Steel Processing Properties and Their Effect on Impact Deformation of Lightweight Steel Structures

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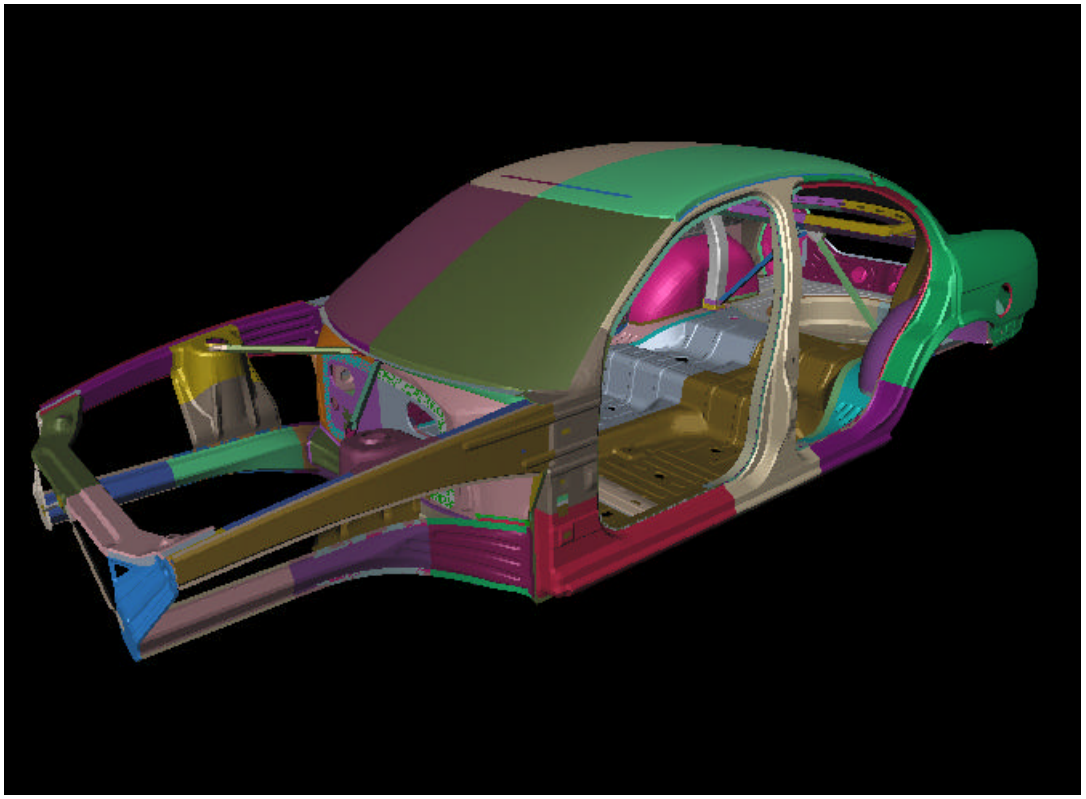
Objective

- To further pursue the lightweight steel auto body design and to investigate and document the effects of advanced material processing, forming and joining techniques on lightweight steel auto body structural performance in high strain rate deformation conditions

Project Deliverables and Impact on Industry

- Advancement in predictive modeling capabilities to aid in accelerated vehicle design development.
- Integration of material processing into structural simulation model
- Evaluation of influence of forming conditions of high strength steels on vehicle impact properties
- Evaluation of compatibility of new vehicle design with the existing U.S. car fleet

Ultra Light Auto Steel Body



- Developed by AISI and Porsche Engineering
- Utilizes new steel processing technologies and materials
- Employs holistic design approach

ULSAB Styling

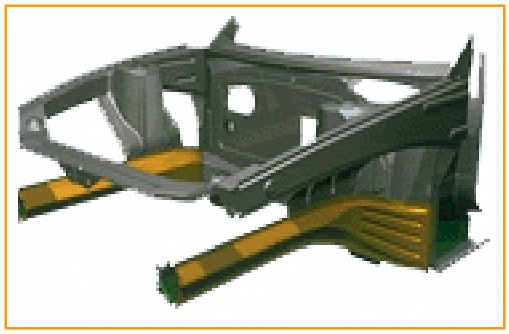
Phase 1

1. Develop a partnership between AISI member companies, ULSAB design teams, and Oak Ridge National Laboratory
2. Select candidate lightweight steel vehicle designs for analysis

