IOWA STATE UNIVERSITY
Department of Mechanical Engineering

Automating Forming Processes

Prof. Robert Landers

Advanced Manufacturing Collegiate Chair of Mechanical Engineering
Department of Aerospace and Mechanical Engineering
University of Notre Dame

Faculty host: Juan Ren

Seminar on April 16, 2024 at 11:00 AM in 2004 Black Engr.

Abstract

Small batch production and repair of components having complex geometries is often done most effectively by hand. Forming processes for these components are very complex and, unlike traditional manufacturing processes like machining, require multiple steps where each step requires knowledge of the results of the previous step. Essentially, the operation must be replanned at each step. Indeed, the metal workers and scientific glassblowers that perform these operations in industrial setting are also often artists. These workers are leaving the workforce at a greater rate than they are being replaced, driving the need to automate these complex fabrication processes. This talk will begin with our work in Incremental Sheet Forming (ISF) where a thin sheet of material, secured inside a clamping frame, is formed as a CNC mill or robot moves a hemispherical tipped tool along a programmed path. We will discuss our use of Iterative Learning Control (ILC) to automatically adjust the process plan based upon part errors measured with a digital image correlation system. The talk will then transition to our work in Digital Metal Forming (DMF) and Digital Glass Forming (DGF). These processes seek to provide automation capabilities to metal workers and scientific glass blowers similar to how CNCs provides automation capabilities to machinist. The DMF process consists of 1) selective spatial heating of the part to improve formability, 2) applying a load to the part to reshape it, 3) measuring the final part morphology, and 4) making decisions on how to process the part in subsequent iterations. The interesting sensing and control challenges found in DMF and DGF processes will be discussed. The discussion will be highlighted with results of an automated bending process in a DMF process to achieve precision angles and the thermal control of a DGF process to increase productivity while avoiding bubble formation.

Robert Landers is is the Advanced Manufacturing Collegiate Professor in the Department of Aerospace and Mechanical Engineering at the University of Notre Dame. He was previously a Curators' Distinguished Professor at the Missouri University of Science and Technology and served for three years as a program manager at the National Science Foundation working in the Dynamics, Controls, and System Diagnostics, Foundational Research in Robotics, Cyber Physical Systems, Future Manufacturing, and Leading Engineering for America's Prosperity, Health, and Infrastructure (LEAP HI) programs. He received his Ph.D. degree in Mechanical Engineering from the University of Michigan in 1997. His research interests are in the areas of modeling, analysis,monitoring, and control of manufacturing processes, and in the estimation and control of lithium-ion batteries and hydrogen fuel cells. He received the Society of Manufacturing Engineers' Outstanding Young Manufacturing Engineer Award in 2004, the ASME Journal of Manufacturing Science and Engineering's Best Paper Award in 2014, and the ASME Journal of Dynamic Syst ms, Measurement, and Control Best Paper Award in 2020. He is a Fellow of ASME and SME, and a senior member of IEEE

This seminar counts towards the ME 600 seminar requirement for Mechanical Engineering graduate students.

www.me.iastate.edu