TECHNICAL PRESENTATION

THE LONGSHOTS

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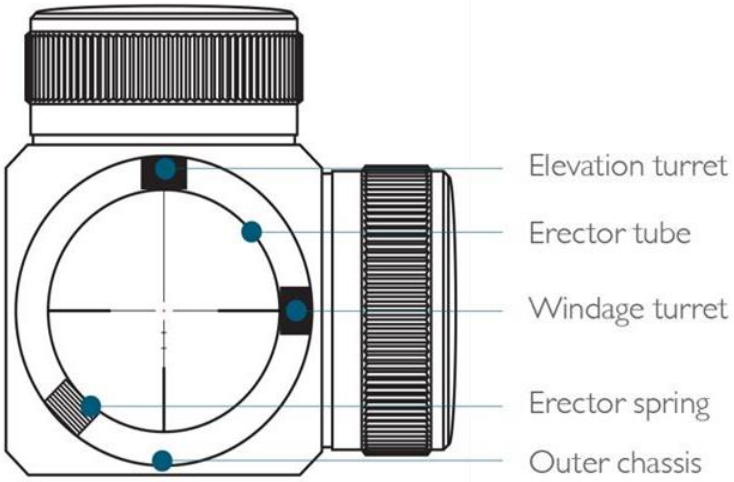
PROJECT INTRODUCTION



- Client is NightForce Optics
- Scopes are adjusted using turrets/lead screws
- Screws need to fit tight tolerances to be suitable for use.

PROBLEM STATEMENT

- Currently lead screws are burnished and tested by hand and the torque specs are defined as what feels good to the workers.
- Our job is to quantify the torque values that “feel good” and create an autonomous machine that burnishes to those values.
- The minimum acceptable backlash for the threads is around 0.0001”, so our machine must also measure to see if the threads meet that requirement.

DESIGN VALUE PROPOSITION

- Allows client to repurpose up to 2,000 labor hours
- Eliminates human factors involved with hand-burnishing
- Reduces wasted materials and machining time
- Increases accuracy of backlash measurements

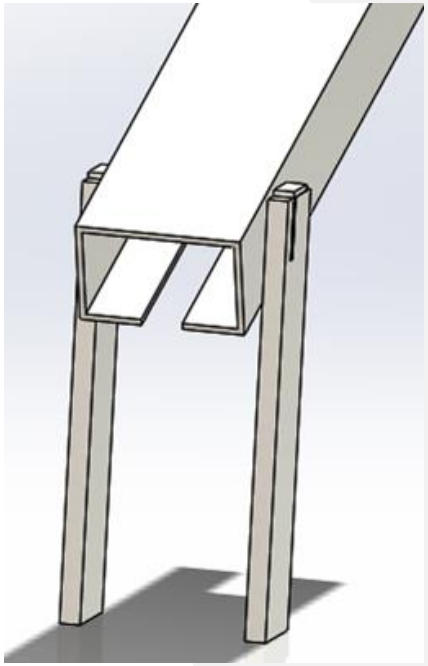
SPECIFICATIONS

- Maximum size - 2ft by 2ft
- Maximum weight - 50 lbs
- Burnish acceptable turrets at similar or increased rate to current process
- User Friendly
- There are 7 different models of lead screws
- Easily modified to accommodate future turrets

DESIGN CONCEPTS: WORKFLOW

- Must be user friendly
- Consists of 4 stations:
  - Load turrets
  - Burnish turrets
  - Measure backlash
  - Eject turrets
- Must be easily interchangeable between turret models

