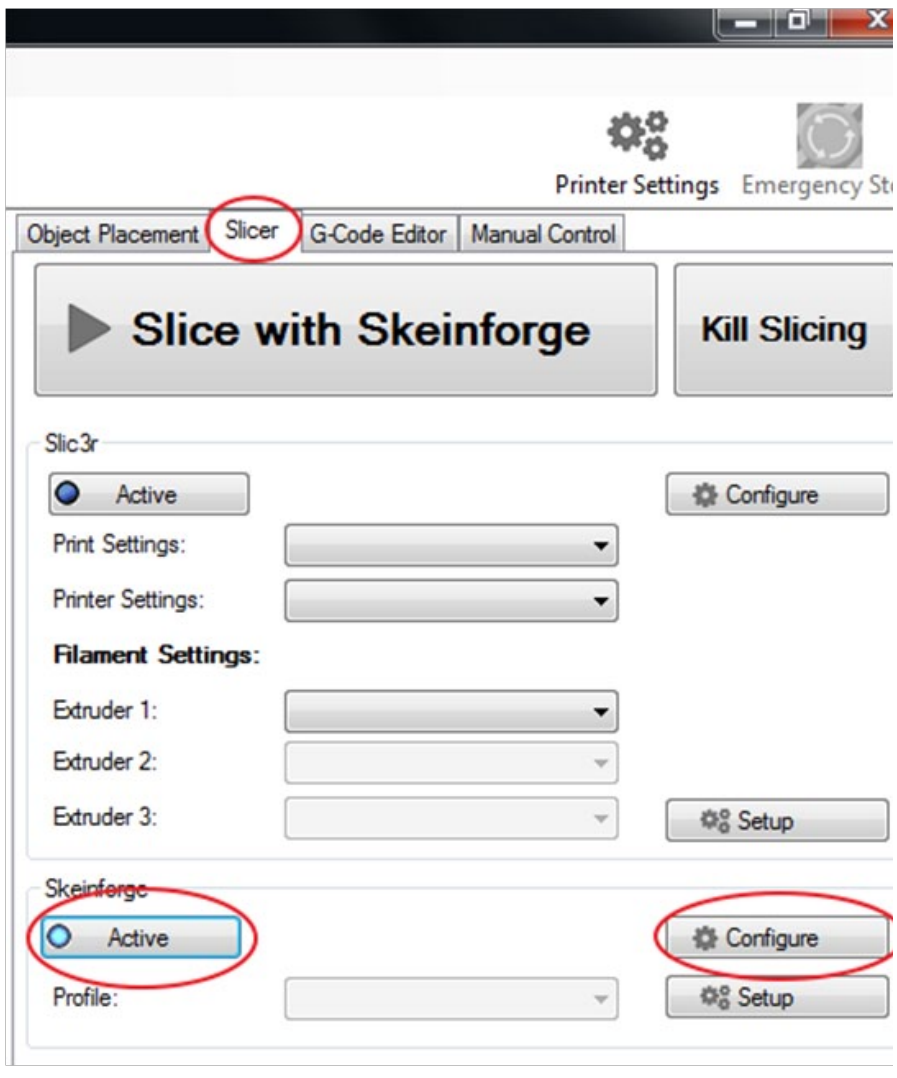
With the advent of Slic3r, Skeinforge has become less popular. I believe, however, that it still has its place as an accurate slicer with a plethora of options. That same seemingly overwhelming number of options though can make the program seem intimidating. With a little guidance and some patience, Skeinforge can be another tool in your RepRap arsenal.

This guide is intended to be a getting started guide and a supplement to other guides that are available, such as those here: http://fabmetheus.crsndoo.com/wiki/index.php/Skeinforge. It also assumes some familiarity with Slic3r and RepRap printing basics.

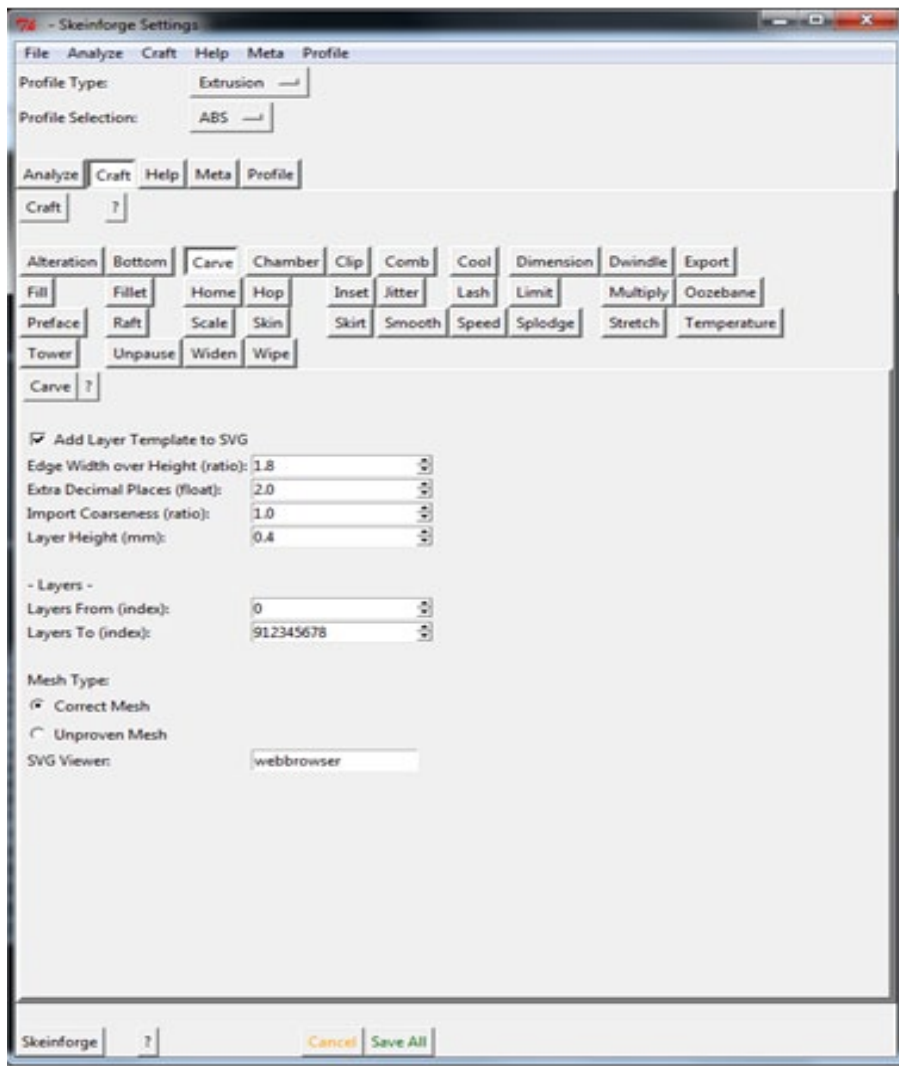
For this guide I am going to be using Repetier Host, which has Skeinforge built in. It also includes PyPy, which speeds up Skeinforge significantly over a basic installation, and Slic3r, for when you want basic slicing capabilities. Repetier Host also includes a nice 3D Gcode viewer. If you just want Skeinforge on its own, see the instructions at the link provided above.

To start off, download, install, and open Repetier Host. Go to the Slicer panel and activate Skeinforge, then click Configure.

A screen will be presented as shown below:

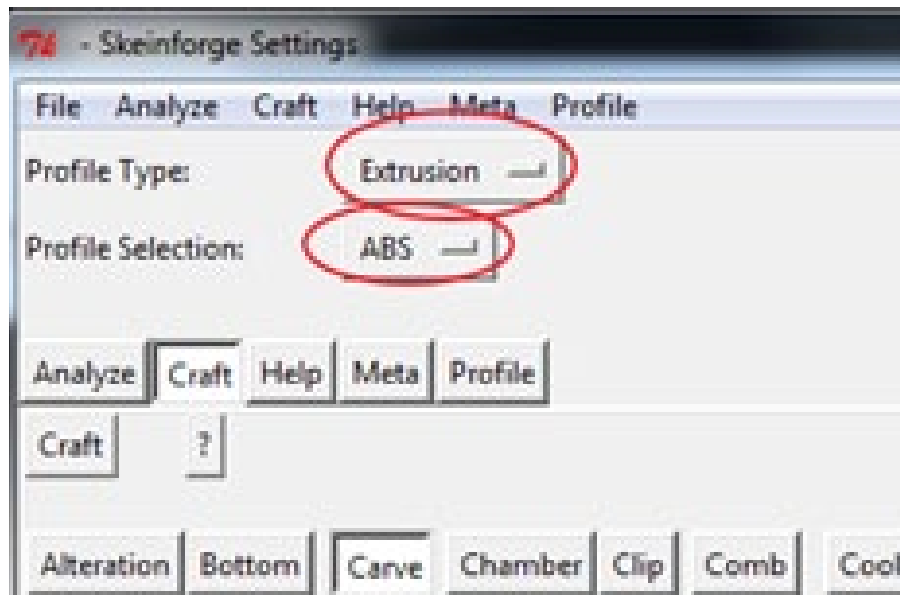


Repetier Host Slicer panel



Skeinforge main screen

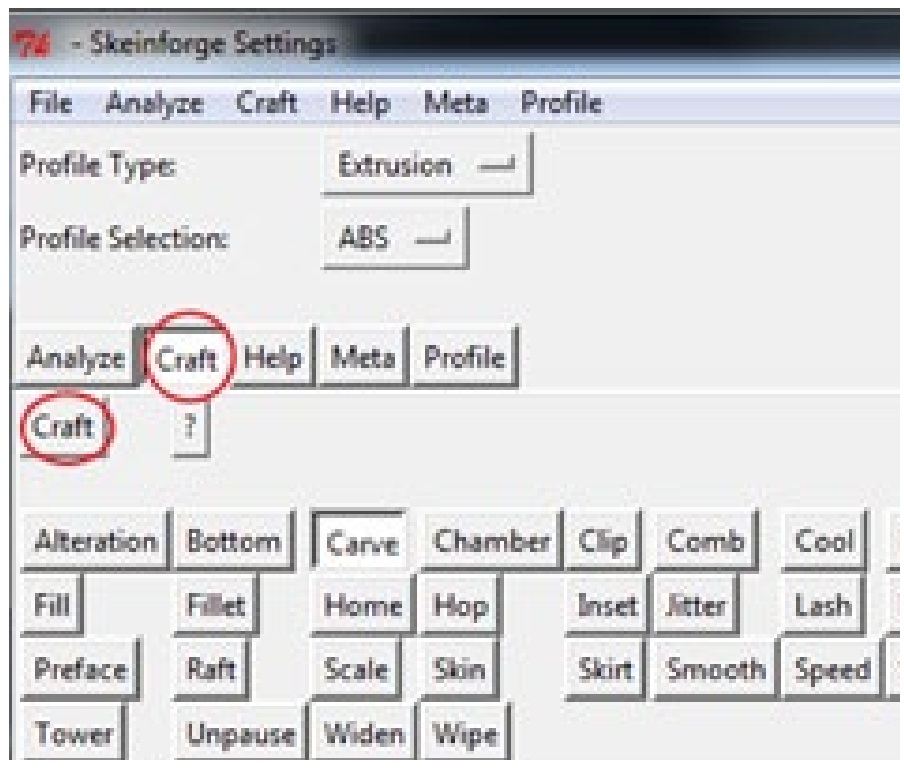
As this guide will focus on using Skeinforge as a 3D printing tool, the Profile Type we will use is Extrusion. For Profile Selection, select either ABS or PLA. These are simply names for the profile you will be creating. Other profiles can be created, but that is outside the scope of this article.



Profile Selection

Next are the main sections of Skeinforge: Analyze, Craft, Help, Meta, and Profile. Only Craft will be discussed here. You will notice that there are two buttons named Craft. The top one selects the Craft options, while the bottom one performs Craft on an object.

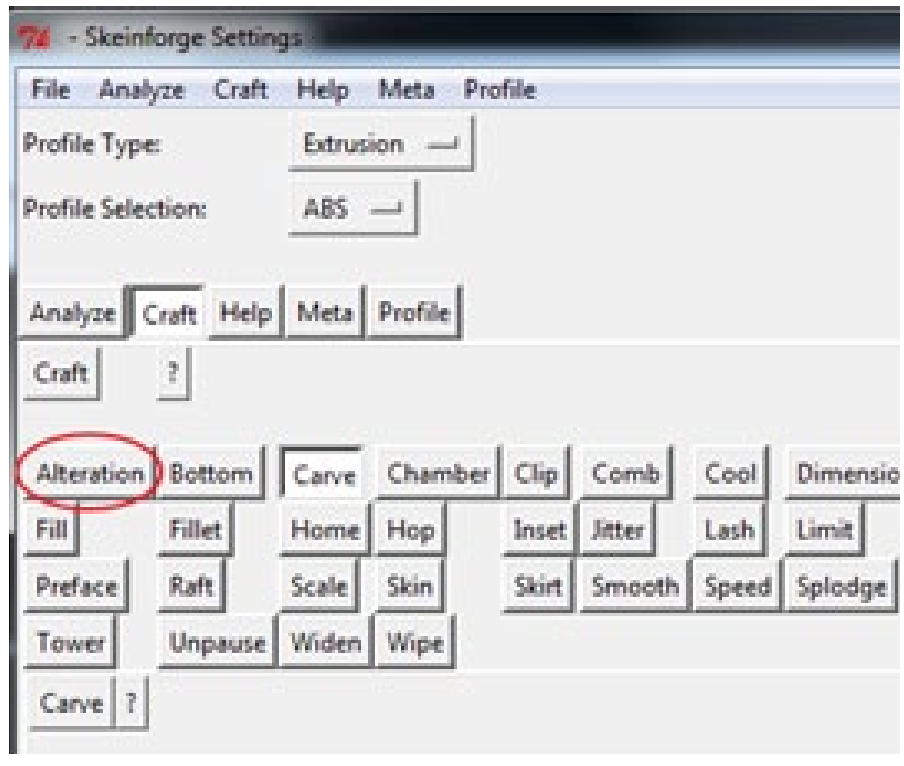
In this guide the bottom one will not be used.



Craft options

Underneath Craft, you will see a multitude of options, starting with Alteration.

Alteration performs simple operations on the final Gcode, such as adding start and end Gcode to the final Gcode file. With Repetier Host, this setting is not needed, as Repetier Host includes an area for start and end Gcodes.

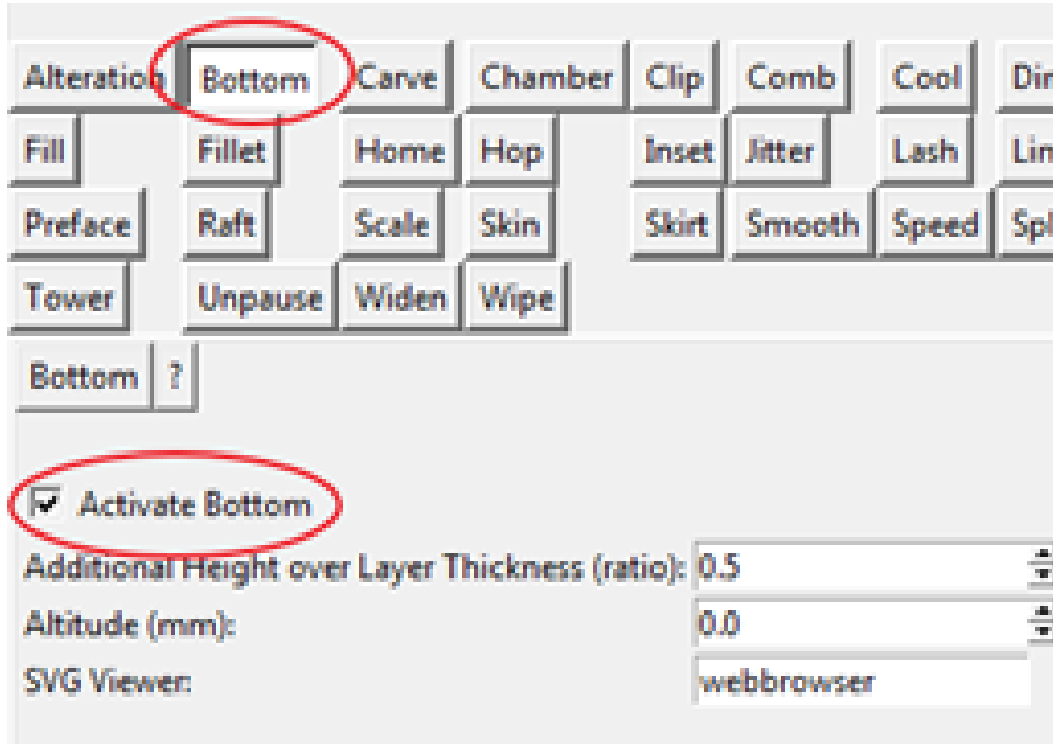


Craft options - Alteration

Bottom simply adds height to the first layer of the print, so that the print starts at a proper height above the build surface. The checkbox simply activates the Bottom module (all modules include this checkbox to activate or deactivate the module).

Skeinforge uses ratios to a great extent, starting with the Bottom module. At this point a layer height needs to be decided on. For this guide a layer height of 0.2mm will be assumed. Additional Layer Height over Layer Thickness (ratio) adds height to your print equal to your layer height times the ratio. For 0.2mm layer height and a 0.5 ratio, this adds 0.2mm * 0.5 = 0.1mm of height.

Altitude does the same thing, but allows you to specify the height in mm directly. The SVG option is not used in this guide.



