Simulation of Single Point Incremental Forming of polymer sheets

Shubhamkar Kulkarni

Advised by

Dr. Gregory Mocko

CEDAR
Clemson Engineering Design Applications and Research

CLEMSON UNIVERSITY

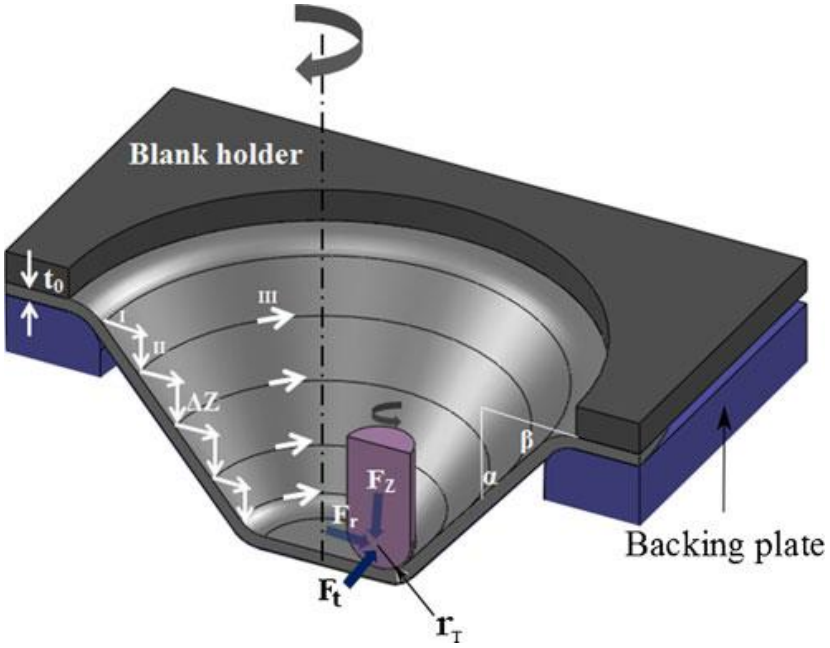
Outline

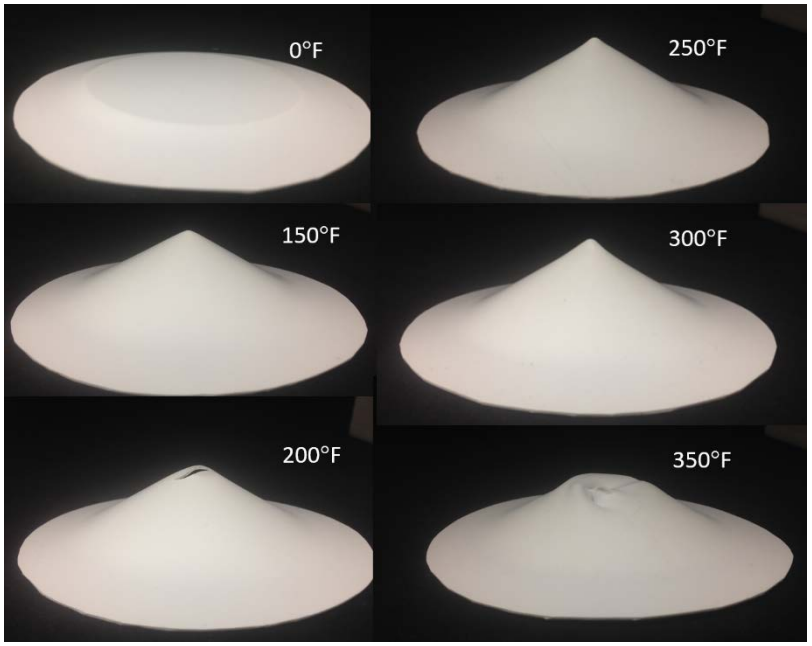
- Introduction
- Research plan
- Phase 1: Literature review summary
- Material Models
- Simulation setup
- Current Status
- Future plan of action

shubhak@g.clemson.edu

Introduction

- Single point incremental forming is a process for dieless forming of sheets
- Localized heating has shown to improve the formability of Polystyrene sheets