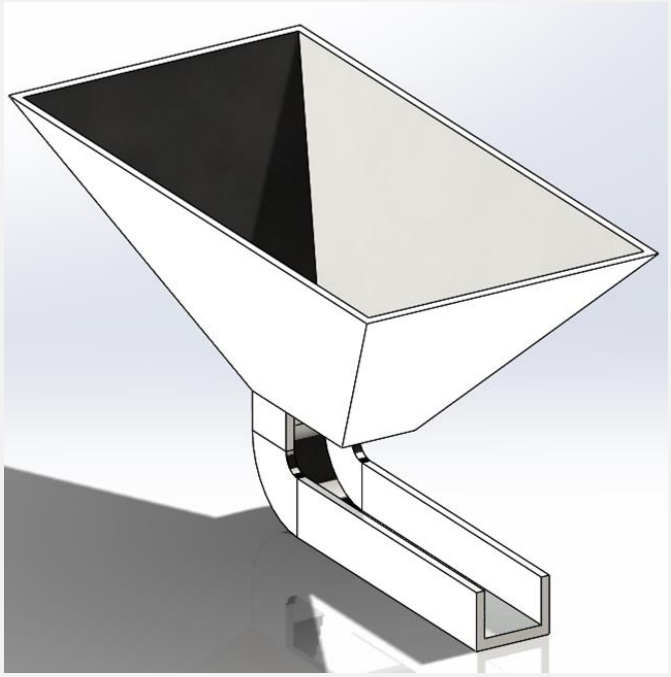
DESIGN CONCEPTS - WORKFLOW



Magazine

Pros: Simple, Inexpensive, Easily changed

Cons: More labor intensive to load

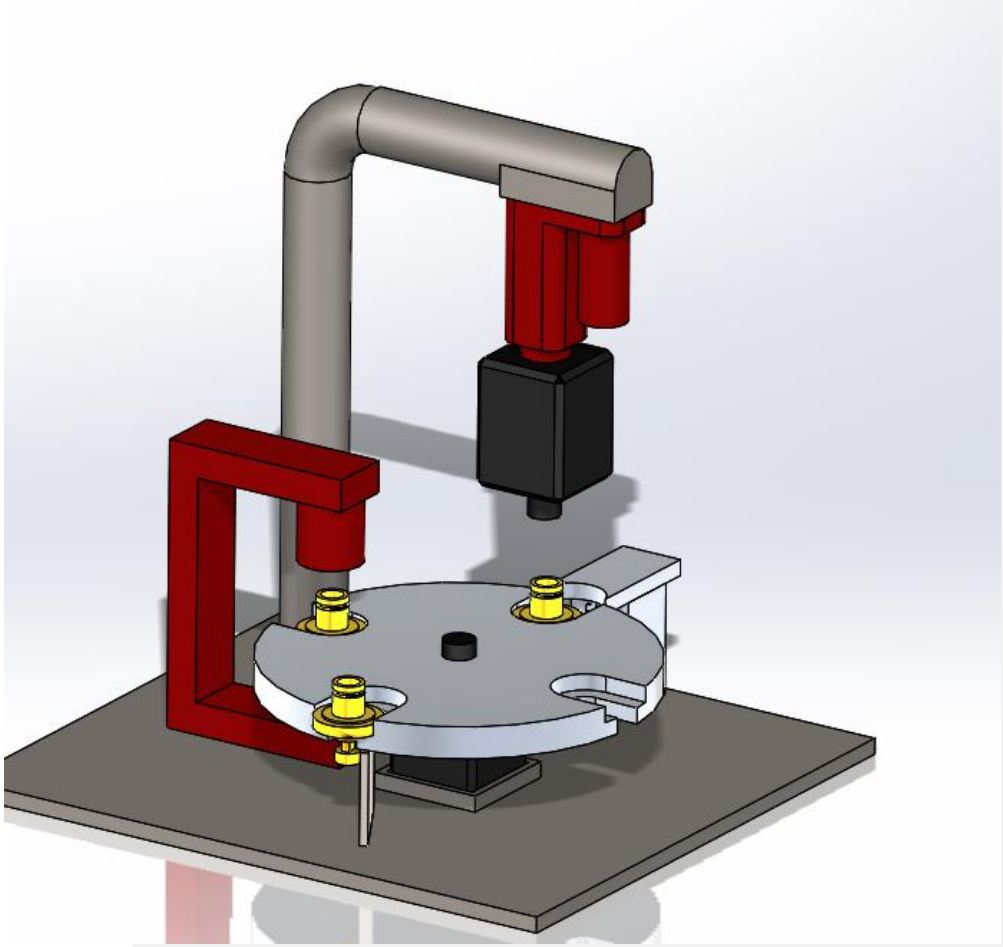


Hopper

Pros: Little labor necessary to load

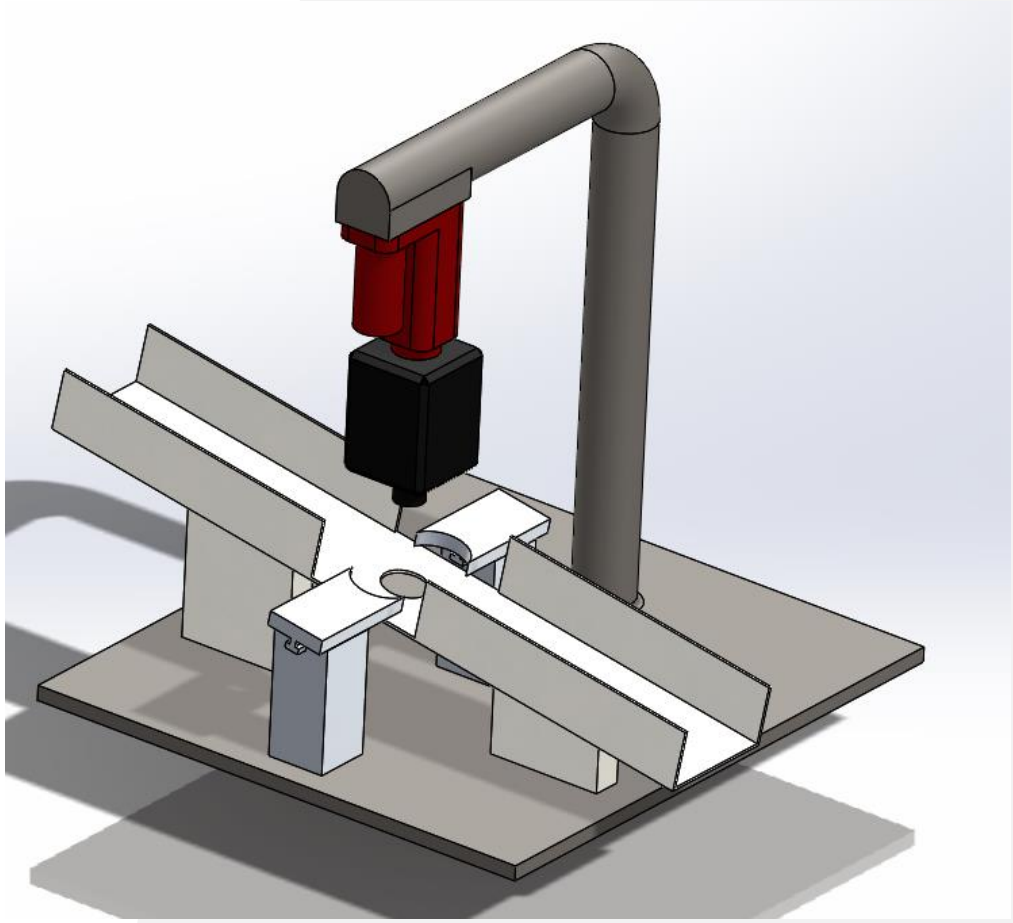
