University of New Hampshire

THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

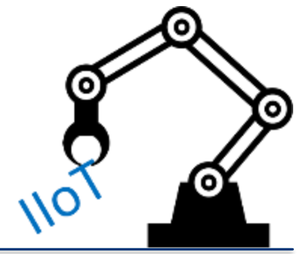
UNC CHARLOTTE

Acoustic sensor to monitor and control of forming processes

Madhav Baral, Yannis Korkolis and Brad Kinsey, Mechanical Engineering

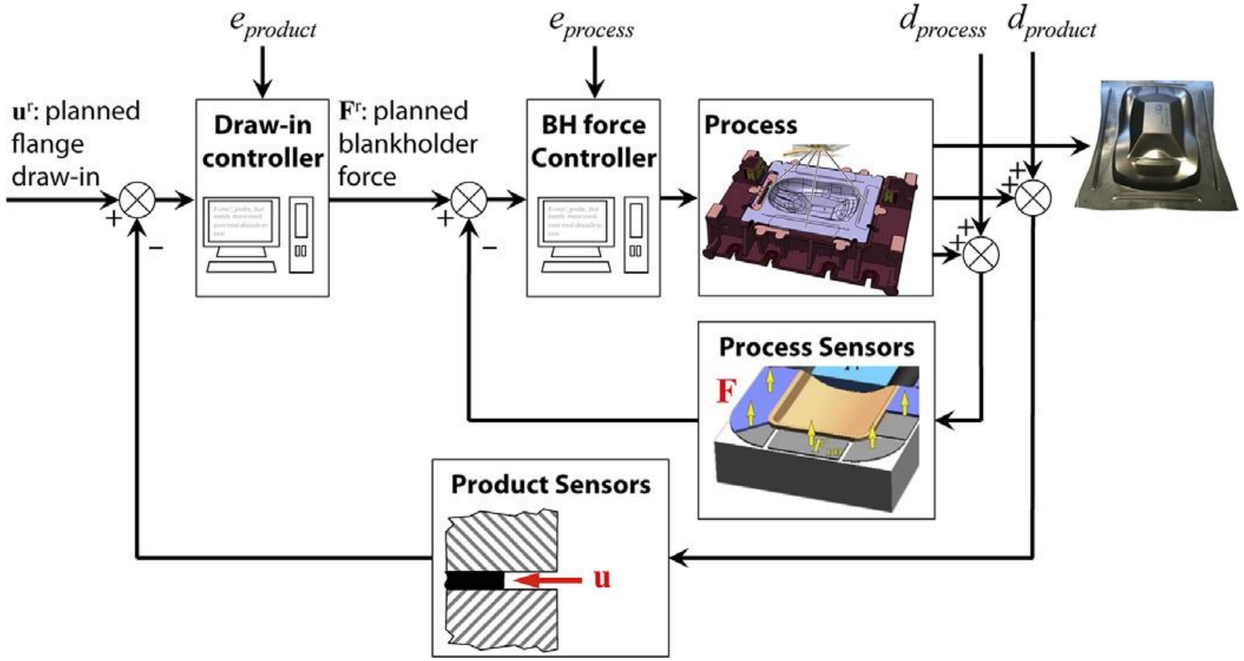
Pedro Campos and Nicholas Kirsch, Electrical and Computer Engineering

