

# **CSE/ECE 848**

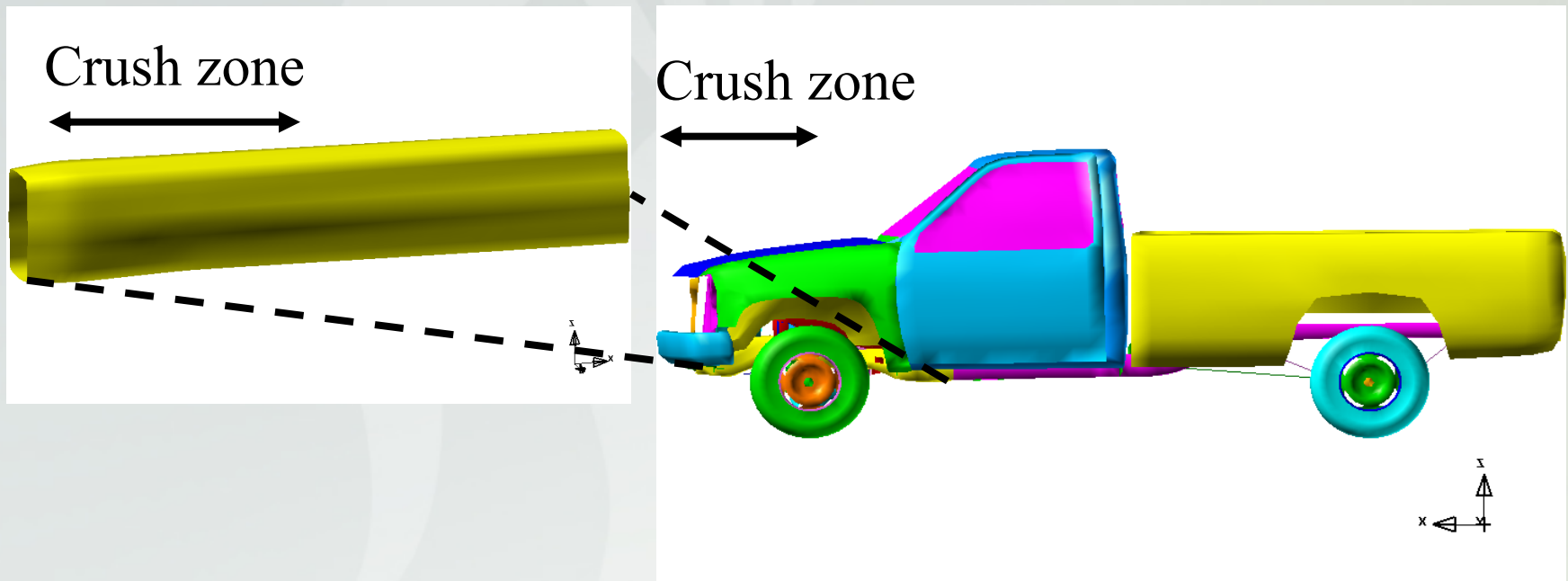
## **Introduction to**

# **Evolutionary Computation**

**Module 4, Lecture 21, Part 3**  
**Parallel EC and Implementations**

**Erik D. Goodman, Executive Director**  
**BEACON Center for the Study of Evolution in**  
**Action**  
**Professor, ECE, ME, and CSE**

