



CNC Stippling Machine

Senior Design II Spring 2018

Supporter: Ali Bahar, Mammoth Machine and Design

Mentor: Dr. Terence Fagan

Project Team Members: Talal Alatiah (talatiah@uncc.edu), Daniel Domingo (ddoming1@uncc.edu), Gokul Mohandas (gmohanda@uncc.edu), Matthew Osborne (mosbor27@uncc.edu), Sergio Verastegui (sveraste@uncc.edu), Corey Workman (cworkma5@uncc.edu)



UNC CHARLOTTE

The WILLIAM STATES LEE COLLEGE of ENGINEERING

Objective

- To create a fully functioning prototype of a multi-axis computer numerically controlled stippling machine within a budget of \$3000
- Must be able to repeatedly stipple an organic surface of any arbitrary shape using a heated tool tip

Background

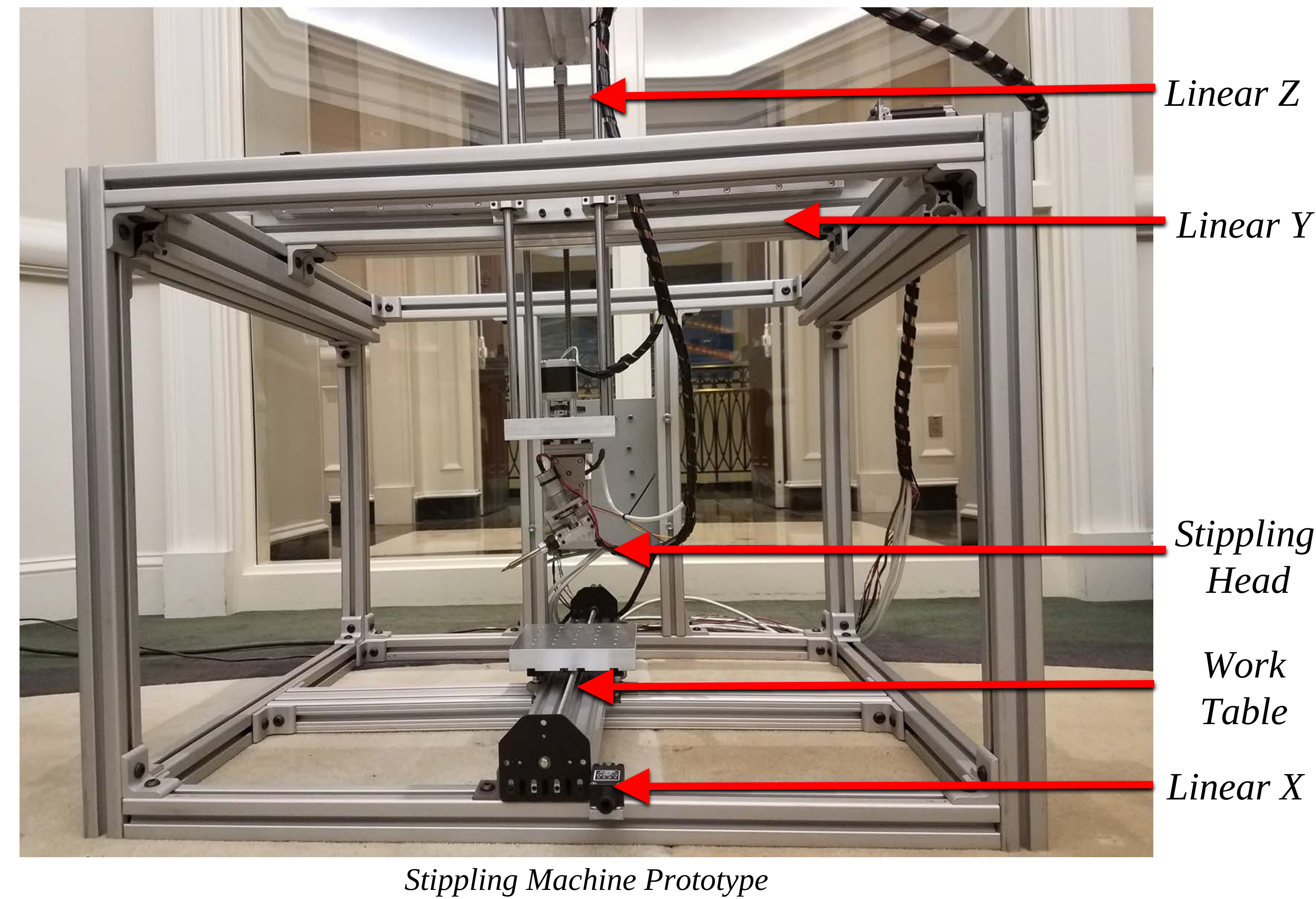
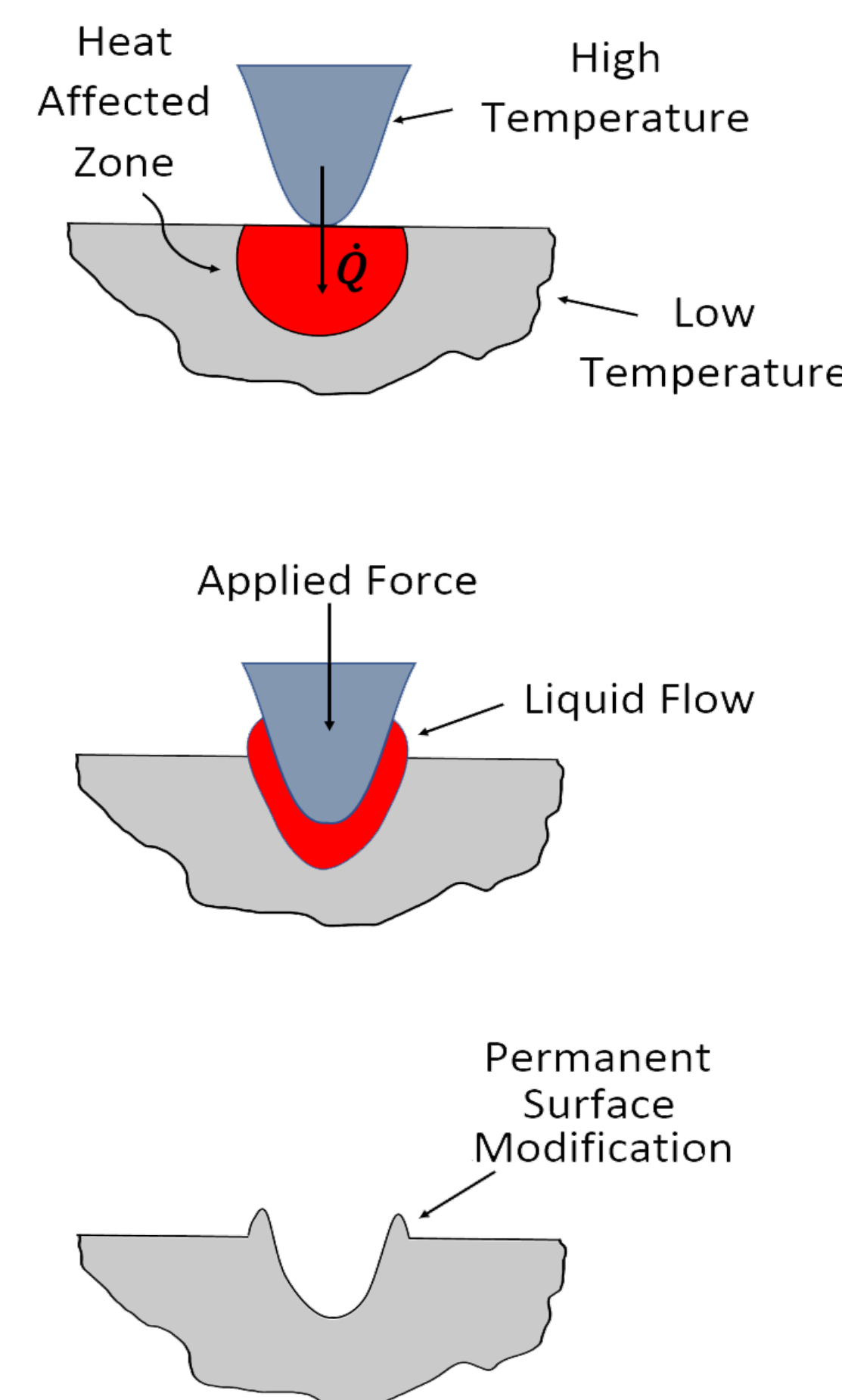
Stippling involves making patterns (markings) on workpieces by surface manipulation. Conventionally, the material is vaporized using a heated tool tip or by laser so as to form grooves which results in better grip. The process is done mostly by hand (with the exception of the laser vaporization method) which is time consuming and work intensive.