Cons: Complicated, expensive, could damage threads

DESIGN CONCEPTS - WORKFLOW



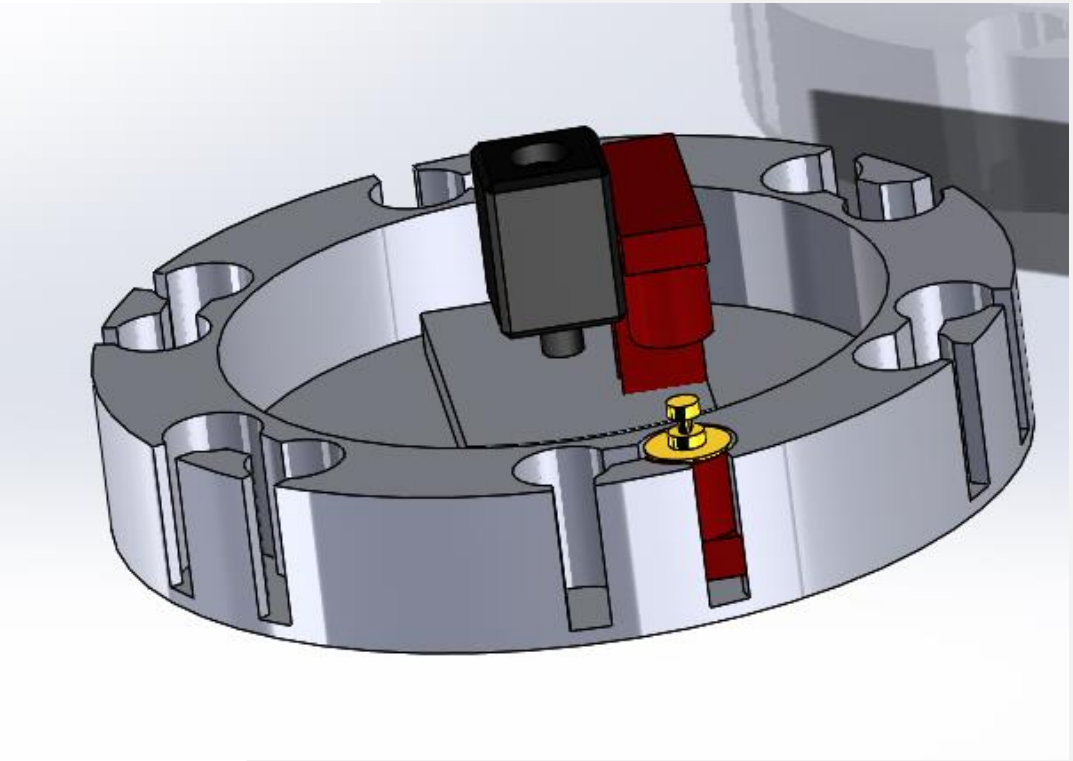
- Fed via magazine
- Burnishing accomplished with direct drive stepper and linear actuator
- Stepper motor used to turn turntable
- Ejection accomplished using an angled plate

