OVERVIEW

- Current weld optimization approach
- New weld optimization process - Concept
- Case Study: MDO based weld optimization
- Current project with Ford MDO team
- Summary and future work
CURRENT WELD OPTIMIZATION APPROACH

- Current weld optimization process
  - Limited capabilities
  - Computationally expensive
  - Time-consuming
  - Inefficient

- This leads to...
  - Increased cost
  - Manufacturing delays

- We set out to test a process that is...
  - User friendly
  - Robust
  - Time saving
  - Less computationally expensive
  - Multidisciplinary

- Which leads to...
  - Reduced manufacturing cost
  - Increased production speed
Uniform weld distribution
High number of welds

Non-uniform weld distribution
Overall reduction in welds
Similar performance
MULTIDISCIPLINARY OPTIMIZATION CASE STUDY

- Open source model simplified for faster simulation.
- Front and side impact cases tested in parallel.
- Spot weld points were converted into lines and parameterized.
- **Objective**: Reduce total number of welds in model.

<table>
<thead>
<tr>
<th>Baseline Design</th>
<th>Number of Welds</th>
<th>Front Intrusion (mm)</th>
<th>Side Intrusion (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7094</td>
<td>64.7</td>
<td>195.7</td>
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</table>
OPTIM WELDS GUI

- Prepare model for optimization
- Specify optimization load case information
- Review design results
MODEL SETUP

Convert existing spotweld points to spotweld lines

Define groups of lines for design variable creation

Automatic optimization task creation

Output created lines and task to other models for MDO

Model is prepared in 3 easy steps!
MODEL SETUP
- Lines divided into 16 groups according to location.
- These groups are divided according to length of line.
- A total of 32 groups and design variables were used.
LOADCASE SETUP

- Specify loadcase files and parameters.
- LS-Opt workflow is automatically generated.
- Optimization task with parameterized lines is created.
- Weld lines along with the optimization task are transferred to any additional loadcases.
- Loadcases are then defined inside Optim Welds.
OPTIMIZATION WORKFLOW

- Optimization process is driven by LS-Opt.
- LS-Opt workflow is automatically generated and executed.
- The optimizer drives the spacing for defined weld groups.
OPTIM WELDS FOR MDO

Previous Design

Critical Welds

Line Spacing

Front Impact

Side Impact

Durability
CRITICAL WELDS

- Welds are post-processed through a META session.
- A weld that passes a user-defined threshold is considered critical.
- These welds are carried over to the next design.
- Connectivity is preserved.
First Round Design
Schematic Representation

Weld locations provided by line spacing only.
Weld locations are marked as frozen (manufacturing) welds.

Manufacturing welds are preserved
META Post-Processing

User-generated session files are executed after simulation run. Optimization constraints and weld criteria are processed simultaneously. Beam axial and shear force for the length of the simulation is plotted. Absolute maximum from every curve is extracted. Any welds above 6000 N threshold are marked as critical. This location is stored and a weld will be realized at this location for the next round.

Result of the first simulation yields two welds marked as critical. They will carry over to the next design.
OPTIMIZATION PROGRESSION

Too close to other welds
REPORT WINDOW

- Best designs are dynamically reported in the GUI.
- Design ID and reduction of welds is displayed.
- Models can be imported for inspection.
- Detailed design info concerning responses can be found under More Info.
OPTIMUM DESIGN

- Optimum design reduced total number of welds in the model by 3.8%

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<td>Optimized</td>
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CONTINUATION OF WORK

CURRENT PROJECT WITH FORD MDO TEAM
CURRENT PROJECT WITH FORD MDO TEAM

Load Cases

SORB  ODB  Roof Crush  Side IIHS
OPTIM WELDS PARALLEL METHOD

Iteration 1
3 Designs

Iteration 2
Base model

Iteration 2
3 Designs

Critical Welds:
- Design 1
- Design 2
- Design 3
- All previous iteration critical welds

Iteration 3
Base model
CONCLUSIONS

- Optim Welds process is able to reduce overall number of welds in a vehicle or assembly
- Extremely flexible and allows users to optimize with multi-discipline models
- Fewer number of runs compared to traditional spotweld line optimization
  - Important welds are targeted and non-critical welds are free to be deleted
- Non-uniform distribution of welds means more efficient weld placement
- Reducing the number of welds leads to:
  - Faster production
  - Cost savings: 270 welds removed, Assuming 5000 cars/week

<table>
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<th>$/Weld</th>
<th>$/Car</th>
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THANK YOU

Q & A

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Presentations will be available for download on SMDI’s website on Wednesday, May 22