

The Falconer 3D printer

Thoughts about a robust, general purpose DIY 3D printer including the optional functions of an FDM lathe and light router/PC drill

It looks like DIY machines are soon going to be completely swamped by the number of commercial offerings, both ready-built and self-assembly kits from seriously well-financed companies. Design and development is moving very quickly. The REPRAP Pro Ormerod 2 is a direct commercial descendant of my REPRAP Prusa machine but the two could not be so different in concept. It will be interesting to see how the Ormerod cantilevered X axis arrangement works out. Maybe the pure DIY build machine will become very much a minority. However, these designs, too, continue to improve and there will always be room in Makerspaces for such projects.

As my original REPRAP Prusa machine is showing its age (3 years) with various printed ABS and PLA parts cracking or even splitting apart, I have been thinking about a more robust machine built from as many standard metal parts as possible but still leaving the option of using printed parts where preferred.

The main improvements over the Prusa that I am seeking are:

- 1) A really stiff bridge-type frame from standard aluminium and channel sections. (This configuration follows the arrangement of the [DIY CNC router](#) that I built over twenty years ago. The machine and its Acorn BBC Master computer are still working well.)
- 2) An increase in the table area to the size of an A4 scanner glass (332 x 250 x 3) with scope for an even larger table. This will allow parts (wing ribs, plane and ship- hull formers) of a really useful size. I think I can get the table, glass and carriage mass down to less than that on my current machine, so acceleration load with jerk control should be O.K.
- 3) Z axis motion at least 250 mm.
- 4) Longer motions require stiffer guide bars so I have gone for 10mm dia. (The Ormerod has 12mm bars). Oddly, at the moment, most of the 10mm parts from Zapp Automation are exactly the same price as the 8mm parts.
- 5) Use as many off-the-shelf parts as possible. These are stiffer, more accurate, more durable, and cheaper than printed parts (but heavier...). So, a Falconer 3D printer could use Zapp bearings in housings for the Z-axis but PLA printed parts for the Y (and X) motions.

- 6) Use 2 or 3 point guides and 3 point table levelling. The centre screw at the back of the build table will control fore and aft pitch and the two at the ends of the front bar will control left-right roll. These adjusters will be very easy to access.
- 7) Mount the (single or double) extruder via a quick release mechanism to the vertical face of the carriage for quick change without re-feeding filament. The quick-release mechanism would accept a light router for CNC cutting of balsa and ply parts. To use the wood cutting or PC drilling modes the glass build plate would be protect by a light MDF cover. There would be reduced accelerations for lower x and Y velocities.
- 8) Introduce a removable lathe style mechanism mounted with a simple release across the main frame pillars. This would clamp glass cylinders of required sizes in such a manner that the outer surface would act as a rotating mandrel for filament deposition. The Z-and Y axes would behave as usual with the X-axes being replaced by rotational motion of the mandrel. Rotational drive would be provided by stepping motor through a gear or belt drive as required. I have found on my Prusa that a clean glass plate works wonderfully well when heated to 50-60C. Consequently, the mandrel would have hot or cold air blown in from one end and exiting from the other. The air could be fed internally through an axially disposed perforated tube in which the perforation space could be varied to ensure a constant temperature along the glass cylinder.
- 8) Use the [Panucatt Azteeg X3](#) printer controller with their own plug-in [SureStepr SD8825](#) stepper drivers. The X3 seems well engineered with screw connectors, on-board regulation and fuse, max and min micro-switches, together with lots of expansion possibilities. It also runs the software that we use (Marlin). The SD8825 is upside down to the usual offerings, allowing heat sinks to be fitted to the top. The design also brings out the current limit setting point to a real (accessible) pin. These look like the most practical electronics currently available.
- 9) Increase the heat / sq mm to the table so that heat up time is halved to 10 minutes.
- 10) Replace the second-hand PC power supplies with a 12 V 20-30 Amp switch-mode PSU. These may be cheaper, are tidier and do not have unused cables hanging around.

The following pictures illustrates the main concepts of the Falconer design. Note that these are not intended to be detail drawings as much development of each component needs to be completed. New mandrel slicing software would be needed.