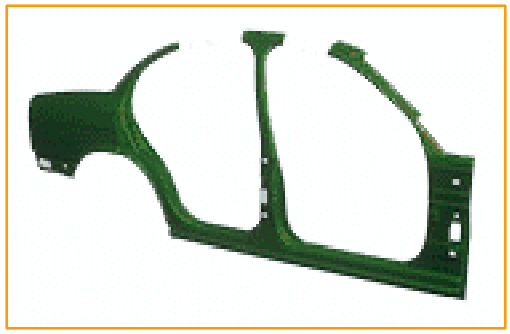
Phase 2

1. Develop finite element models for computational study of new lightweight steel design
2. Incorporate material processing and manufacturing effects into structural finite element model of the vehicle
3. Develop parametric computer models that will allow for:
   - modifications of material structural properties based on processing and manufacturing conditions
   - modifications of vehicle geometry. 4. Investigate the effects of material processing and manufacturing on vehicle structural performance

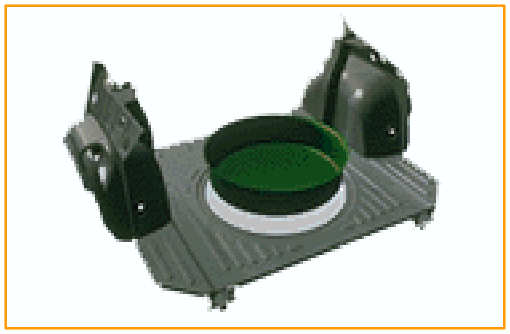
ULSAB Components



Front Rails



Body Side Outer



Spare Tire Tub

Hydroformed Roof Rail

Floorpan

Tasks, Year 1

1. Develop a partnership for ULSAB vehicle study
2. Determine vehicle designs to be modeled and analyzed
3. Determine the US car fleet models to be used in impact with ULSAB vehicles
4. Determine the impact scenarios to be analyzed
5. Determine material processing and manufacturing conditions which are going to be incorporated into ULSAB structural models and analyzed
6. Document developments and findings of the project to date

Tasks, Year 2

7. Develop models that simulate the effect of material processing and manufacturing (defined in Task 5) on structural properties of finished material
8. Incorporate material processing related structural models into computational models of ULSAB vehicles
9. Combine different ULSAB, barrier, and fleet car models to develop impact situations (defined in Task 4) to be analyzed
10. Perform computational analysis of impact scenarios developed in Task 9 using the vehicle models that incorporate materials processing conditions and were developed in Task 8
11. Evaluate the effect of advanced material processing, forming and joining techniques on ULSAB structural performance
12. Document the developments and findings of the project to date

Tasks, Year 3

13. Determine the weight reduction potential of ULSAB design for different vehicle classes that are represented by US car vehicle fleet model
14. Determine the applicability of the ULSAB design for different vehicle classes
15. Develop general ULSAB design modifications for different vehicle classes
16. Evaluate the effect of the advanced material processing and manufacturing associated with ULSAB design on structural performance
17. Develop a library of computational models used in the project
18. Document the developments and findings of the entire project

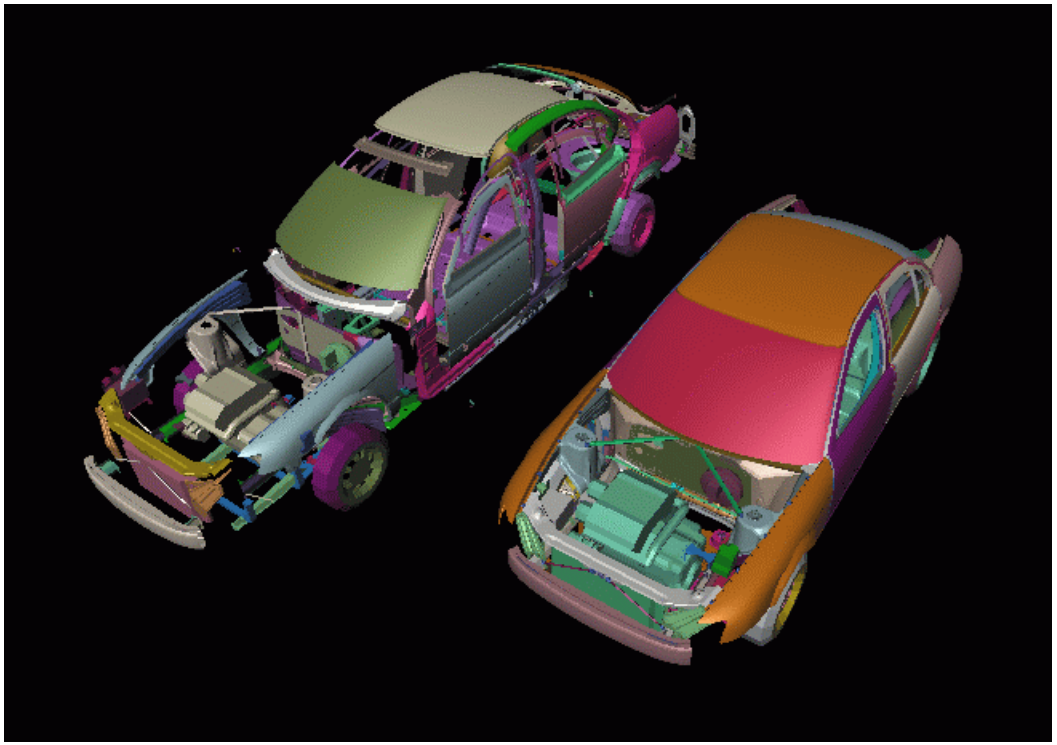
Project Status

- Completed tasks for Year 1
- Performed ULSAB-rigid barrier crash simulations for crash performance evaluation
- ULSAB and US car fleet vehicles are being modified to perform car-to-car crash simulations
  - models have to employ compatible simulation approaches
- Performed car-to-car crash simulations

