PRECIOUS PLASTIC
MONASH UNIVERSITY

Start Here:

Throughout the process of building and running the machines we found various problems which were not accounted for during the design phase. This document describes these issues and the solutions or work-arounds implemented in order to meet operational requirements. General changes were added to the original machine's designs not as solutions to any problems, but as general improvements to better suit the overall aesthetics or to make use of easily obtainable components. In the document, future possible upgrades have been added to help collaboration from other Precious Plastic chapters, so have fun, and let's recycle!

1. Problems Encountered:

1.1 Sheared Compression Screw:

Due to hardened plastic left behind from a previous run, and no heating elements were turned on before starting the motor, the compression screw underwent extreme shear stress resulting in complete brittle fracture of the screw at the screw and hex impact socket. This happened because of two factors. First, the extruder was not properly purged after the run previous and this caused plastic to solidify around the barrel. Second, the heating elements were not turned on before the motor, as to allow for the plastic to melt before the screw started spinning. By doing these at the end and start of each run should allow this issue to be avoided.

1.2 Improper Temperature Measurement:

The temperature measured by the thermocouple was the temperature being released by the heating bands. This would be a considerable difference to the plastic inside the barrel. To counter this issue, the temperature needs to be measured directly inside the barrel. If this is an issue, it is possible to determine the average heat loss and so the PIDs can be adjusted accordingly to what the desired barrel temperature is required.

1.3 K type thermocouple:

Initially, there was a problem with installing the K type thermocouple as the screw type thermocouple has a bigger probe, which is hard to install between the band heater and barrel. In Dave Hakkens' video, he cuts off the probe, which was thought will cause inaccuracy of the thermocouple. Another issue was that the response time of the thermocouple was too slow. Response time is an important factor of a PID system. It is important for a PID to restore the actual temperature to the desired temperature without overshoot and delay. Therefore, the thermocouple couple was changed, which has better performance.

1.4 Solid Plastic inside the Nozzle:

Some of the work arounds implemented to mitigate this issue caused alternate problems. One of which was the BSP nozzle fitting at the end of barrel and the nozzle itself. There is a reasonably large gap between the end of the screw and the end of the nozzle, which resulted in solidified plastic inside the BSP fitting and also the nozzle. To overcome this, a heating band was placed directly over the nozzle. It is recommended, without adding plastic feed, the motor to be turned on after sufficient heating of the barrel and nozzle to let any remaining plastic to be pushed out from the previous run.

2. Future Upgrades

2.1 Output Flow controls:

There are four types of nozzle ends with different sizes of holes on them. However, the output is fixed each time since the nozzle cannot be removed and changed during the operation of the extruder and the motor speed is constant as well. Adjustable nozzles are preferred to change the flow rate of the filament, which could be achieved by drilling a hole through the nozzle wall and adding a screw from Dave Hakkens' original design. Another upgrade of the nozzle could be the shape of the nozzle holes. Instead of the normal circular holes, other shapes of filament could be fabricated by using special nozzles such as square or line or cross.

2.2 Motor Upgrade:

The present motor has a limitation of working in only one direction with constant speed. In this case, a polarity switch for the motor is desirable to change the screw direction in case of issues with normal operation. It could also deal with the issues of screw getting stuck.

2.3 PSoC Microcontroller:

PSoC (Programmable system-on-chip) is a microcontroller, which usually includes a CPU core and mixed-signal arrays of configurable integrated analogue and digital peripherals. It is one of the most flexible mid-range controllers that could be programmed easily. PSoC Creator can be used to generate the start-up configuration code which could enable automation or even prevent of human error in operation. To prevent the screw shearing again on the extruder, a PSoC microcontroller is recommended to be established into the circuits, alarming and stopping the machine from running automatically before the barrel has been heated up for at least 15 minutes at 150C.