DESIGN CONCEPTS - WORKFLOW



- Fed via magazine
- Turrets are stopped at stations using servos
- Turrets slide through machine

DESIGN CONCEPTS - WORKFLOW

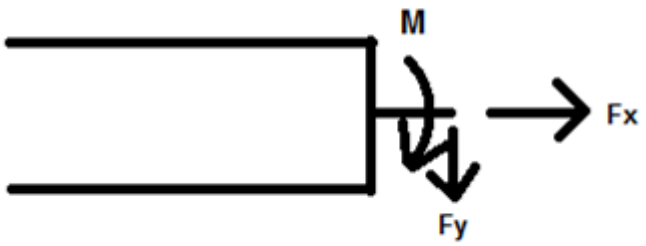


- Fed via magazines
- Different station for each turret size
- Reduces changeover time

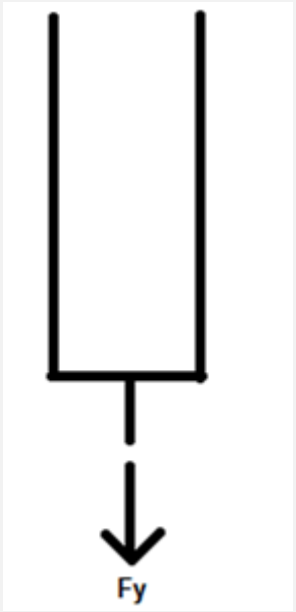
DESIGN CONCEPTS: BURNISHING

- Threads must be burnished to a specific torque value currently defined as what “feels good”
- Avoiding axial forces on threads is important
- Torque sensing is a critical part of burnishing

DESIGN CONCEPTS - BURNISHING



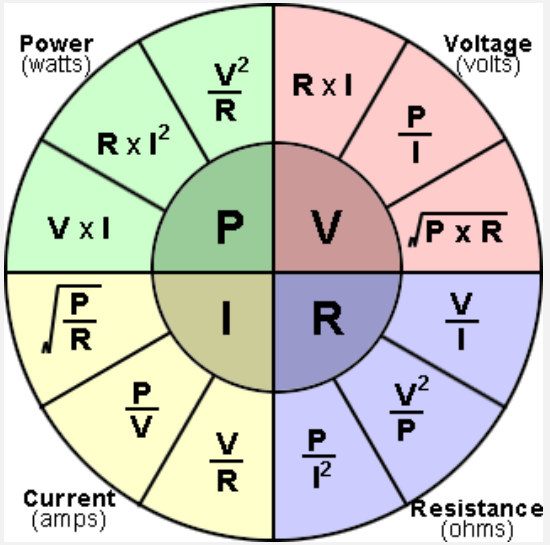
- Horizontal
- Pros: less axial weight on threads
- Cons: workflow of horizontal turrets would be difficult