Crash Simulation Results

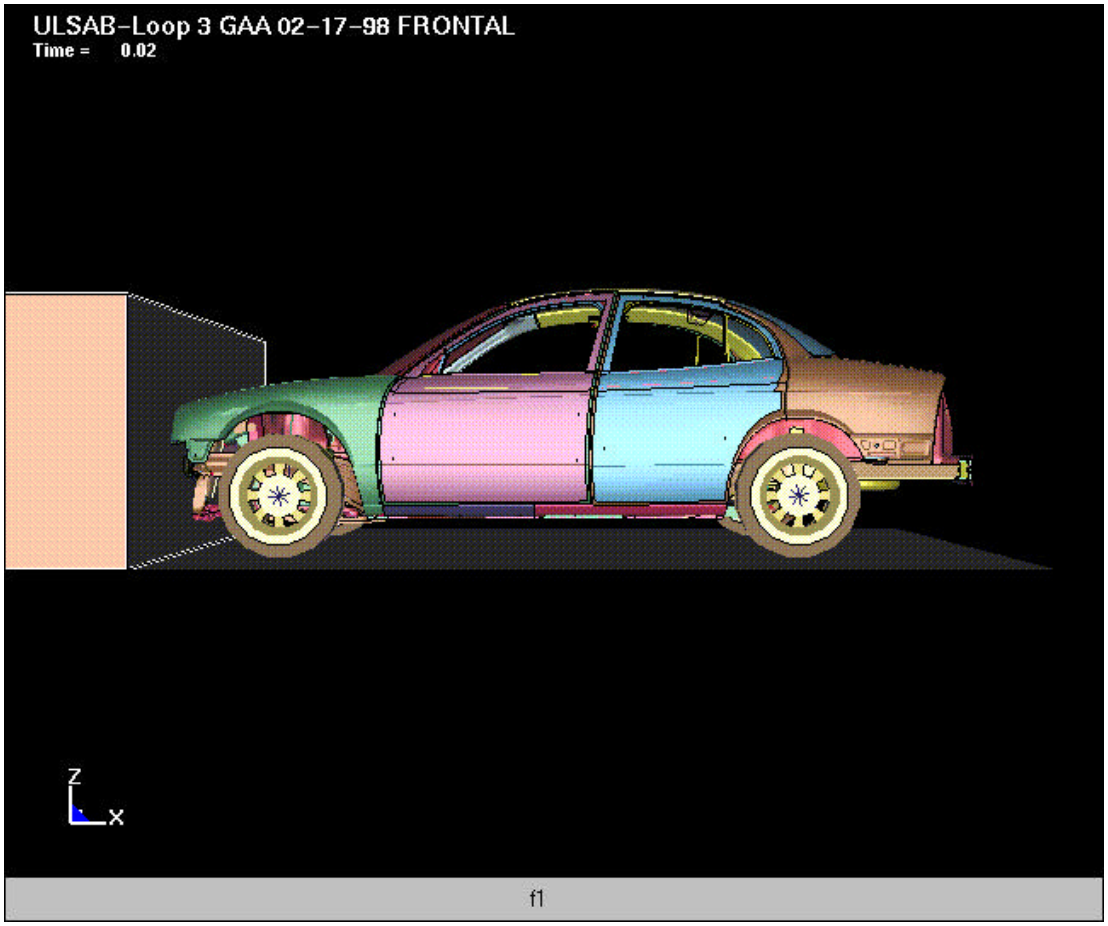
- ULSAB to rigid barrier (100% frontal impact)
- ULSAB to rigid barrier (50% frontal impact)
- ULSAB to Ford Taurus (100% frontal impact)
- ULSAB to Chevy Lumina (100% frontal impact)

