UNC CHARLOTTE
The WILLIAM STATES LEE COLLEGE *of* ENGINEERING

Senior Design Project Description

Company Name	*Oerlikon*	**Date Submitted**	*11/24/2020*
Project Title	*Design and Implementation of a Smart Recoater in a Laser Based Metal Additive Manufacturing System* **(OER_RECOAT)**	**Planned Starting Semester**	Spring 2021

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills:

Discipline	Number	Discipline	Number
Mechanical	2	Electrical	2
Computer	2	Systems	
Other (civil engineering - environmental)			

Company and Project Overview:

Oerlikon AM is spearheading the revolution that is Additive Manufacturing. We have gathered together a dynamic team with deep industrial knowledge, backed with state of the art facilities worldwide, built specifically for AM.

We provide AM solutions in metal alloys, ceramics and plastic materials. We support our AM printing capability with our own metal powder production, research and development, component design, application engineering, and finishing capabilities.

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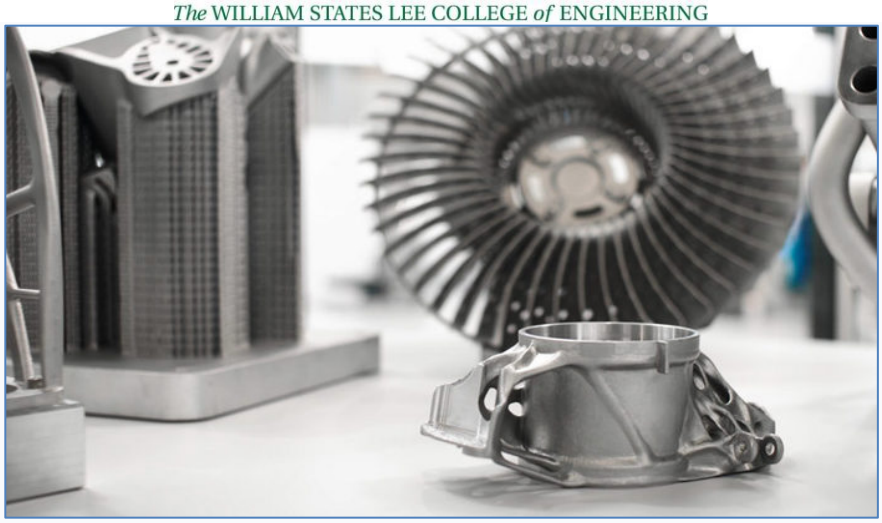


We are pioneering AM for all scales of manufacture from a single custom part to series production runs lasting decades across all industries.

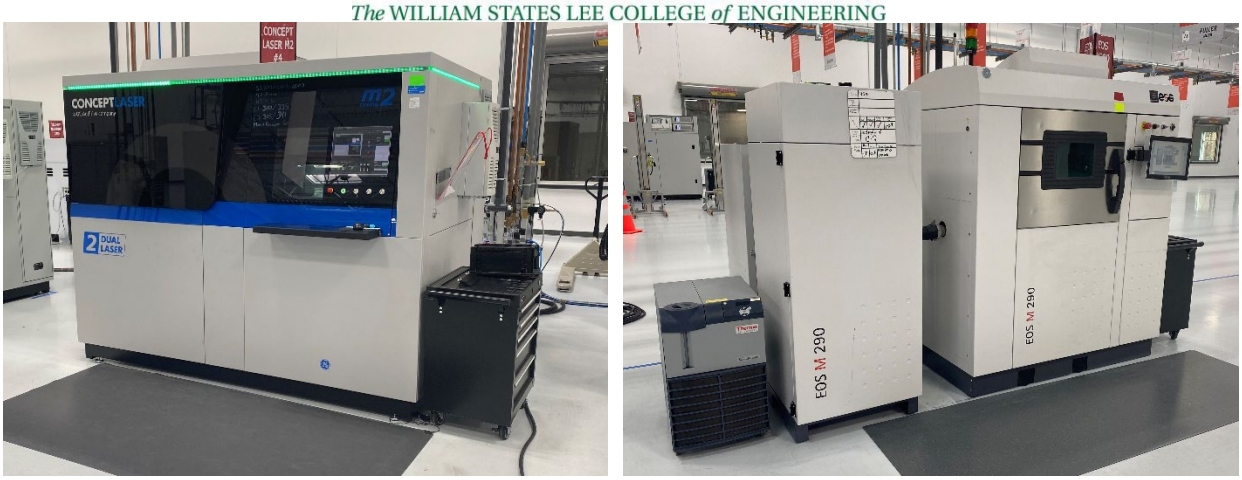
AM allows the creation of new components which cannot be achieved by any other process. There are obvious benefits. Weight may be reduced, saving material costs and providing benefits for the service life of the product. Strength may be increased, and several components may be combined into one. Manufacturing costs may be reduced, while product performance and durability can be increased.

This project seeks to design an intelligent recoating system by adding a group of sensors to the current recoating system. A successful design will notify engineers and technicians of problems as they develop and will help to narrow down regions requiring post build inspections.

