INNOVATION PARTNERSHIPS
UNIVERSITY OF MICHIGAN

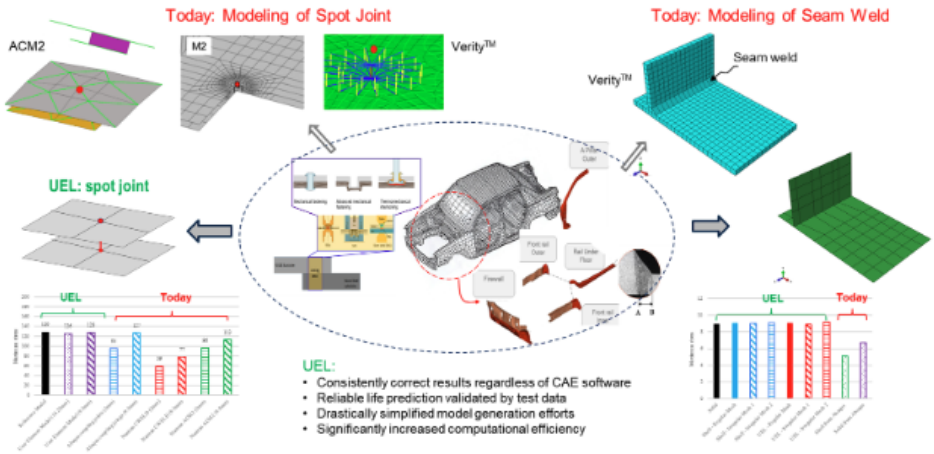
A Prototype CAE Durability Engineering Software with Robust Weld and Joint Modeling Capabilities

TECHNOLOGY NUMBER: 2022-230

Accelerate Blue Foundry - 2025 (Physical Sciences)

OVERVIEW

More than 95% of durability failures in vehicular structures are related to joints (fusion welded or mechanical-fastened). Existing CAE durability tools require calibration through hardware testing. A new "User Element" (UEL) technology streamlines how vehicle joints like spot welds, seam welds, mechanically fastened joints, are digitally modeled, enabling manufacturers to design durable structures faster and at a fraction of the cost, by eliminating complex CAE model preparation and reducing sensitivity to modeling parameters, offering unprecedented accuracy in structural durability prediction.



DESCRIPTION

The UEL method offers a simplified, plug-and-play way to represent joints in virtual vehicle models: instead of explicitly creating the detailed shape of each weld, engineers use an easy-to-implement element that mimics the behavior of a real joint. This technology cuts out the painstaking process of modeling the exact joint geometry, which is normally labor-intensive and prone to errors if certain simulation settings aren't perfect. Importantly, UEL handles both spot and seam welds with the same streamlined approach while maintaining or improving the accuracy of stress predictions compared to current alternatives.

Technology ID
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Category
Software
Engineering & Physical Sciences
Accelerate Blue Foundry - 2025/Physical Sciences

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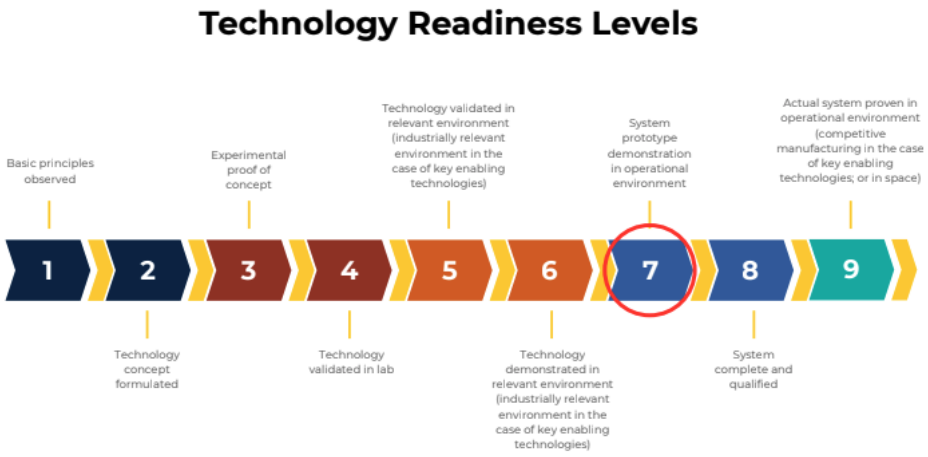
VALUE PROPOSITION

- **Dramatic Efficiency Gains:** Cuts model-building time and costs by at least a factor of 10 by replacing thousands of intricate joint representations with simple elements.
- **Accurate, Reliable Results:** Delivers robust and precise stress calculations regardless of how the simulation mesh is configured, avoiding common pitfalls in current modeling.
- **Versatility in Joint Types:** Easily adapts to both spot and various seam-welded connections without the need for special geometry, making it broadly applicable across vehicle assembly scenarios.

TECHNOLOGY READINESS LEVEL



INTELLECTUAL PROPERTY STATUS

Patent Applications are Pending.

MARKET OPPORTUNITY

Vehicle manufacturers and their suppliers urgently need faster, less expensive ways to test and validate structures as digital prototyping becomes the industry norm. This technology can impact the automotive, aerospace, rail, and heavy equipment sectors, where structural joints number in the thousands and modeling accuracy is mission-critical for safety and durability. Reducing time and cost constraints radically improves design flexibility and supports rapid iteration in electric and autonomous vehicle programs.

Industry data shows rapid digital transformation: automotive simulation software market alone is projected to exceed $3 billion by 2030, driven by demands for speed and cost-efficiency in product development.

- This project has participated in Customer Discovery

REFERENCES

- "An Implicit Fillet Weld Element Formulation for Mesh Insensitive Fatigue Evaluation of Complex Structures."
- "A spot weld element formulation and implementation for mesh insensitive fatigue evaluation of lightweight structures."
- "A Special User Shell Element for Coarse Mesh and High-Fidelity Fatigue Modeling of Spot-Welded Structures"