

Team #42: PCB Laser Etcher

Kevin Broadbridge, Will Fisher, Gregory Suhor, Jared Swetnam

Objective

Develop a machine that tangibly improves the creation of printed circuit boards and photomasks for the LSU PCB lab through increased precision and efficiency relative to existing processes.

Engineering Specifications

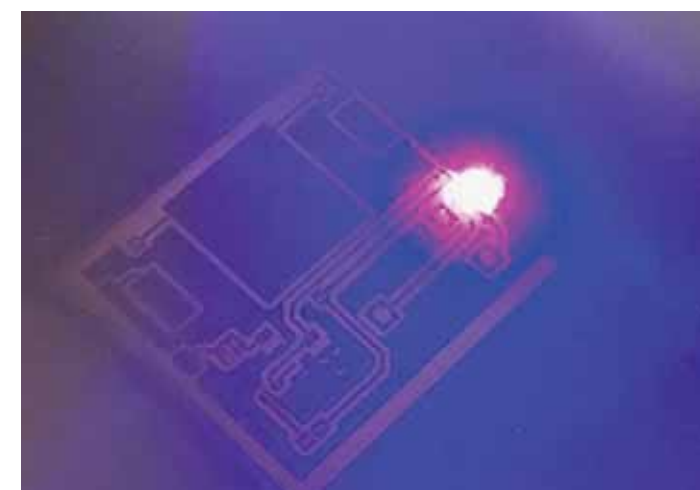
Specification	Target	Achieved
PCB Active Area	12" x 9"	13" x 11.8"
PCB Production Time	< 1 hour	0.5 hours*
Machine Dimensions	< 2.5' x 6'	1.92' x 2.48'
Trace Width Capability	< 8 mils	3 mils

*Production time depends heavily on board size and the number of features.

