Coil Development for Electromagnetic Corner Fill of AA 5754 Sheet

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Outline

- Introduction
- Hybrid forming research
- Coil requirements
- Unsuccessful coil designs
- Successful coil designs
- Conclusions

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INTRODUCTION

Introduction

- EMF has been considered as a means to obtained sharp features that can't be obtained by conventional forming
- Possible applications: door inner features, license plate pocket corners, etc
- EMF has been shown to be a feasible process for sharpening features (Daehn *et al.*; Psyk *et al.* 2008,2007; Liu *et al.*, 2009; Golovashchenko, 2010, Imbert and Worswick, 2010)

Introduction

- Coil design is crucial for corner fill applications, as it is for all EMF processes
- EMF coils must work under very harsh conditions (Golovashchenko *et al.*, 2006)
- Recent EMF Research at uWaterloo focused on sharpening of features using hybrid conventional/EM forming

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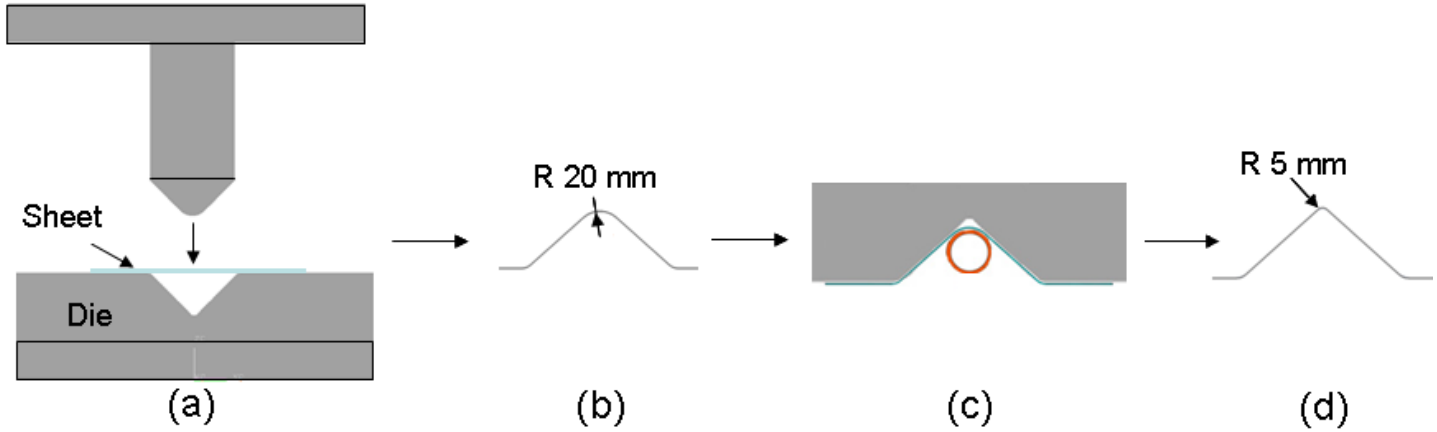
HYBRID FORMING RESEARCH