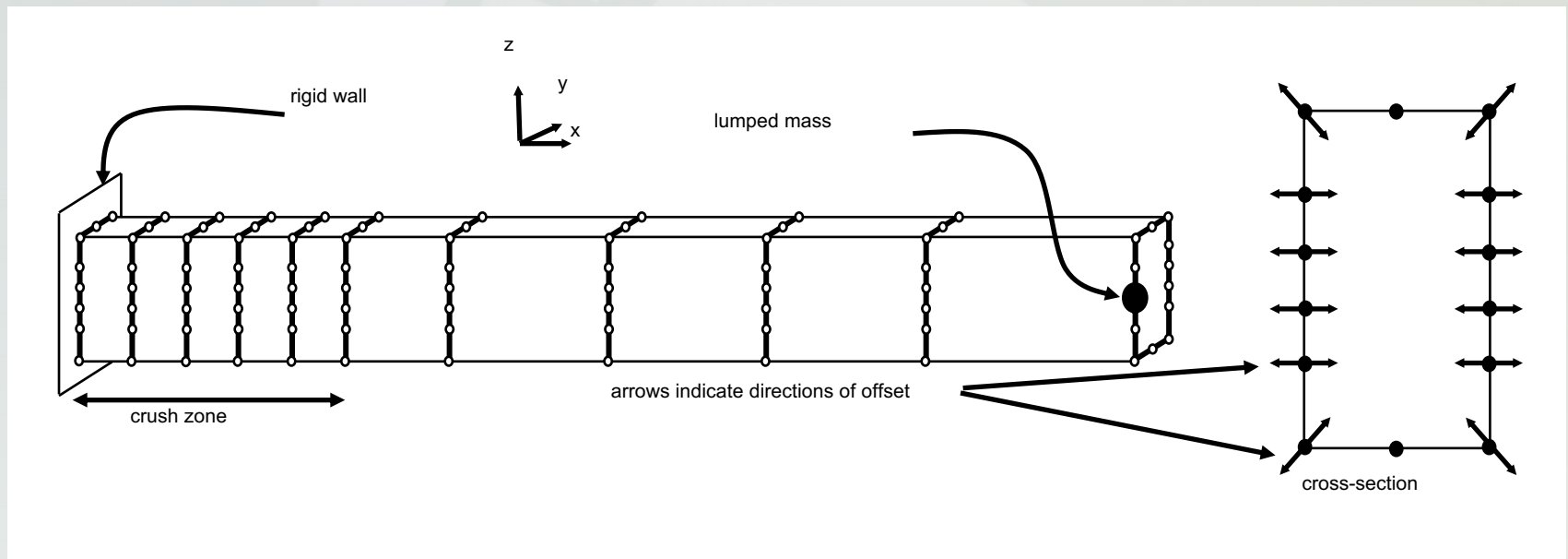
# Heterogeneous Parallel GA Example: Hydroformed Lower Rail



# Shape Design Variables

67 design variables:

66 control points and one gauge thickness



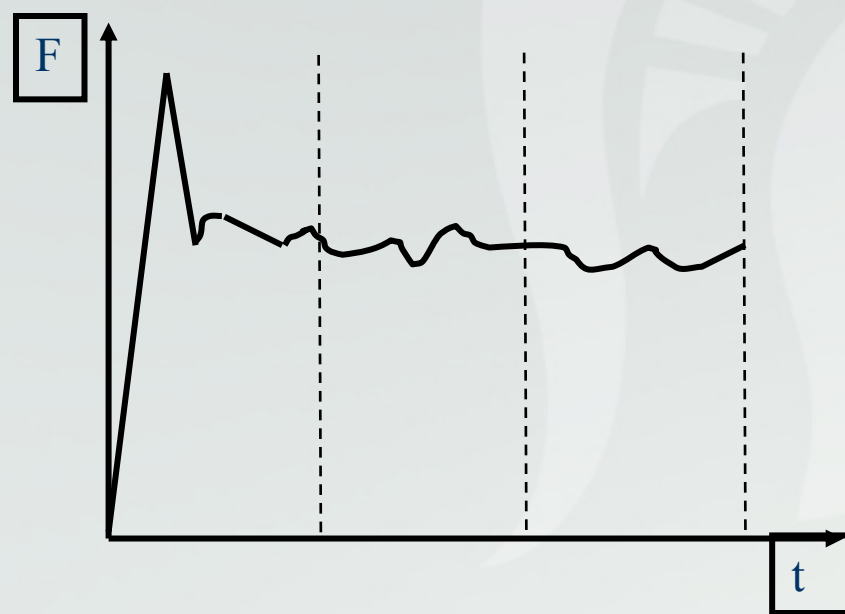
# Optimization Statement

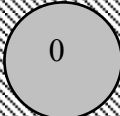
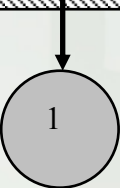
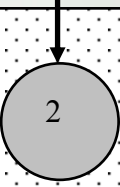
- Maximize energy absorbed in crush zone
- Identify the rail shape and thickness
- Subject to constraints on:
  - Peak force
  - Mass
  - Manufacturability