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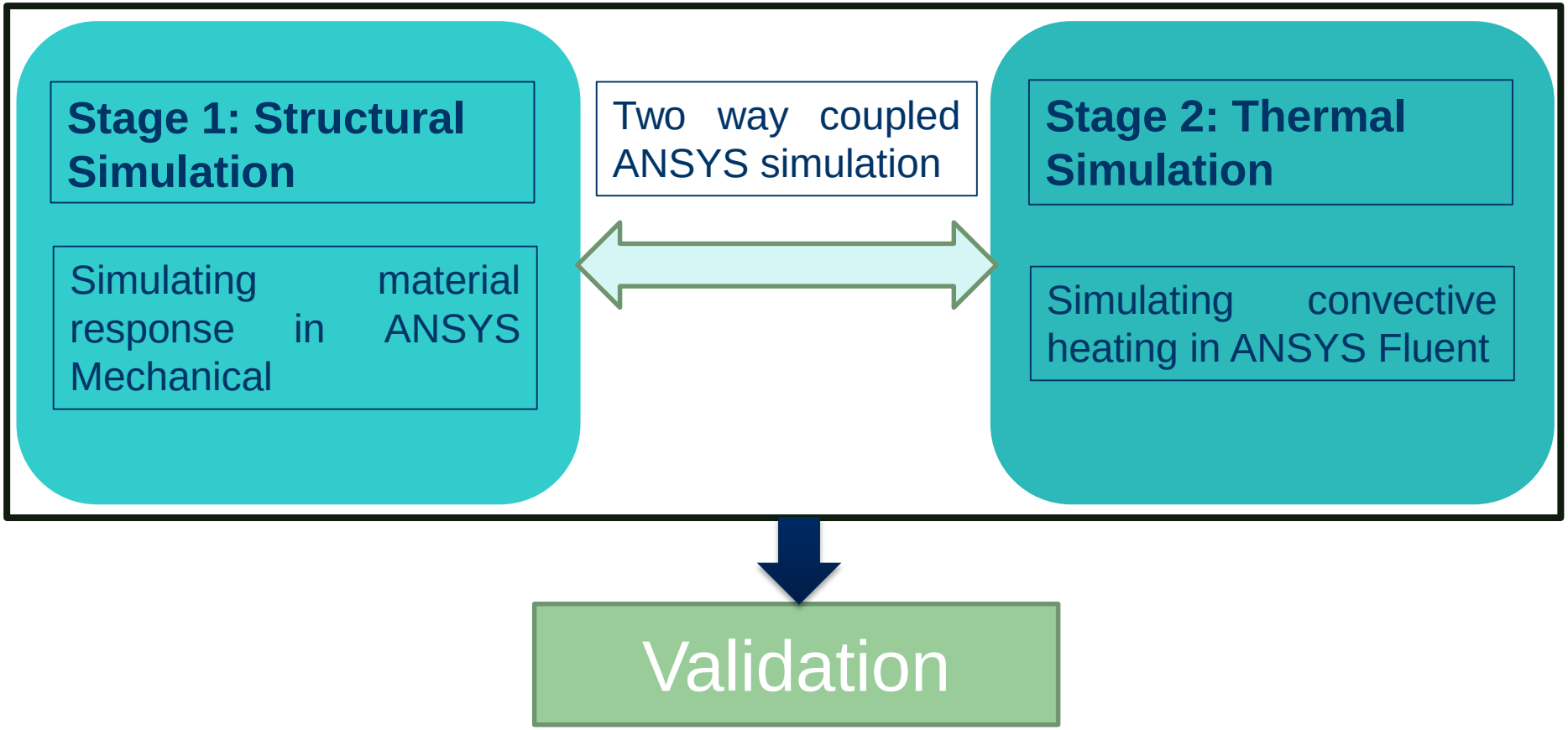
Research Overview

Objective: Simulation of polymer heat assisted SPIF for improved understanding and control of the process