Corner fill experiments

- Hybrid conventional/EM forming operation



- As-received and pre-strained sheet
- No draw-in allowed for the EM operation

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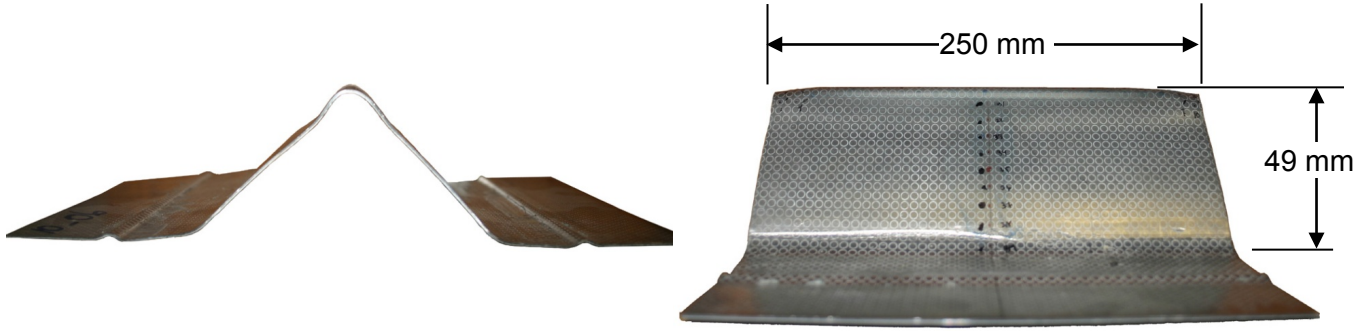
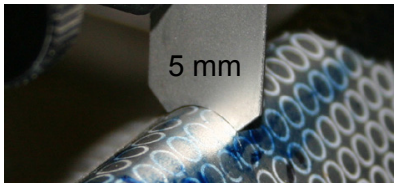
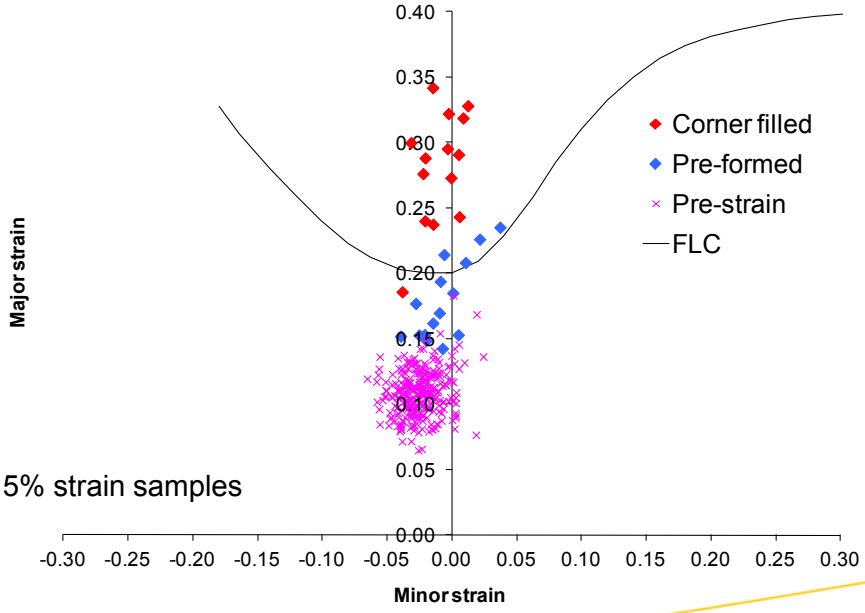
Experimental Results





