Springback Control of Ultra-High Strength Steel Sheet Parts

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Executive Summary:

• **Objective/Industrial Need:** control springback in UHSS (>1 GPa)
• **Approach:** use varying punch stroke trajectories for improvement
• **Deliverable:** effective forming method and FEA simulations
• **Budget and Timeline:** $400k for 2 years; supports two RAs
• **Comments:** close collaboration with OEMs for trial part design, material suppliers, and servo press manufacturer for experiments
Industrial Need and Relevance:

• For lightweighting purposes, the use of UHSS is desirable (> 1 GPa).

• However, *excessive springback*, limited ductility, and tool life concerns are problematic. Thus, methods to form UHSS are required, focusing first on springback.

• Modeling required for virtual predictions, validation, and physical understanding of effects.
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Project Objectives:

1. Implement forming process on a servo-press to allow flexibility with respect to the variable ram motion/control;

2. Simulate and validate process; and

3. Control springback of UHSS sheet to allow more structural stamping applications.
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Approach/Methodologies:

• Investigate punch stroke trajectories, e.g., stepwise mode, using a servo-press that can improve formability of UHSS.

• Past research has shown potential but need on > 1 GPa material

Barlat et al., 2015, IJMF
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Approach/Methodologies:

- Past research has shown improvements for a stepped binder force trajectory, determined using a neural network (NN) based on initial punch force trajectory.
- Springback angle controlled between $10^\circ$ – $12^\circ$ using NN.

Vishwanathan, Kinsey, and Cao, 2003, JMSE
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Approach/Methodologies:

• The proposed scaled test article(s) is a combination of a B-pillar and shotgun.

• Perform numerical simulations, including punch stroke trajectories, for validation of the process and physical understanding.
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Approach/Methodologies:

- Results from past servo-press research

![Various punch stroke trajectories](image)

- Increased drawing depth
- Elimination of wrinkling
- Elimination of fracture

Osakada et al, CIRP review paper, 2011
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Deliverables:

• Test component for further assessment
• Servo-press punch stroke trajectories for controlled springback
• Numerical simulation models for improved understanding of physical phenomena
• Criteria and empirical guidelines

Barlat et al., 2016, MMTA
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Budget and Timeline:

Estimated cost of the project is $400k for two years.
2 RAs will work on the project (1 experimental and 1 FEA)

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<th>Task / Milestone</th>
<th>Year 1</th>
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<td>Tooling design/production</td>
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NSF I/UCRC Planning Meeting
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Discussion:

– Are the industrial need and relevance accurately captured?
– Are the objectives realistic and complete?
– Are the approaches technically sound and appropriate?
– Are there alternative implementation paths or better approaches?
– Are the deliverables impactful to industrial partners?
– Are the budget and timeline reasonable?
– Are there conflicts with intellectual property or trade secrets?