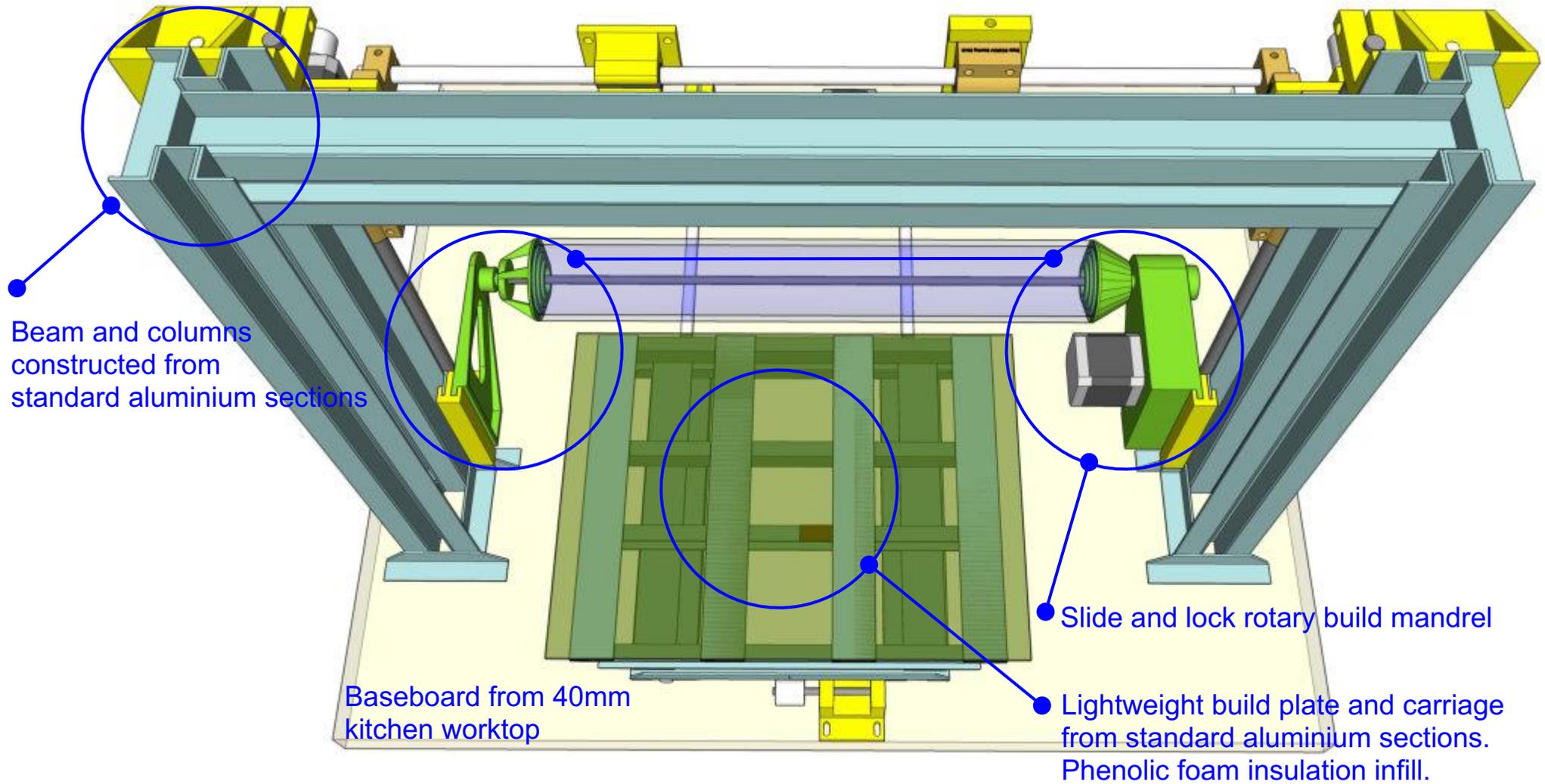
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17/11/2014