Sample with 5 mm radius gauge



Measured strain for 15% strain samples

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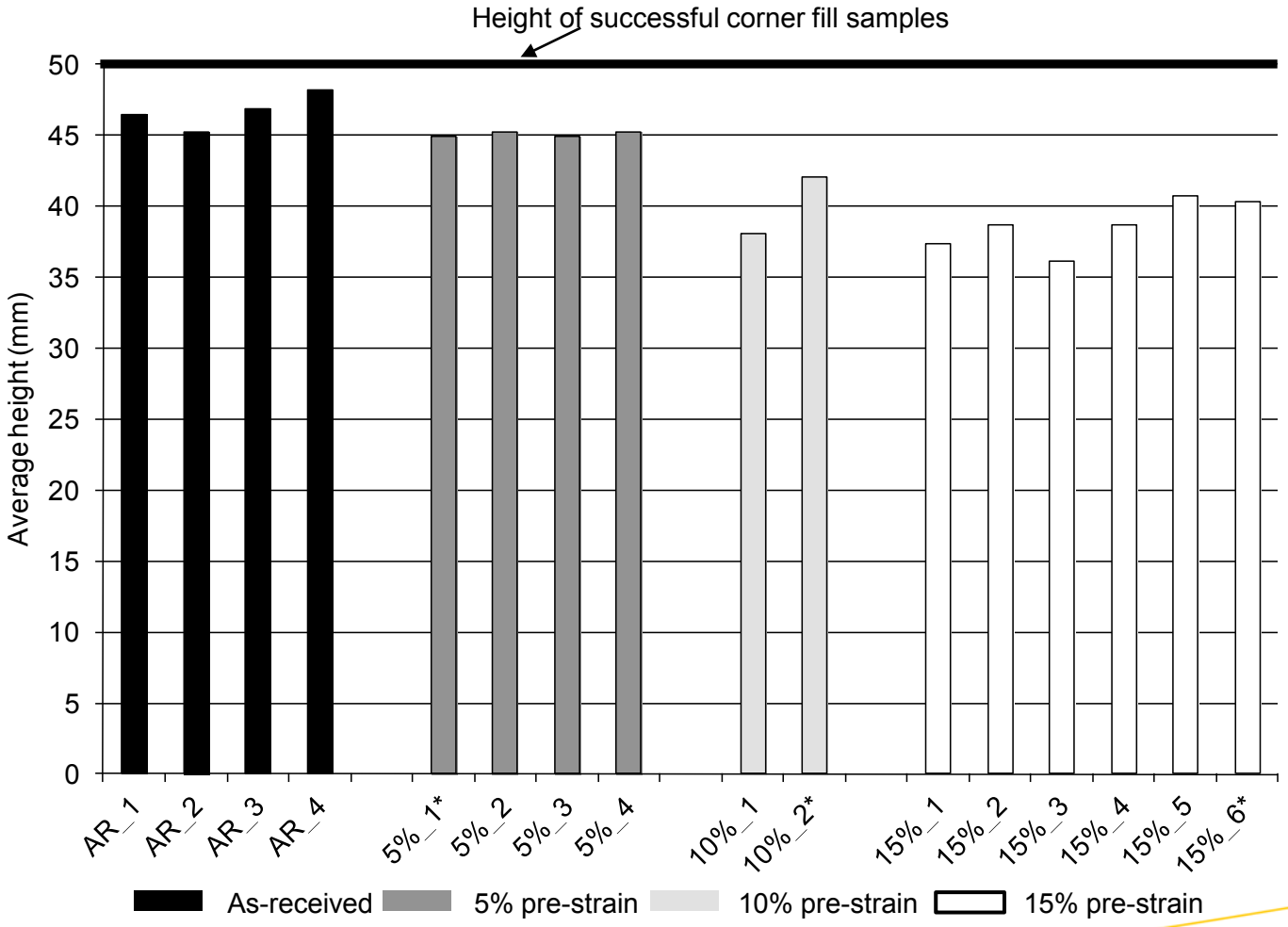
Conventional Fill Results



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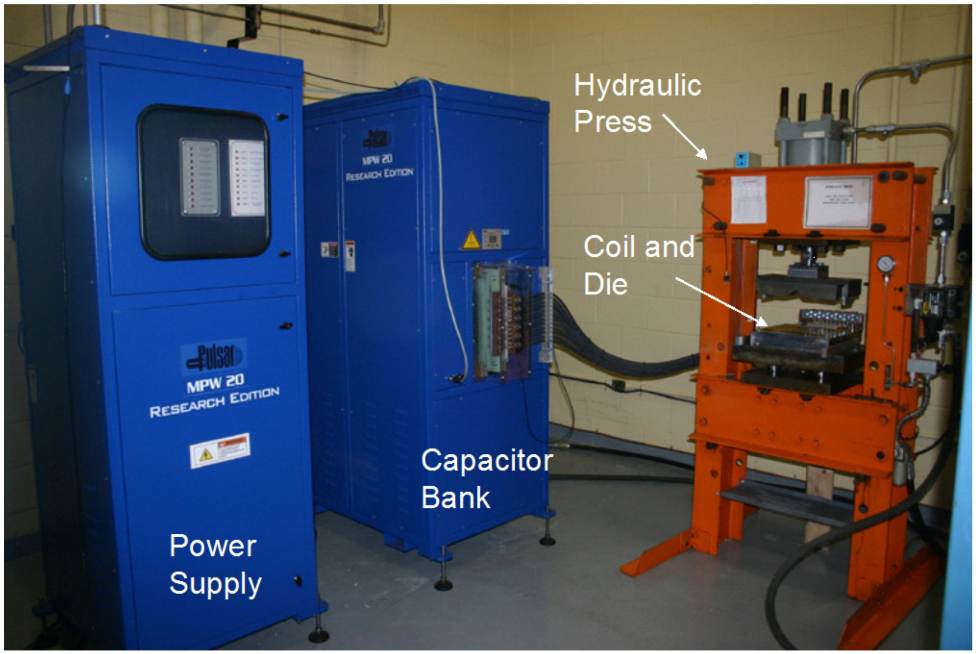
uWaterloo EMF Laboratory



- Pulsar Research Edition 20kJ, 9 kV Pulse Generator
- 7,500 V,15.1 kJ used for succesful corner fill experiments