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Literature Review

- A clear conclusion about the best material model for simulating polymer SPIF cannot be made
- Lack of common protocol for testing the models
- Computational time is high due to multiple nonlinearities (finite strains, material behavior and boundary conditions)
- Only two material models have been used for partial simulation
- Trend to develop models requiring lesser number of inputs, reduced computational time and resources
- Material models for polymer and hyperelastic materials have also been investigated

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Selected Material Models

Following material models have been selected

Sr.No	Model Name	Implementation
1	Gomma/Le	Usermat routine in ANSYS
2	Yonan	Usermat routine
3	Response Function	Inbuilt in ANSYS
4	Three Network Model	From Veryst, Inc.

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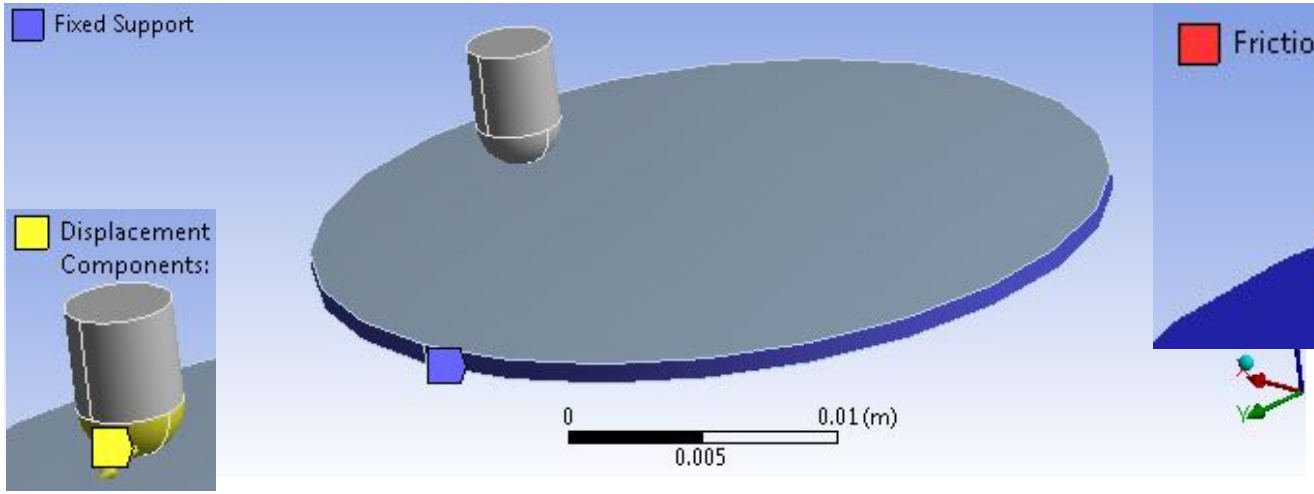
Simulation setup

- Transient structural analysis in ANSYS Mechanical
- Two CAD models: small and large scale

	Small scale	Large scale
Purpose	For testing implementation	For actual testing
Blank diameter	30mm	90 mm

- Fixed support on the perimeter of the blank
- Frictional contact between tool and blank (μ=0.3)
- Tool displacement with time is specified



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Usermat routine- ANSYS

- For implementing custom material behavior
- Written in Fortran
- Routine is compiled and linked to ANSYS mechanical
- Configured in co rotational frame
- Specific to the type of element
- Currently trying to obtain required version of Fortran compiler