University of New Hampshire



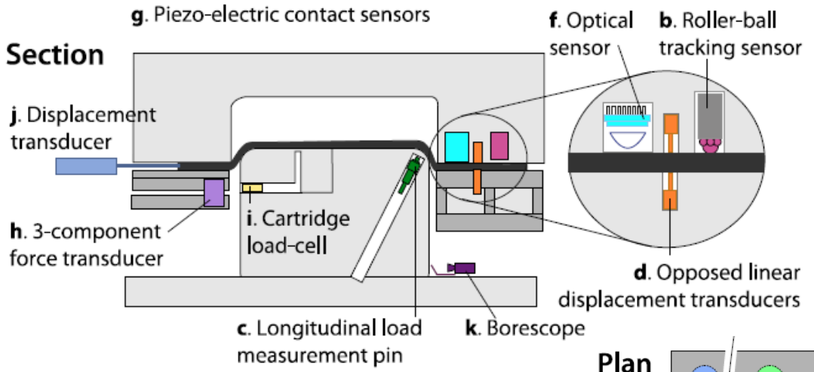
Industrial Need and Relevance

- Metal forming is a high throughput and high material utilization process
- Dimensional variations and component failures exist
- Closed loop control in metal forming could be used to:
  - Reduce springback
  - Prevent fracture
  - Control strain distribution
  - Improve final product accuracy and quality
- Network measurement information for data analytics and optimization

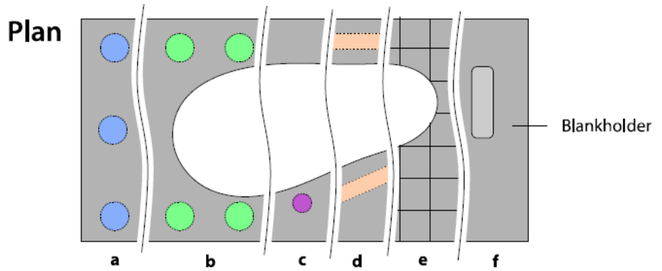


Project Objective

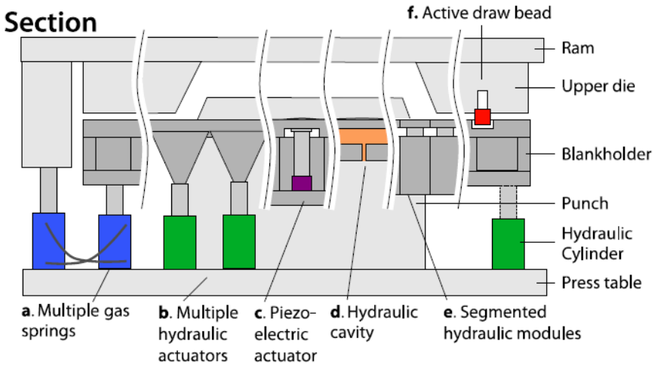
- Incorporate sensors, actuators, and systems to improve forming operations
- Sensors
  - Material draw-in: laser, optical, tactile, etc.
  - Forming forces: load cell piezoelectric, etc.
- Actuators
  - Blank holder: hydraulic actuators, gas springs, etc.
  - Active draw beads
  - Punch: servo-controlled motion, hydraulic pressure, etc.
- Network infrastructure for closed loop control