## Simple, Three-Agent Topology

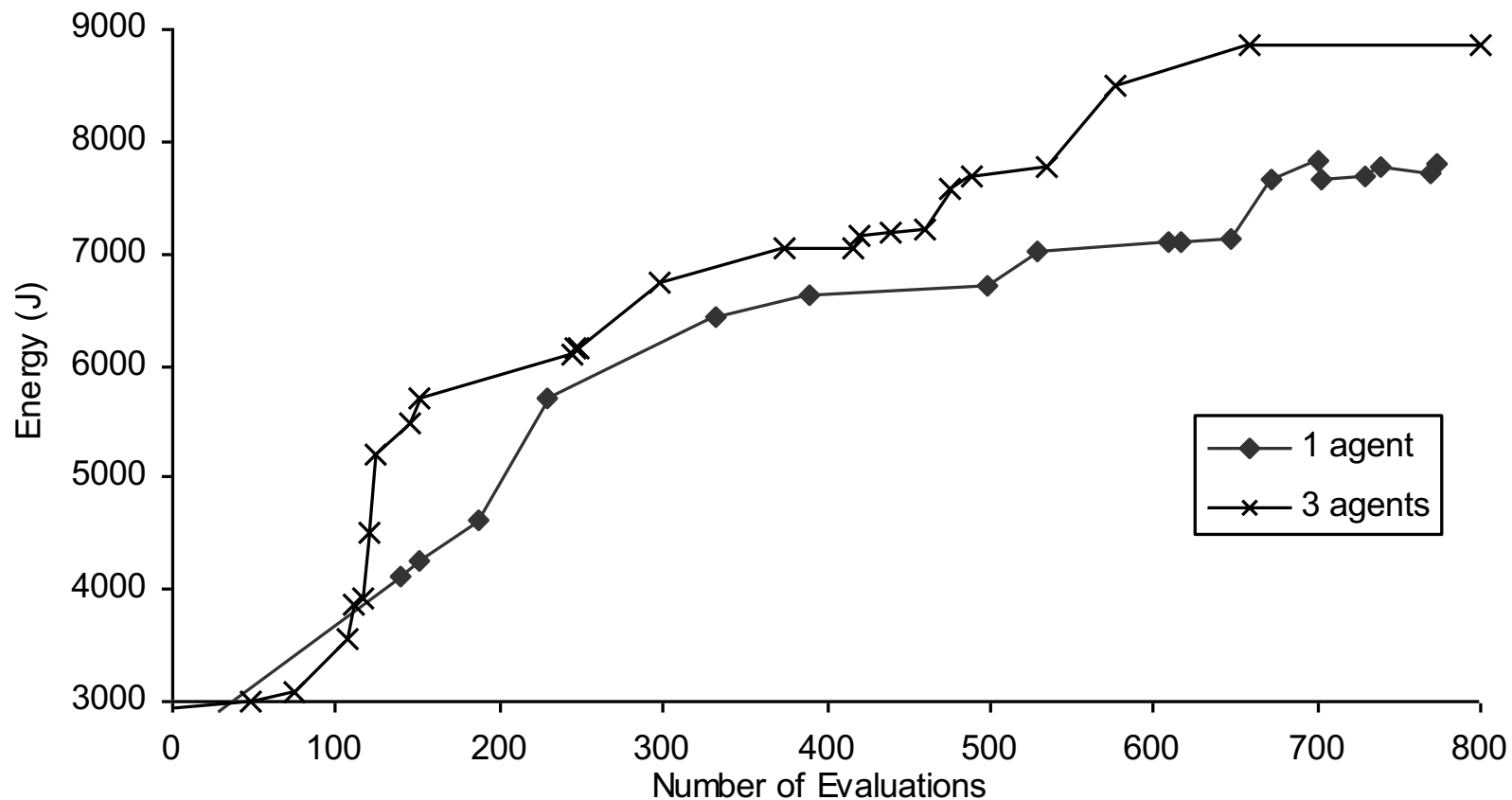
### Treat DIFFERENTLY:

- crush time simulated (reduces CPU time)
- discretization of design variables (reduces design space)



Crush Time	Agent Topology	Design Variable Discretization
t=6 ms		Coarse
t=10 ms		Medium
t=14 ms		Refined