- Vertical
- Pros: less forces, easier workflow
- Cons: axial force on threads

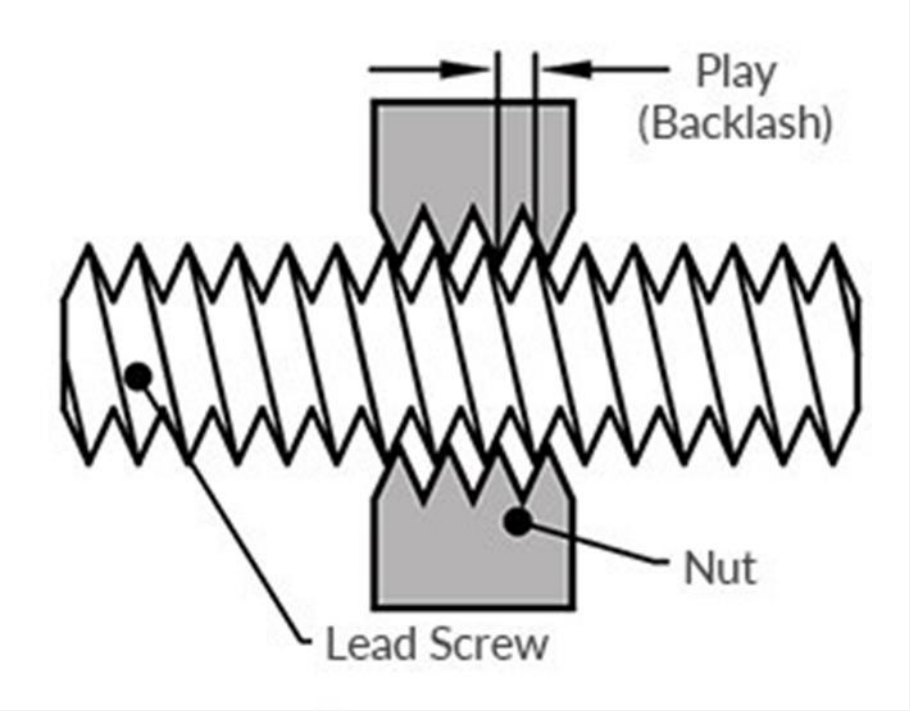
TORQUE SENSING

- Use stepper voltage and current to find torque
  - Higher the Torque, Lower the Speed
  - PWM to change speed
    - Encoder to adjust PWM based on load



DSIGN CONCEPTS- BACKLASH

- Tolerance - 0.0002”-0.0004” (5.08um-10.16um)
- Over burnishing
- Axial loading



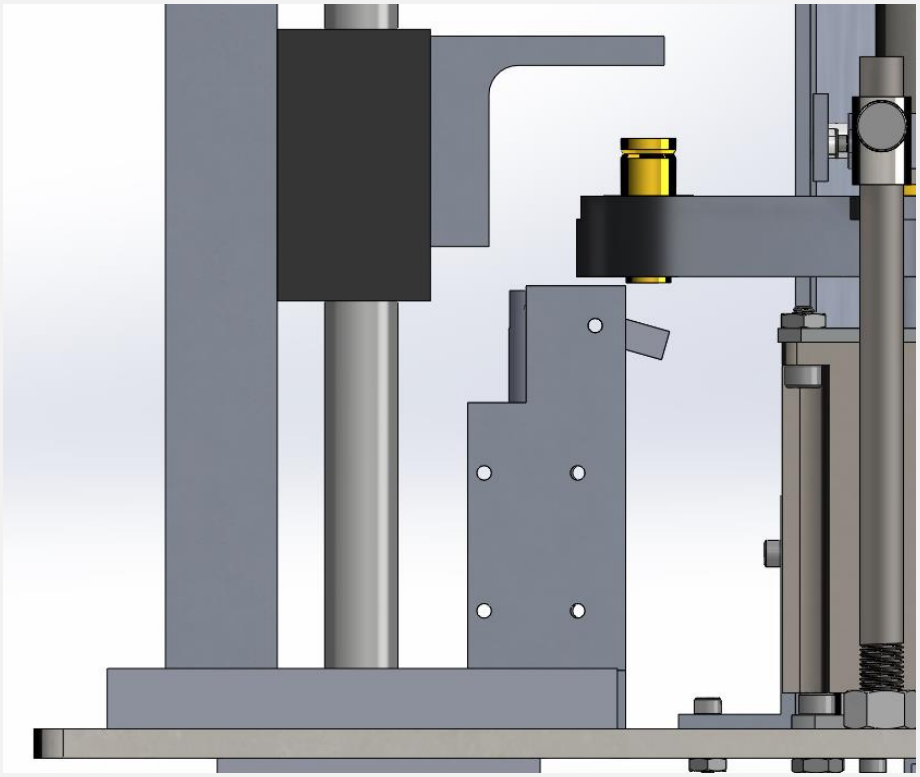
DESIGN CONCEPTS- BACKLASH

Precision Components

- Contact Displacement Sensor
- High Precision Actuator
- Laser Displacement Sensor
  - MicroEpsilon optoNCDT 1420