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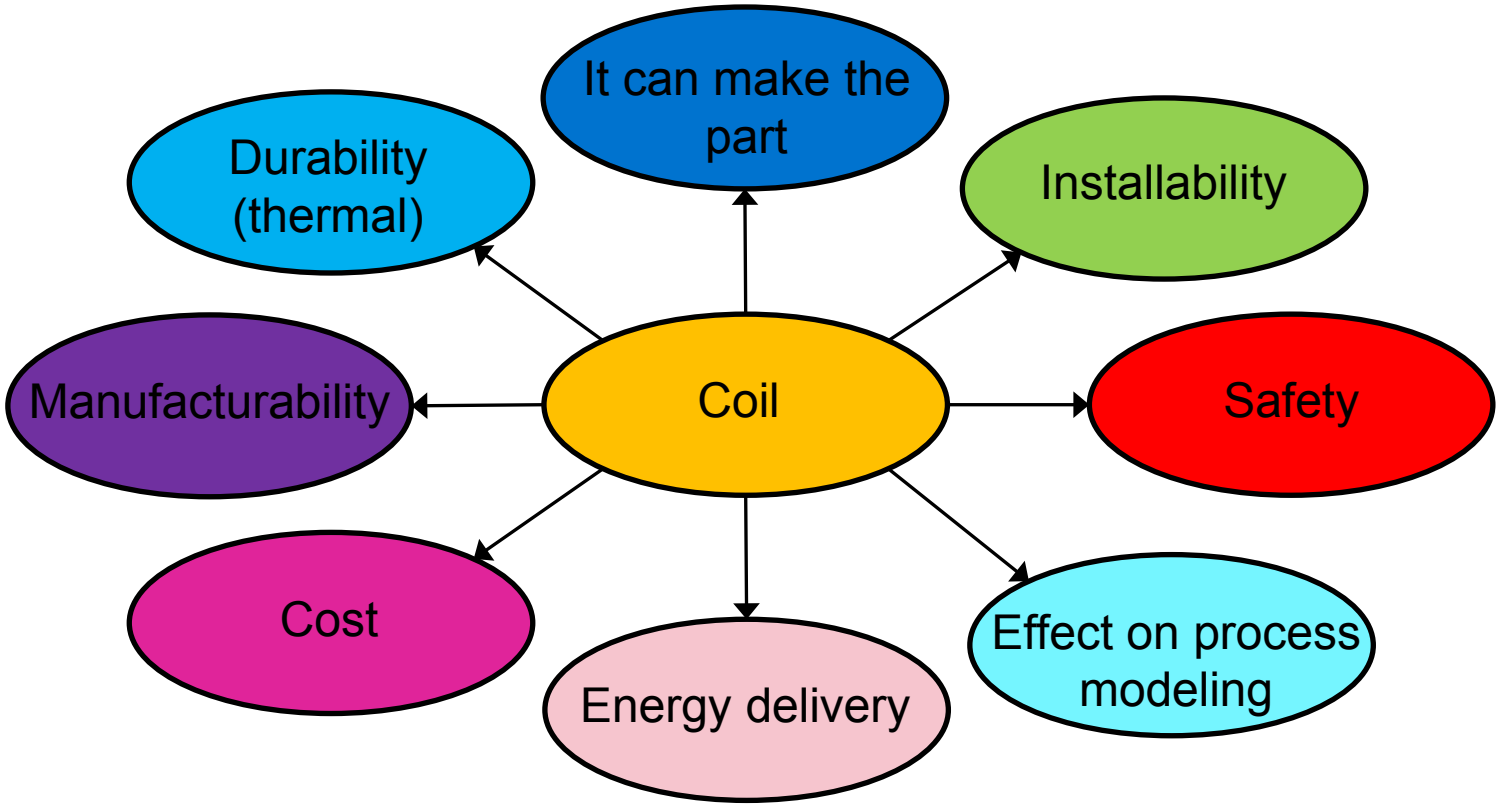
COIL REQUIREMENTS