# Energy Absorbed by Rail vs. Number of Rails Evaluated



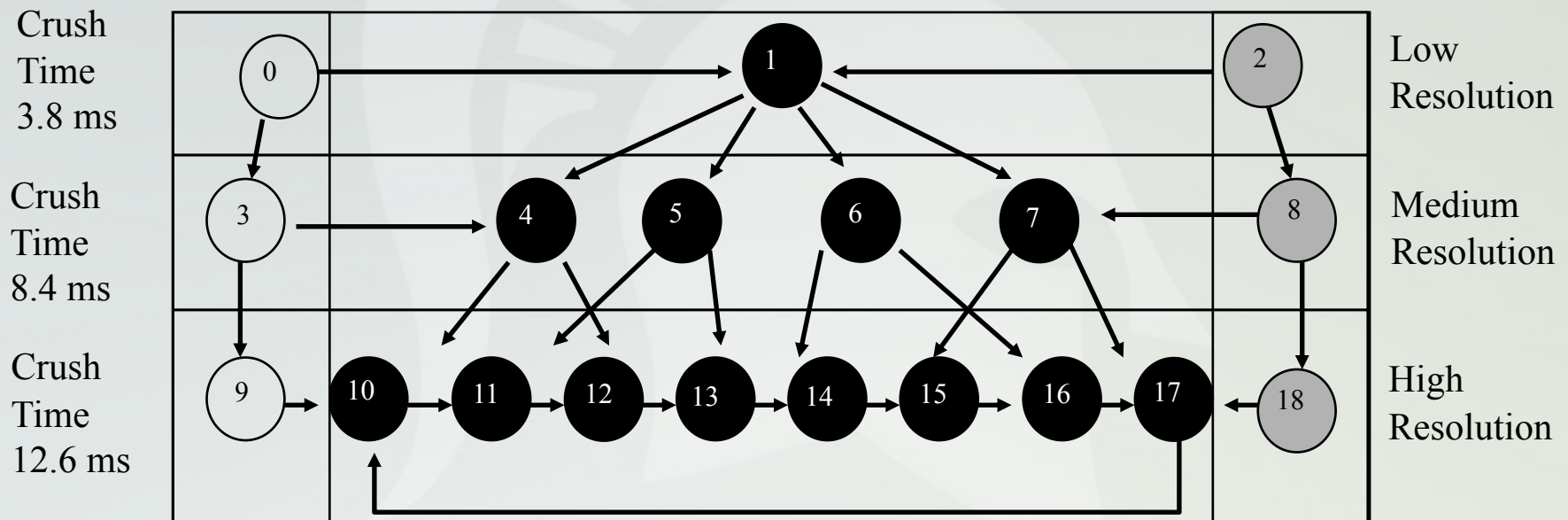
# Collaborative Agents: Example Agent Topology