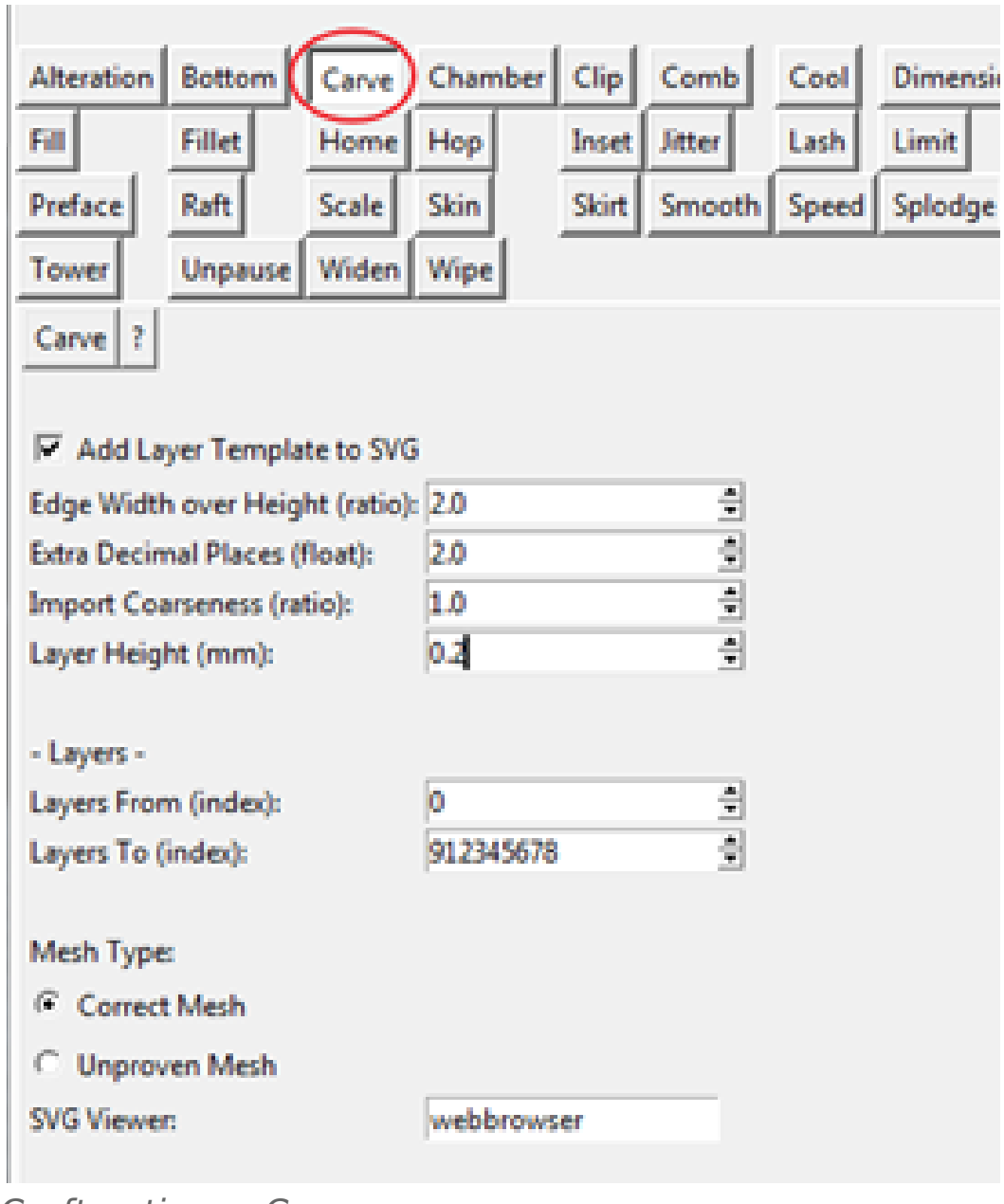
Craft options - Bottom

Up next is the Carve module. This module sets up the layer height and perimeter width. Add Layer Template to SVG is not used, and can be left as is.

Edge Width over Height (ratio) is the ratio of perimeter width to layer height. For a ratio of 2.0, that is 2.0 * 0.2mm = 0.4mm perimeter width. Extra Decimal Places and Import Coarseness can be left as-is. For Layer Height, enter the layer height that you would like to use (0.2mm in this guide).

Layers From and Layers To will allow inclusion of only certain layers. In this case, leave them as-is.

Mesh Type only affects the console output of Skeinforge. If Correct Mesh is selected and the STL file has errors, Skeinforge will throw warnings. If Unproven Mesh is selected and the STL file has errors, Skeinforge will ignore the errors. Again, SVG Viewer is not used.

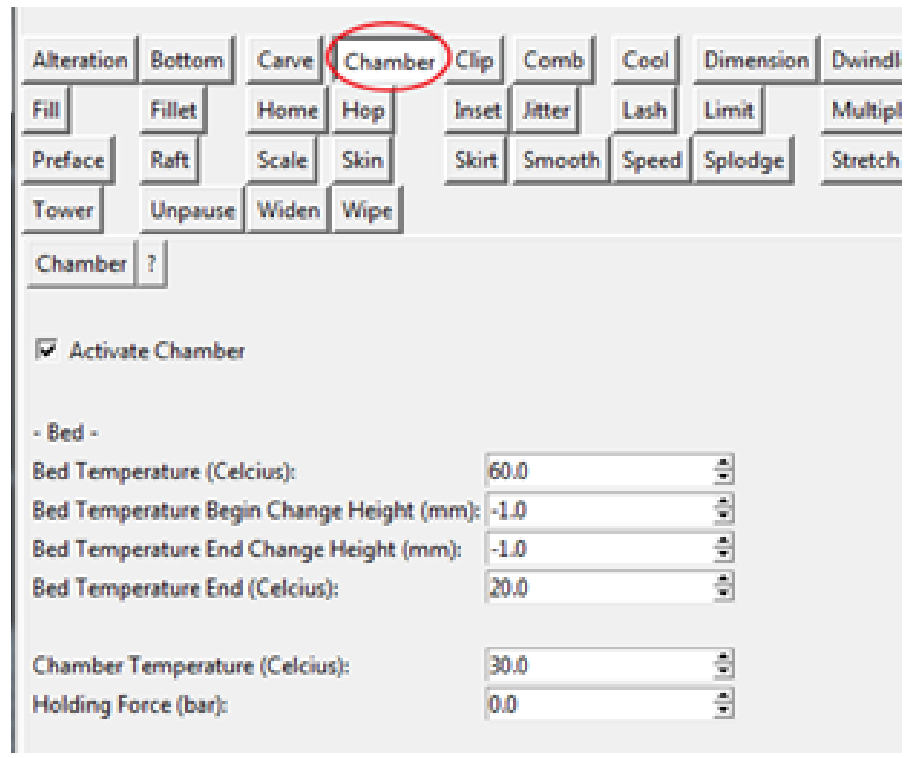


Craft options - Carve

Following Carve is Chamber. This module controls heated bed temperature and heated chamber temperature, if you have one.

Bed Temperature is the temperature the heated bed will be run at. For PLA this is usually around 60, for ABS this is around 110. Bed Temperature Begin Change Height, Bed Temperature End Change Height, and Bed Temperature End control ramping the heated bed temperature. For this example, setting them to -1, -1, and 20, respectively, will disable bed temperature ramping.

Chamber Temperature is only used for printers with a heated enclosure. Holding Force is used when the machine has a vacuum or otherwise actuated table for holding down objects. It is not used in this example.

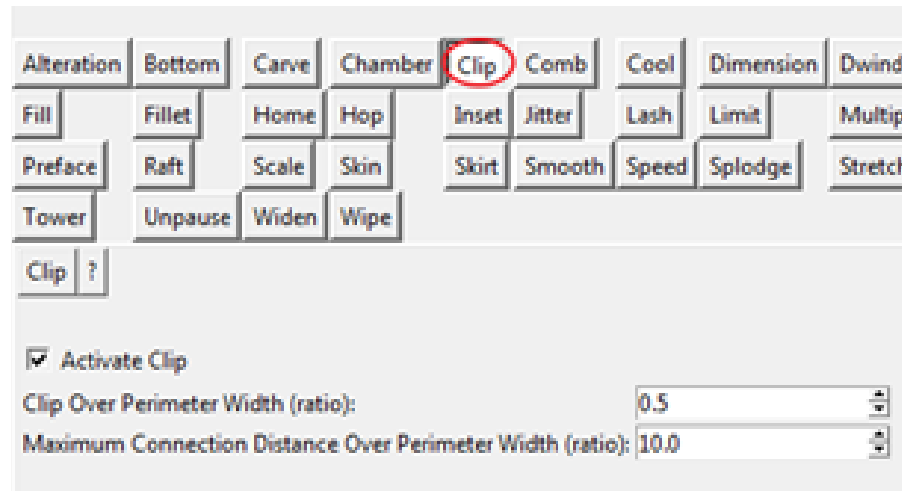


Craft options - Chamber

Next is Clip. This module controls the gap between the start and end of a perimeter, and whether one perimeter is connected to the next. These settings can be left as-is.

Clip Over Perimeter Width controls the gap between the start and end of each perimeter. Too large a number and the perimeter will have gaps. Too small and there will be bulges. The number is a ratio based on perimeter width, which is based on layer height, so 0.5 * 2 * 0.2mm = 0.2mm gap on each side, so the total gap is 0.4mm.

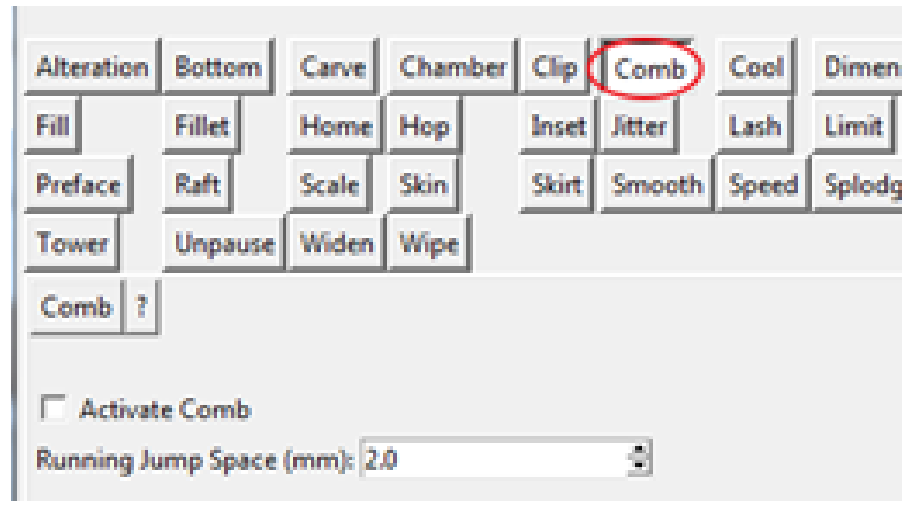
Maximum Connection Distance Over Perimeter Width is another ratio that defines whether an inside perimeter is connected to an outside perimeter. A ratio of 10 means that any perimeters that have a start and end within 10 * 2 * 0.2mm = 4mm will be connected.



Craft options - Clip

Comb is used to minimize stringing. Specifically, it minimizes crossing of perimeters. If stringing is a problem with your printer, then enable it. If not, it can be left disabled, as enabling it will slow down print time some.

Cool is important for printing small volume objects, where fast printing speeds may not leave enough time for a layer to cool before another layer is deposited on top of it. Cool sets a minimum layer time so that the layer has time to cool before the next one is laid on top of it.



Craft options - Comb

The next issue will continue with describing the features available in Skeinforge.

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Mastering Repetier-Host

Until an object is printed with a 3D printer, several processing steps need to be executed. The design goal of Repetier-Host is to help you handle all required steps within one piece of software.

For slicing, external software like the great Slic3r or Skeinforge slicers are called, but even this is done in an integrated way. The only sign showing you are using different programs are the changed designs of these. The basic steps are more or less self explanatory. For that reason, I will concentrate on the often unknown features and little tricks, which can help you master the work more efficiently. The description assumes you have the latest windows or linux version of Repetier Host installed, which is at the time of writing 0.85. Most of the said features also work on the latest mac version 0.54.

Configuring the host and slicer

For fast daily work, you will need good pre-settings. At first you go into the printer settings and define your printer. Here you can define any number of printer configurations. To use printer configurations efficiently, you should know what belongs to a printer setting. The following data is associated with a printer configuration:

-All values entered into the printer setting dialog.

-All codes in the g-code editor except the g-code. You need to press the little save button to store the code permanently with the printer configuration!

-Selected slicer and slicer profiles.These are stored on any change.

Depending on how many printer you have and for which purposes you use them, it may be convenient to have multiple configurations even for one printer. If you have two extruders you may like two setups, one if you only want to use one extruder and one for the use as double extruder.

Lazy and clever people finish one setup and then store the same configuration with a different name.

Print job initialization and end

Everyone has their own preferences how they like to start and finish the print job. The print job has three positions where you can change what is happening:

-The “printer” tab in printer settings
-The codes in the g-code editor
-In the slicer.

For a normal print using the host, the sequence of commands sent to the printer is as follows:

1-“Start code“ from the g-code editor.
2-“Start code“ from your slicer. This is the beginning of the slicer generated g-code.
3-The generated g-code.
4-“End code“ from your slicer. This is the end of the slicer generated g-code.
5-“End code“ from the g-code editor.
6-Actions enabled in the printer settings form.

As you see, the start and end code are listed twice. So which one to use? If you use the one in the host, you have the same behavior for all slicers used and you can change them very fast. If you save them inside the slicer configuration, the code is already included in the generated g-code file and you can switch it by selecting a different slicer profile. Where you do it is more a personal preference, as long as you understand how it is handled.

If you save a sliced job with the „Save job“ button, you can select, if you want to include 1+5 or 6 together with the generated g-code file. This allows a fast copy to an SD card to be used later in the printer, without losing your initialization code. When using the SD card manager you have the same options for the upload.

If you want to save only the generated g-code file, use the little save button inside the g-code editor. This only works if g-code is selected. All other codes are saved as printer bound preset when you hit the save button!

Adjust other codes in g-code editor

If you followed the tutorial with a host in parallel, you may have noticed there are some more codes in the g-code editor. The „Run on pause“ will be handled later. The „Run on Kill“ code is something nobody wants to use. Every time you hit the „Kill Job“ button, this code and afterwards the set kill actions from the printer settings get executed. Here you could move the extruder in a parking position. The last five are plain scripts. These codes get sent to the printer by selecting the matching send script action in the printer menu. Place here some codes you need frequently.

Optimized workflow

Preparation

The work starts with the object you want to print. First you have to create it or get a copy from the internet. In order to import it later, you need to export it in stl format. The stl format is a simple list of triangles with normals pointing outwards. To prevent any problems, make sure only the outer hull is contained. If you have two intersecting solids, the generated stl format is non-manifold and the slicer will complain this. If you need intersecting objects, always merge them to one object before exporting them.

Importing stl files

The first step in your workflow within the host is importing the created stl files. If you have different printer, make sure the right one is selected, so the dimensions match the one of the destination. Then go to the “Object Placement“ and import the files. You can do this by dragging one or more stl files onto the host window (mac users drag the file on the host icon in the dock) or using the “Add Object“ button, where you also can select more than one object at once.

The host will position the new objects in a non-intersecting way, if possible. If you want to change the position select the object to move with the right button. Press shift button to mark more than one object. Then you can drag the objects while holding the right button to any position you like.

Expert tip: Never leave the rotation mode for the 3d view. You can rotate the view with the left mouse button. Press shift and left mouse button to shift the view. Use the scroll wheel to zoom in and out.

Slicing

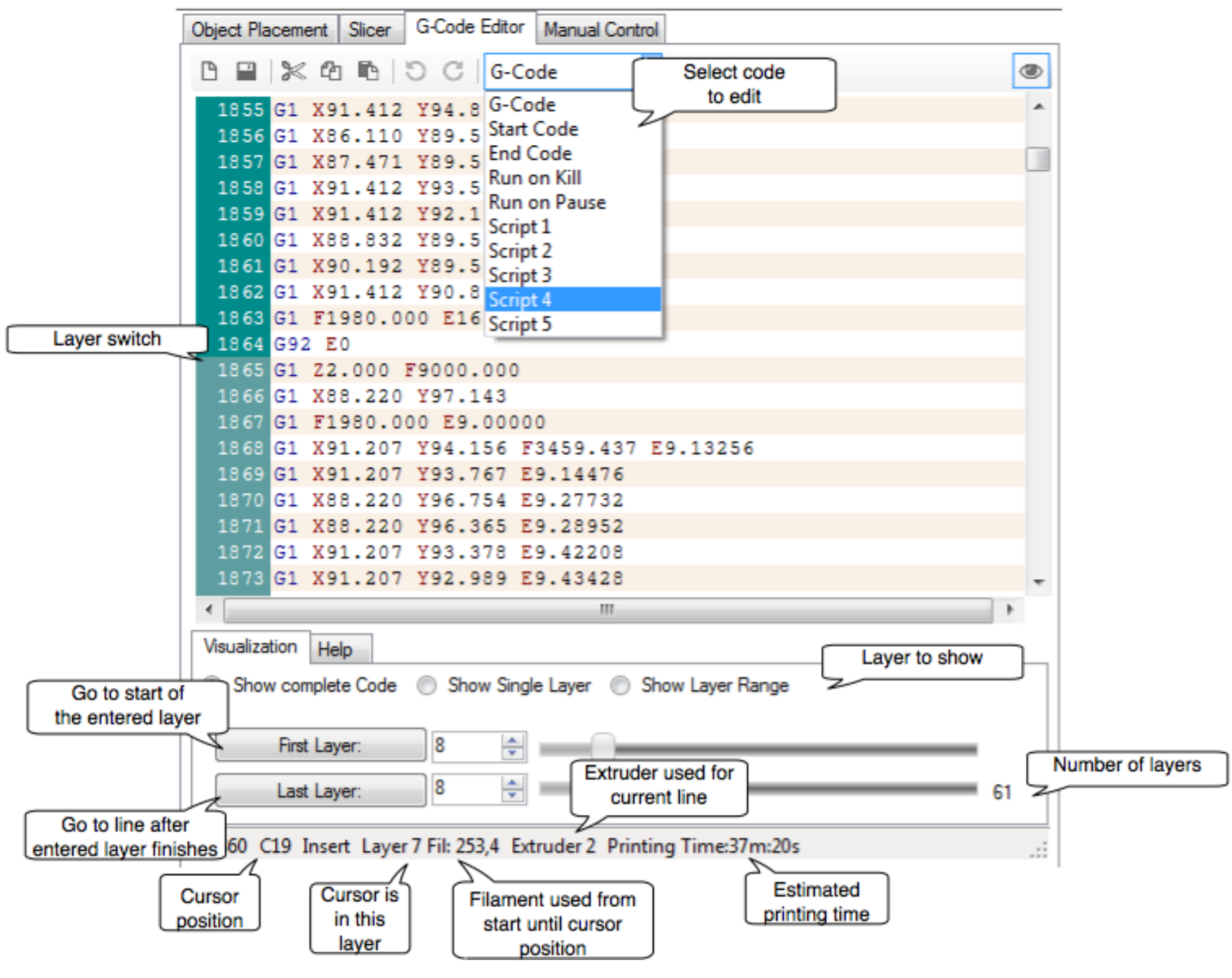
The host has no own slicing function. Instead it uses Slic3r or Skeinforge/SFact for the slicing. These slicer allow the definition of profiles. If you go into the slicer tab in the host you see which slicer will be used, when you start slicing and which profile will be used.

If you always use the same slicer settings, you can start the slicing process form the object placement tab. If you are not sure, switch to the slicer tab. If you have stored your working slicer settings you only need to select the kind you need for your current print.

Once your profiles are selected you hit the slice button and wait for the slicer to start. In the wait window you have the option to start the print directly after slicing is finished. Do this only, if you trust your settings and know the result is as expected. In most cases, it is a good idea to verify the slicing result first in the g-code editor.