ULSAB Crash Model



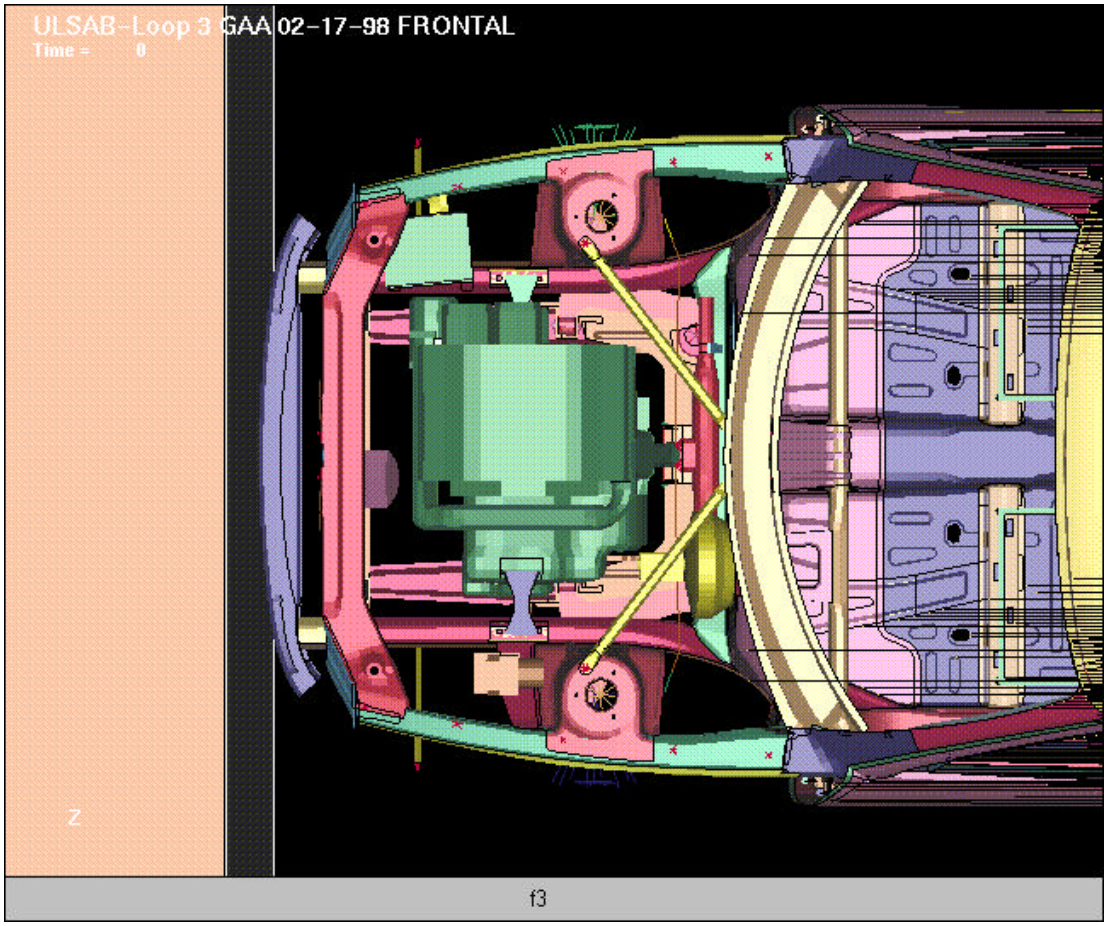
- Suspension, engine package, and bumper system were added to simulate realistic crash situations

100% Frontal Impact



- Vehicle speed is 35 mph
- Focus is on progressive crush of load path components and integrity of passenger compartment