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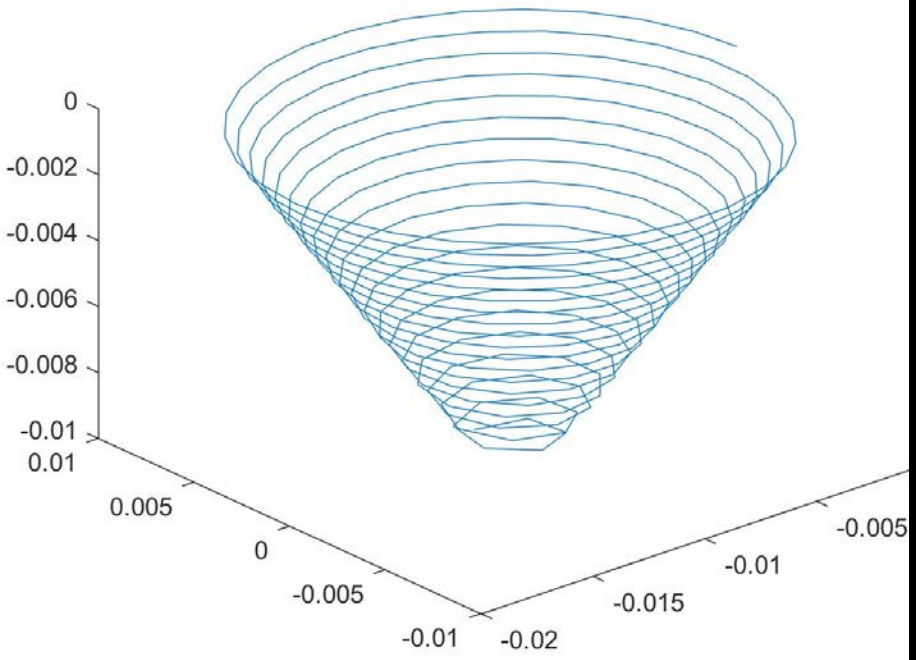
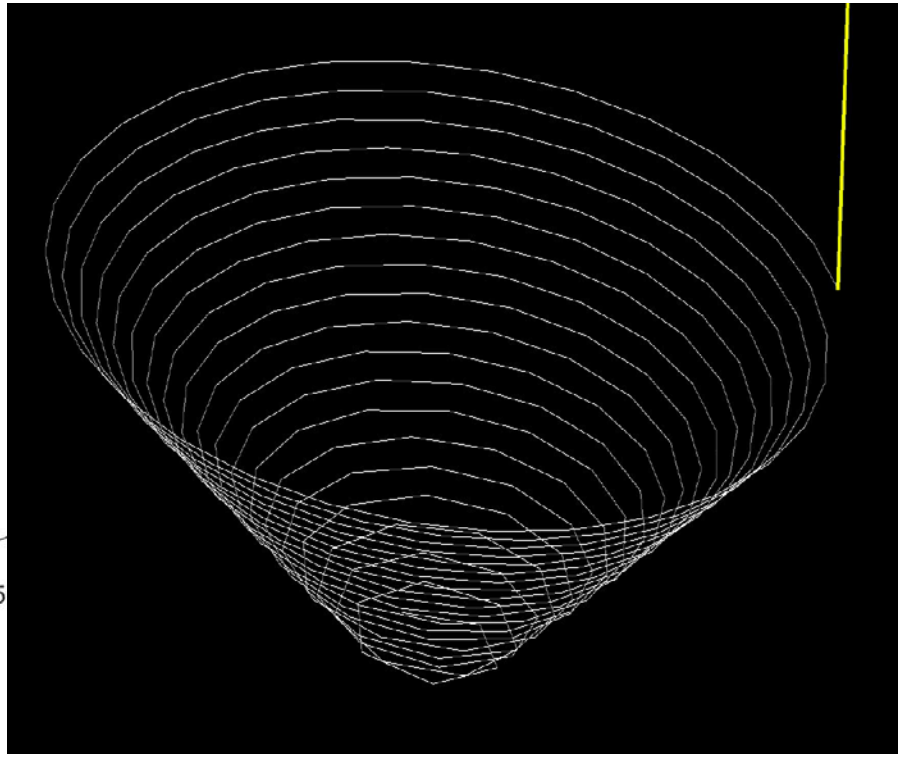
MATLAB for tool path generation

- MATLAB code for generating tool path in the shape of a spiral
- Inputs required; initial radius, slope, layer size, feed and the duration
- Also generates a G-code for the same