Verifying generated g-code

If you do not want to waste time and plastic with faulty prints you should always perform at least a short check, if the generated g-code matches your object and is printable or if you might need support where your slicer thinks you don‘t need support. Often the stl files are non-manifold, which can confuse the slicer, resulting in unexpected g-code shapes. If you have special cases like bridges without support, you should also test, if the lines go in the right direction and start with enough support.



The g-code editor has some tools to help you check the generated code. The image shows all the parts which can help you to orient inside your g-code. You start with a the complete g-code visible and rotate a bit to see and check the obvious, like supports you didn‘t want or missing parts.

Then you can show only a single layer and use the slider or up/down counter to navigate through the layers. Most layers are of minor interest. What you really want to see are layers starting with something new or with bridges where you might expect some errors.

Spice up your g-code

If you are satisfied with the created code, you can continue to print it, or you spice it up a bit. But what could you want to do with your code? For most codes produced this is enough. On the other case, special project require special additions. Two interesting cases are:

-Your print contains hollow parts, where you need to insert a nut, some balls or whatever you want. You need to insert the parts, before the holes are closed in the next layer.

-You want to change the colors depending on the z-height with only one extruder. In these cases you need to pause the print at a precise time. With prints taking hours and more, you are likely to miss that special moment. To help you with this, you can add so called host commands into your code. These commands are recognized by the host and executed by the host instead of being send to the printer, at the time it would be their turn. Host commands start at the first column with a @ or in newer versions also with ;@. The first command we need is the pause:

@pause Please insert the nut now

This has the same effect as pressing the pause button in the toolbar. The pause window will show the text behind the command giving us some hints, what to do. The big difference is, now we can set the exact line, when we want this to happen.

Now you need to find the line within half a million lines. No big problem if you know how to navigate to your destination layer. Select single layer, move to your layer and hit the „Last layer“ button. This moves your cursor to the first line of the next layer. If you hold the shift key while pressing the button, the code between your last position and that line gets marked. For most cases the layer switch is all you need. If you need to find a special line, you can hold the shift button and mark the code. You will see the marked code highlighted in yellow by default. Mark until you see the part you need gets also colored - congratulations, you have found your line.

If you use the pause command, you should edit the run on pause script. You do not want the extruder to stay above your last printed last. It will melt your print and ooze after a while. Instead, move the extruder to a position where it can‘t ruin anything and gives you access to your printed object. Then do whatever you want to do and continue the print. If your extruder had oozed a bit, prime some filament before continuing your print and wipe the ooze away. On continue the host will move the extruder back to the starting position and continue with the print.

Hint: You will get a little blob where the print continues. Therefore position the pause command at a position where it doesn‘t hurt, e.g. in the infill.

The next thing is, you want to be ready to do the special task. So how can the host help you to get ready in time?

There are three commands which might help you:

@info Get ready
@sound
@execute PathToExternalCommand Param1 Param2

The info command simply writes a message in the log. You are likely to miss it, but you could add some text about your next task in combination with the other commands.

The sound command is much better. At least if you are in the same room as your computer. If you have configured a sound for this command, it gets played.

The execute commands is our catch all solution. Write or install a program that sends you an email, a sms or whatever you want.

Print your object

If you came to this point, your g-code is ready and all you need is to send it to your printer. You have four possible ways, to achieve this.

Direct print from your host

This is the most versatile method. Only with this method you can use all the host commands. In the status bar you will see the remaining print time. Clicking on the time switches to the estimated finishing time.

The timing computation does not consider the needed accelerations, which is the main reason the time changes during the print. Instead, it adds a fixed percentage to the computed time, which can be changed in the printer settings. The little drawback of this method is, that it requires your computer to run all the time. And if your windows thinks it is time for an update or crashes in another way, your print is lost.

Upload to SD card

With the built-in SD card manager, you can upload the g-code including the start/end codes directly from the host. No need to switch sd cards all the time. The penalty you pay is, that uploading via serial connection is slow. For some tricks on speeding this up, see the last issue.

Copy to SD card directly

You can copy the g-code including start/end code if you click on the „Save Job“ button. You can even select the binary protocol, if you are using the host in combination with Repetier-Firmware. The direct upload on your computer is much faster than the serial transfer.

Use a remote print server

If you have Repetier-Server installed, e.g. on a Raspberry Pi, you can store the g-code to disk with the „Save Job“ button and upload it using the server web interface. Later Repetier-Host versions will get a server connector, so you can use the printer remotely as if it is connected directly to your computer. The nice thing with the server solution is, that the printer does not need to be near your computer. I have my Raspberry Pi with a wifi stick making it completely mobile in my house.

I hope you learned one or two tricks, helping you with your prints.I have my Raspberry Pi with a wifi stick making it completely mobile in my house.

With the availability of diode lasers with sufficient power for material processing and in price ranges from some ten to a couple hundred Euros (common DIY-range) it’s possible to modify an existing RepRap, a CNC-mill or old flatbed-XY-plotter to carry a slim, lightweight laser head and start laser-working at home.

445nm@500mW-fiber

DIY Factory

DIY Factory

Viktor Dirks

Author

Alias:
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Website:
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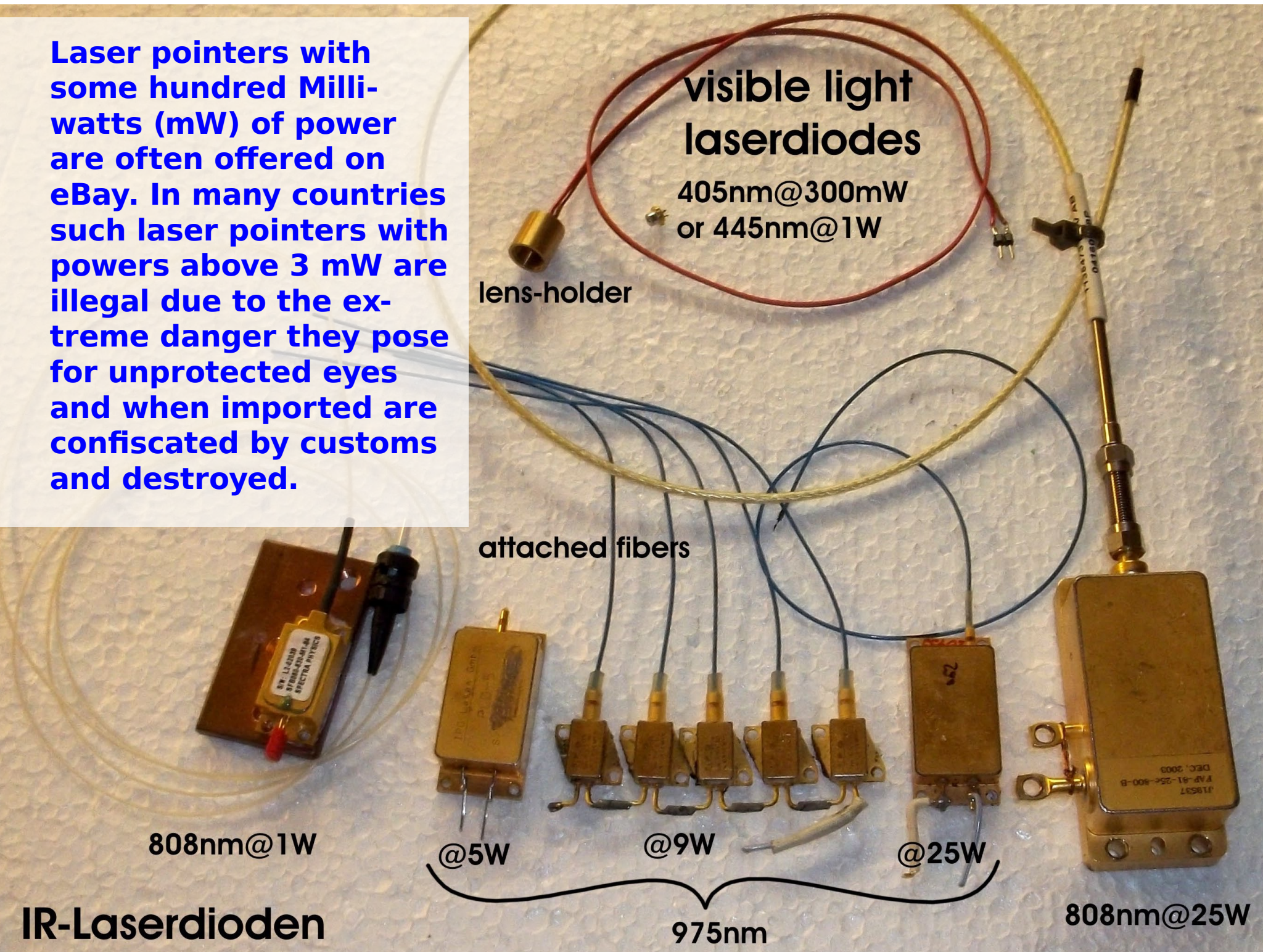
A DIY-laser tool with diode lasers for material processing.

Types and sources of diode lasers

Diode lasers with some hundred Milliwatts (mW) of power can be found in modern DVD-writers, in BluRay players and in some Digital Light Processing (DLP) video projectors. But also as ‘party-toys’ and ‘burning’ laser pointers on eBay. In many countries such laser pointers with powers above 3 mW are illegal due to the extreme danger they pose for unprotected eyes.

Better DVD writers often contain red laser diodes with a wavelength of 658nm and infrared laser diodes with 808nm wavelength and between 100 and 300 mW of power.

Laser pointers with some hundred Milliwatts (mW) of power are often offered on eBay. In many countries such laser pointers with powers above 3 mW are illegal due to the extreme danger they pose for unprotected eyes and when imported are confiscated by customs and destroyed.



BluRay players use ultraviolet (UV) laser diodes with a wavelength of 405nm and between 100 and 500 mW of power.

Casio was the first company to bring a DLP video projector using 24 blue laser diodes with a wavelength of 445nm and a power of 1Watt to market. Today it is possible to buy these blue laser diodes singly and often they can be reclaimed from such video projectors.

Green Diode-Pumped Solid-State (DPSS) laser pointers use infrared laser diodes with a wavelength of 808nm and powers of a couple hundred mW up to 1 Watt to excite the green resonator.

Infrared laser diodes with high power and wavelengths between 808nm and 975nm are used as light pumps for solid state and fiber lasers. Their power lies mostly between 5 and 25 Watts – but laser diodes with even higher powers are currently being developed.

In order to obtain such laser diodes it is worthwhile to find defective units where they are used and to cannibalize any useful parts. Often the focusing optics as well as the driver electronics can be used in addition to the laser diodes.

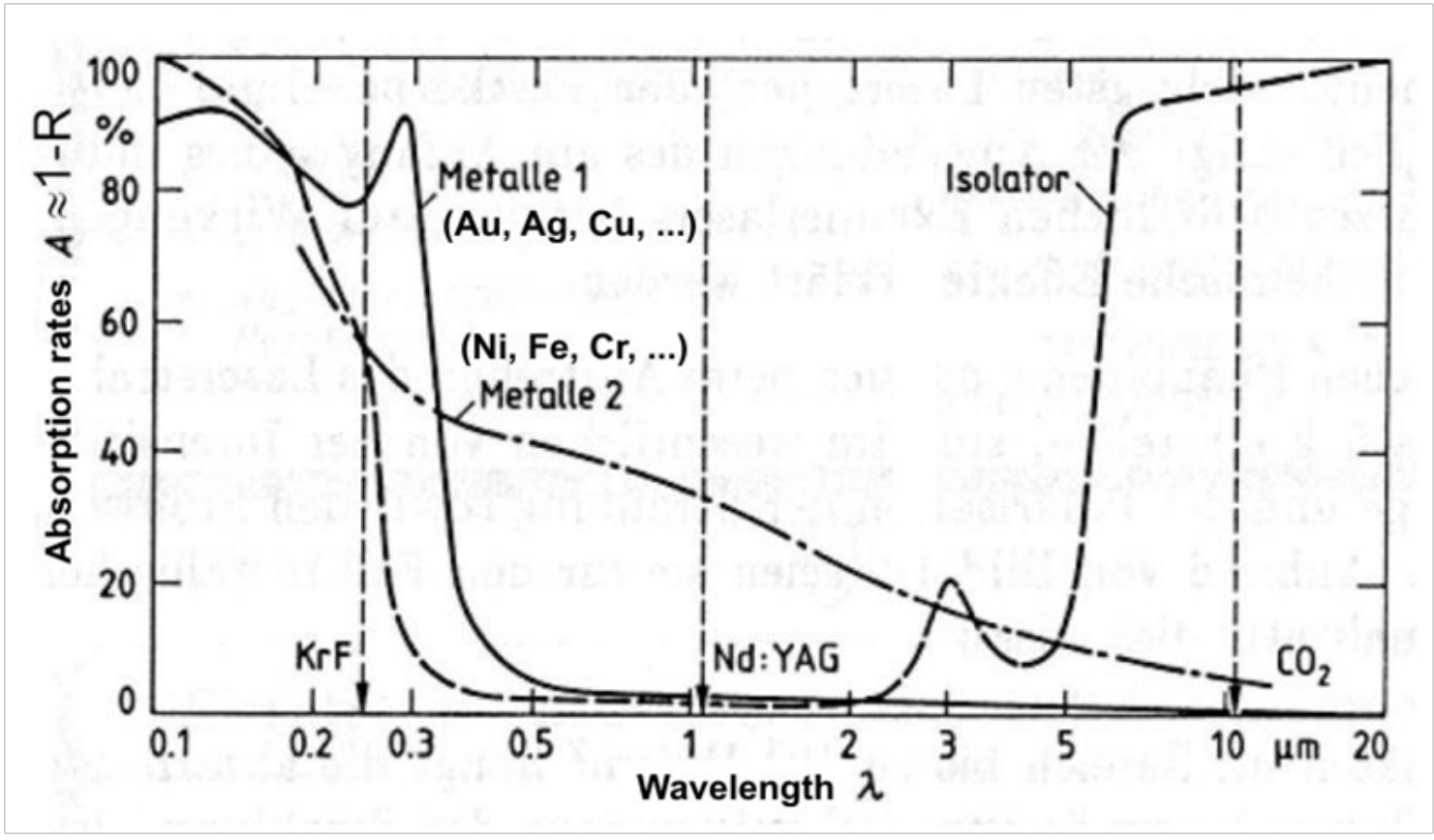
Another source are numerous online auction platforms as well as DIY and laser forums.

The normal price for commercial high power laser diodes is now so low that they could be used for hobby projects, e.g. infrared laser diodes with 9 Watts often cost less than 400 Euros.

Wavelength and Usage

The various wavelengths and types of laser diodes determine how they can be used and the maximum power determines the thickness of material that can be cut or depth that can be engraved.

The following graph shows the absorption spectrum for different materials:



Absorption spectrum for different materials

Here we see that most materials absorb very little energy in the visual spectrum (~380nm to 780nm) and in the near infrared (NIR) spectrum. So they require many Watts of power up to kilowatts in order to be effective in this wavelength ranges.

To increase the absorption carbon black or dark pigment can be mixed with plastic such that almost 100% of the energy is absorbed, such that, for example, black foil or foam can then be cut with power of only some Milliwatts, although only slowly and using a maximum material thickness of no more than a few millimeters.

As to the Diode types and power:

405nm @200mW:

-Just enough to engrave and to cut paper and bright plastic
-Useful for removing dark paint from copper boards
-Ideal for exposing photo film
-Ideal for hardening UV resin e.g. for UV 3D printing

445nm @1W:

-Just enough to engrave and to cut paper and bright plastic
-ideal for removing dark paint from copper boards
-Good for exposing blue light sensitive photo film
-Good for hardening UV blue light sensitive resin e.g. for UV 3D printing

658nm @300mW (from DVD writers), 808nm @300mW (aus DVD-Brennern), 808nm @1W with 0.05mm fiber:

-Ideal for engraving and cutting dark plastic
-Ideal for removing dark paint from copper boards

975nm @9W with 0.1mm fiber:

– ideal for engraving and cutting dark plastic
– ideal for removing dark paint from copper boards
– good for melting dark plastic powder and some metal powders

IR laser diodes with higher powers can run proportionally faster or be used to cut thicker foils as well as thin plastic boards.

