DEPARTMENT OF MECHANICAL ENGINEERING

TEAM D5
Multi-Sample Laser Profilometer

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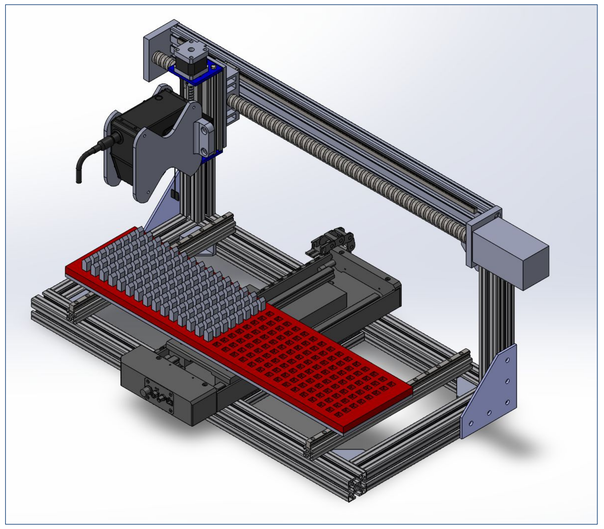
Motivation, Goal, Impact

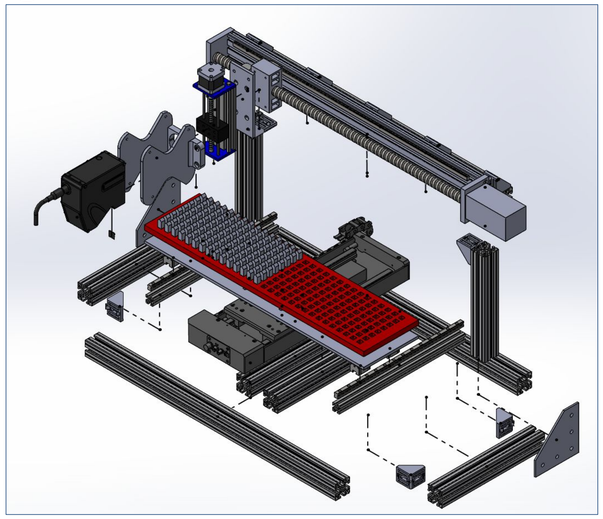
- Automate and expedite sample scanning and data collection process
- Reduce downtime in scanning process and reallocate human resources more effectively
- Maintain precision, consistency, and reliability

Requirements

- Process at least 20 samples with various size without human intervention
- Automatically save and process files for the surfaces

Final Design

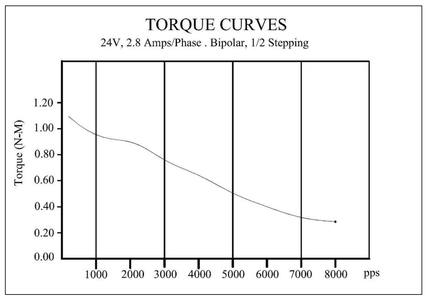




Key Components

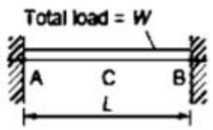
- Ball Screw Linear Rail w/NEMA23 Stepper Motor
- Aluminum Extrusion
- Linear Stage
- Digital Motor Controller
- Support Rails
- Scanning bed
- Keyence Laser

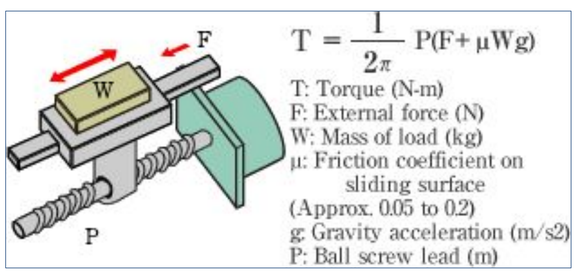
Design Calculations & Decisions



- Stress and deflection analysis of encastre beams (fixed on both ends) and distributive load across the entire length of the beam

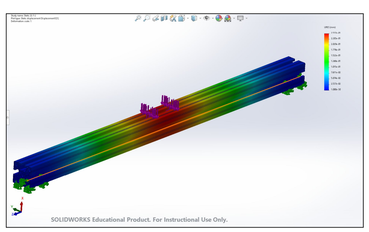
$$\delta_{max} = \frac{wL^4}{384EI}$$



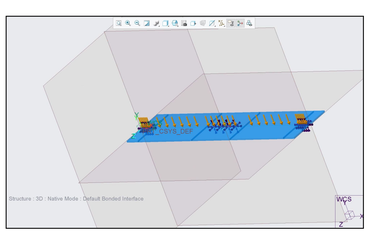


$$T = \frac{1}{2\pi} P(F + \mu W g)$$

T: Torque (N-m)
F: External force (N)
W: Mass of load (kg)
μ: Friction coefficient on sliding surface (Approx. 0.05 to 0.2)
g: Gravity acceleration (m/s2)
P: Ball screw lead (m)



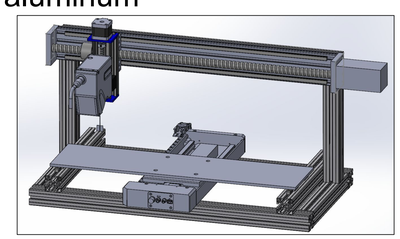
FEA of railing for the x-axis as simply supported beams with fixed ends at both sides



FEA of scanning bed pinned on both ends and the middle to simulate support of the linear guide rails and Zaber linear stage to withstand 44.9 lbs

Prototype & Test Results

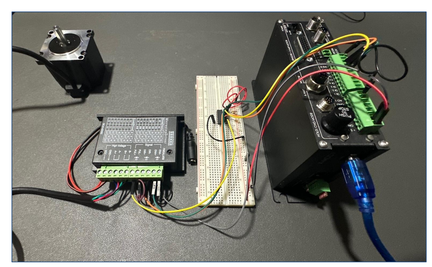
Fabrication: Prototype materials consists of aluminum extrusions, ball screw linear actuators, linear guide rails, stepper motors, stepper motor driver, and machined aluminum

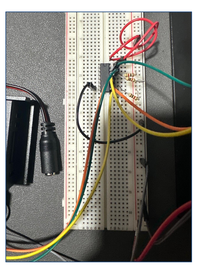


First iteration CAD for multi-sample laser profilometer

Prototype Tests:

- Linear movement across the x, y, and z axis
- Movement and carrying capacity of at least 20 samples for each type of fracture test
- Successful scan of each sample type





Electronic circuitry for x-axis linear movement using the Zaber controller used by NSWC