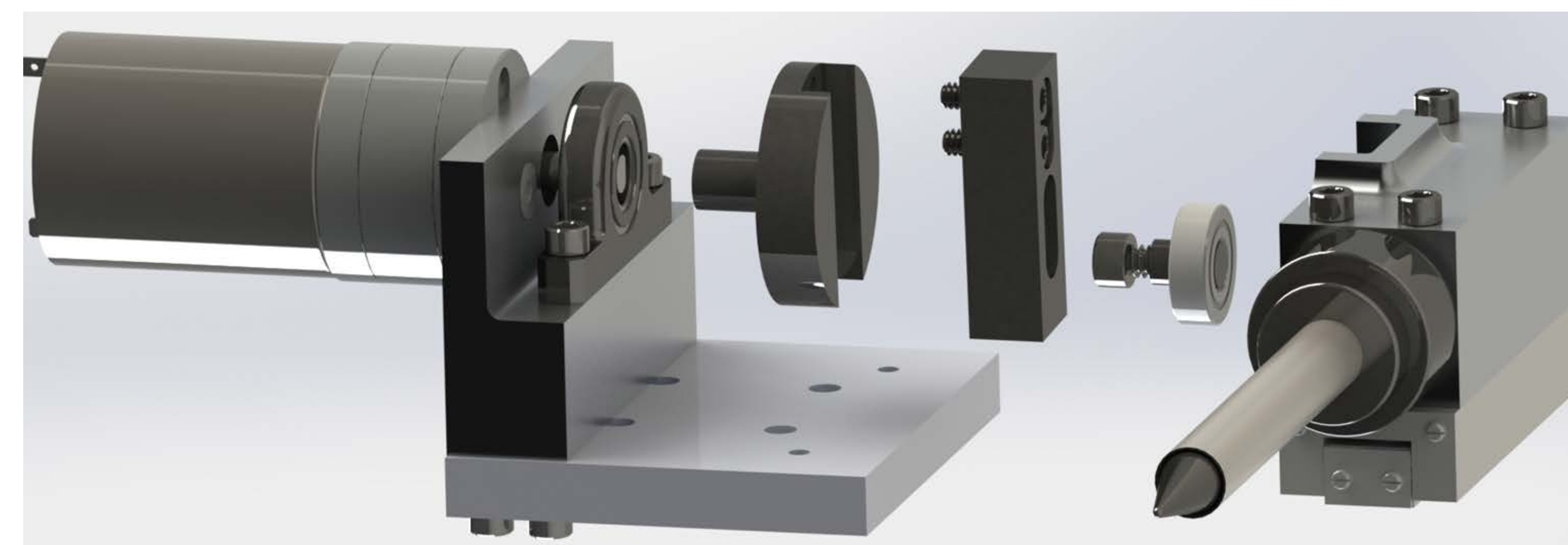
Example of Stippled Part

Project Requirements

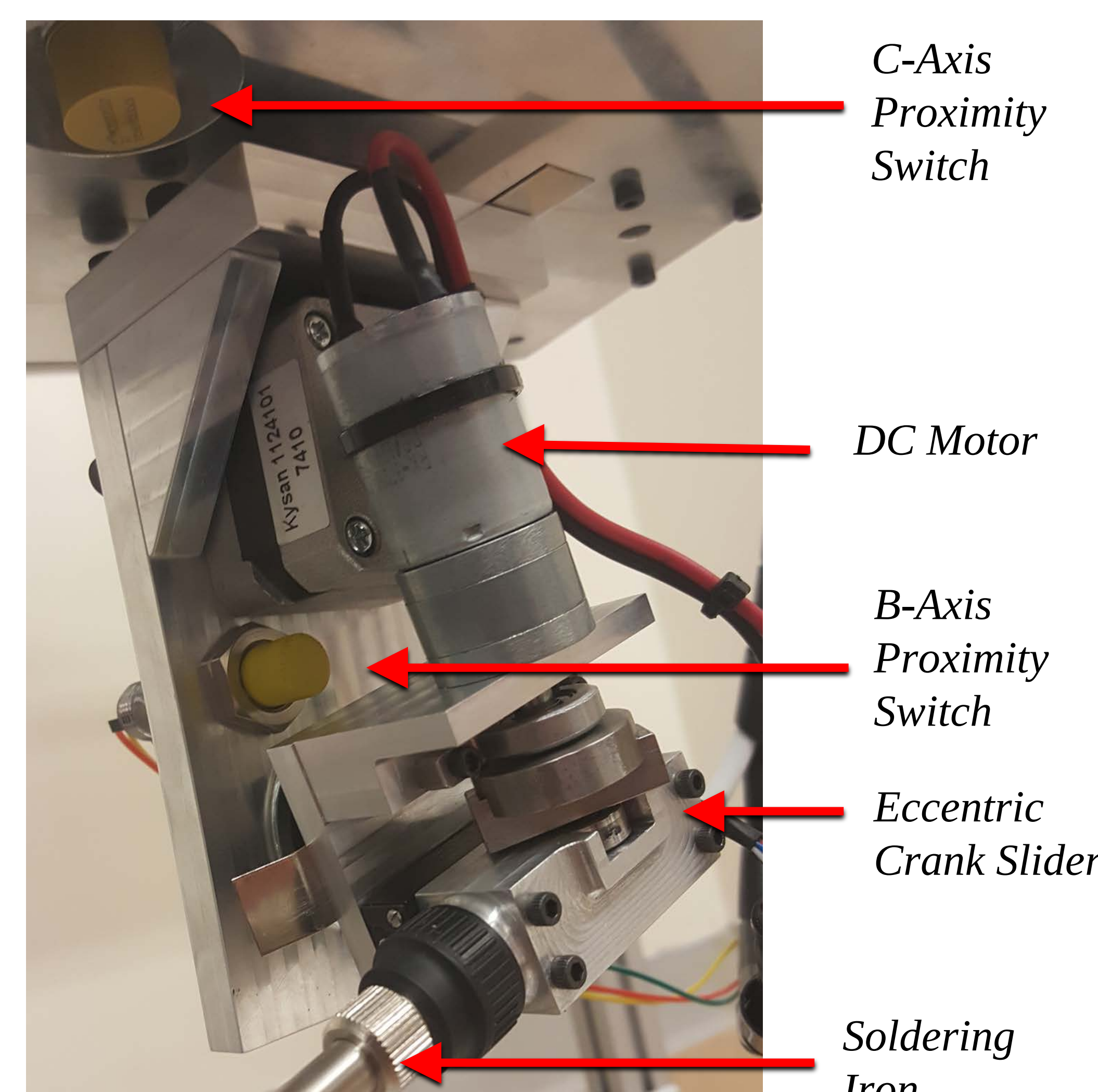
- PS1: The working area of the machine must be 150mm × 150mm × 150mm
- PS2: The operational temperature of the tip will be less than 320 °C
- PS3: The stippling mechanism should have adequate force capacity to stipple a variety of polymers
- PS4: Precision of the machine should be less than or equivalent to 0.01 inches