## Lower Compartment Rail Example – 19 Agents/19 CPU's

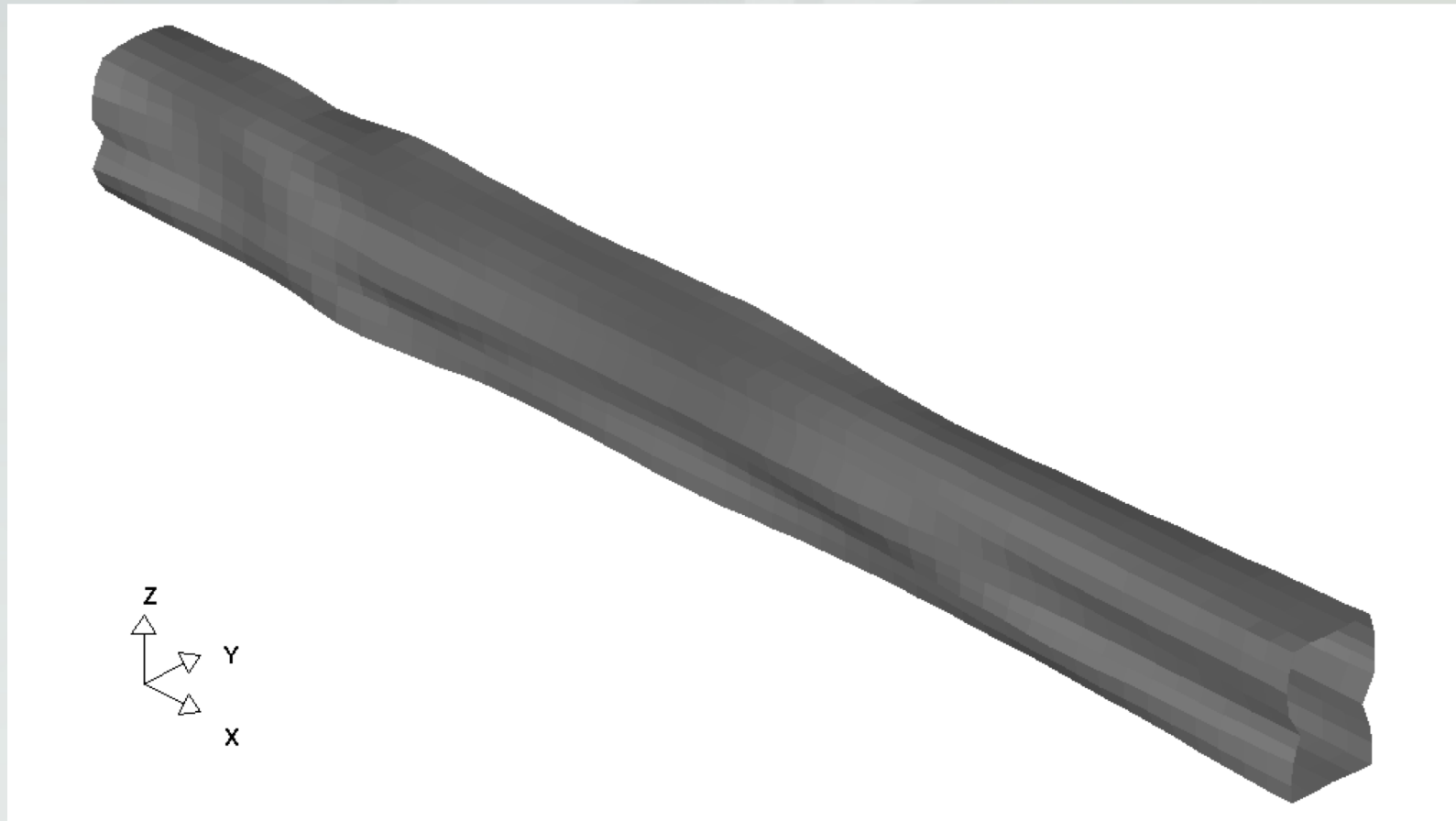
Axial Load Case  
(Deterministic)

Stochastic Load Cases  
(and Stochastic Design Variables)

Offset Load Case  
(Deterministic)

