

RESEARCH EXPERIENCES FOR TEACHERS
 Enhancing knowledges and skills in modern manufacturing
 18 May 2018

Project #3: Material-Manufacturing Relationships – 4 teachers

Project #3a: Drill Geometry Design and Drilling Efficiency

- Research topic: Design drill geometrical parameters for high-efficiency drilling of materials
- Focus: One week on drilling concept, drill design, prototype, test, and validation.
- Lab training: This project empowers teachers to understand the advanced drill geometry design for a wide variety of materials from soft polymers to brittle ceramics, and further, to understand how the force/torque, drilling stability, and hole quality are affected by the geometry. For example, these parameters may include high point angle (135°) vs. low point angle (90°), regular point vs. split point, and high helical angle (30°) vs. low helical angle (10°). Participants will learn using CAD software to modify the drill geometry, prototype them, and conduct drilling tests on simulant materials with ductile to brittle characteristics. This project provides fundamental understanding on the material-cutting tool relationship.
- Authentic research experience: Teachers would understand the principles and help to collect data for research projects on cutting tool optimization for brittle material machining.
- Equipment: *Fabrication*: high-resolution 3D printer, CNC platform, dynamometer; *Metrology*: profilometer, digital microscope; *Characterization*: drilling force and torque analysis.
- Expected outcomes: Know and practice safety rules. Know machining characteristics of various materials and effects of drill geometry. Be able to design a tool based on material. Teachers can then guide their students on how to (i) design a drill bit, and (ii) select an appropriate tool and operating parameters for their projects.

This module will be repeated 3 times (week #3, 4, and 5) for groups of 4 participants.

Date	Topic	Note
Mon – Jun 25 – Jul 2 – Jul 9	Introduction to drill geometry and advanced drill design Project overview, demo, lab rules, and basic safety training	Classroom setting or in a conference room
Tue – June 26 – Jul 3 – Jul 10	– Review on CAD and Solidworks – Drill design (from a template model) – Prototype using SLA and DLP printers	Computer room and/or in the lab
Wed – June 27 – Jul 4 (off) – Jul 11	– Post-processes of 3D printed drills – Experiment setup and exercises – Conduct preliminary tests	In the lab (the second group will skip this step)
Thu – June 28 – Jul 5 – Jul 12	– Conduct drilling tests on simulant materials – Data analysis and comparisons – Discussion on parameter and material effects	In the lab
Fri – Jun 29 – Jul 6 – Jul 13	Group discussion: implementation and challenge Tentative topic and plan for implementation	Group social activity follows