Sensors

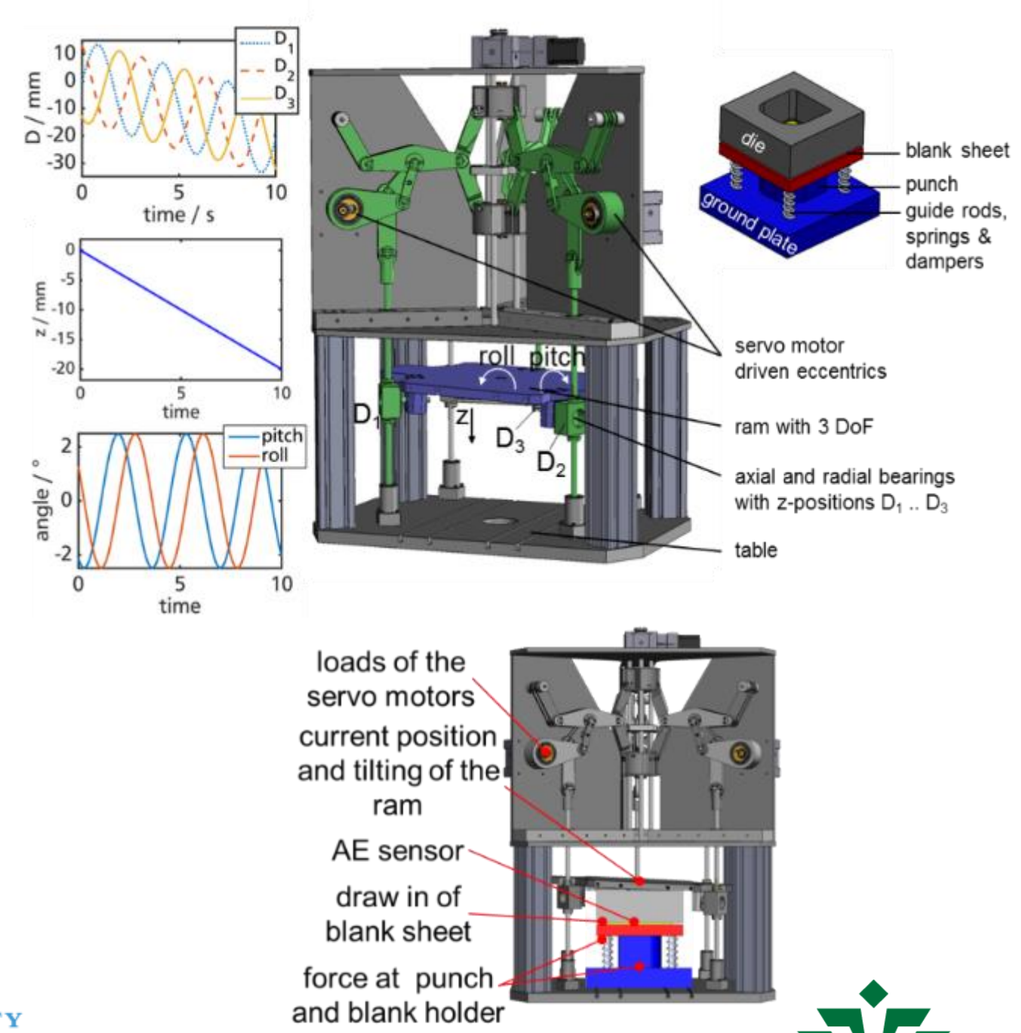


Actuators

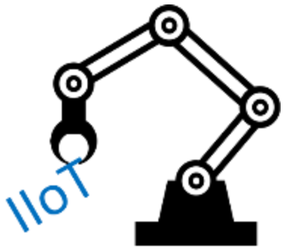


Approach/Methodology

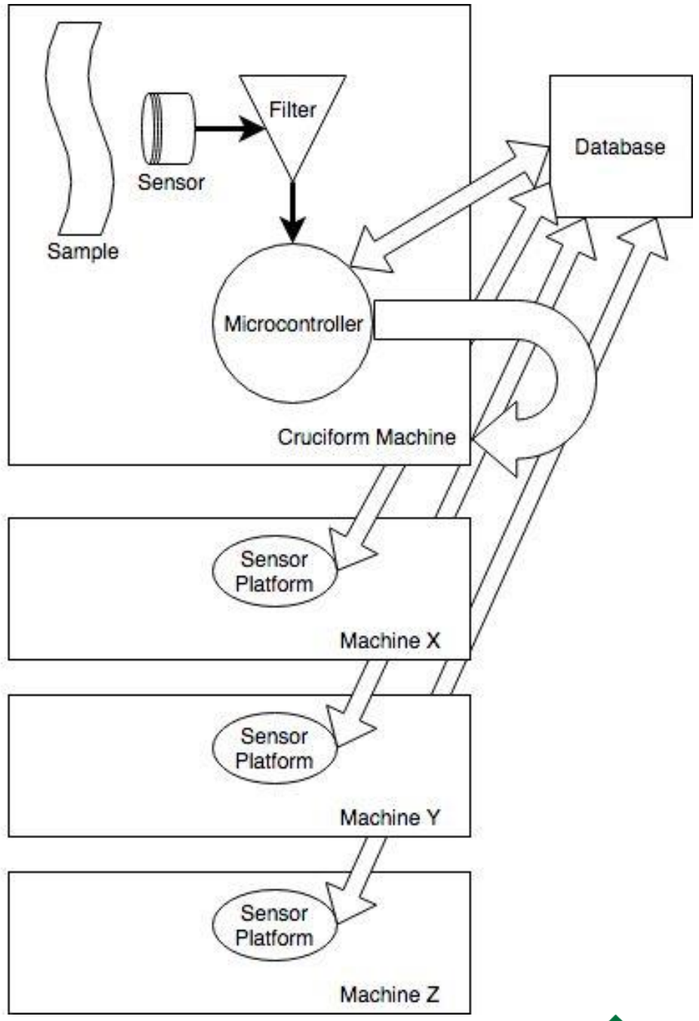
- Exploit 3D servo-press (NSF funded collaboration with Technical University of Darmstadt, Germany) which allows roll, pitch, and vertical displacement to manipulate process
- Imbed acoustic emission sensor to monitor process and prevent fracture
- Increase control of deformation path during process