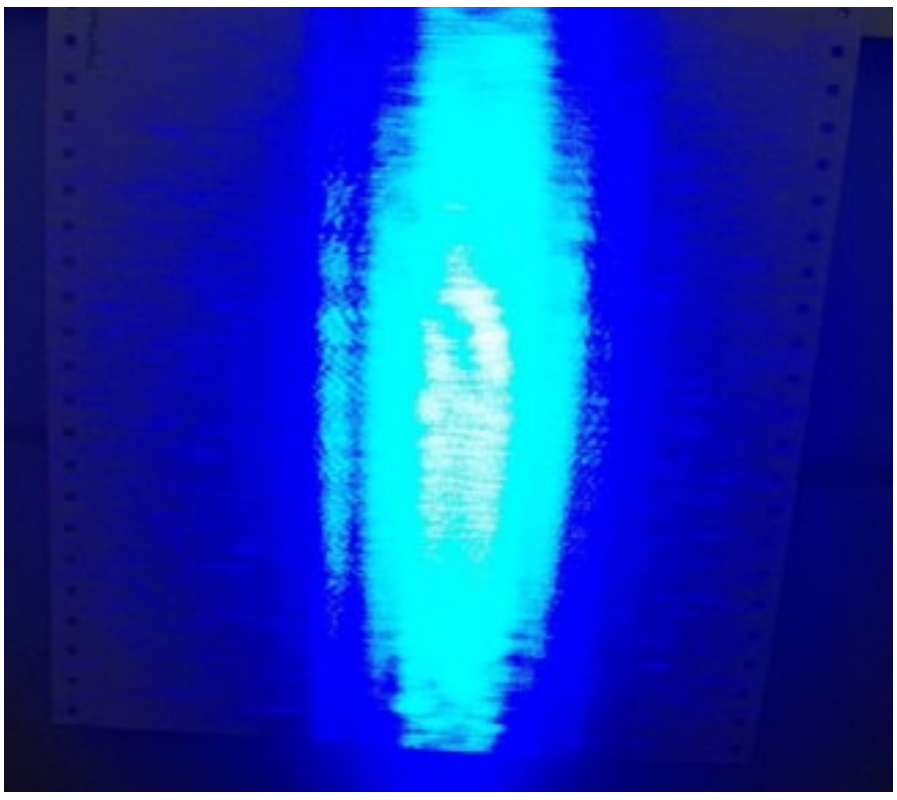
Dioden types	Photofilm	UV-resin	Paper	Folie sheets	Balsa wood	Dark plastics	Dark plastics Powder	Dark ceramic	Metal powder
405nm@200mW	++	++	o	o	o	o	o		
445nm@1W	+	+	o	+	+	+	+		
658nm@300mW				o			o		
808nm@300mW				o			o		
808nm@1W +0.05mm-fiber			o	+	-	+	++	-	
975nm@5W +0.1mm-fiber			-	++	-	+	++	-	
975nm@9W +0.1mm-fiber			-	++	-	++	++	o	-
975nm@25W +0.1mm-fiber			o	++	o	++	++	+	+

Legend: 0 works; - works poorly; + works well; ++ works excellently

Optical construction and focusing:

The typical beam from a laser diode (depending on its construction) is not a small round beam but instead a wide strip that is difficult to focus down to a point. Here are a few examples of direct beams without focusing optics:

405nm-Diode without optics-20cm

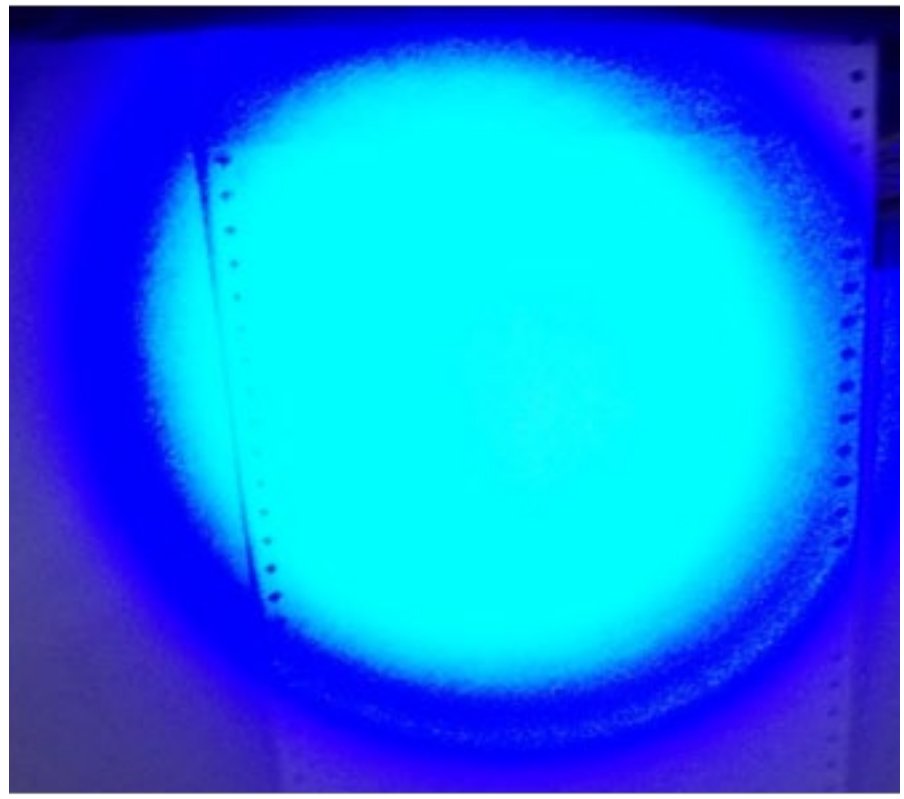


445nm-Diode without optics-40cm

In order to obtain the desired round beam, or to be able to properly focus the beam, a construct with prisms or cylindrical lenses must be used to compress it, however this requires very expensive prisms or lenses with a complex focusing mechanism.

Much cheaper is an aperture plate that only allows the middle of the beam through, however this means that the majority of the beam energy is lost.

Better suited are diodes with fiber optic cables, here the manufacturer positions the diode (sometimes coupled with focusing) such that a maximum of the diodes energy is sent into the fiber optic cable.



445nm-diode through fiber-40cm

The fiber optic cable bundles the laser light by total internal reflection such that at the end of the cable a perfect round beam emerges however no longer with the same properties (coherence, parallelism, phase and polarity) as the original laser beam.

Typical fiber diameters are 0.1mm, even more with higher power.

This beam due to its perfect symmetry can then be easily collimated (focused) using simple glass lenses.

With a 1:1 construction, where the distance from the end of the fiber optic cable to the lens and the lens to the focal point are approximately the same, we then achieve a focus diameter that is somewhat larger than the diameter of the center of the fiber optic cable.

By carefully adjusting the distances between the end of the cable, the lens, and the focal point, it is possible to obtain a point of focus that is somewhat smaller (how much depends on how homogeneous the beam is) than the diameter of the center of the fiber optic cable, however only by using high quality lenses.

445nm-diode collimated - 1m

Driver electronics and control:

The simplest and safest control method is to drive the diode using a constant current power supply with the maximum current set considerably below the maximum current for the diode, together with an appropriately sized radiator (and/or active cooling e.g. a Peltier effect cooler) such that the diode remains under 30°C even under continuous duty.

For currents under 1 Amp it is possible to use a constant current power supply together with an LM317 with a power resistor that defines the maximum current. The circuit can be taken from the LM317 data sheet.

Dangers and Safety measures:

When working with laser diodes with power over 5mW all observers must wear protective goggles to protect from damage or blinding caused by the laser beam.

The easiest protection is achieved using an opaque housing around the construction. A webcam can be added to the enclosure to allow observation of the procedure. Using this method even normally invisible IR laser diode beam can be seen.

In the next edition of the RepRap Magazine I will show possible areas of application for these self-built laser diode modules as well as showing some practical applications.

Prusa I3 visual instructions

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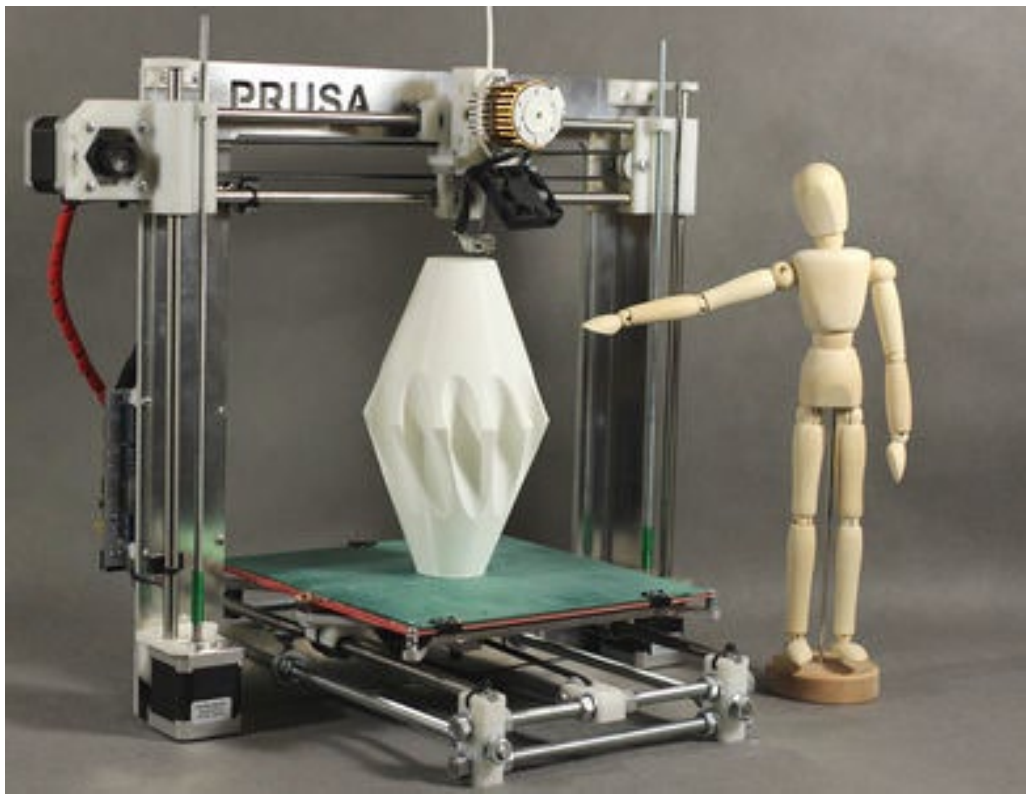
One of the most popular RepRap models is Prusa I2, but iteration 3 has already been released for a little while.. In this article we will show you how to assemble it.

If you are trying to build your first 3D printer then before you start getting the parts you need to know where you can find the resources you need to assist you on that process.

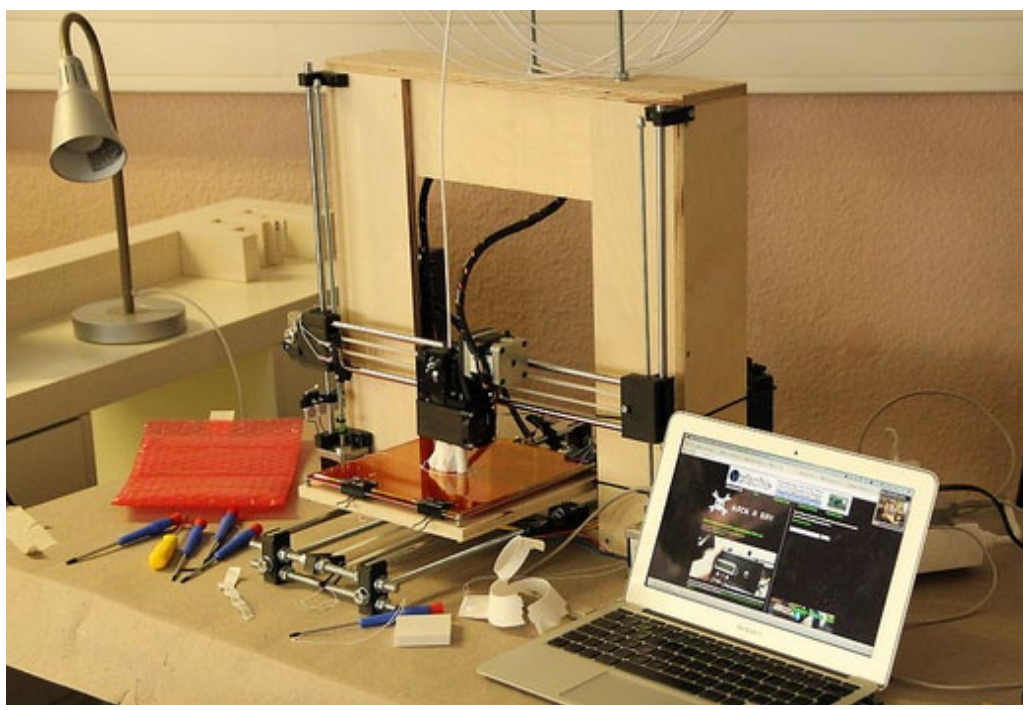
There are two basic choices, whether you buy a kit containing all the parts needed for your printer or you source the parts by yourself. The last option can consume some time researching for the best prices, quality of the parts and trying to get it from the small number of suppliers as possible so you can save some money on the shipping expenses.

Now the first thing I want to talk about is where to get the information you need. Currently the files required for the Prusa I3 are hosted at Github. There you can find the original version by Josef Prusa, the designer of the printer, but you can also find other people redesigns and modifications. Also you need to know that there are actually 3 versions of Prusa I3: Single plate, Box frame and the Mini version.

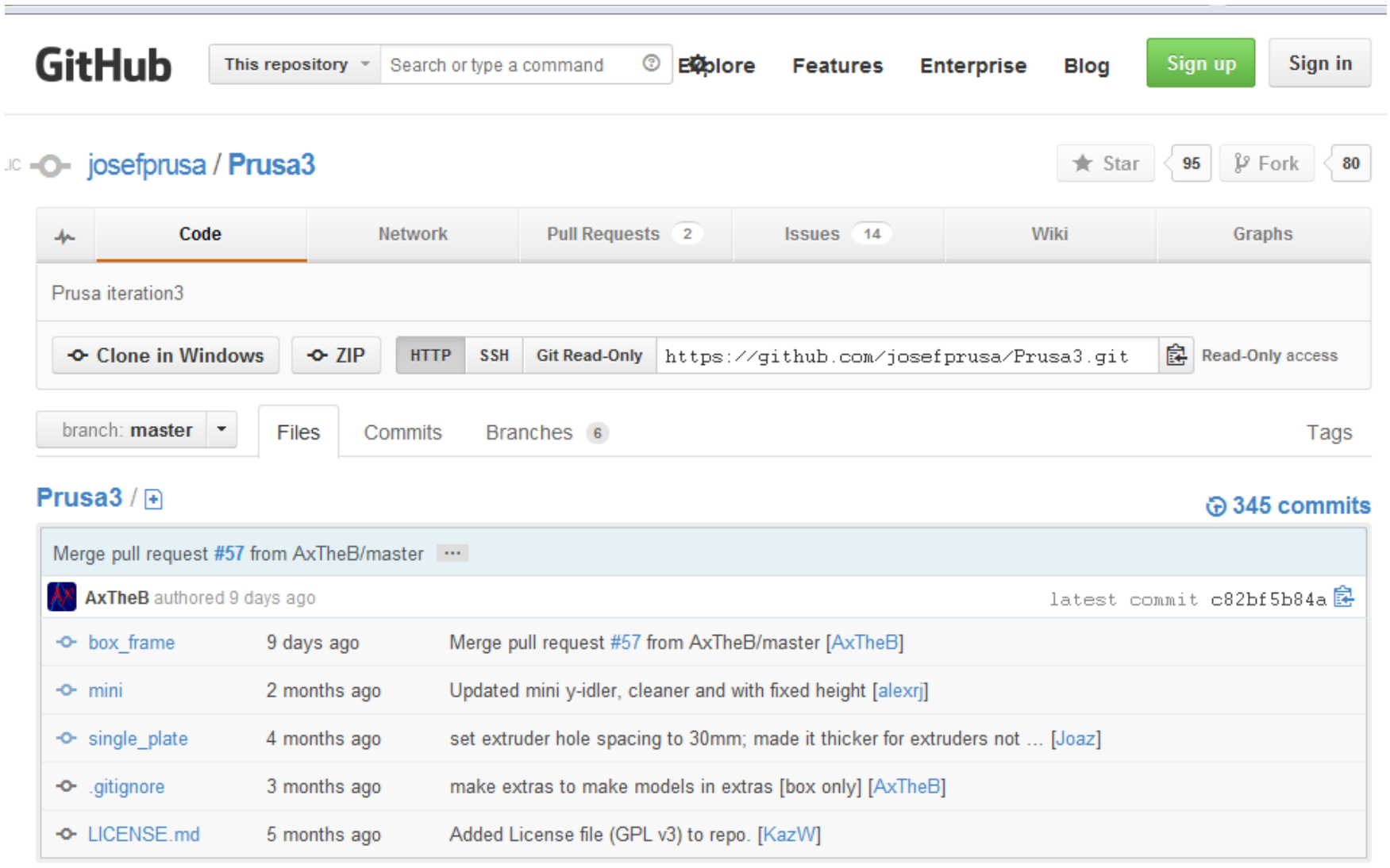
This instructions we will cover the Single plate version, the Einstein version. This version uses only M10 threaded rods on the Y axis, and uses 608 bearings on the idlers. Also we will use this version to use the Compact Dual extruder, and set you up with the possibility for dual extrusion right from the start.



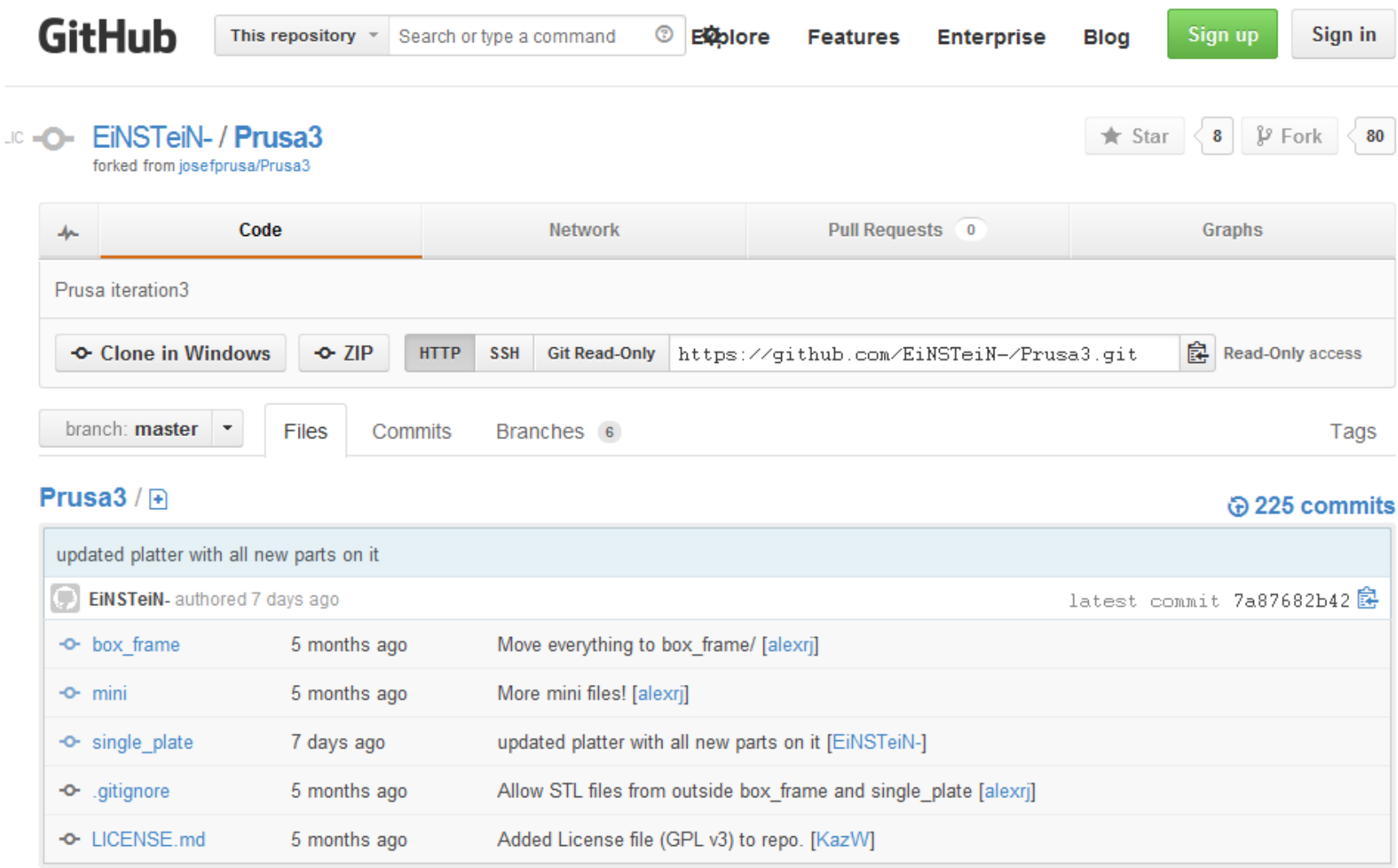
Prusa I3 - Single Plate



Prusa I3 - Box Frame

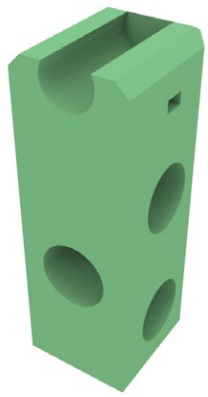


Josef Prusa GitHub repository for Prusa I3

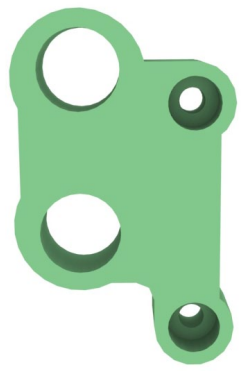


EiNSTeiN GitHub repository for Prusa I3

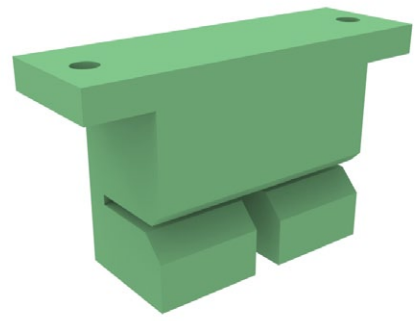
Printed Parts:



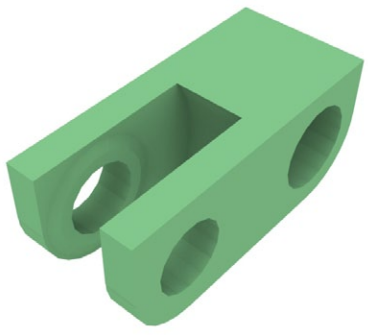
Y Corner - 4



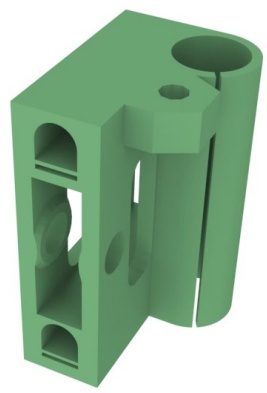
Y Motor - 1



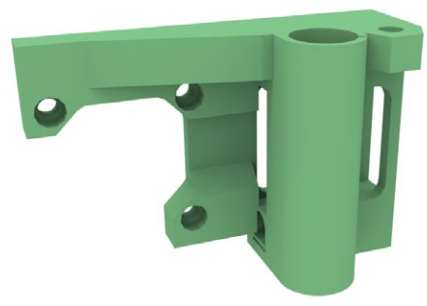
Y Belt - 1



Y Idler - 1

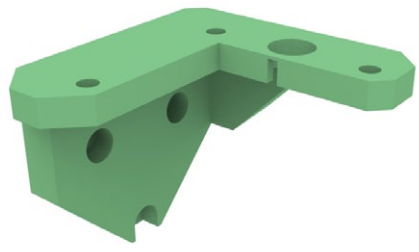


X End Idler - 1

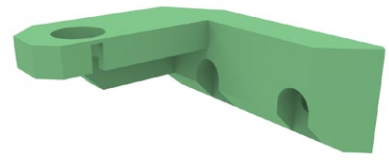


X End Motor - 1

X Carriage - 1

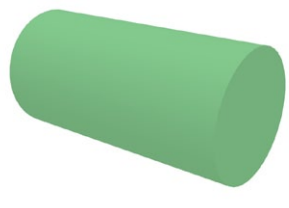


Z Bottom - 2 (Symetrical)

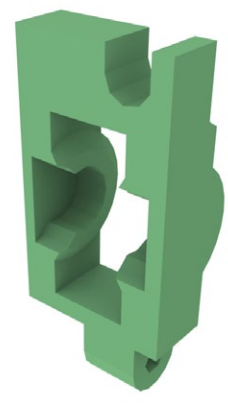


Z Top - 2 (Symetrical)

Extruder Boddy - 1



Idler Cylinder - 2



Extruder Idler - 2 (Symetrical)

BOM (Bill of materials)

	Part	Dimensions	Qty
	Aluminium frame		1
Hot-end	J-Head		1
	Thermistor		1
	Heating cartridge		1
Rods	Smooth rod 5/16	1 meter	3
	Threaded rod M10	1 meter	2
	Threaded rod M5	1 meter	1
Bearings	LM8uu Linear bearing		10
	608zz		3
Belts and pulleys	GT2 timing belt 2mm	~950mm lengths	2
	GT2 pulleys		2
	Mini hyena	5mm shaft	1
Motors	NEMA17 steppers	5mm shaft	4
	PG35L Geared stepper	5mm shaft	1
Electronics	RAMPS v1.4		1
	Power Supply 29A		1
	LCD controller		1
	Endstops		3
	Wire kit		1
	Power cord		1
	USB cable		1
	On/off switch		1
	Heat Bed		1
	45mm fan		1
Print surface	Borosilicate Glass		1
Nuts and bolts	M10 nut		50
	M10 washer	15/16mm MAX 18mm	50
	M8x25	width	2
	M4 nut		2
	M4x30 screw		2
	M3x10 grub screw		4
	M3x10 screw		11
	M3x16 screw		20
	M3x25 screw		20
	M3 standoff		4
Dual extruder	J-Head		1
	608zz		1
	Mini hyena		1
	PG35L Geared stepper		1
	thermistor	5mm shaft	1
	Heating cartridge		1
	Dual Fan Extender		1

Rod lengths

Rod	Size	Type	Qty	Length (cm)
Y axis	M10	Threaded	4	22
Y axis	M10	Threaded	2	44
Z axis	M5	Threaded	2	31
Z axis	M8	Smooth	2	34
Y axis	M8	Smooth	2	42
X axis	M8	Smooth	2	38

Wire lengths

Connect to?	Wire type	Length
PG35L motor (2x)	motor wire from rrd, male crimp	70cm
Z motor (right)	motor wire from rrd, solder to motor	30cm
Z motor (left)	crimp direct on 30cm motor wires	
Y motor	crimp direct on 30cm motor wires	
X motor	crimp direct on 30cm motor wires	
dual fan 40mm and single 50mm	motor wire from rrd, male crimp	70cm
dual thermistor	motor wire from rrd, solder to thermistor	90cm
power supply to arduino (2x)	red/black wire from reprapdiscount	50cm
bed	red/black wire from reprapdiscount	50cm
bed thermistor	2-wire thermistor connector from rrd	40cm
mains power connector	connect direct to power supply screw terminals	
endstop z	from rrd, female crimp	30cm
endstop y	from rrd, female crimp	50cm
endstop x	from rrd, female crimp	100cm
		(full length)

Others

Electronics

Ramps V1.4	1
Arduino	1
Power supply 29A	1
Endstops	3
Heatbed	1
Thermistor	3
45mm fan	1
USB cable	1

Aluminium

Frame	1
Bed Frame	1

Others

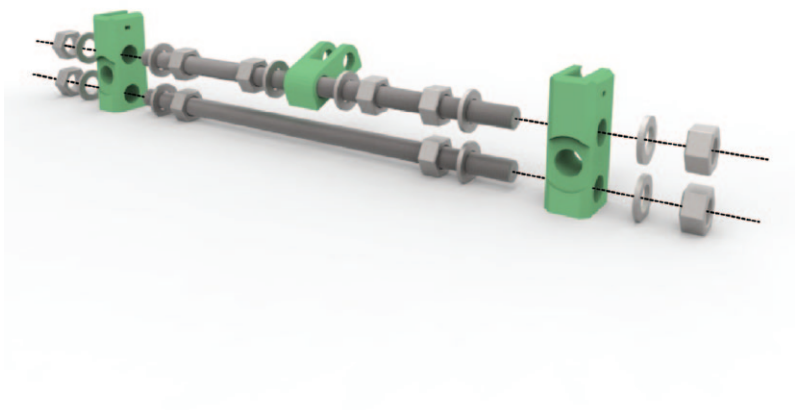
Zipties	Approx. 20

Extruder nuts and bolts

M3x45mm	1
M3x35mm	2
M3x20mm	2
M3x16mm	6
M3 washer	8
M3 nut	11
M4x25	2
M4 nut	2
M4 washer	2

Hotends

J-head	2
Heating cartridge	2



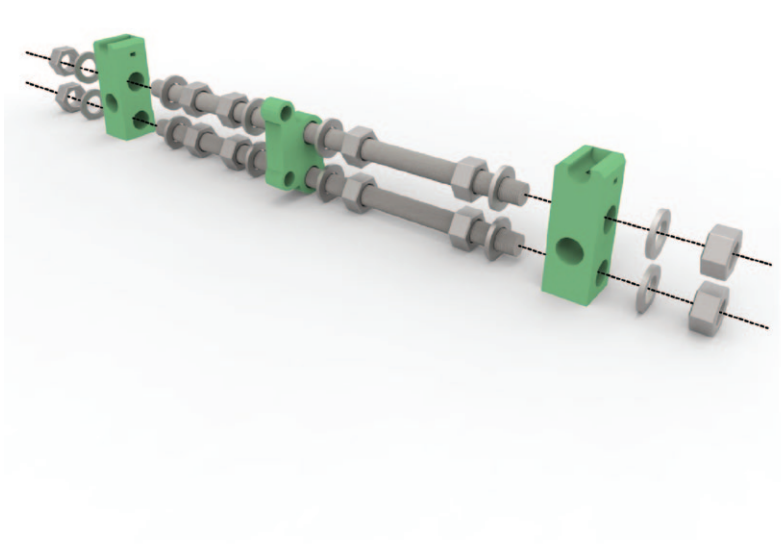
1

Parts:

Y-corners - 2
Threaded m10x220mm - 2
Y-idler - 1
M10 nut - 10
M10 washer - 10

Start building the y-axis by assembling the front of the axis. Take one M10x220mm threaded rod and slip the y-end-idler into the midle of it, and secure it using two M10 nuts and washers.

Next secure both M10x220mm rods to the y-corners.



2

Parts:

Y-corners - 2
Threaded m10x220mm - 2
Y-motor- 1
M10 nut - 12
M10 washer - 12

Next assemble the back of the y axis. Insert the y-motor plastic part on the center of the M10 threaded rods. Secure it with the M10 nuts and washers, and secure the threaded rods to the y-cornes like in the previous step.

Note that later we will need to align the y-end-motor and y-end-idler with the y-belt-holder.

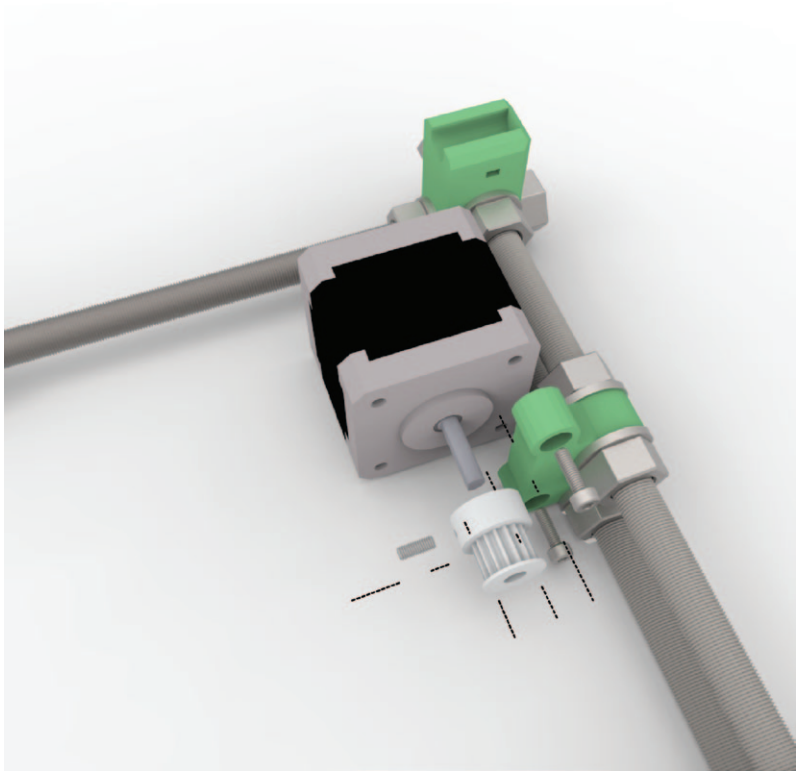
3

Parts

Threaded m10x440mm - 2
m10 nut - 12
m10 washer - 12

Now connect the two parts previously assembled using the the two M10x440mm threaded rods.

Make sure you don't forget to insert two M10 nuts and washers in the midle of each of the threaded rods. This you be used later on to secure the y axis assembly to the frame of the printer.



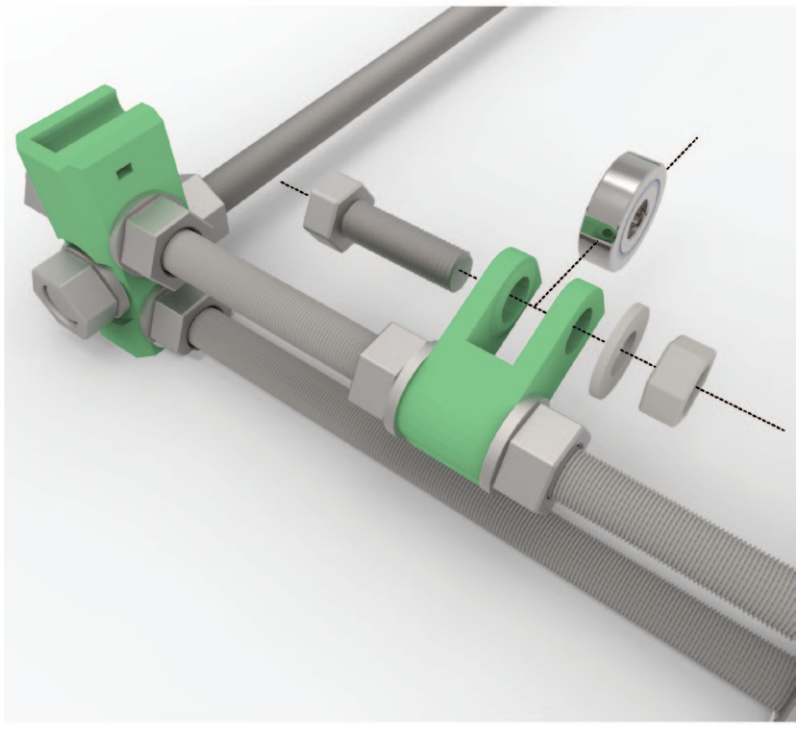
4

Parts

Nema17 stepper -1
GT2 pulley -1
M3x10mm grub screw -1(on the pulley)
M3x16mm - 2

Mount the stepper motor to the y-end-motor and the GT2 pulley to the motor shaft.

The GT2 pulley will be tight on to the motor shaft and to be certain that it does not slip we use the flat on the shaft. If your stepper does not have one flat on the shaft you should add one.

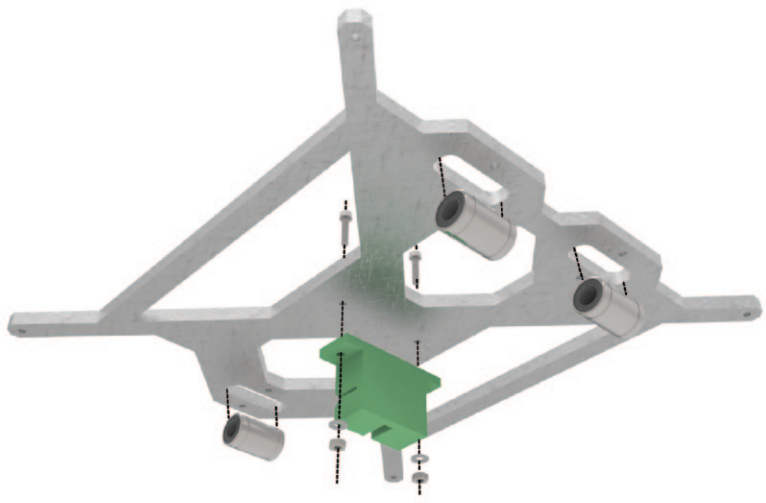


5

Parts

M8x25 - 1
M8 washer - 1
M8 nut - 1
608zz bearing -1

On the front side of the Y-axis insert the bearing into the y-idler and secure it.



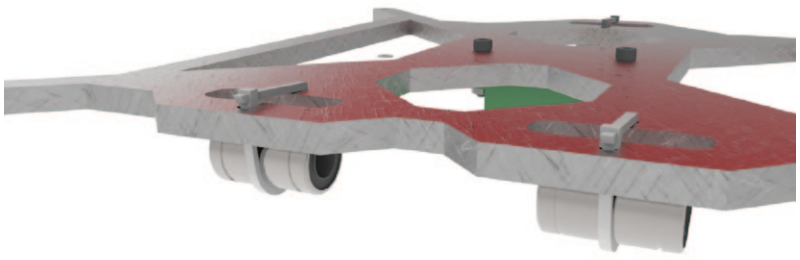
6

Parts

Bed frame -1
LM8uu -3
y-bel-holder -1
M3x16 -2
M3 washer -2
M3 nuts -2

Atatch the y-belt-holder to the heated bed frame, it stays in the center of the frame.

Next secure the LM8uu linear bearings to the frame. There are tree cuts where they can be placed and secure them there using zipties.



7

Use the zipties to secure the LM8uu linear bearings in place.

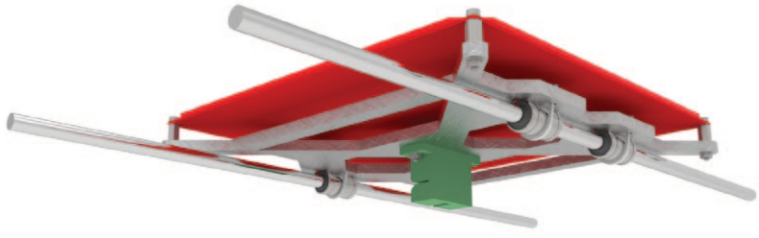
8

Parts

Bed frame -1
Mk2 heated bed -1
M3 standoff -4
M3x10 - 4
M3 washers - 4
m3 nuts -4
20x20cm glass -1

To complete the printing bed assembly start by securing the M3 standoff to the bed frame and them secure the PCB MK2 to the standoff’s.

The glass is them put on the top of the Heated bed and secured using bulldog clips.