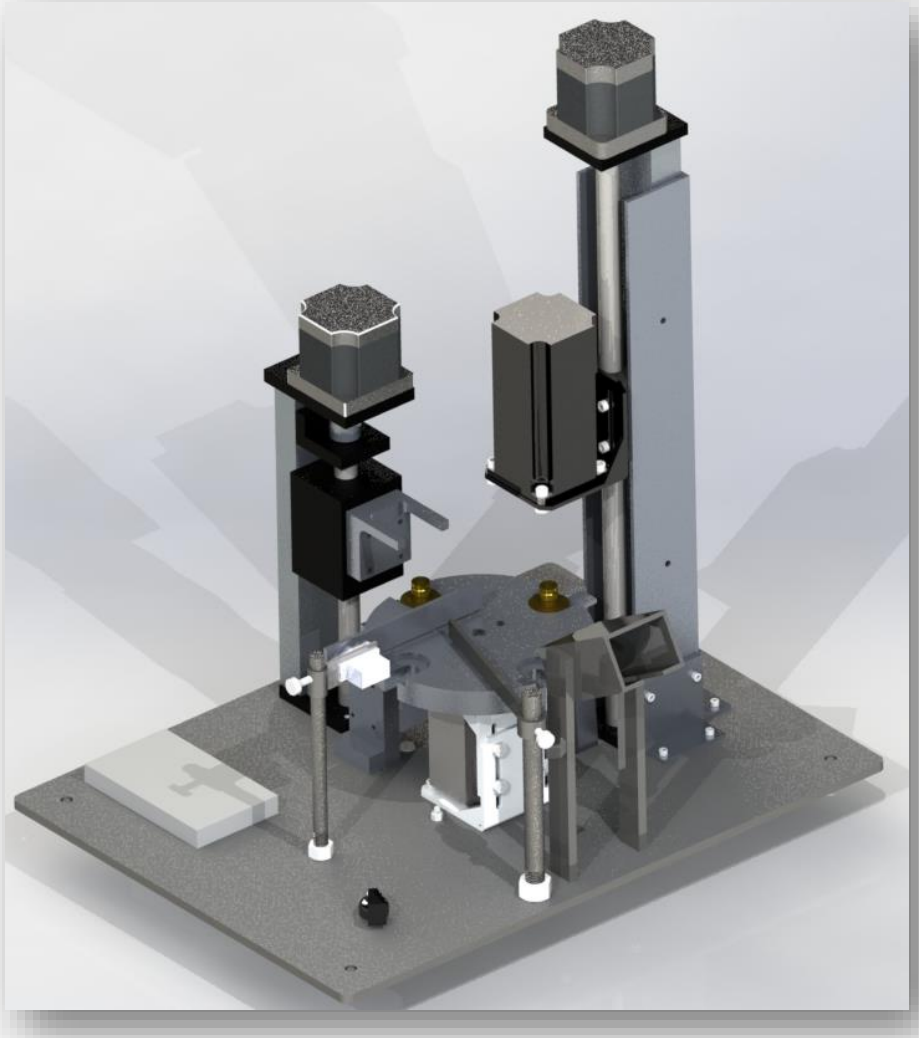
DESIGN CONCEPT - BACKLASH

- Immobilizing Actuation
- Precision Actuation/Measurement



FINAL DESIGN CONCEPT

- Turntable workflow
- Direct Vertical Burnishing Controlled by Slide Table
- Laser position sensor
- Use stepper voltage and current to find torque



Automation

- Original Plan:
  - PIC 32 Motor Controller
  - Inline Debugger
  - MP-Lab (C)

- Final Result:
  - Arduino Uno

Problems / Recommendations

- Refine Automation Coding
  - Torque Sensing
  - Backlash laser output integration
  - Actuator Life

QUESTIONS?