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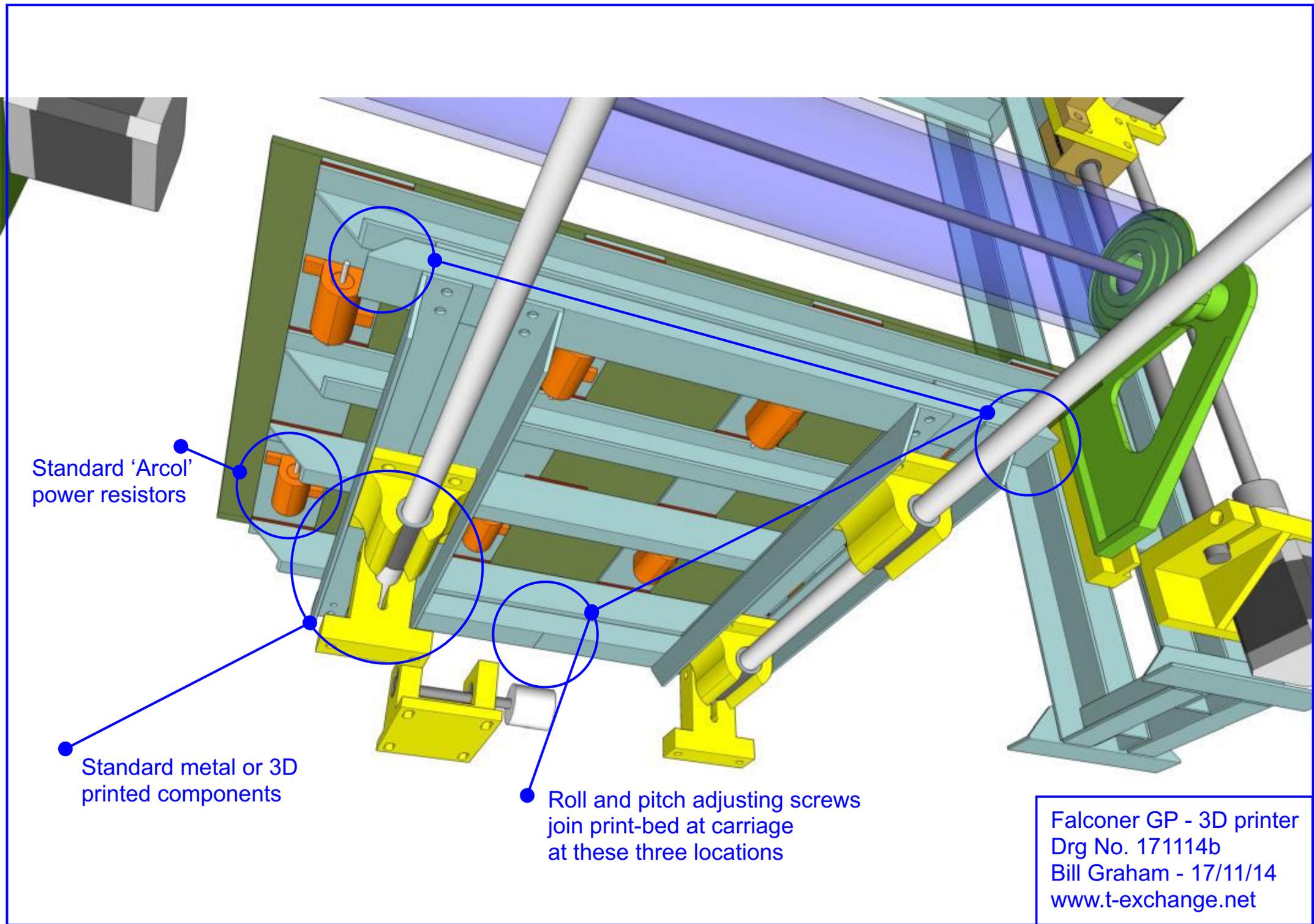
Beam and columns constructed from standard aluminium sections

Baseboard from 40mm kitchen worktop

Slide and lock rotary build mandrel

Lightweight build plate and carriage from standard aluminium sections. Phenolic foam insulation infill.