100% Frontal Impact, Top View



- Simulation shows progressive and controlled stacking of vehicle components

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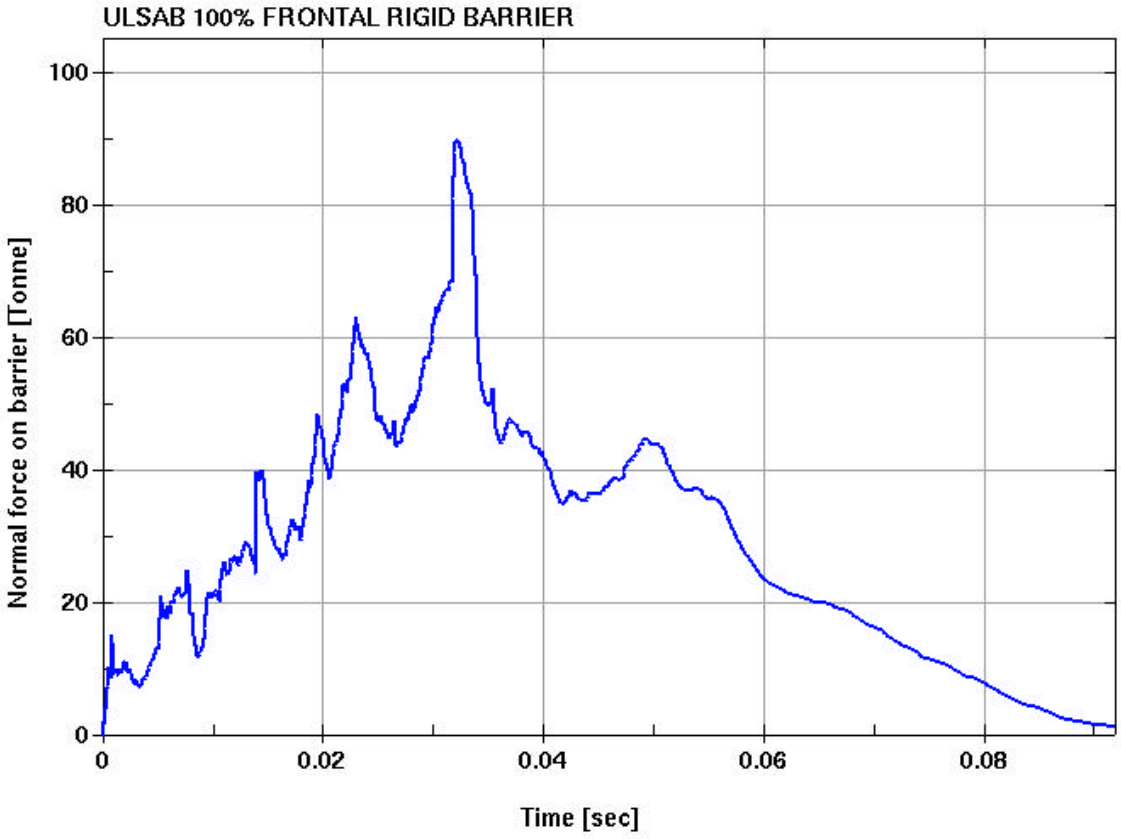
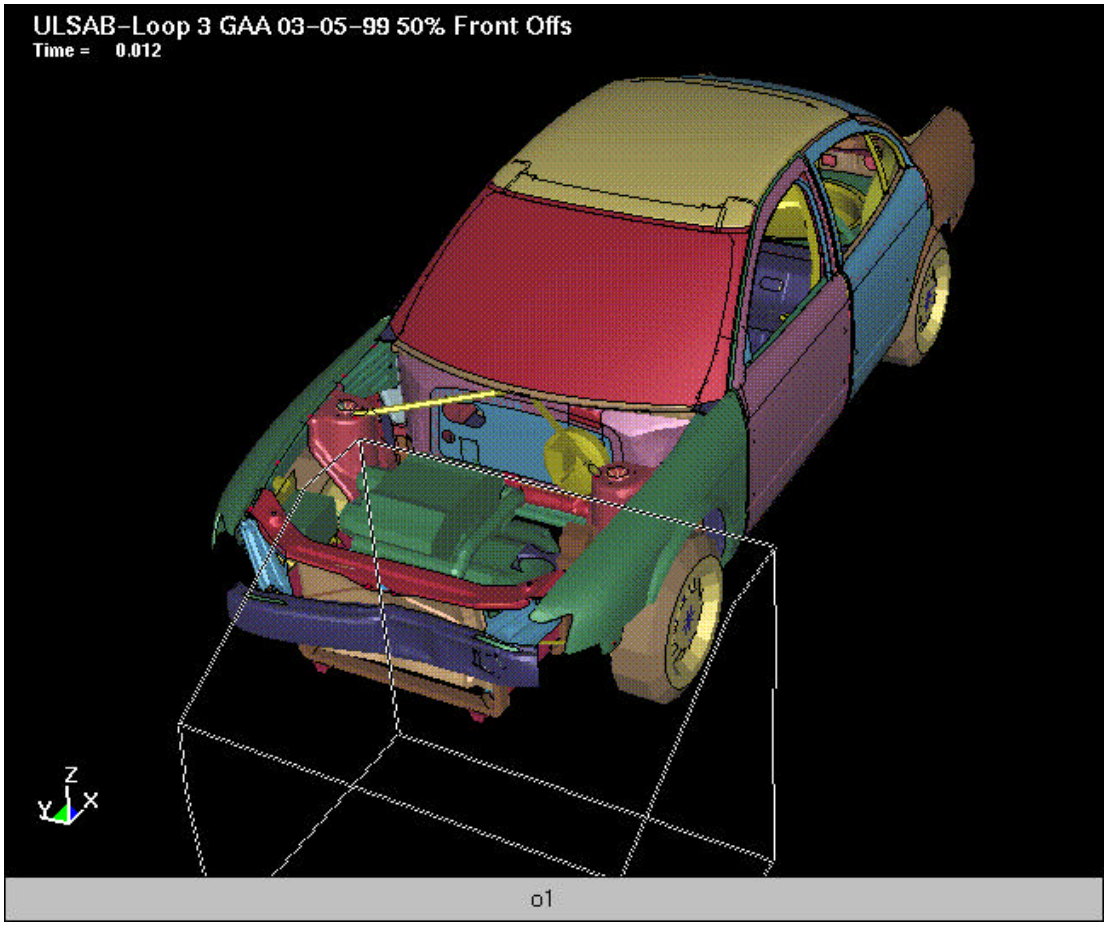
100% Frontal Impact Barrier Force