Approach/Methodology

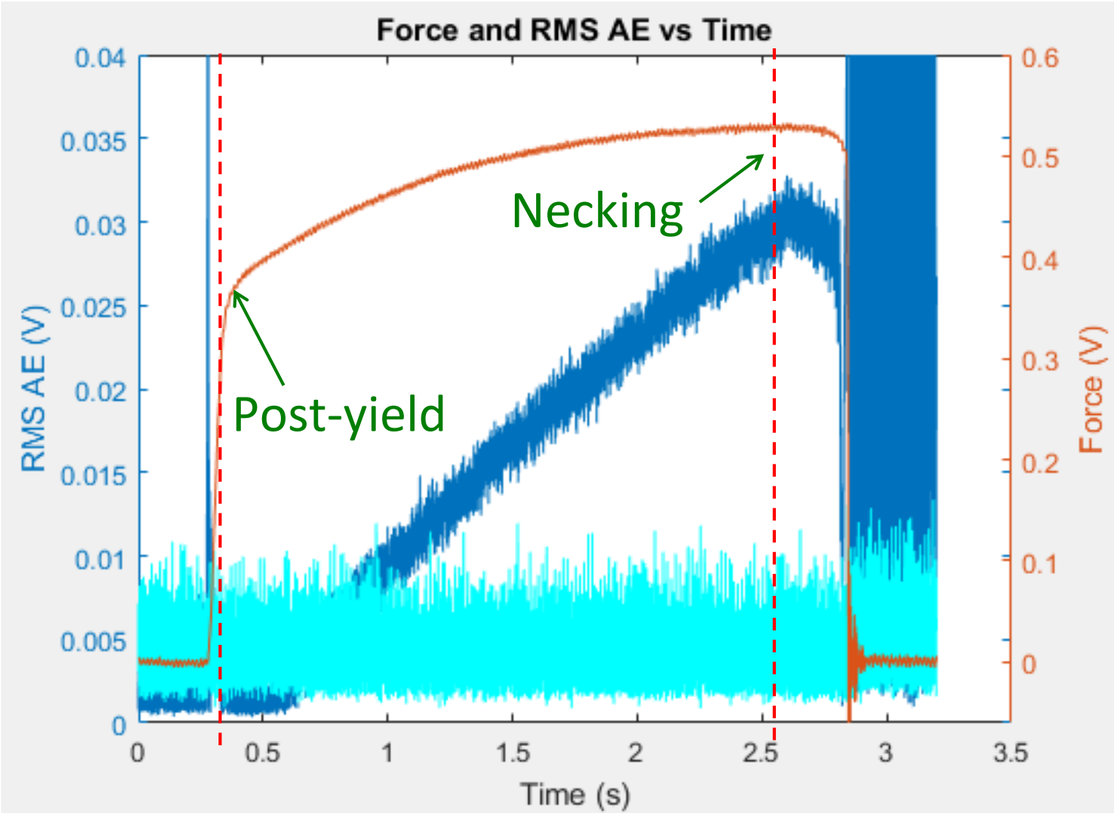


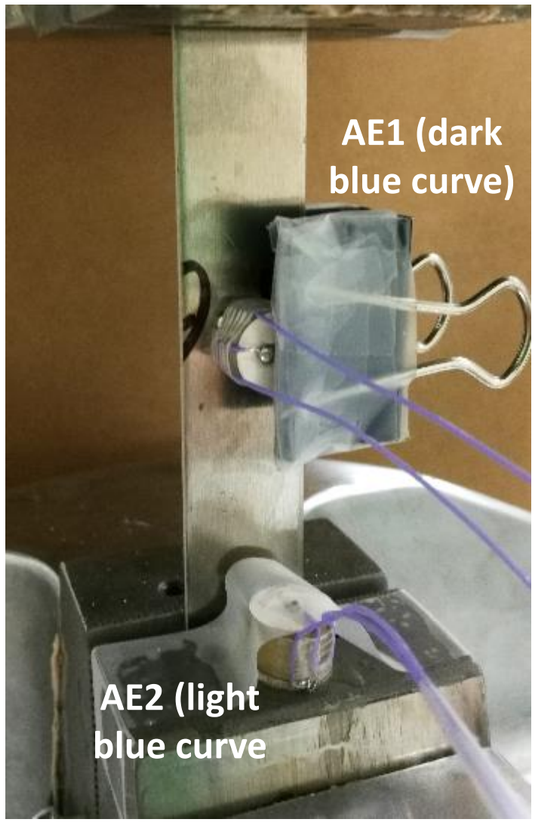
- Smart sensor platform detects aspects of a process
  - Filter and analyze
  - Control the process based on analysis, e.g. adjust or stop deformation
  - Wirelessly transfer essential information to a database
- Other machines and processes have part specific knowledge