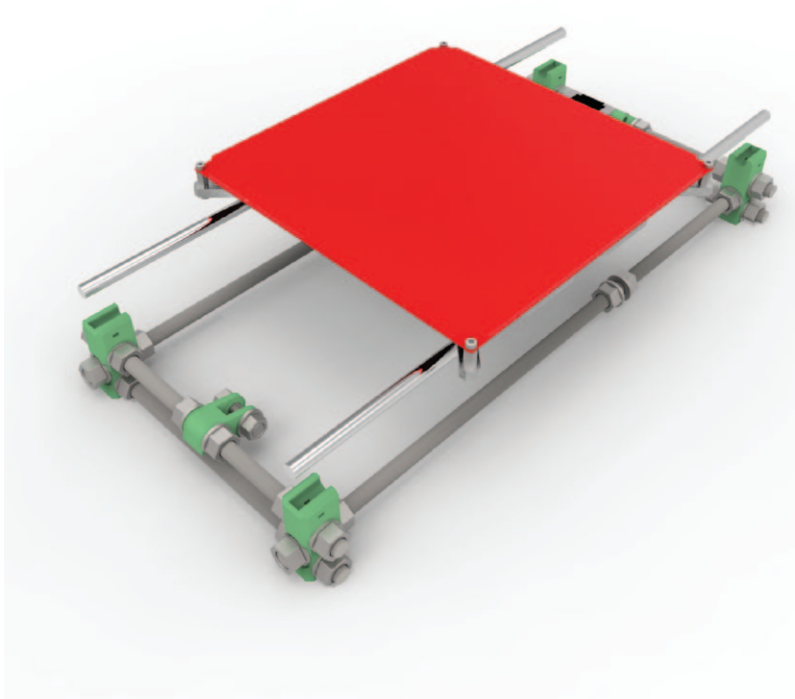


9

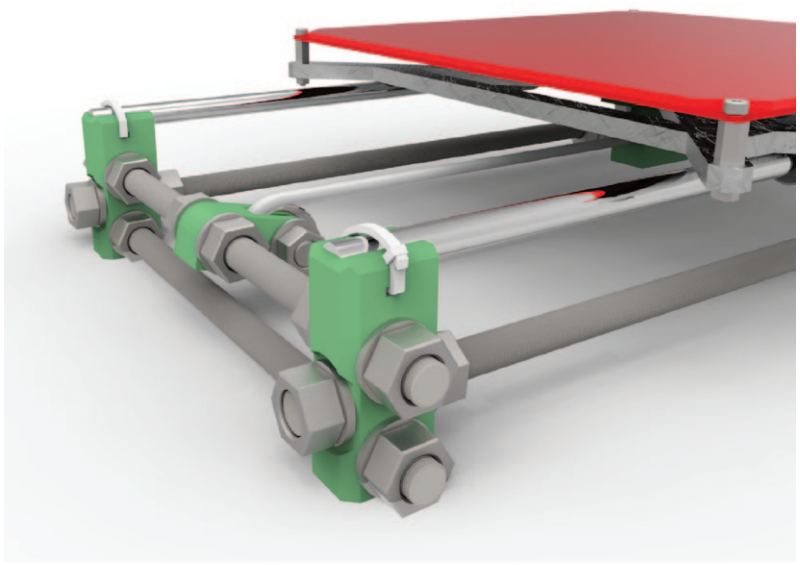
Parts

M8 smooth rods 400mm -2

Insert the y smooth rods in the linear bearings and add this assembly to the y axis structure made previously.

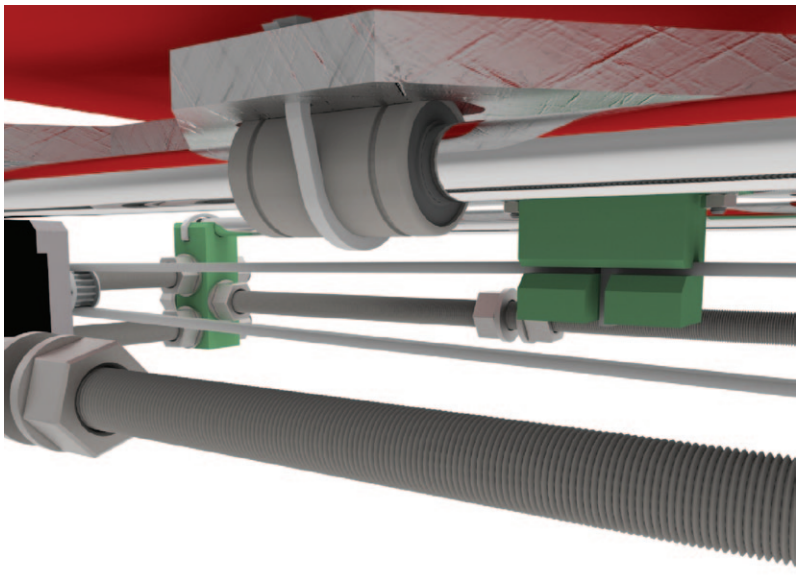


10



Secure the smooth rods using zipties.

11



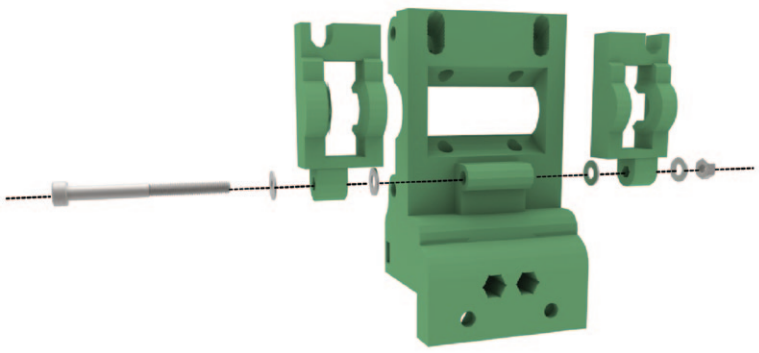
Parts

GT2 timming belt 950mm -1

12

Pass the belt by the pulley and the y-end-idler bearing and secure it on the y-belt holder.

Remember to try and keep the top part of the belt as much horizontal as possible. Use the y-idler to do this alignent.



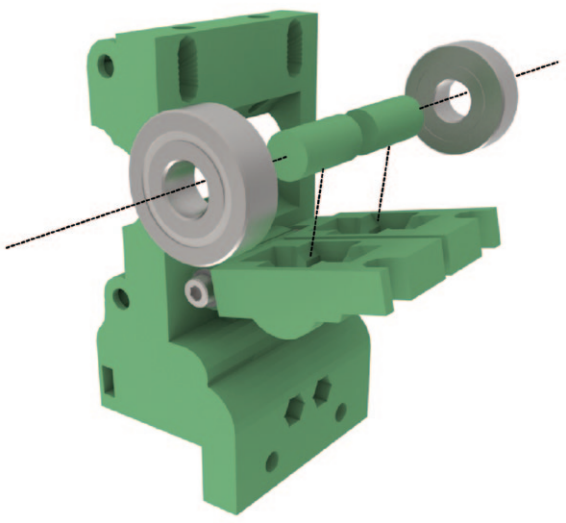
13

Parts

Extruder body -1
Idler -2 (they are simetrical)
M3x45 -1
M3 washer -4
M3 nut -1

Next start on the X axis assembly, and to do this we will first build the extruder.

To start the work on the extruder secure the idlers in place using the m3x45 screw, using washers between the connections.

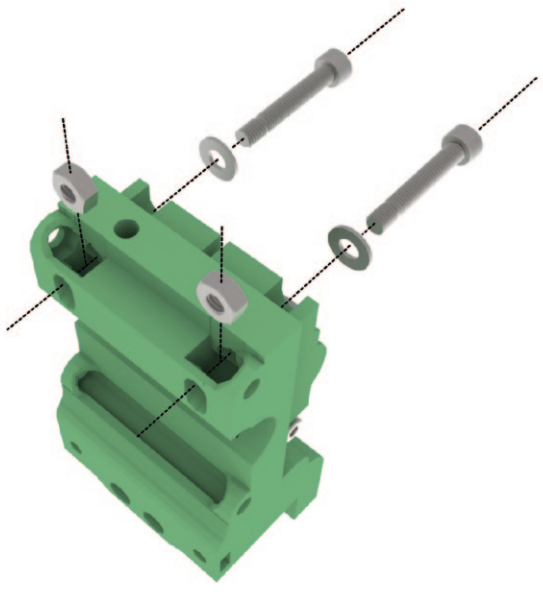


14

Parts

608zz bearing -2
printed rods -2

Insert the printed rods on the 608zz bearings, and put the bearings into the idlers.



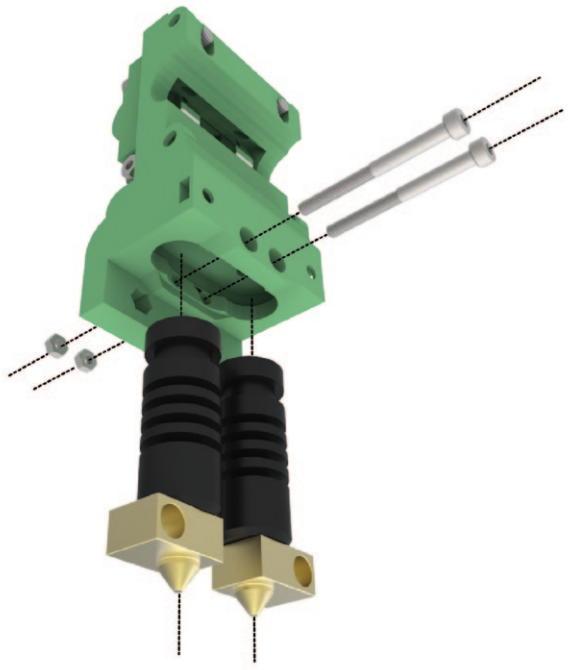
15

Parts

m4x25 -2
M4 nut - 2
M4 washers -2 (optional)

The idlers job is to push the filement against the hobbed bolt (in this case the Mini Hyena) so that it can grip it and push it in the hotend.

To adjust this pressure we use the M4x25 screws and two M4 nuts on the extruder body.

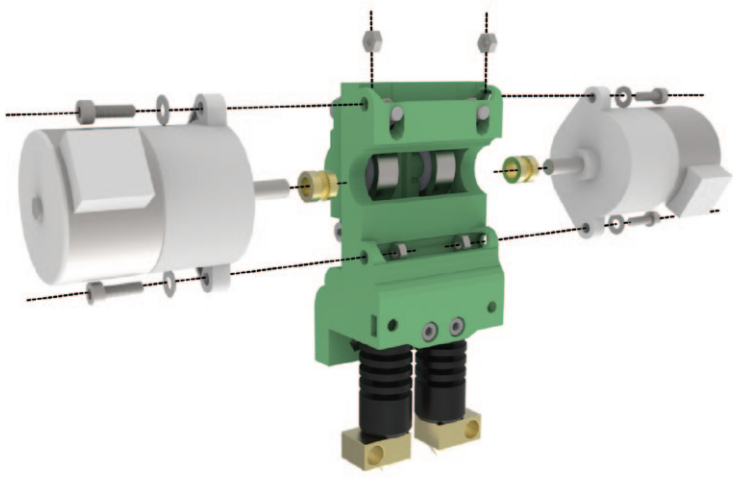


16

Parts

J-head - 2
M3x35 -2
M3 nut -2

Attach the two hotends to the extruder body, and tighten it in place using the M3x35 screws.



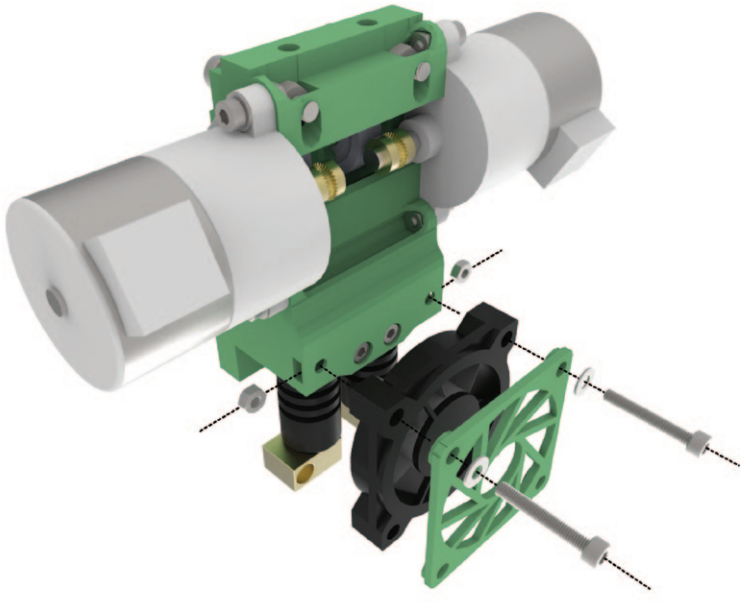
17

Parts

PG35L -2
M3x16mm -4
M3 washers -4
M3 nuts - 4
M3x10mm grub screw -2
Mini hya -2

To atach the stepper motors to the extruder first insert one Mini Hyena in each of the shafts of the motors. Next secure the motors to the extruder body.

You will need to make sure to align the Mini hyena to the hotend and the filement later on.

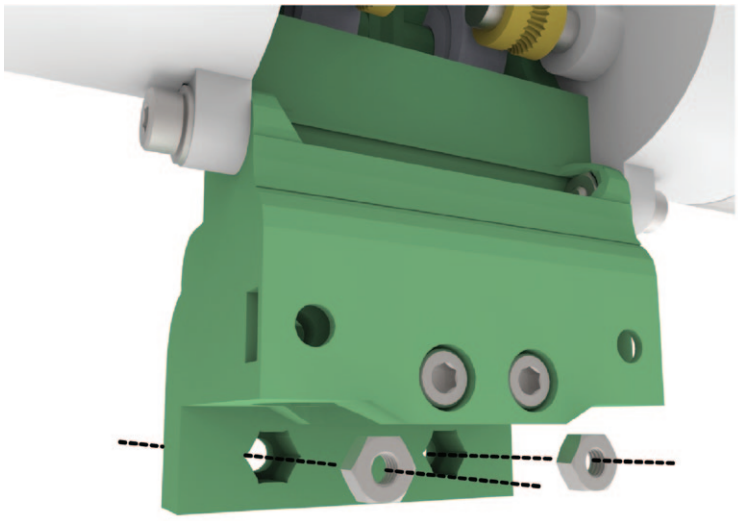


18

Parts

45mm fan -1
45mm-fan-grill -1
M3x20mm -2
m3 nut -2
m3 washer -2

Next secure the 45mm fan and its grill to the extruder.



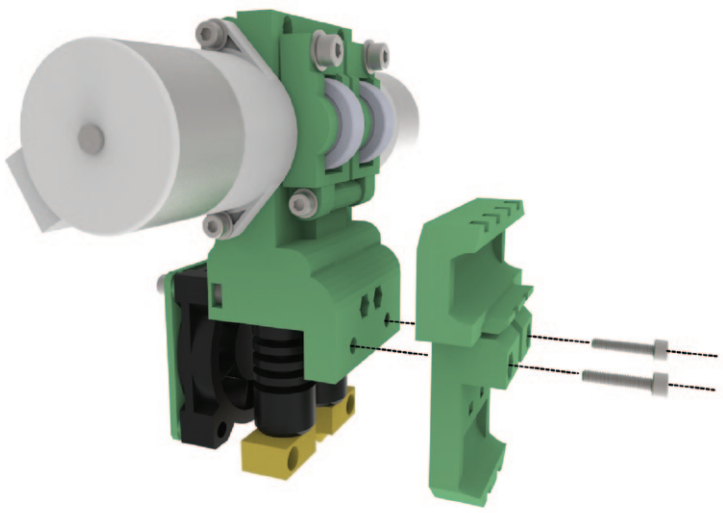
19

Parts

m3 nuts -2

To secure the extruder we need to insert two nuts in the extruder body. Depending on how loose they are in your plastic part you can do this before ataching the hotends to the extruder.

If they are loose it´s better to do this just before ataching the body to the X-carriage, but you might to remove the hotends to insert the nuts in its place.

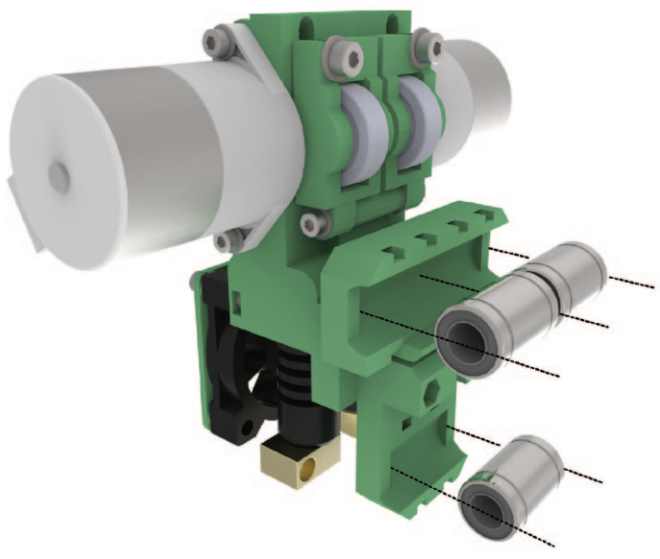


20

Parts

m3 x15 -2

Secure the x-carriage to the extruder body.

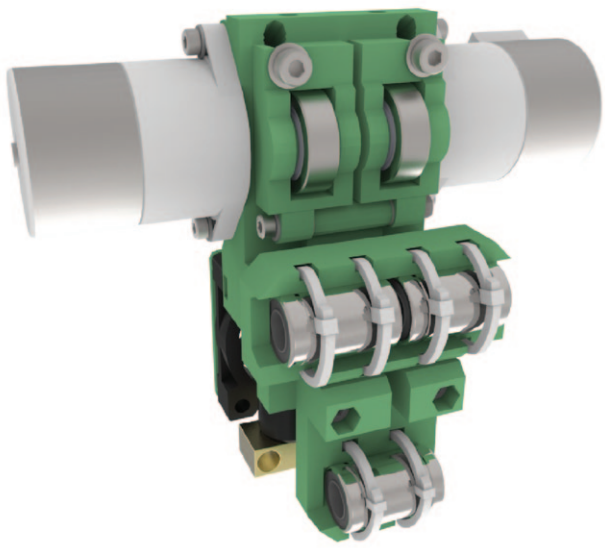


21

Parts

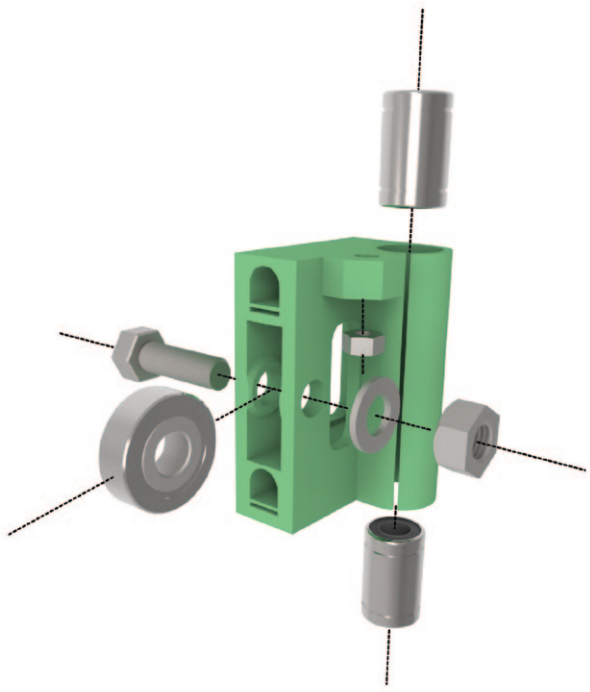
LM8uu linear bearing -3

Insert the three linear bearing into the x-carriage and secure them using zippties.