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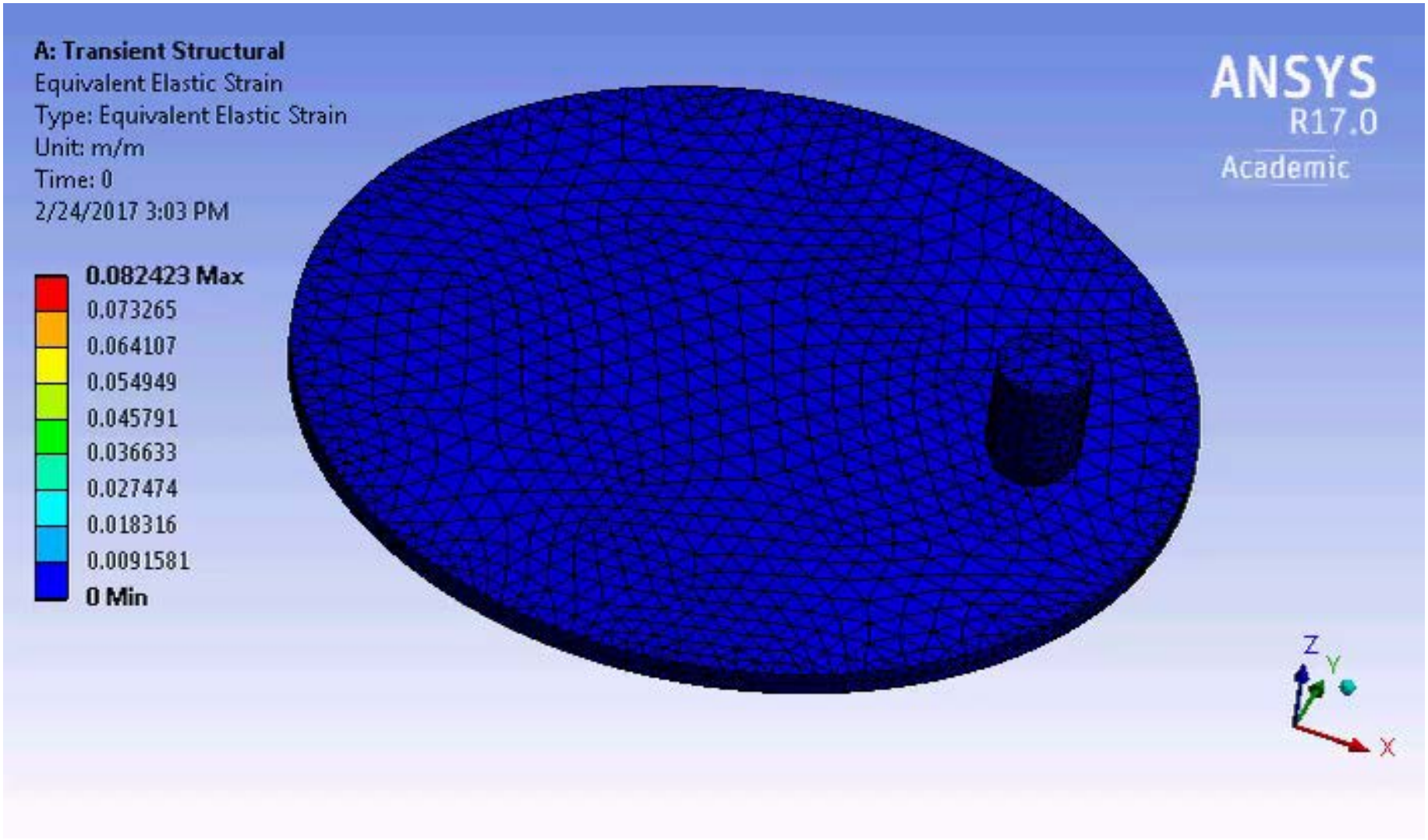
Small scale test



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Current Status

- Setup has been tested using an Ogden material model (Inbuilt in ANSYS)
- Large computation times (5-7 days)

Sr.No	Model Name	Fitting method
1	Gomma/Le	Usermat routine ready. Awaiting compiler
2	Yonan	Usermat routine to be ready by 3/17
3	Response Function	Awaiting tensile test data
4	Three Network Model	Awaiting tensile test data