Coil requirements



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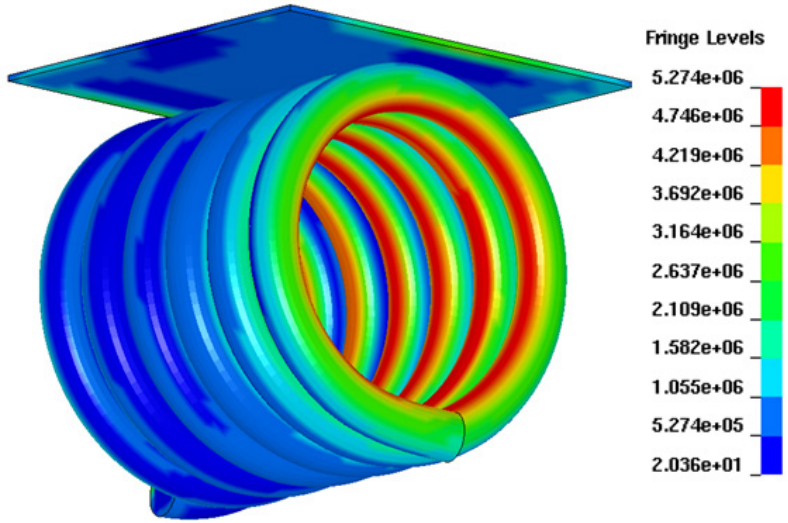
UNSUCCESSFUL COIL DESIGNS

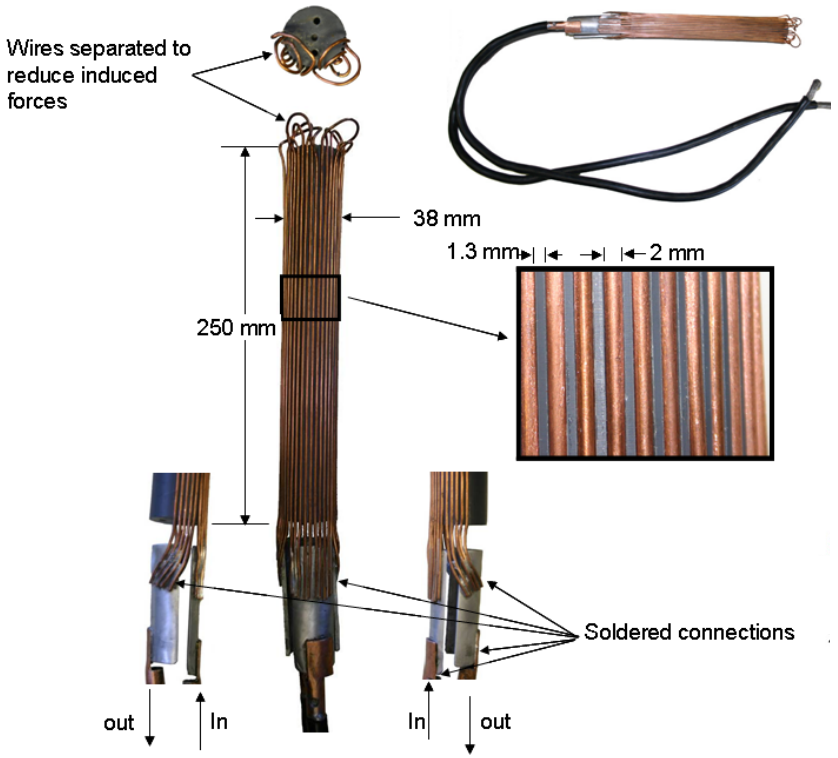
Spiral Coil

- Easy to make, affordable, easily installed, easy to model, and apparently safe
- It could not make the part
- It could not deliver the energy to where it was needed.



Wound Coil

- Not durable
- Hard to manufacture
- Soldering-NOT adequate
- Health and safety concerns (loud bangs)
- Challenging to model
- Never made a part