22

Use the zipties to secure the LM8uu linear bearings in place.



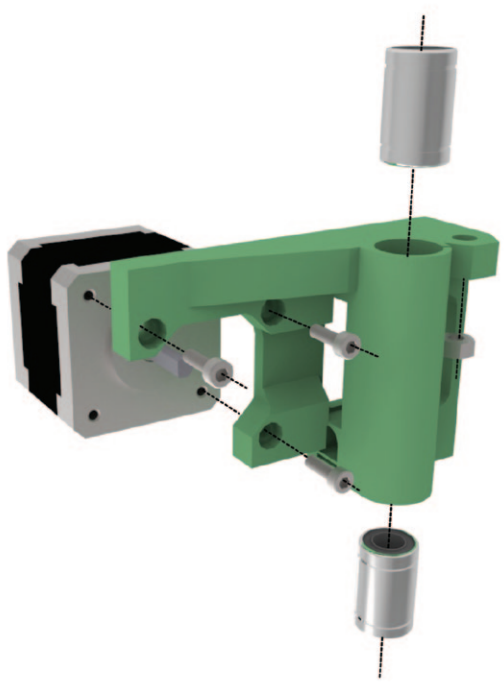
23

Parts

x-end-idler - 1
LM8uu -2
608zz -1
M8x25 -1
M8 nut -1
M8 washer -1
m5 nut -1

Next lets do the x-end-idler. We need to secure the 608zz bearing using an M8x25 screw. Also insert the LM8uu linear bearings into the x-end-idler.

There is also a slot to insert an M5 nut. Now if this nut is a little loose and doesn't hold in place save it for later, when we attach the x axis to the z axis.



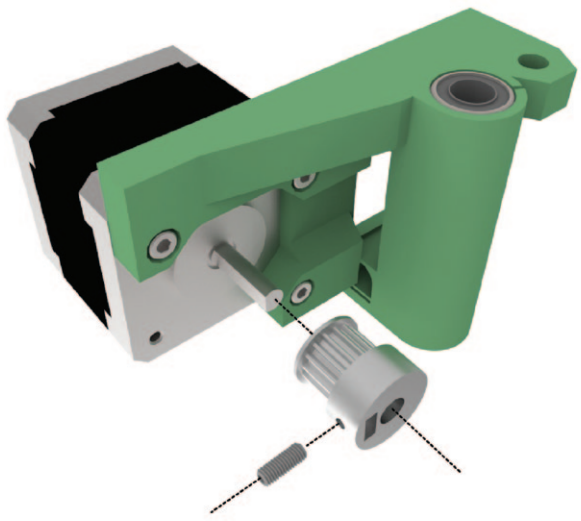
24

Parts

M3x16 - 3
M5 nut -1
Lm8uu -2
Nema 17 -1

On the x-end-motor we need to atach the stepper motor and insert the linear bearings in their slots.

There is the same question on the M5 nut as in the previous step.

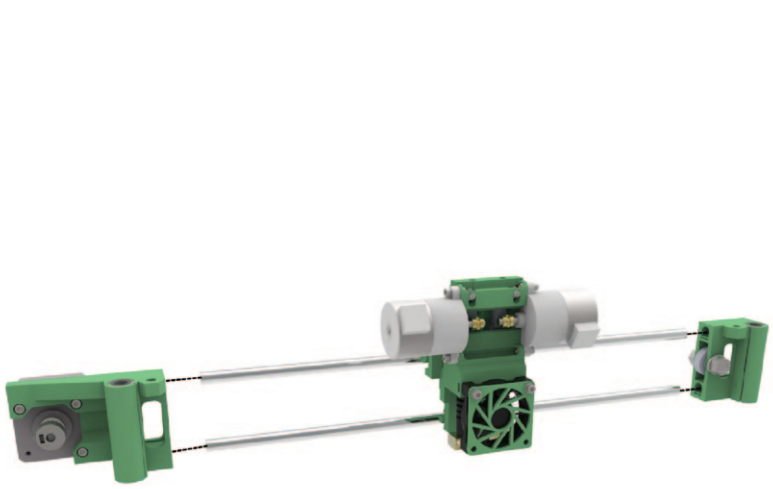


Parts

25

GT2 pulley -1
M3x10 grub screw -1

Now secure the GT2 pulley to the motor shaft and tight it using the M3 grub screw.



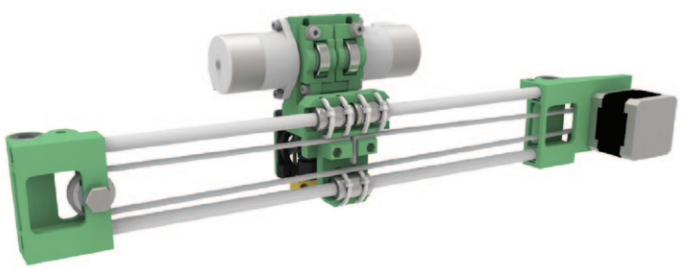
Parts

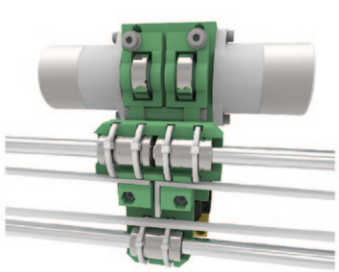
26

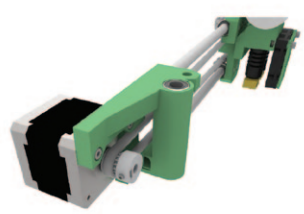
M8 smooth rods 350mm -2

To finish the x axis insert the smooth rods into the linear bearing on the x- carriage and snap the x-ends into the ends of the smooth rods.

Facing the extruder fan side the x-end-motor should be on the left side.







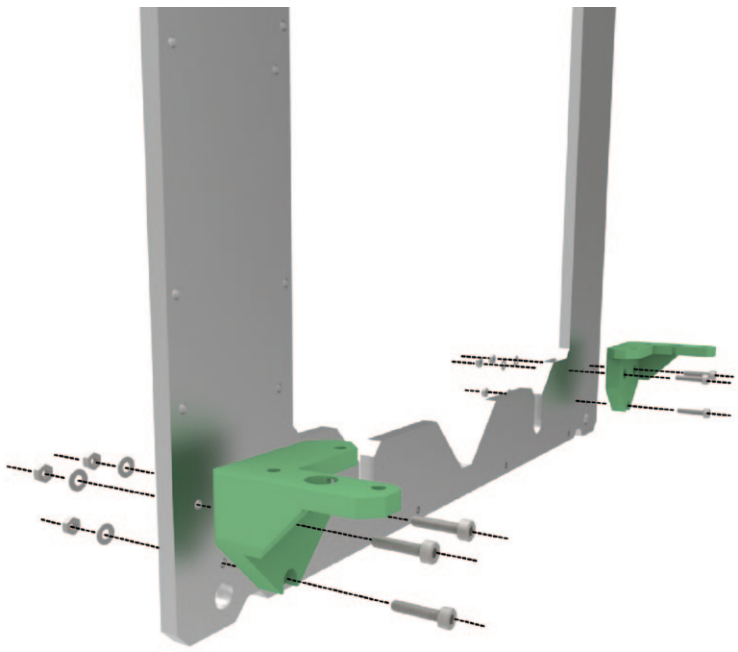
Parts

27

GT2 timming belt 950mm -1

Next add the GT2 timming belt. Pass the belt by the pulley and the x-end-idler bearing and secure it on the x carriage.

Make sure that it has the right tension.

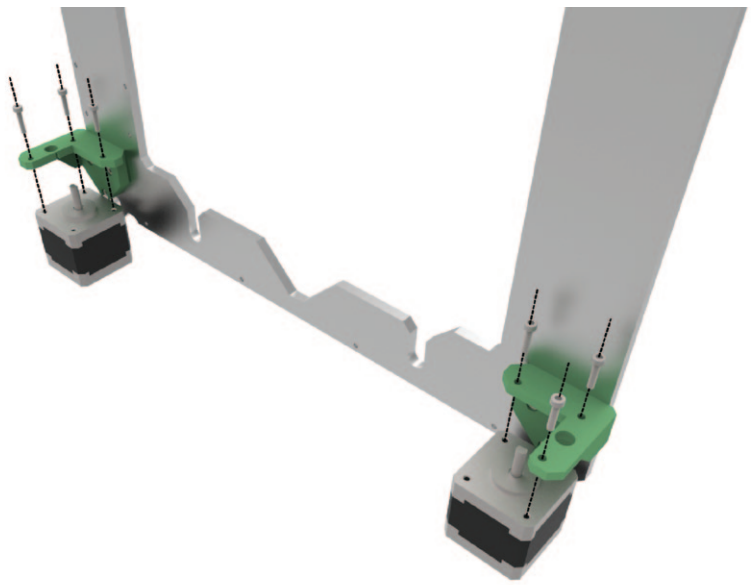


28

Parts

M3 nut - 6
M3 washer - 5
M3x16 - 6

The last step is to do the z-axis.
Lets start ataching the z-bottom plastic parts to the frame.

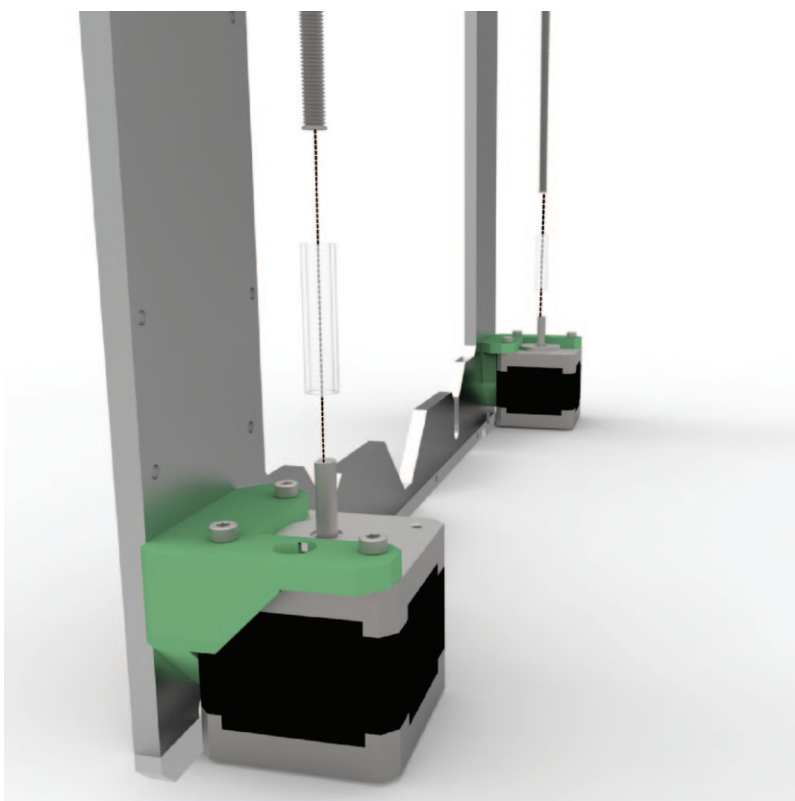


29

Parts

M3x16 - 6

Next secure the two stepper motors to the z-bottom.
This steppers will not use pulleys and timming belts, instead we will be ataching two M5 threaded rods to their shaft.

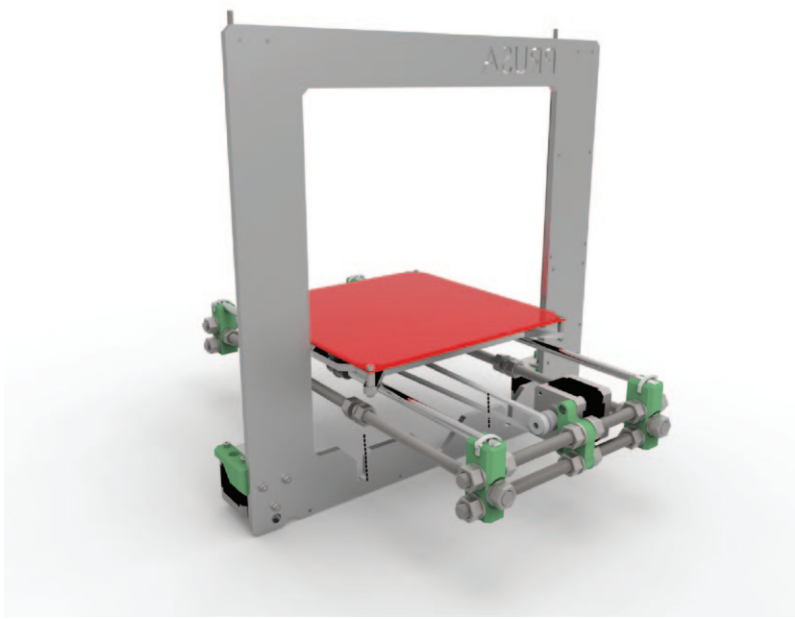


30

Parts

5mm inner diameter flexible tube, 30mm -2
M5x310 threaded rod -2

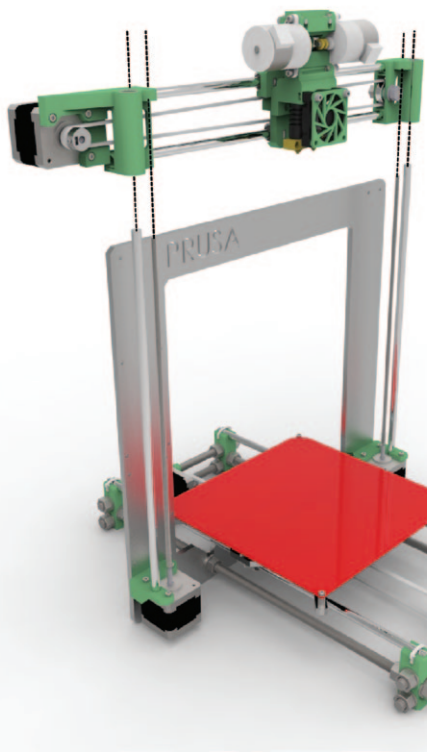
To attach the M5 threaded rods to the steppers shaft we will be using a flexible tube with 5mm of inner diameter.



31

Now we only have to add the y and x axis to the frame and the z-axis f the printer.

To secure the Y-axis to the frame we will use the M10 nuts we have insert in the midle of the M10x440mm on the y-axis.



32

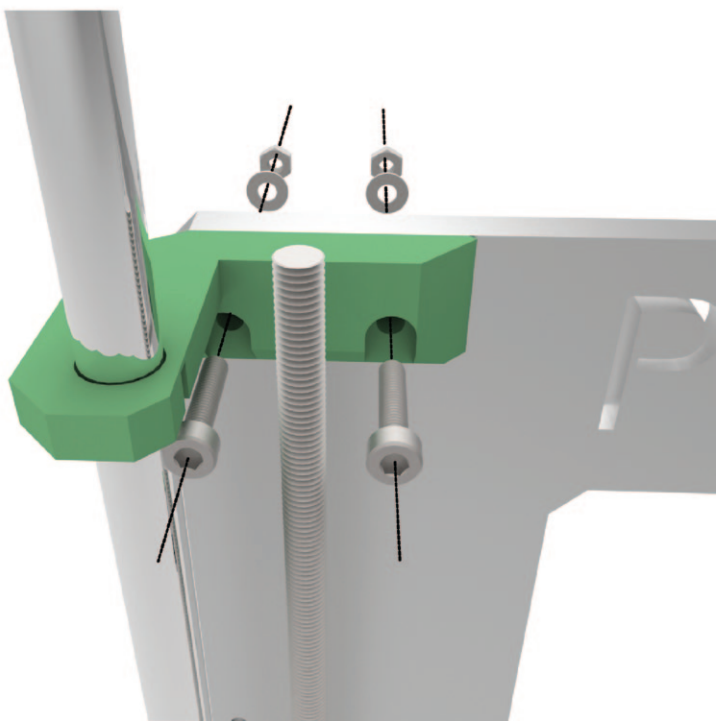
Parts

M8x340mm smooth rods- 2

Now lets insert the x-axis into the z-axis.

Place the smooth rods in their slots and then insert the x-axis into the z axis.

Now remember that we need one M5 nut in each of the x-ends (motor and idler) and if use save it for later now its the time to insert them.

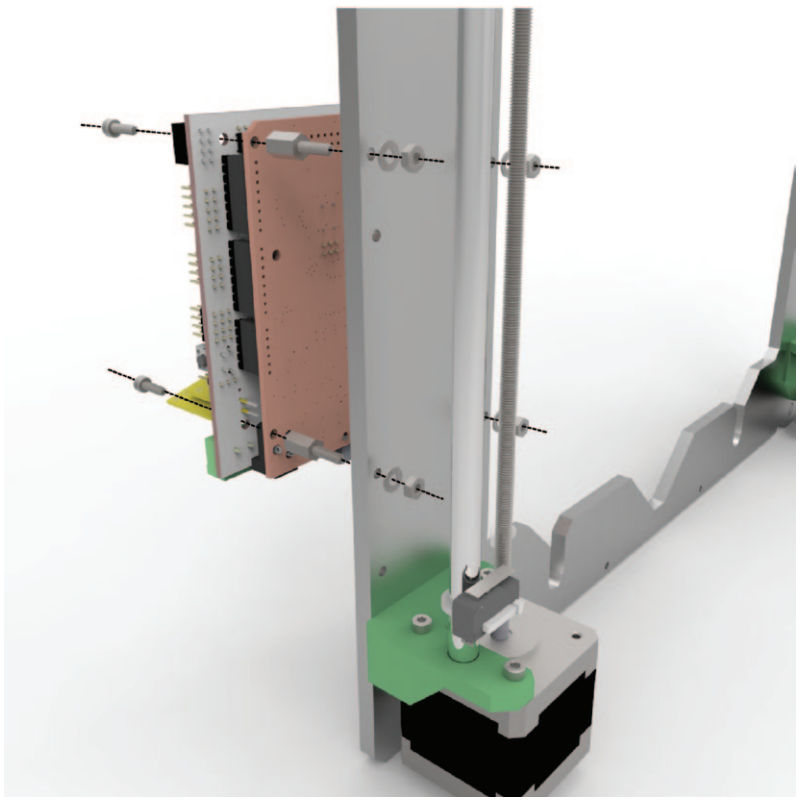


33

Parts

M3x16 - 4
M3 washers - 4
M3 Nuts -4

Secure the z smooth rods to the frame on the top side using the z-axis-top plastic parts.