Concept Selection



Direct Exposure



Photomask Development

Safety



Safety Interlock



Emergency Stop



Warning Light

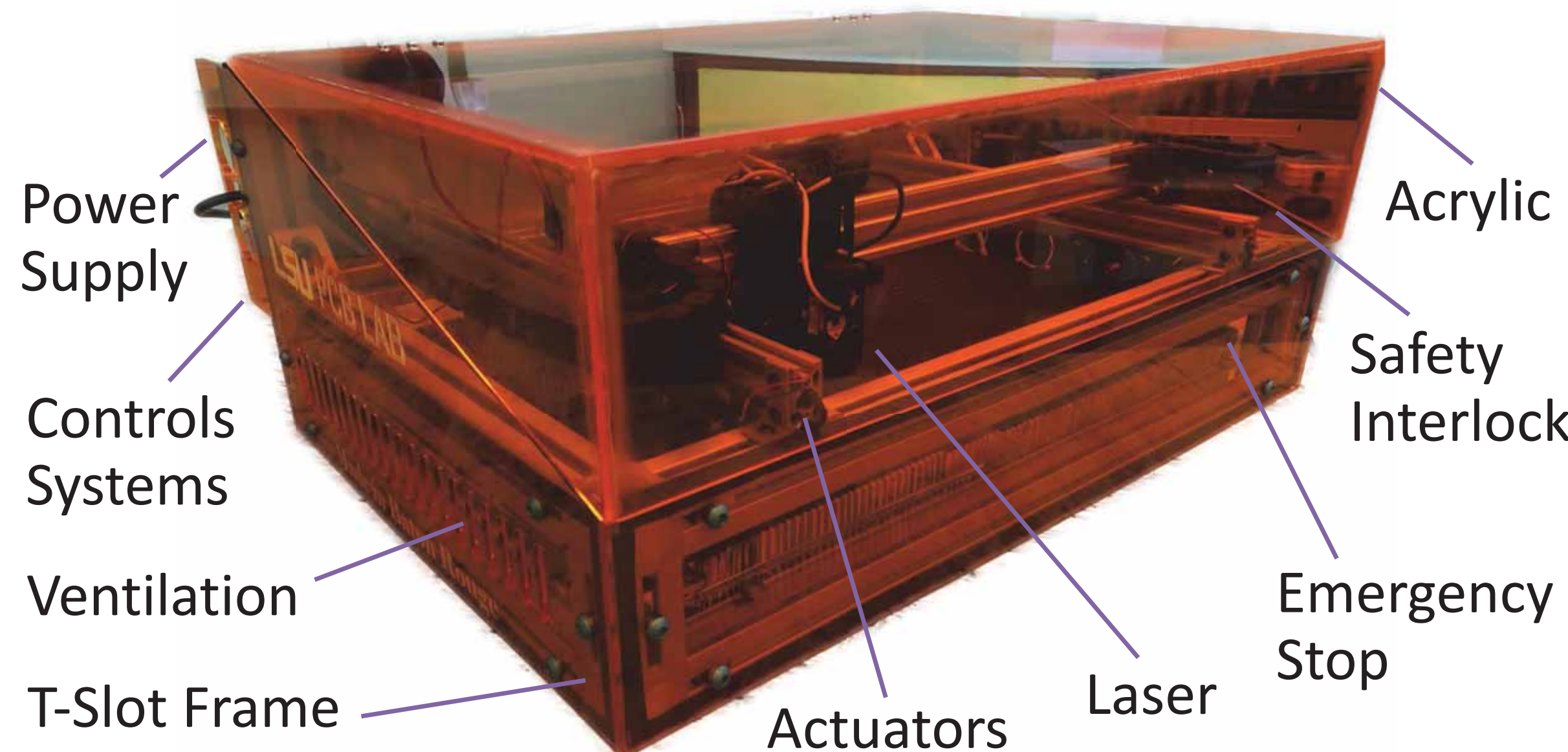


Safety Goggles



Diffusing Acrylic

Prototype Design



Manufacturing Process

Table & Band Saws

Acrylic panels

Soldering Iron, Heat Gun

Wire connections

Drill Press

Screw holes

Laser Cutting Machine

Smaller acrylic panels

PCB Milling Machine

Printed circuit board

Fusion 360 Software

Smaller acrylic panels

Engineering Analysis

$$\text{Spot size due to diffraction} = \frac{4M^2\lambda f}{\pi D}$$

λ = wavelength
 f = lens focal length
 D = input beam diameter at the lens
 M^2 = beam mode parameter

Conclusion: Wavelength is proportional to trace width. Thus, the 405nm laser option is more precise than the 445nm option at a spot size of 4 mils versus ≥ 8 mils.