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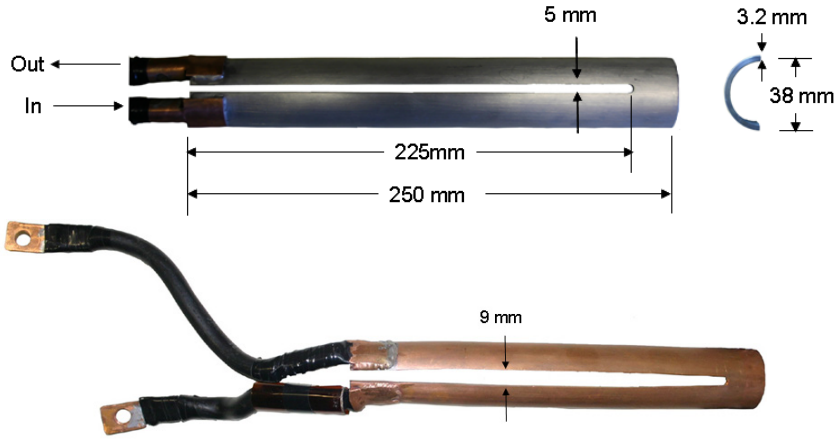
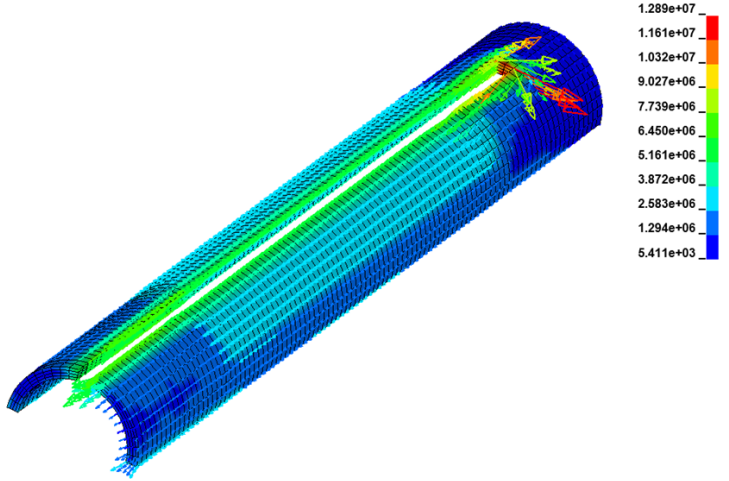
“U” Coil

- Al and Cu versions
- Al - significant deformation, but no corner fill
- Cu- not structurally sound
- Easy to make and install
- Cu welds were used
- Connecting cables too close and repelled each other
- Relatively easy to model





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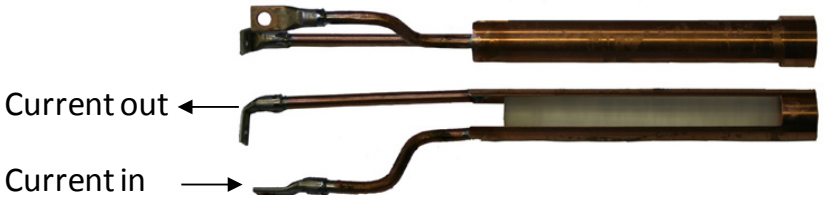
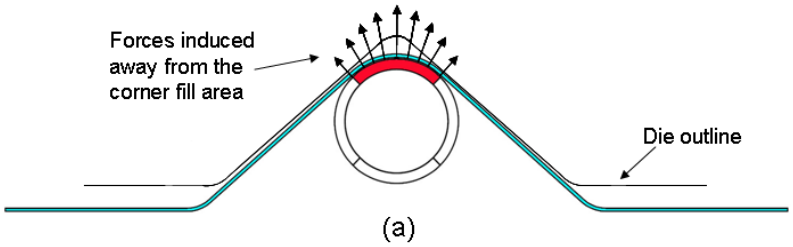
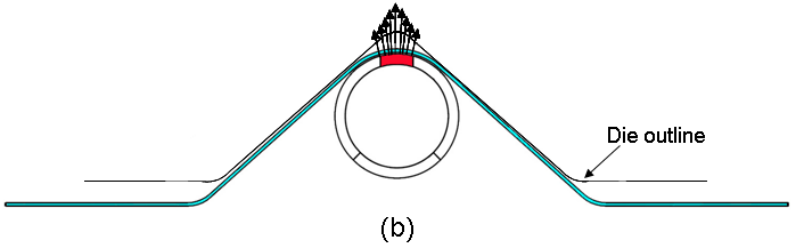
“Pin” Coil

- Did not deliver enough energy to form the part
- Soldered joints still being used
- Coil structure robust, with exception of joints
- Solid polycarbonate “fill” helped with structural strength