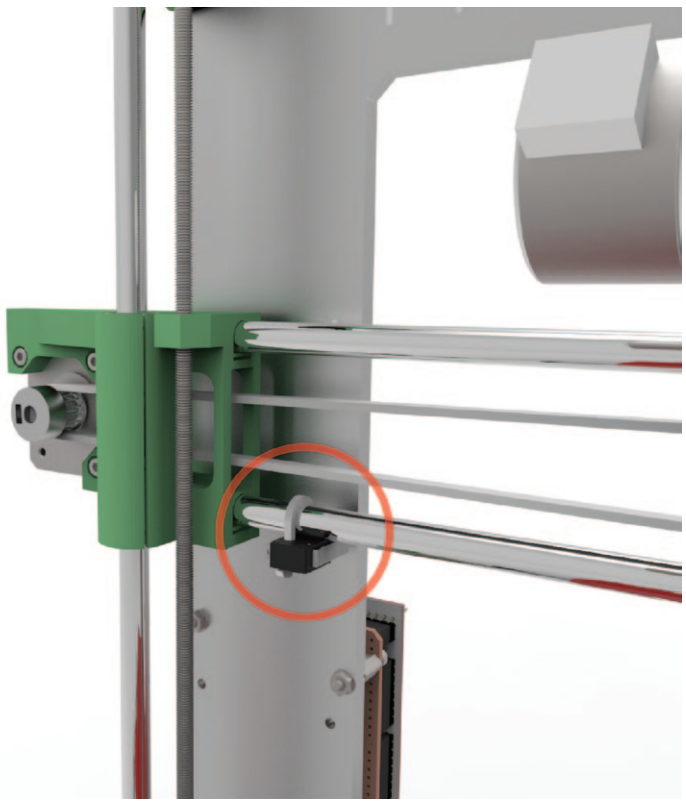
34

Parts

M3 standoff -4
M3x10 -4
M3 Washer -4
m3 nut - 4

Now lets add the eletronic board to the frame, using M3 stand off to make sure its surface does not touch the frame.

If your board does not fit in the standard holes you can always drill some or once you have you printer up and running print one adapter!

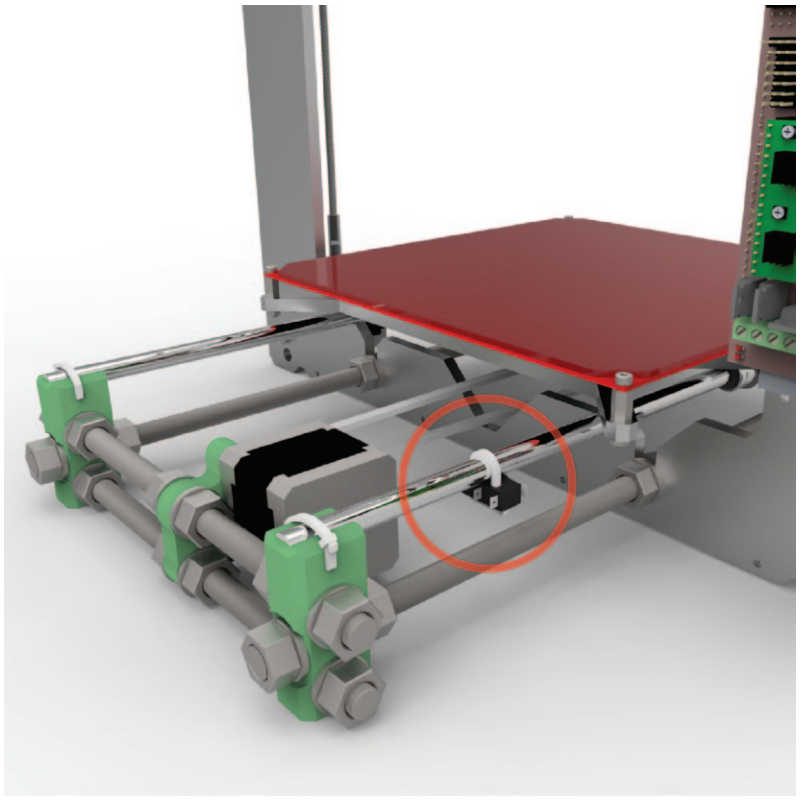


35

Parts

Microswitch -1
ziptie -1

Secure the X axis endstop to the smooth rod using a ziptie, on the side of the motor.

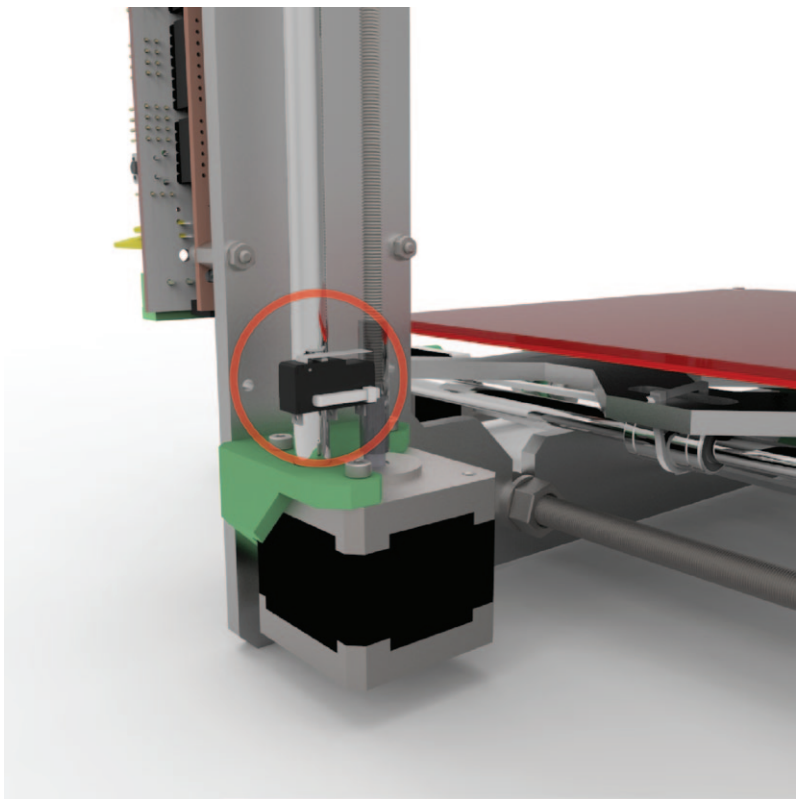


36

Parts:

Microswitch -1
ziptie -1

Secure the Y axis endstop to the smooth rod using a ziptie, on the side of the motor.



Parts

37

Microswitch -1
ziptie -1

Secure the Z axis endstop to the smooth rod using a ziptie, on the side of the board.

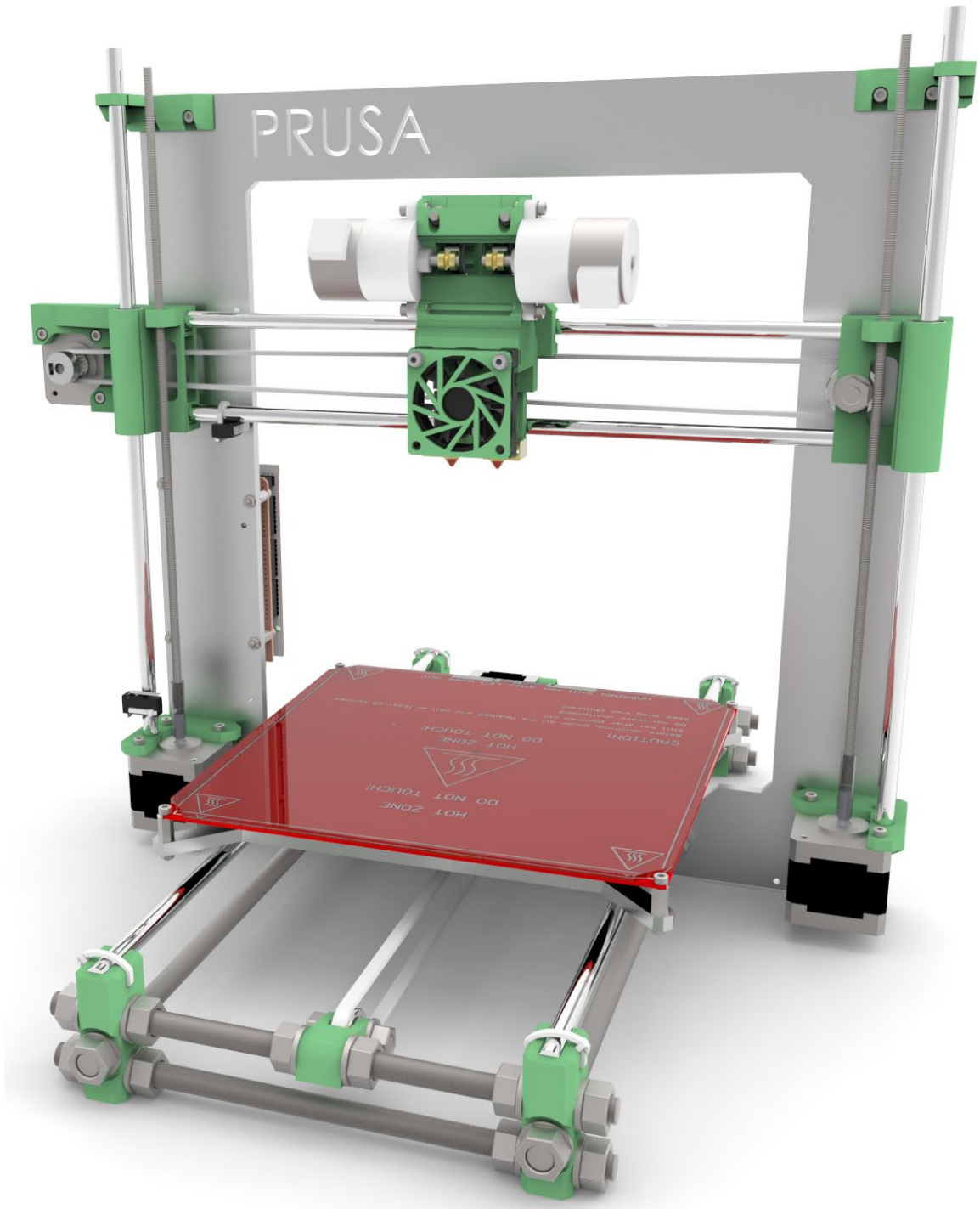
Finishing the build

The building part its done, but the printer is not yet finnished. In order to finish your 3d printer you need to do the wiring of the eletrical components (motors, thermistor, heated bed, endstops...), install all the softaware we need and last but not least we need to calibrate the printer.

This article focuses on the building assembly of the printer so we will not focus on the steps we just mentioned, but we will leave you with a road map to get you going!

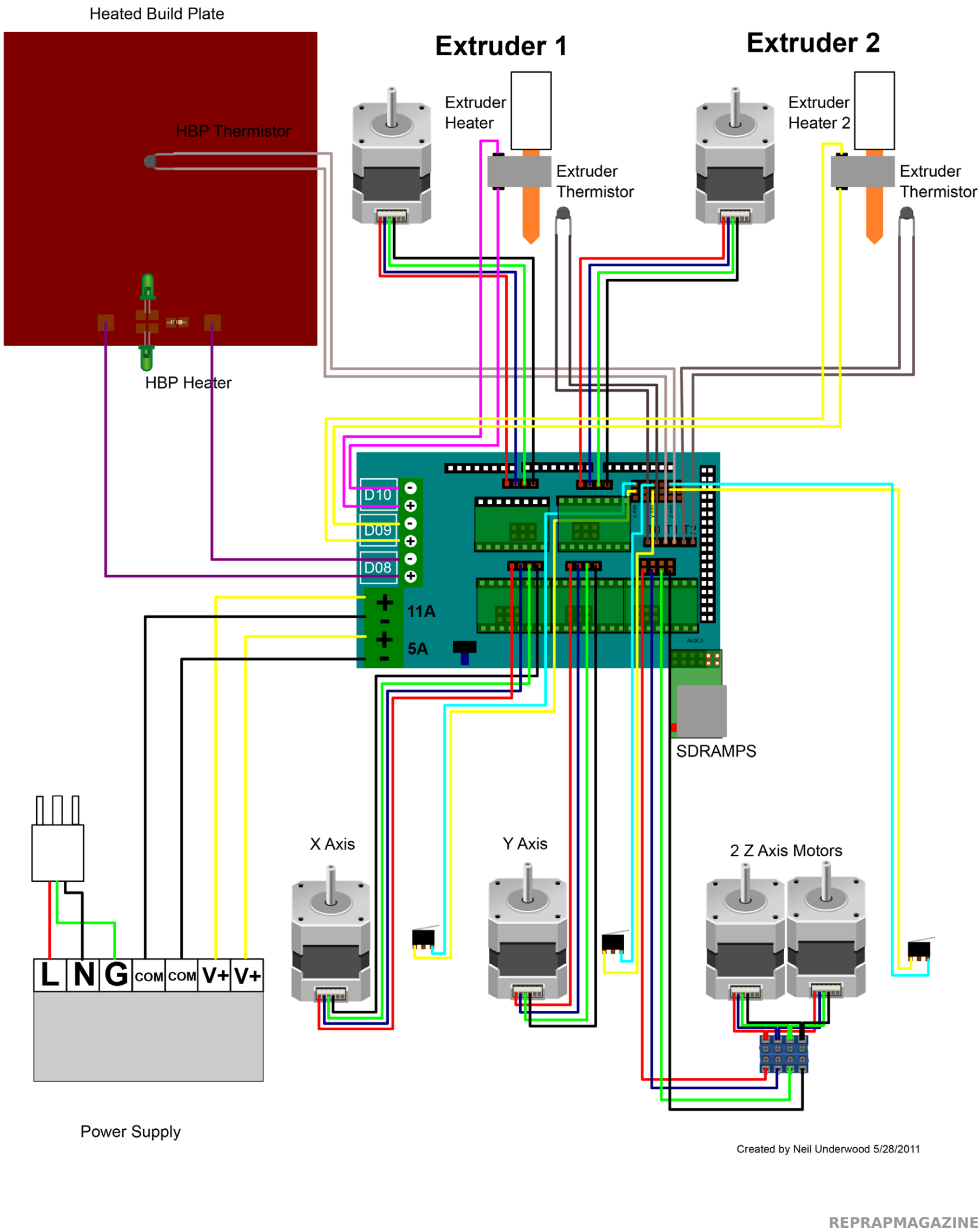
In this magazine there is a great article on some electronic boards done by Richard (RichRap) and you can use to see some alternatives and to see whats commum and necessary for you to have.

If you build the extruder we have used in this build then a board that can handle two hotend is necessary. This means you need to have 5 stepper drivers, three thermistors and three heaters (two for the extruders and one for the heated bed) if you run the heated bed power throught the board.



EiNSTeiN Prusa I3 Render

Wiring of the printer using the Ramps Boards as an example.



One sorce of help is the RepRap Wiki page. You can find building instructions on several printer models, buyers guides, getting started guides and manny more useful information. Here are just two good links:

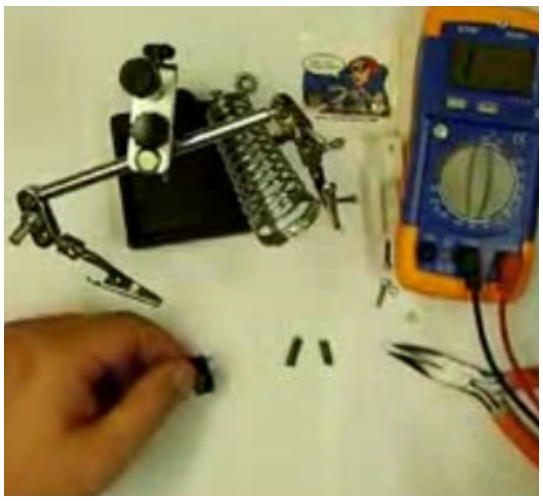
http://reprap.org/wiki/RepRap_Buyers'_Guide

http://www.reprap.org/wiki/The_incomplete_reprap_beginner's_guide

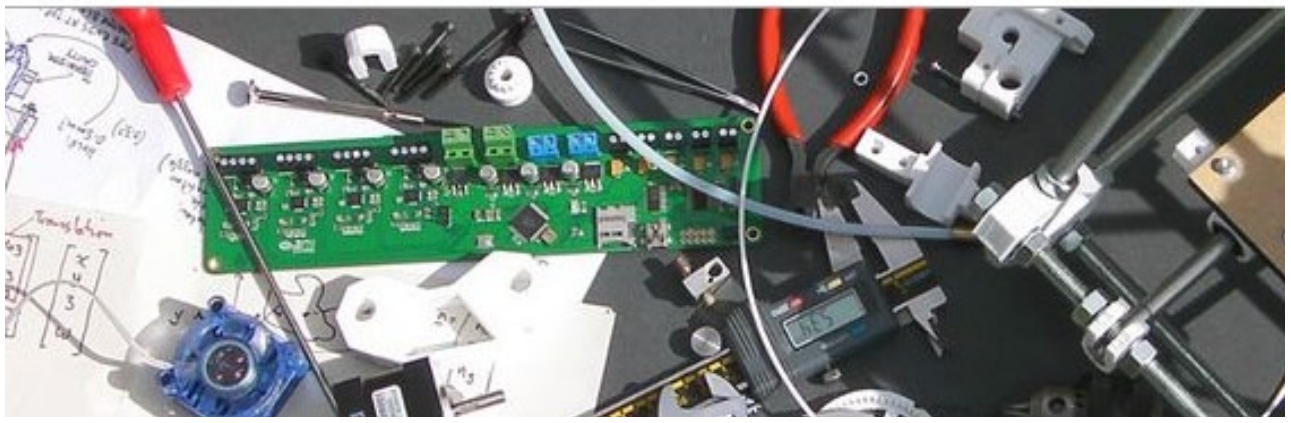
Another valid option for info is YouTube and other movie channels. Now if you search for RepRap there will be a lot of movies but i would like to mention one in particular, the channel of Neil Underwood.

It has some great resorces for someone that its completly new to some parts involved like soldering eletronic components. It did helped me building my first RepRap.

It can be found here: *http://www.youtube.com/userRepRapLogPhase?feature=watch*



Neil Underwood Youtube channel



RepRap Wiki

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