- Data can be used to optimize manufacturing, processing time, etc.



Results

Note	Time/div	Volts/div	Sampling rate	Noise Red.	Sensor
8 mm/s	640 ms	100 mV	5 MS/s	+3 bits	1070 t = 9.1 mm





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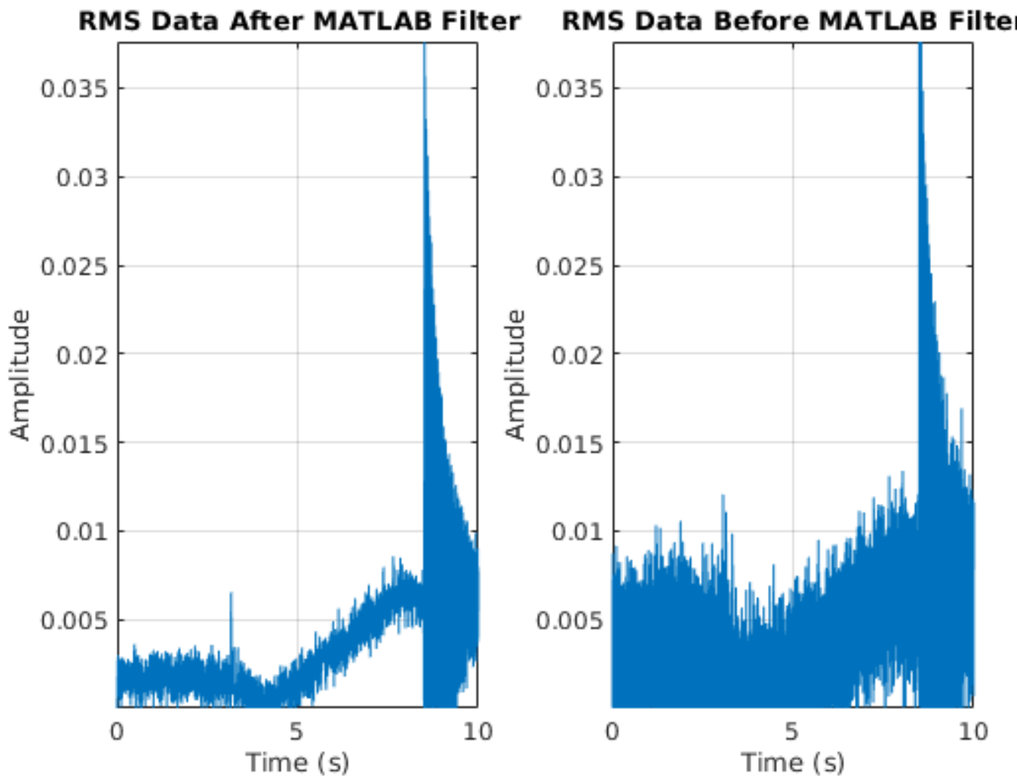
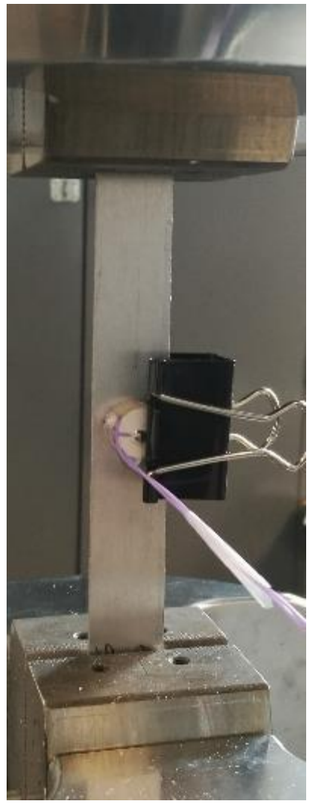
Results

