

Michigan State University
College of Engineering; Dept. of Electrical and Computer Eng.
ECE 480 Capstone Design Course Project Charter

Sponsoring Company/ Organization:

Contact Information:

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Background Information:

Business Case:

- Explain why is this an attractive opportunity for your company to pursue now.
The ECE Cleanroom presently has a standard mask aligner. With a maskless lithography system, many of the samples we wish to process could be done without purchasing a mask, and would give students the flexibility to change the lithography patterns rapidly without the added costs associated with purchasing additional masks.
- Describe the discontinuity creating the competitive opening in the marketplace that makes this project timely. (Competitive action, Legislation, Regulation, etc.)
Most commercially available mask aligners are above \$100,000 and more commonly in the \$200,000-\$500,000 range. This proposed project should reduce the cost and increase flexibility of the system at the cost of some resolution limitations. The low cost nature of this system could be commercially competitive.
- Explain how this product / service will be positioned as a commodity (low cost to serve) or a differentiated (value priced) offering. Why?
I think this would be a low cost commodity to serve the specific needs of researchers using the ECE Cleanroom.
- Outline the competitive barriers to marketplace entry the Design Team needs to take into consideration.
Competitive laser based systems exist, but are again at cost ranges similar to the mask aligners listed above. This system would have a price target in the \$10,000-\$50,000 range.
- What is the hypothesized basis of for a sustainable competitive advantage?
 - o Patents, Trade Secret, Low cost, privileged relationships?
Commercially available products and scientific journal articles.

Project Intellectual Property Considerations:

- Will the student Design Team be required to sign a Non-Disclosure Agreement?
No
- Will the Design Team be able to post their work on the course web site?
Yes

- Will the student Design Team be working with technology contained in pending patents not yet granted?

No

- Can the electronic design be shown, but the embedded software protected?

Yes

Opportunity Statement:

- What **clearly defined Customer Problem** you hope to solve with this project?
 - o Is this problem solvable in a 13 week working semester with students?

Yes, I believe so, many of the required parts are already purchased and available, however it is not clear if the x-y-z system and its controller are fully functional and may require some troubleshooting and repair.
 - o Does the design challenge need to be run across two back-to-back semesters?

No
- Does this problem exist now, or in the future?
 - o How long will the window of opportunity be open to alternative solutions?
 - o What will drive the window of opportunity closed in the future?
- Who is the customer?
 - o Who makes the buying decision?

The design team.
 - o Who will the ECE 480 Design Team deliver their project to at the end of the semester?

Tim Hogan
 - o Describe the benefit to the end Customer for this project.

Benefit will be to graduate students taking ECE877 (Cleanroom Procedures), and to researchers who use the ECE Cleanroom.

Deliverables:

- Describe what is to be delivered at the end of the semester.
 - o Proof-of-Concept design? (Bread-boards, wires connecting sub-systems, etc., ugly looking – but functional, development software non-user-friendly interface)
 - o Working prototype? (PC boards, cabling between sub-systems, refined software and user friendly interface)
 - o Sub-system ready to fit into the overall system?
 - o Final solution ready for end use deployment?

Final solution ready for end use deployment.

Goals:

- Describe what success will look like at the end of the semester.

A maskless lithography system that is computer controlled. Software development for position control and UV LED control should allow for CAD drawings and/or bit map images as input for the lithographic pattern.

Demonstrated patterning of 4" diameter silicon wafers will be used to demonstrate the functionality and limitations of the system.

- Goals should be SMART
 - o **Specific** – Exactly what is to be delivered?

A maskless lithography system that includes:

 - 1) A high accuracy x-y-z-rotation stage.
 - 2) Computer control of the x-y-z-rotation stage and the UV LED light source used for exposing the photoresist. The software must take the input file (CAD drawing or bitmap) and use that as the control input for photoresist exposure.
 - 3) The UV LED light source is to be coupled to a fiber optic which terminates into a pulled fiber (tapered to a small diameter) which focuses the light to less than a 10 micron spot size.
 - 4) A demonstration of the system capabilities by delivering a patterned 4" diameter silicon wafer showing a series of patterns that show the capabilities and limitations of the lithography system.
 - o **Measurable** – Describe the measurement system that will determine the degree of success.

The delivered 4" wafer is to be characterized using a scanning electron microscope to show the various test patterns generated with the system capabilities and limitations described.
 - o **Attainable** – Can a student team, with little to no industrial experience complete this project in 13 weeks to your satisfaction?

I believe so. If not, then we can continue the work in a subsequent semester.
 - o **Relevant** – Limited to this design challenge.
 - o **Time Bound** – 13 week working semester (Students lose a week getting organized and a week preparing for Design Week presentations.)

Scope:

- Clearly define what is IN and OUT of Scope for the Design Team. What are the clearly defined boundaries to prevent the project from getting too large and complicated?
 - IN:
 - Mechanical structure to hold x-y-z-rotation stage, LED, focusing fiber
 - Mechanical structure to hold the x-y-z-rotation stage controller
 - Software to control the x-y-z-rotation stage and the LED (on/off)
 - Might need to develop z-axis limit control for close proximity
 - Demonstration of the completed system capabilities
 - Fully assembled system should be compact and clean (look good)
 - OUT:
 - Higher resolution position detection system (use built-in encoders)
 - Software does not need to be from scratch (i.e.: can use Mach3)

- Clearly list chipsets, software, equipment, test set-ups, working systems, etc. that will be supplied to the Design Team to facilitate their efforts and keep project cost reasonable.

The following will be supplied:

- 1) UV LEDs (1mm coupler)
- 2) 1mm diameter fiber optic
- 3) Focusing fiber (pulled to small diameter) with fiber optic coupler
- 4) An x-y-z-rotation stage and control system (might have one motor that need repair/replacement)
- 5) The x-y-z-rotation stage control system manual
- 6) 4" silicon wafer with photoresist spun on (when needed)

Constraints:

- List all constraints on the project team.
 - o Examples include: Equipment the team must interface with, past Capstone Designs the team must build upon previous results, chip sets / software team must use in the design, etc.

Cost for Sponsorship: \$4000

Project Team: (Completed once semester begins)

Name	Responsibility

Faculty Advisor: (Assigned by ECE Dept . based on project requirements)