Project Context:

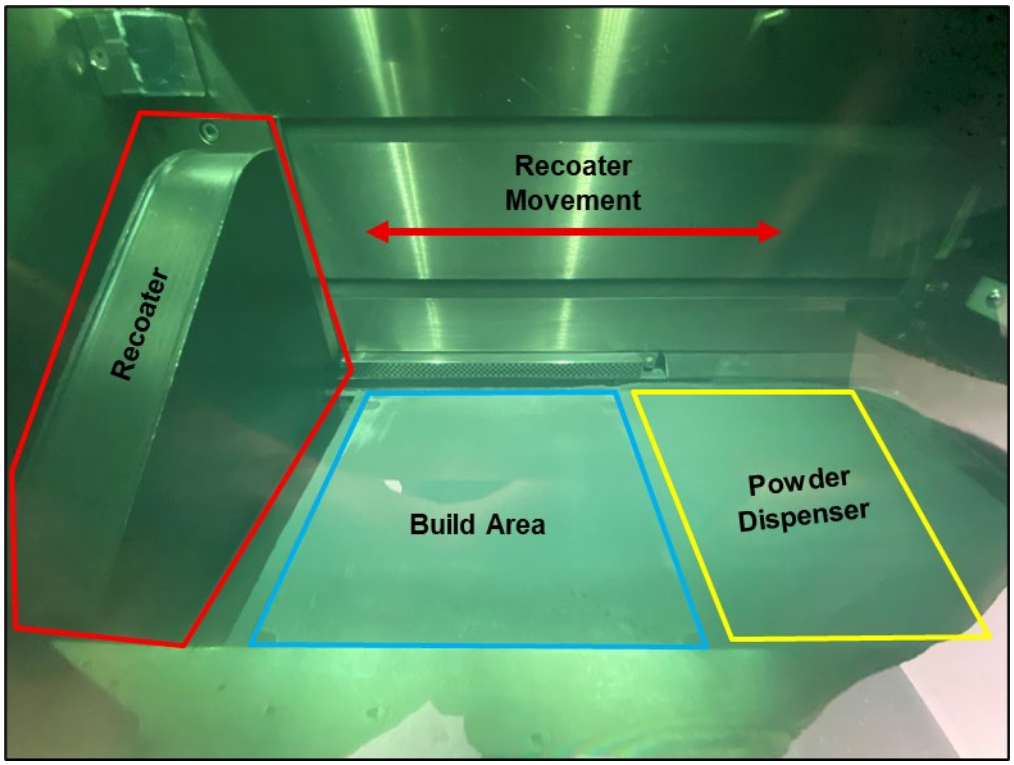
The Concept Laser M2 and EOS M290 are two of the most common mid-size PBF-LB machines used to additively manufacture components. Both powder bed systems work in a similar manner:

1. CAD models are converted to STL's and sliced into 20-90 μm layers.
2. Laser paths are generated for each slice and sent to the AM machine.
3. A thin (20-90 μm) layer of metal powder is laid on a metal substrate.
4. The first layer of the model is exposed with the laser, melting and solidifying the metal powder.
5. The metal substrate drops the height of one layer.
6. A recoater pushes a new layer of metal powder over the exposed layer.
7. The next layer is exposed with the laser. Steps 5-7 repeat until the component is completed.



Photographs of a Concept Laser M2 (left) and EOS M290 (right) PBF-LB machines

Current recoater blades, which make contact with the powder, can be made of steel, ceramic, or polymer. These blades are fixed into the recoater blade holder, which sweeps across the build area. Due to the inherent physics at play during the build process, certain portions of a part may deform slightly out of plane or swell during the laser exposure. If using a hard recoater blade, an impact will occur as the blade passes over/through the raised material. This impact can lead to chatter which impacts the uniformity of the surrounding powder layer. It may also lead to defects within the component itself such as voids or increased surface roughness. For these reasons, this project's highest priority is to attach one or more sensors to the recoater blade which can detect these impacts and scraping events. Any data collected should be stored and the system should be able to notify an engineer/technician of the event.



Inside an EOS M290 build chamber

The secondary goal of this project is to attach a series of non-contact thermal sensors to the recoater. As the recoater is moved across the build area, this would allow us to create a 2D thermal image of the build layer showing residual heat in the part and surrounding powder. This data could then be stacked to give a thermal history for the entire part after completion. Additional sensors that help make the smart recoater more powerful will be considered given the time.

Project Requirements:

The project requires the design of a smart recoater which makes use of multiple sensors to provide data on recoater blade movement and impact with parts being built. The smart recoater needs to be able to notify engineers/technicians when impacts are occurring. The smart recoater will also collect thermal data from both the parts and surrounding powder area to build a thermal history for the manufactured components. Power for the smart recoater will need to be self-contained and data will need to be stored locally or transmitted wirelessly to simplify installation. There is an opportunity to redesign the recoater itself to integrate the sensors and allow room for supporting systems.

Expected Deliverables/Results:

- Fully document a complete design solution that can be retrofitted into the machine
    - Bill of material
    - Drawings
    - Modification instructions
    - Operation instructions
- Design solution to notify engineers/technicians of recoater collision with components being built and provide thermal maps of AM build layers.

Disposition of Deliverables at the End of the Project:

The prototype smart recoater, test fixtures, and intellectual property will be delivered to Oerlikon AM at the completion of the project.

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

- Interest in additive manufacturing/3D printing
- Experience with sensors and data analysis
- CAD and Machine Design
- Interest in Precision Manufacturing