1. Design Specifications
Acceptable Prototype Tolerance: ≤ 0.010 inches.
Machine Width/Depth: ≤ 34 inches.
Heat Mill/Printing Table: Minimum 140°F.
Machine Weight: ≤ 200 pounds.
Part Fixturing: Eliminate Need to Re-fixturing.

2. Problem
Can a Thermoplastic be Printed onto an Aluminum Substrate and Retain Adequate Bond Strength?
Would the bond be sufficient for use in a Prosthetic Device?
Would it be possible to Machine the Thermoplastic After Deposition on the Aluminum Substrate?

3. Testing
Apply Surface Milling or Adhesive Surface Treatment to Aluminum Substrate, Then Print Thermoplastic onto Treated Area.
Prove feasibility of Machining Thermoplastic Printed on Aluminum Substrate.
Use the Instron® Tensile Testing Machine to Determine the Shear Force Required to Separate the Thermoplastic From the Aluminum Substrate.

4. Results
Instron® Force Test Results

5. Machine Build
Mill Spindle and 3D Printer Carriages Mounted to Independent X and Z Axis Travel Gantry for Stability and Rigidity.
Heated Table with Integrated Work Holding Features Travels on Y Axis for Ease of Control.
Mill Spindle Driven with NEMA 23 Stepper Motors Via 12mm Acme Lead Screws with Linear Bearings and Hardened Linear Rails.
3D Printer Head Driven with NEMA 17 Stepper Motors and Toothed Belt with Linear Bearings and Hardened Linear Rails.
Mill Spindle with Power to Provide a Material Removal Rate of Approximately 1 in³/ min (on Aluminum).
Powered Via Typical Household AC Electrical Outlet.

Conclusion: Future designs and testing should consider using an epoxy adhesive.
(*Utah Arm® Prosthetic Hand Grip Force: Approximately 50 Pounds)