Testing & Validation

Laser Trace Width

Trace Resistance

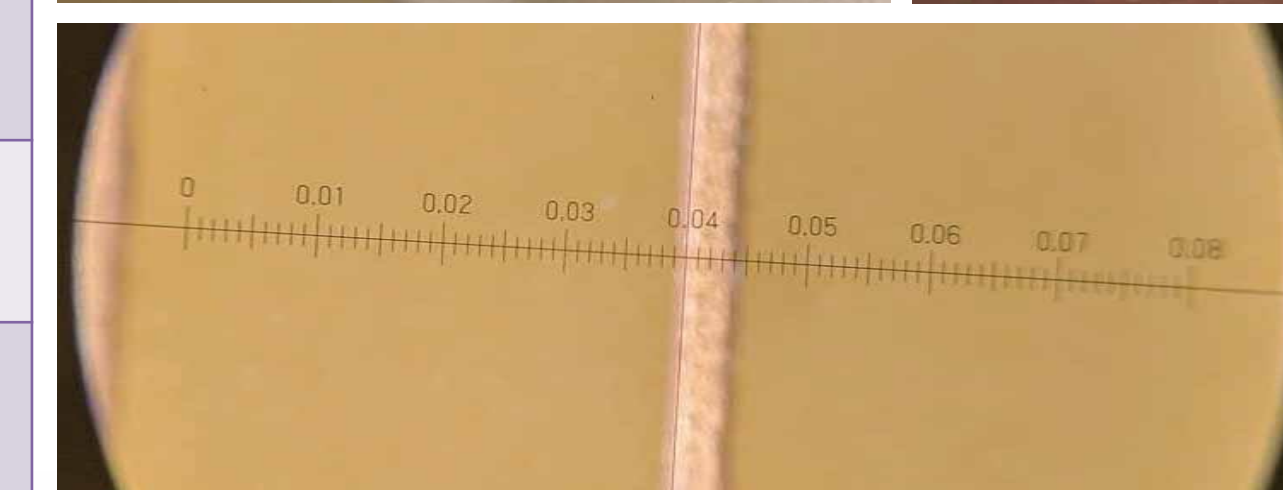
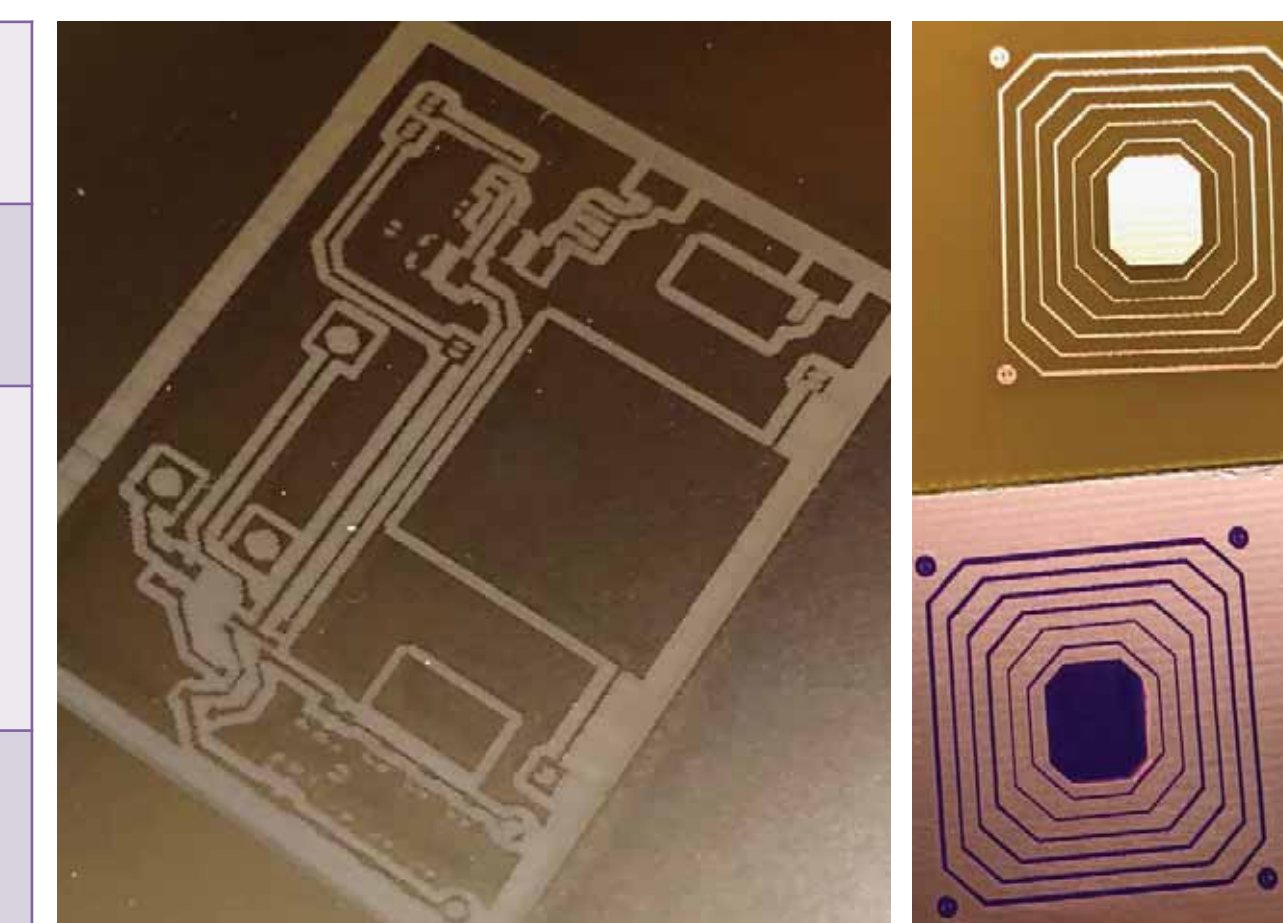
PCB Development