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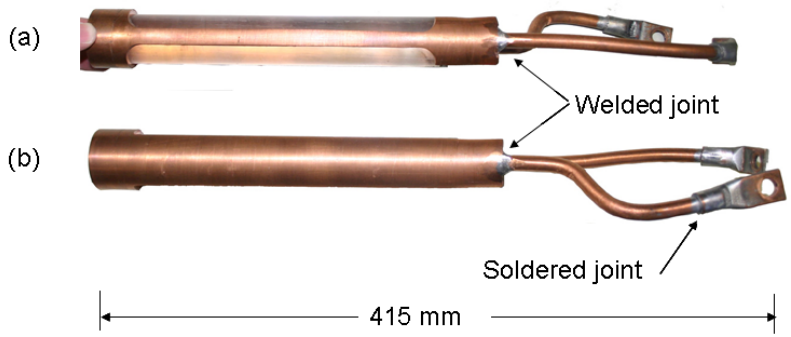
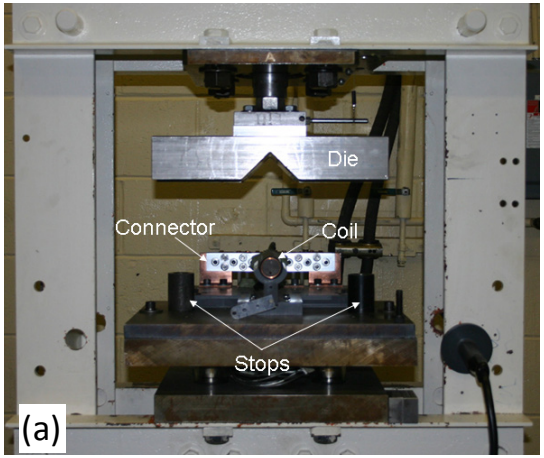
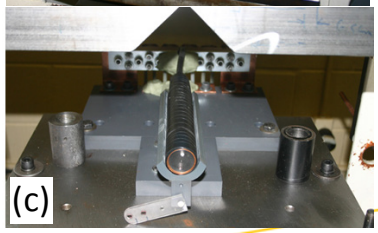
SUCCESSFUL COIL DESIGN

Successful Coil

- Formed the part
- Met all the coil requirements
- Durable in the laboratory conditions
- Robust design
- Clamping load acted against deformation







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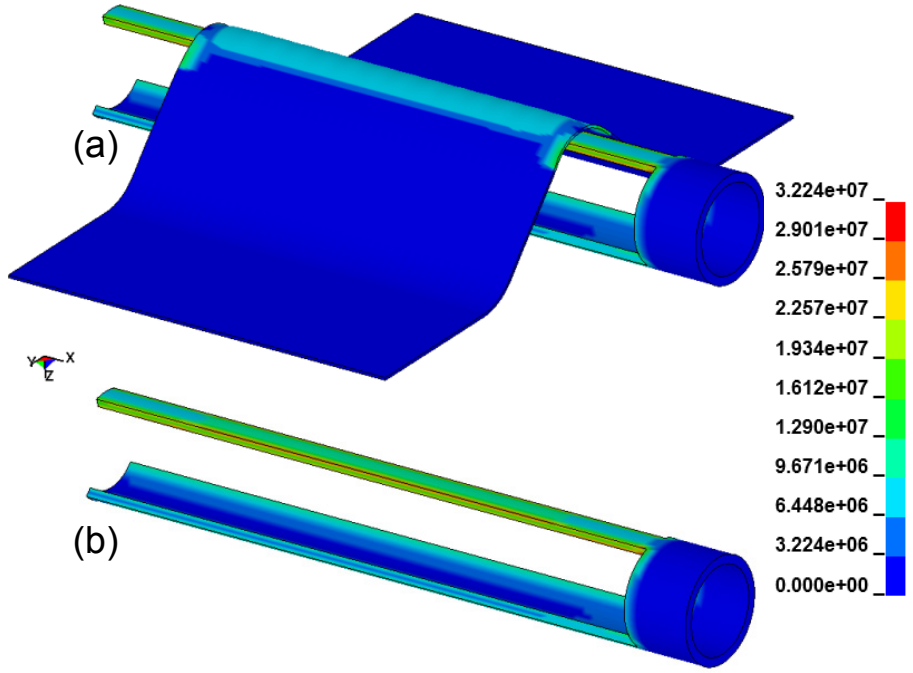
Successful Coil

- Relatively easy to model
- Drawbacks
  - Required a lot of energy
  - Possible improvement by creating a return path
  - Not proved for an industrial



