RESEARCH EXPERIENCES FOR TEACHERS – SUMMER 2019 (rev 6-20)

Project #3: Additive Manufacturing

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1) Focus: 3-day training on fundamentals of additive manufacturing and hands-on training on selected technologies, including model generation, preparation, pre- and post-processes.
2) Lab training and integrated project:
   This short course aims to empower teachers ability to identify and select proper additive method and post-processing techniques by considering part complexity, surface finish and tolerances, production time and costs. Participants will learn and experience two 3D printing technologies (*Fused deposition modeling* (FDM) and *Stereolithography* (SLA)) and compare them to the traditional polymer casting technique.
   Participants will use a 3D scanner to produce a digital model, convert to STL file, and perform model slicing. They will learn how to properly orient the part considering the part strength, appearance, and the removal of support structures. They will use different post processes to finish the part, including mechanical/chemical polishing (for FDM) and post-UV curing (SLA). In parallel, they will learn polymer casting using a flexible silicone mold. All finished parts will then be compared quantitatively by i) surface finish, ii) dimensional accuracy, and iii) total production time.


Figure 1. Additively manufactured parts by SLA (left) and FDM (right)

3) Authentic research experience**:** Participants will gain necessary additive manufacturing skills, understand the pros and cons of different additive manufacturing methods in a quantitative manner.
4) Equipment:
   - Fabrication: FDM printers (Dreamer and TAZ mini), SLA printer (Form 2), UV-curing station, fume hood, iso-thermal oven, vacuum chamber.
   - Metrology: Calipers, CMM, surface profilometer, white light interferometry, digital microscope.
5) Expected outcomes: At the end of this training, the participants should:
   - Be able to identify and describe various 3D printing technologies.
   - Know basic 3D printer operations and post-processes.
   - Understand the effects of model slicing and part orientation.
   - Have the first draft of curriculum integration

6) Scheduling: The training activities are scheduled as follow. Trainees will be grouped into two (Group A and Group B) to run these activities in parallel or together for the best learning outcomes.

Time	Topic		Note
	Group A	Group B	
Day 1 AM	Short lecture, lab rules, and safety training Project overview and timeline		Conference room
Day 1 PM	Conduct 3D scanning[1]	Prepare digital models and submit files to FDM[2]	In the lab* [1]scanning software: Sense 3D [2]slicing software: Simplify3D
	Prepare digital models and submit files to FDM[2]	Conduct 3D scanning[1]	
	Polymer casting - Part 1: mold preparation (assisted by D, V)		
Day 2 AM	Retrieve and clean FDM parts Chemical vapor polishing for FDM part		In the lab
Day 2 PM	Prepare digital file for SLA[3]	Polymer casting – Part II: casting (assisted by D, V)	In the lab [3]slicing software: PreForm

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<table>
<tr><td></td><td>Polymer casting – Part II: casting (assisted by D, V)</td><td>Prepare digital file for SLA^3</td><td></td></tr>
<tr><td rowspan="3">Day 3
AM</td><td>Retrieve SLA, cleaning</td><td>Retrieve cast part, cleaning</td><td rowspan="3">In the lab</td></tr>
<tr><td>Retrieve cast part, cleaning</td><td>Retrieve SLA, cleaning</td></tr>
<tr><td colspan="2">Measure surface finish and dimensions</td></tr>
<tr><td>Day 3
PM</td><td colspan="2">Continue and complete measurements
Compile and present the data
Discuss implementation and challenges</td><td>Lab and Conference room</td></tr>
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*PPE and handouts will be provided for all lab activities.

***Each Project group will begin with an orientation at the given locations during their lab cycle with the MI Lab. Given below are the dates and respective teacher groups:**

1) **Group 2: July 1st (07/01/2019) - Orientation in MEOB 426 at 9am**
2) **Group 1: July 5th (07/05/2019) - Orientation in MEOB 224 at 9am**
3) **Group 3: July 10th (07/10/2019) - Orientation in MEOB 224 at 9am**