Falconer GP - 3D printer
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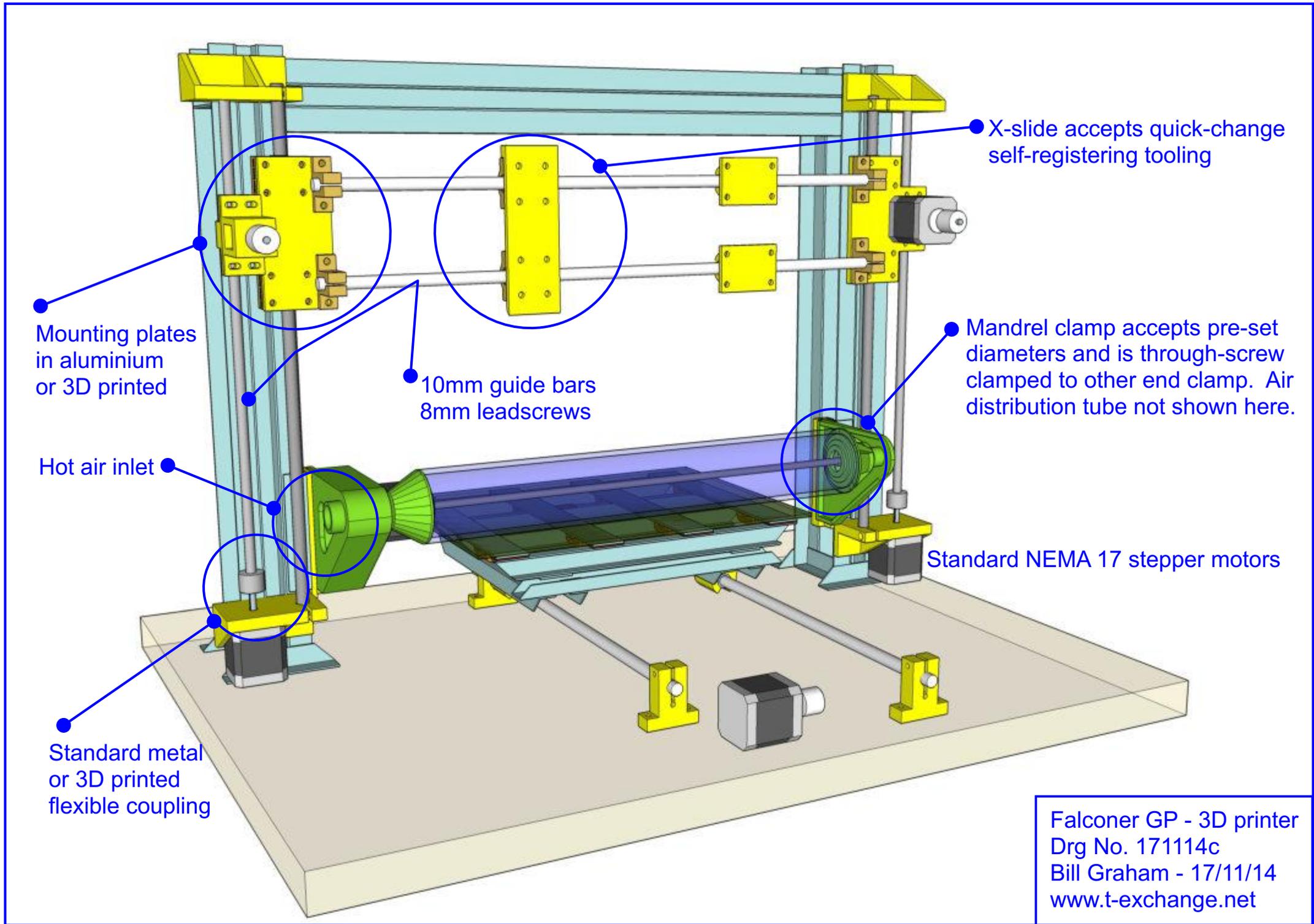


Standard 'Arcol' power resistors

Standard metal or 3D printed components

Roll and pitch adjusting screws join print-bed at carriage at these three locations

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- X-slide accepts quick-change self-registering tooling
- Mounting plates in aluminium or 3D printed
- 10mm guide bars
8mm leadscrews
- Hot air inlet
- Mandrel clamp accepts pre-set diameters and is through-screw clamped to other end clamp. Air distribution tube not shown here.
- Standard NEMA 17 stepper motors
- Standard metal or 3D printed flexible coupling

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