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Conclusions

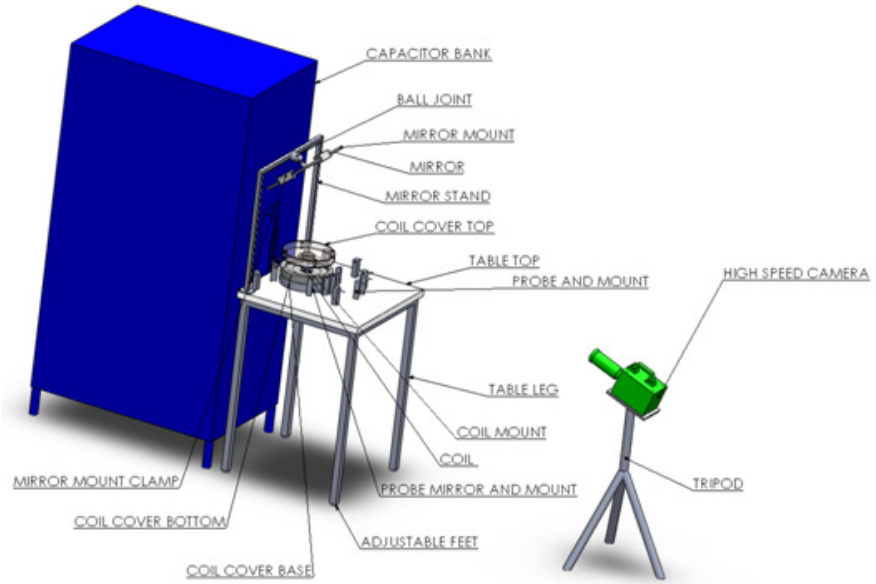
- An effective coil must be:
  - able make the part/deliver the forming energy,
  - manufacturable,
  - affordable,
  - installable,
  - durable,
  - safe, and
  - amenable to modelling

Conclusions

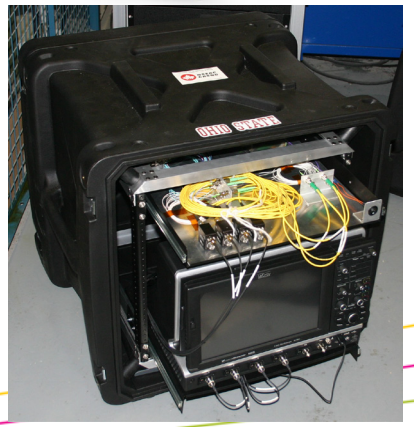
- A successful coil for laboratory environments was presented
- Commercial applications need to be more robust and efficient

On-Going and Future work

- Need material properties at 1 x 10^4 s^{-1}
- Commissioning of expanding ring apparatus
- Automotive Partnership Canada project led by U. Windsor and Ford



PDV



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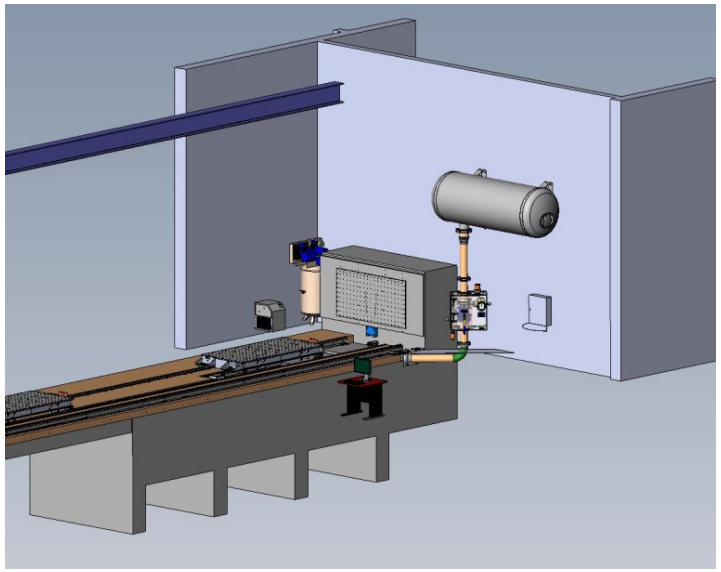
On-Going and Future work

900 ton warm/hot forming press



Crash sled facility
169 kN-m impact
147 kN-m decelerator

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Questions?

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