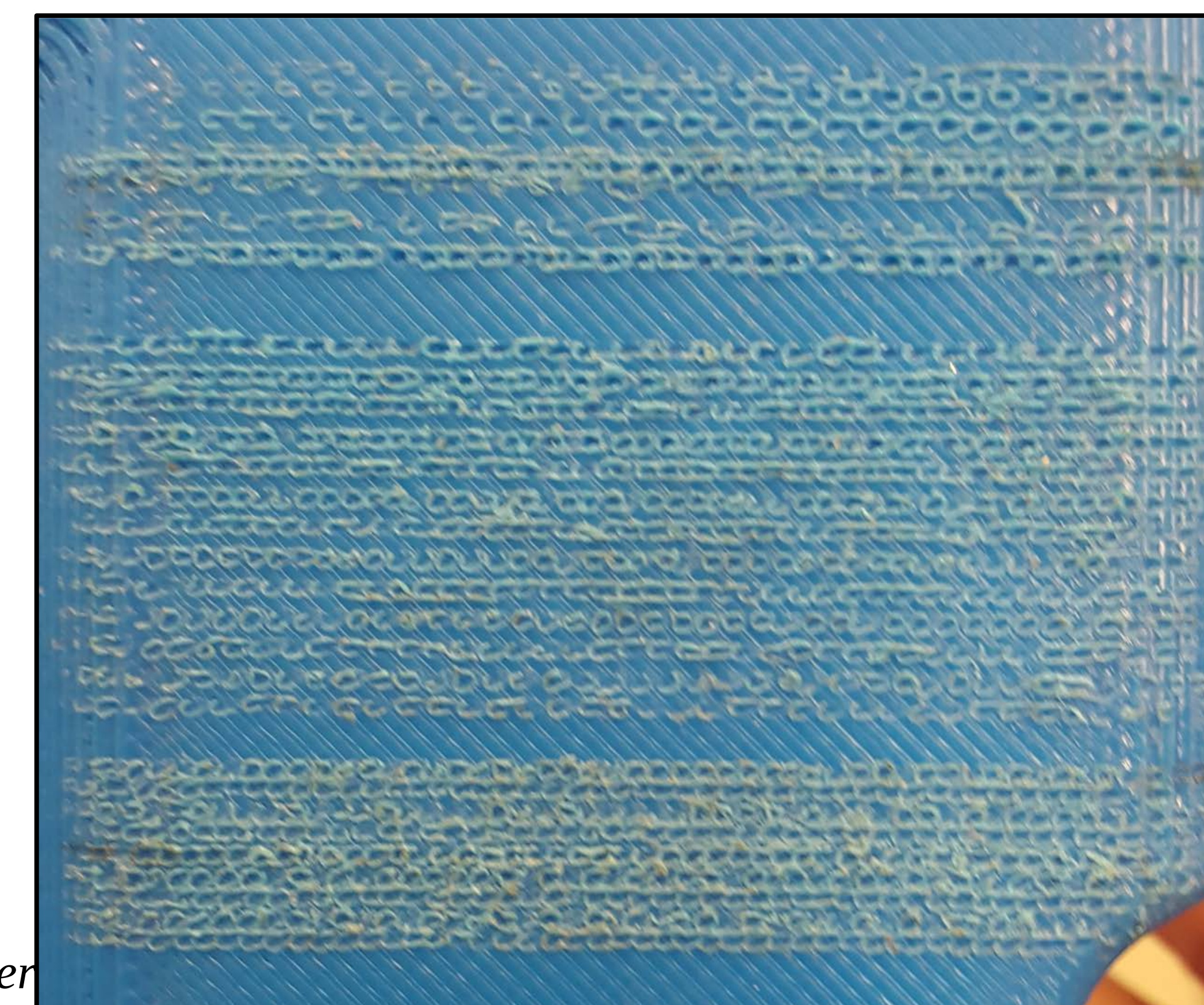
Stippling Machine Prototype



Reciprocating Head Breakdown



Articulated Head Design



Stippling Initial Results

Machine Design

- Design is divided into:
 - **Head Design** which contains the B & C axes and stippling mechanism
 - **Linear axes** which are the X, Y, and Z axes. The workpiece is placed on the X axis

Controls

- Electronics are housed in a panel box
- Includes Stepper motor drivers, the 7i76 MESA card, and Arduino
- All axes are driven by stepper motors
- Controlled using LinuxCNC
- 5-axis tool pathing generated by Autodesk HSM

Kinematics

- Defined coordinate system for tool, workpiece, X, Y, Z, B & C
- Considered center of each joint as the origin of the respective coordinate system
- Derived the kinematic equations for determining joint parameters for attaining specific position for stippling

Conclusion

- Stippling machine prototype was successfully designed, fabricated and assembled
- Plastic sample was stippled to produce satisfactory results
- Working range of the machine is 150 x 150 x 150 mm
- The operating temperature of the stippling tip can be set in the range of 0 °C to 450 °C