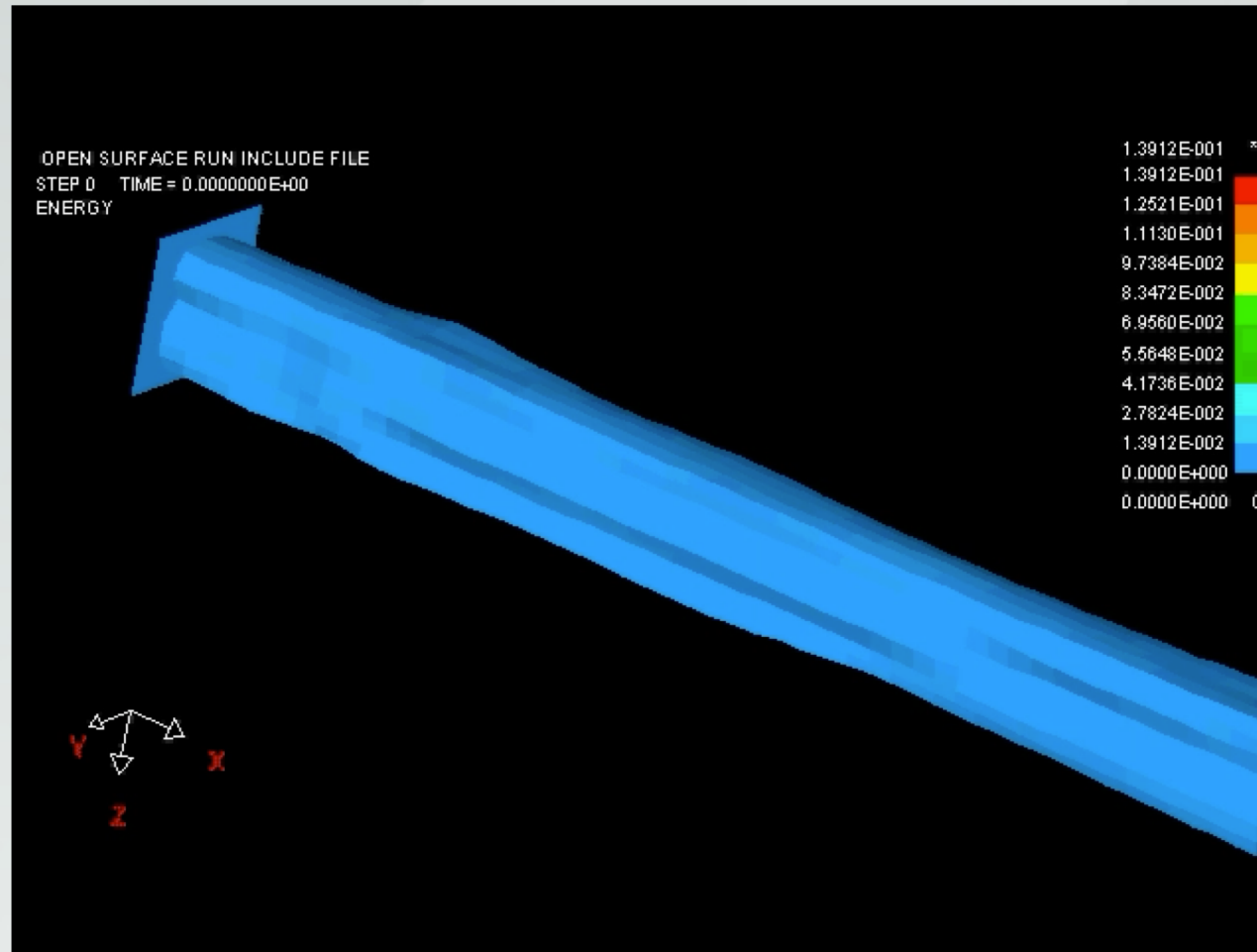


# HEEDS Optimized Design

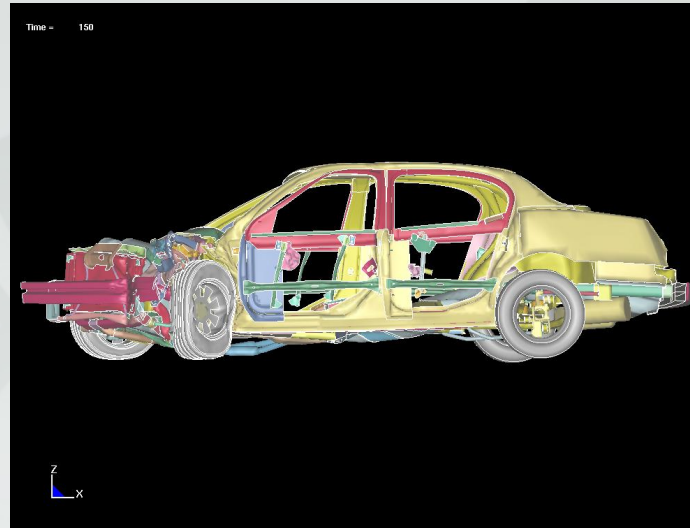




# HEEDS Optimized Design



# Validation



# Lower Rail Benefits

Compared to 6 month manual search:

- Peak force reduction by 30%
- Energy absorption increased by 200%
- Weight reduction by 20%
- Overall crash response resulted in equivalent of FIVE STAR rating
- GM (sponsor) told Averill and Goodman to start a company → Red Cedar Technologies, now part of Siemens. Our HEEDS SHERPA optimizer is now used around the world.

# Additive Effect of Collaborative Independent Agents

- Each agent can use any search method/combination desired
- Using Collaborative Independent Agents simply overlays its gains on the remainder of the search process
- Together, may make **practical** a design optimization that was seen as *infeasible*