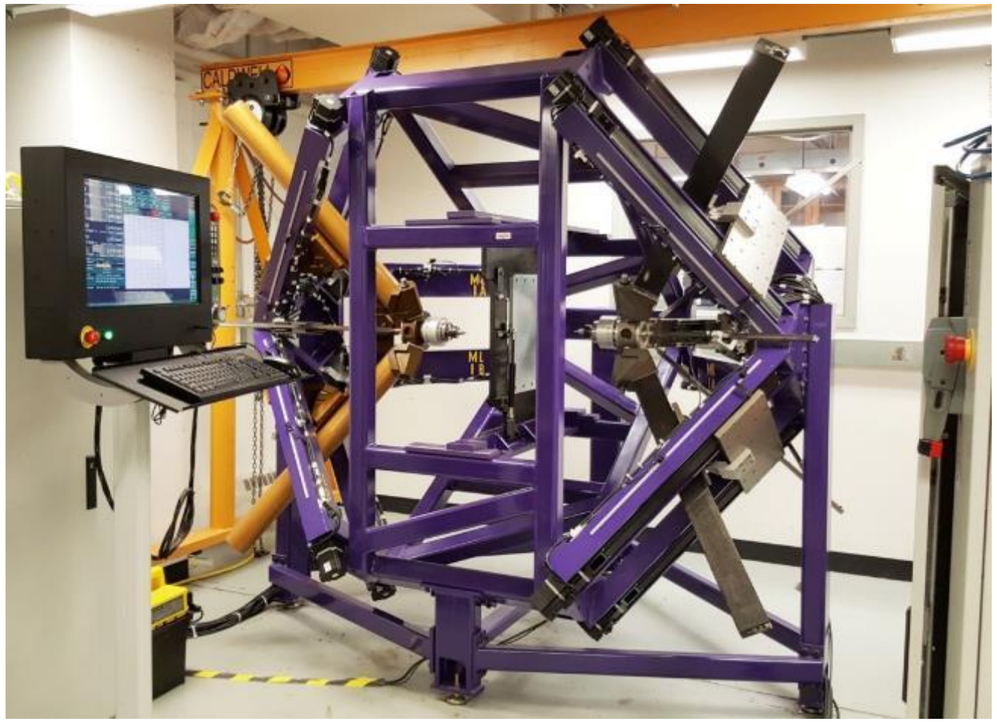
Note	Time/div	Volts/div	Sampling rate	Noise Red.	Sensor
4 mm/s	1 s	100 mV	100kS/s	+3 bits	1070 t = 9.1 mm





Next Steps

- Continue collaboration to incorporate AE sensor into 3D servo-press
- Identify other forming applications to exploit Industry 4.0 through industrial collaborations
- Commission incremental forming machine at Olson Center to demonstrate forming improvements



Custom Double Sided Incremental Forming machine at Northwestern University