- Barrier forces are indicator of vehicle stiffness
- Stiffness indicates compatibility with other vehicles

50% Frontal Offset Impact

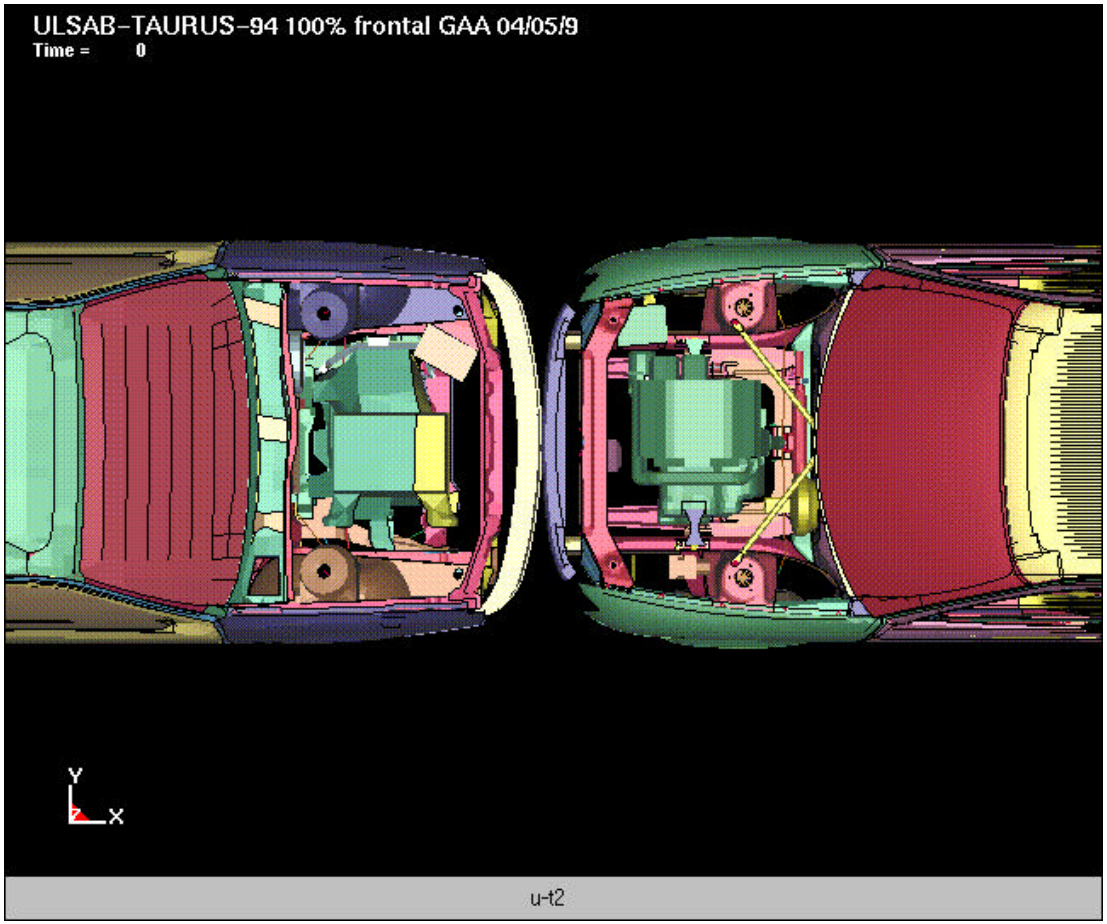


- The most probable impact situation on the road
- Introduces strong shear component in the front end