Efficiency

Operational Longevity

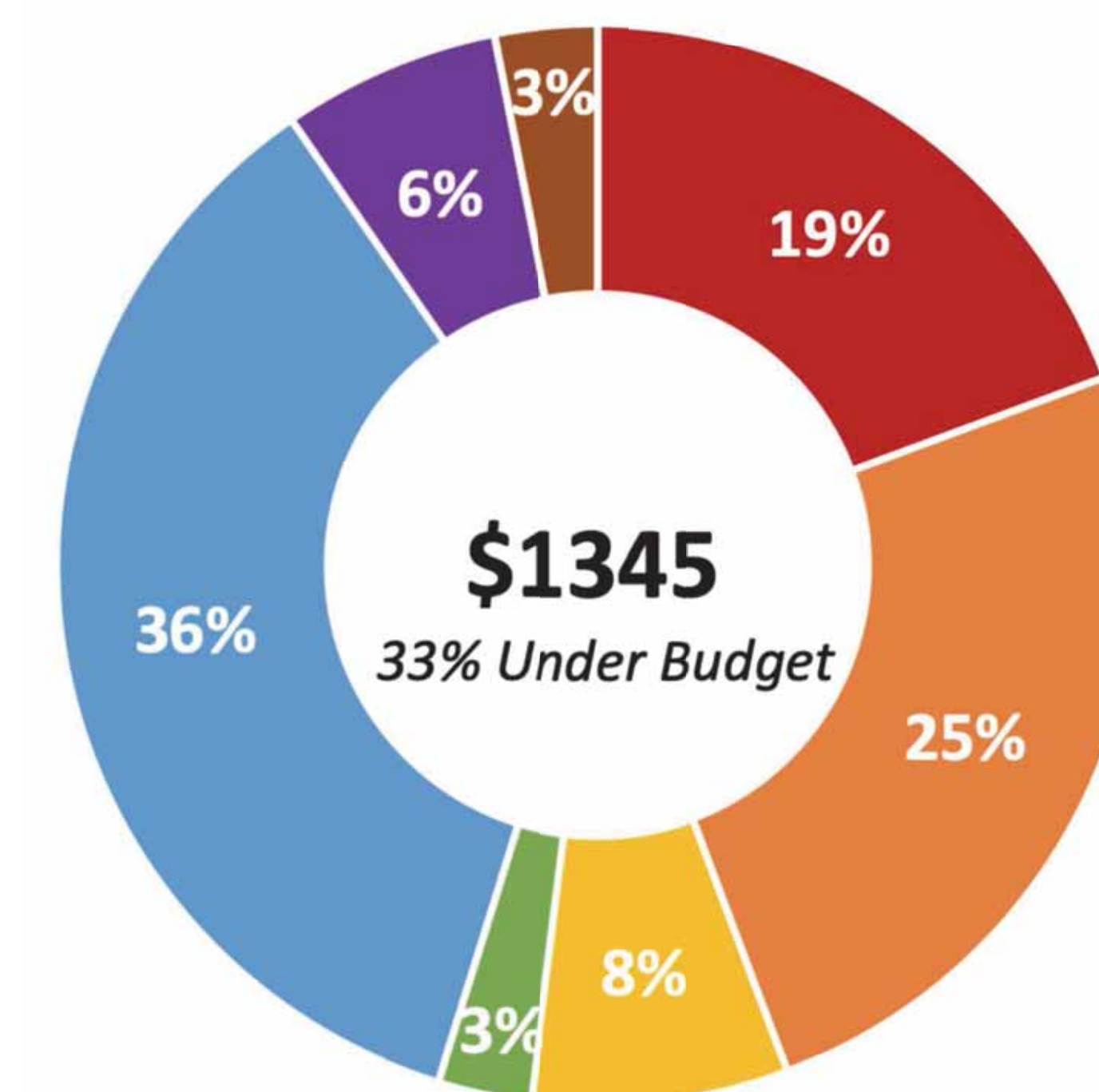
Safety Testing

Software Settings



Budget

Budget: \$2000



- Laser
- Actuator
- Controls
- Power
- Case
- Ventilation
- Software
- Safety

September

October

November

December

January

February

March

April

- Gantt Chart
- House of Quality
- Concept Generation
- Concept Selection

- Functional Decomposition
- Initial Engineering Analysis

- Engineering Analysis
- Simulations
- Prototype Drawings
- Choose Parts

- Order Parts
- Initial Subsystem Manufacturing

- Subsystem Manufacturing
- Order Additional Parts

- Subsystem Manufacturing
- Subsystem Testing
- Order Additional Parts

- Prototype Manufacturing
- Prototype Testing

- Instruction Manual Creation
- Prototype Completion
- Final Testing

Sponsor: Christopher O'Loughlin

Advisors: Dr. Martin Feldman, Dr. Hsiao-Chun Wu, Dr. Theda Daniels-Race