UNC CHARLOTTE
The WILLIAM STATES LEE COLLEGE *of* ENGINEERING

Senior Design Project Description

Company Name	ASML US	**Date Submitted**	05/25/2018
Project Title	Active Dampening of Structures Using Piezoelectrics (ASML_PIEZO)	**Planned Starting Semester**	Fall 2018

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project. 250 hours are expected per person. Complete the following table if this information is known, otherwise the Senior Design Committee will develop based on the project scope:

Discipline	Number	Discipline	Number
Mechanical	5	Electrical	1
Computer		Systems	
Other (controls, including Mechanical)			

Company and Project Overview:

ASML is the leading photolithography tool supplier to the semiconductor industry, and consistently one of the two largest semiconductor equipment suppliers in the world. We engineer, design, build, market, install and maintain the machines that print the majority of the semiconductor chips used in computers, cellphones and elsewhere.

ASML's headquarters are in The Netherlands, where the main engineering and integration site is located. The company also has two large engineering and production sites in the US: Wilton CT (ASML US), and San Diego CA (Cymer). Cymer produces the light sources that enable the lithography process. This includes Deep Ultraviolet Lasers (193nm wavelength - light path in air and water) and the Extreme Ultraviolet Light Source (13nm wavelength – light path in very low pressure hydrogen). ASML US in Wilton produces all variants (including DUV and EUV versions) of several major modules of the TWINSCAN® Lithography machine: The Reticle Stage, the Reticle Handler, and several optical modules, including Wafer Alignment, Wafer Level Sensing (topology mapping), and Actinic Light Uniformity Compensation. All EUV modules are designed to operate in ultra-clean vacuum environment. In addition, Wilton also produces the optical module of the YIELDSTAR® in-line wafer inspection tool.

This Student Project will be sponsored by the Mechanical Development Group of ASML US (Wilton), and will target one of the mechanical issues that are intrinsic to our capability to keep up with an aggressive roadmap, where our machines have to perform at ever decreasing error levels to enable printing ever smaller features on chips.

The issue of investigation for this project is the vibrations of structures. It is important for static

optical modules, where the blur caused by vibrations decreases the performance of the optical sensors. It is also important for moving mechatronic devices in our machines, such as precision stages, where vibrations diminishing positioning performance, and robotic devices, where vibrations compromise the accuracy of wafer and reticle transfers.

In this project, students will investigate ways to use piezoelectric actuation and/or sensing to actively damp flexible structures down to micron-level amplitudes. They will also engineer, design and construct a simple flexible structure and use piezoelectric elements as active dampers.

Project Requirements:

The students, in consultation with advisors at UNCC and ASML, shall:

Perform a search of methods and techniques for piezoelectric damping of mechanical structures.

Understand a "typical" ASML flexible structure, and outline the dynamics and controls architecture best suited to damp this type of structure.

Propose "proof of concept" structure(s) simple to build, while capable of simulating the fundamental behavior of the typical ASML structure. The proof of concept may be as simple as a cantilever beam, a simply supported beam, or the like.

Search for (low-cost) off-the shelf piezoelectric actuators suitable for damping the proof of concept structure. A proposed goal is to reduce the amplification at resonance (Q) by a factor of at least 5x (Q with damper on compared to Q with damper off), for the fundamental mode. Attenuation for higher modes may be less. No amplification of any mode.

Conceptualize the proof of concept design(s), including actuators, electronics, controls, etc.

Down select to a proposed proof of concept design based on tradeoffs.

Finalize the design of the proof of concept, including actuators, electronics, controls, etc.

Order all purchased components.

Build and program the proof of concept.

Test the proof of concept.

Write a report, including test results, lessons learned, recommended improvements, and conclusions.

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Expected Deliverables/Results:

- Recommended method for damping a "typical" ASML structure using piezoelectric actuators and/or sensors.
- Recommended dynamics and controls architecture.
- Conceptual design(s) of "proof of concept" according to the above.
- Final proof of concept design, including specifications and CAD model.
- Working proof of concept with demonstrated 5x attenuation of the fundamental mode and no amplification of any mode.
- Final report including test results. (Meeting including ASML's participation)

Disposition of Deliverables at the End of the Project:

Proof of concept, results, etc. may be presented at the EXPO.
Proof of concept may remain at UNCC after completion of the project, for the purpose of re-use in subsequent ASML projects.

List here any specific skills, requirements, knowledge needed or suggested (If none please state none):

Periodic progress reviews with ASML (suggested weekly ~ 1 hour) on Skype.
PDR, CDR and Final Report meetings at UNCC and/or Skype.

Skill/knowledge/interest:

- Mechanical Engineering with a strong interest in precision mechanics.
- Mechanical (or other) Engineering with a strong interest in vibrations/dynamics.
- Mechanical (or other) Engineering with a strong interest in electronics/controls.
- Mechanical (or other) Engineering with a strong interest in testing.

At the outset of the project, ASML requires no specific knowledge beyond acceptable academics in Engineering. However, the individual(s) must be willing to dedicate substantial effort towards "on the job" learning in the areas outlined above.