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Evaluation of material parameters

Uniaxial tensile testing for evaluating model parameters for Polystyrene

Sr.No	Model Name	Fitting method
1	Gomma/Le	Least squares (MATLAB)
2	Yonan	Least squares (MATLAB)
3	Response Function	Least squares (ANSYS)
4	Three Network Model	MCalibration

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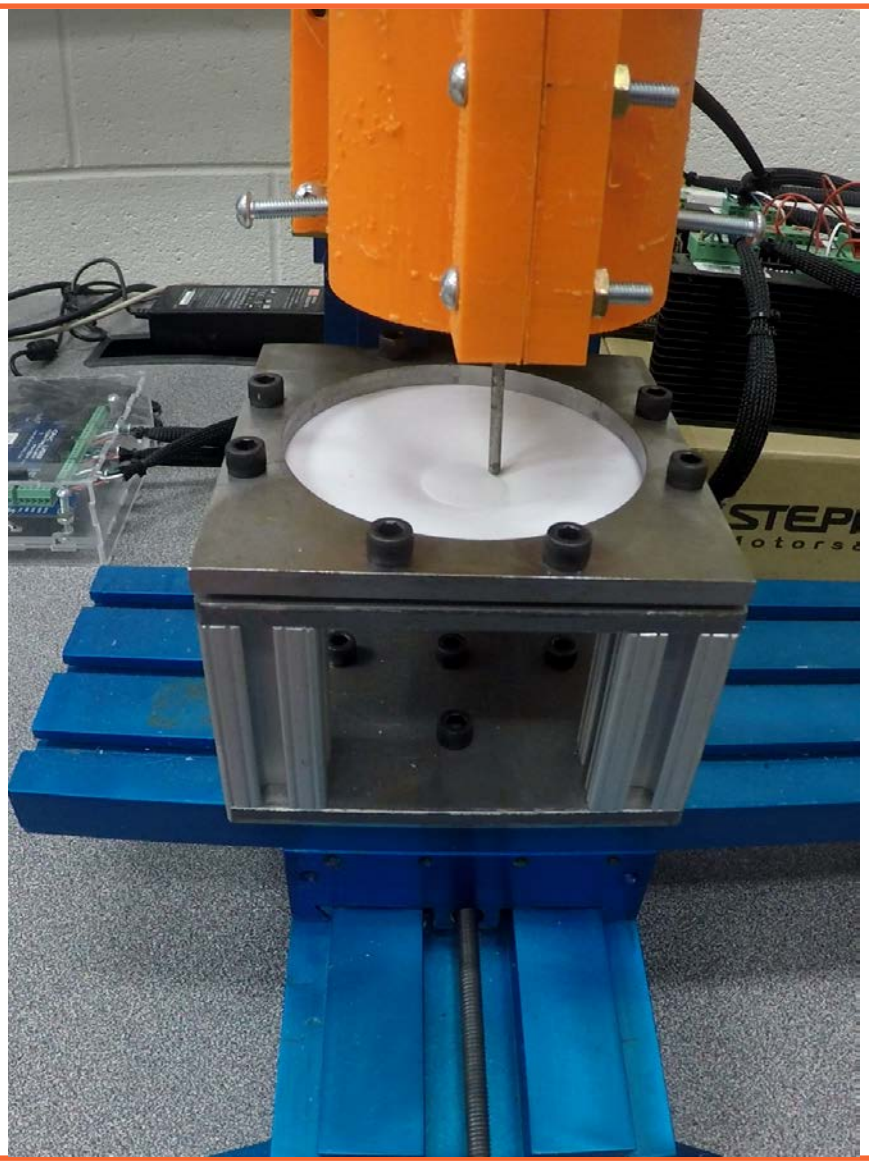
Validation

- Generated G-code will be used for fabricating test specimens
- Formed parts will be measured using CMM
- Comparison to ANSYS generated deformation



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shubhak@g.clemson.edu

THANK YOU

shubhak@g.clemson.edu