ULSAB - Ford Taurus Frontal Impact

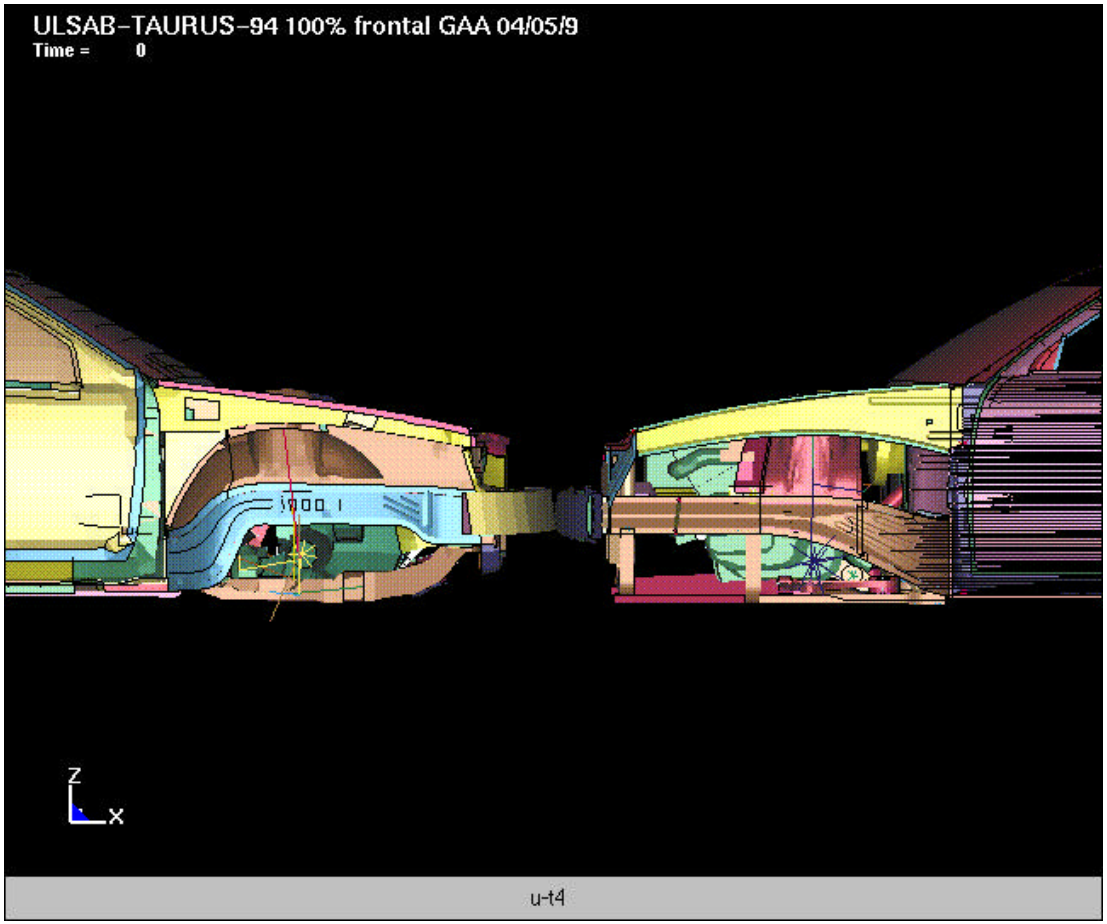
- Speed of both vehicles is 35 mph
- Simulation is performed to evaluate compatibility between two designs

ULSAB - Ford Taurus, Top View



- Simulation shows comparable deformation and component stacking sequence

ULSAB - Ford Taurus, Side View



- Simulation shows comparable deformation of main energy absorbers

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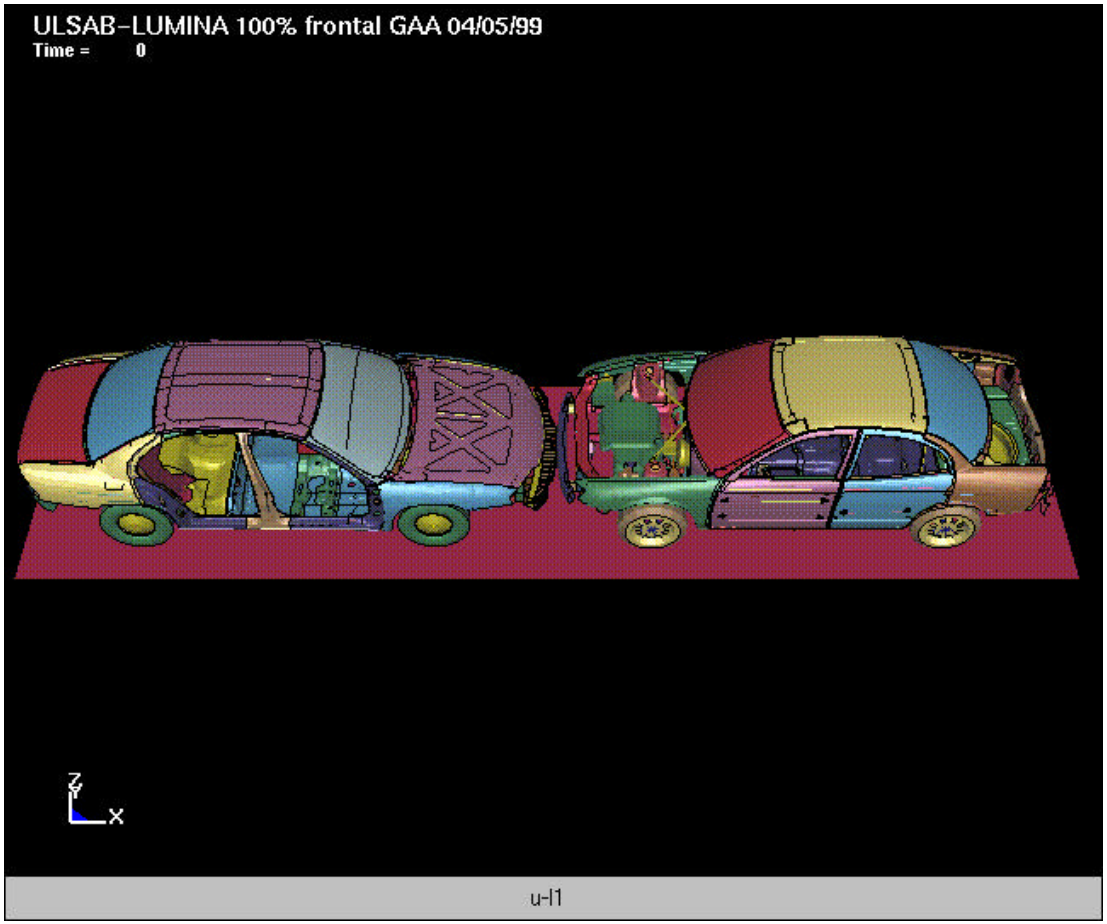
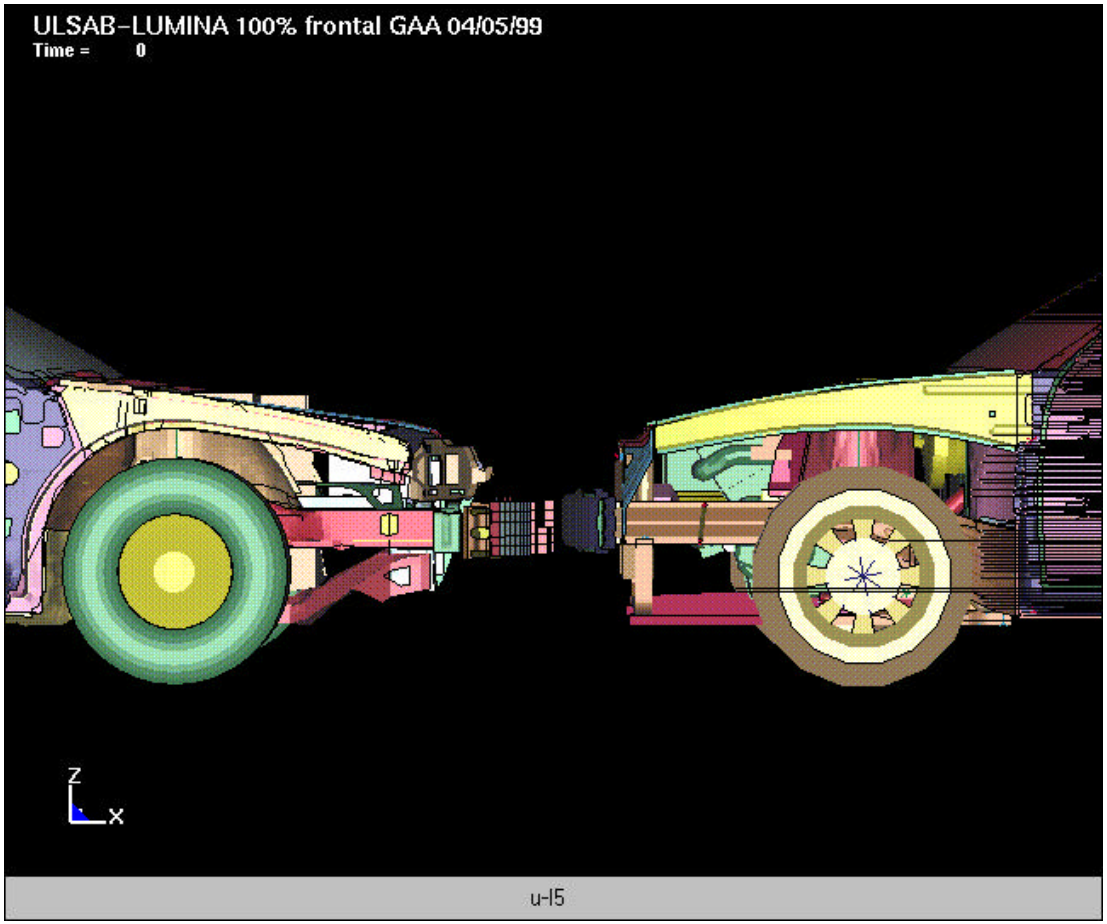
ULSAB - Chevy Lumina



- Speed of both vehicles is 35 mph
- Simulation is performed to evaluate compatibility with a PNGV design

ULSAB - Chevy Lumina, Side View



- Simulation shows comparable deformation in main energy absorbing components

Future Work

- Perform impact simulations to evaluate ULSAB model performance and interaction with vehicles representing the current U.S. car fleet
- Use forming simulation data for defining ULSAB as-formed part properties
- Document developments and findings of the project