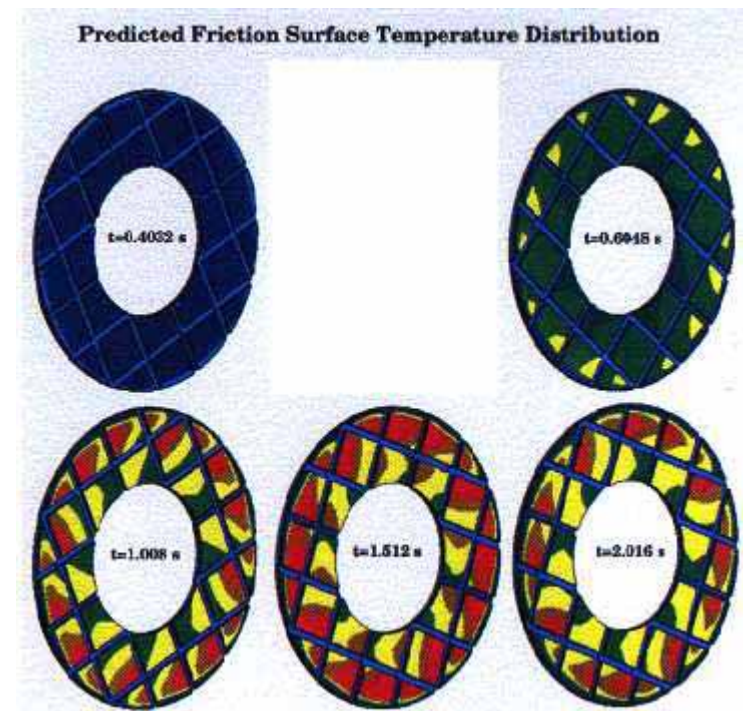




# Clutch Thermal Analysis

- ¥ Thermal Transient Response
- ¥ 3D Finite Volume Numerical Method
- ¥ Uses
- ¥ Brick or Wedge Elements
- ¥ Lagrangian Based Sliding Thermal Source
- ¥ Conjugate Heat Transfer Across Differential Material



# Thermal Clutch Model

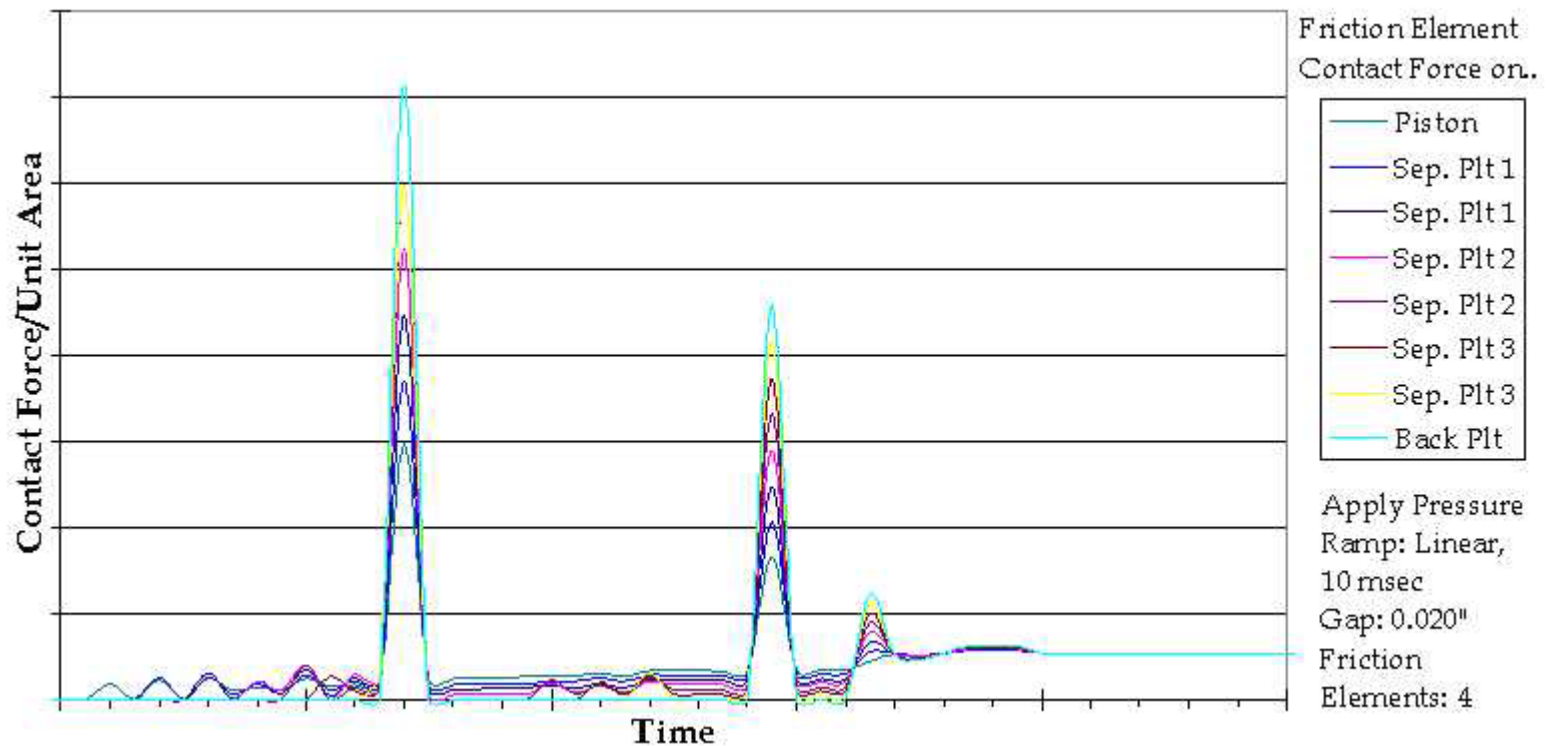
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- ¥ Predicts Thermal Transient Response
- ¥ 3D Finite Volume Based Numerical Method
- ¥ Uses Brick or Wedge Elements
- ¥ Models Complex Groove Patterns
- ¥ Lagrangian Based Sliding Thermal Source
- ¥ Conjugate Heat Transfer Across Different Materials



# Plot for Contact Forces Between Friction Elements During Shift

¥ Contact Forces Between Friction Elements and Output Elements During the Shift Transient



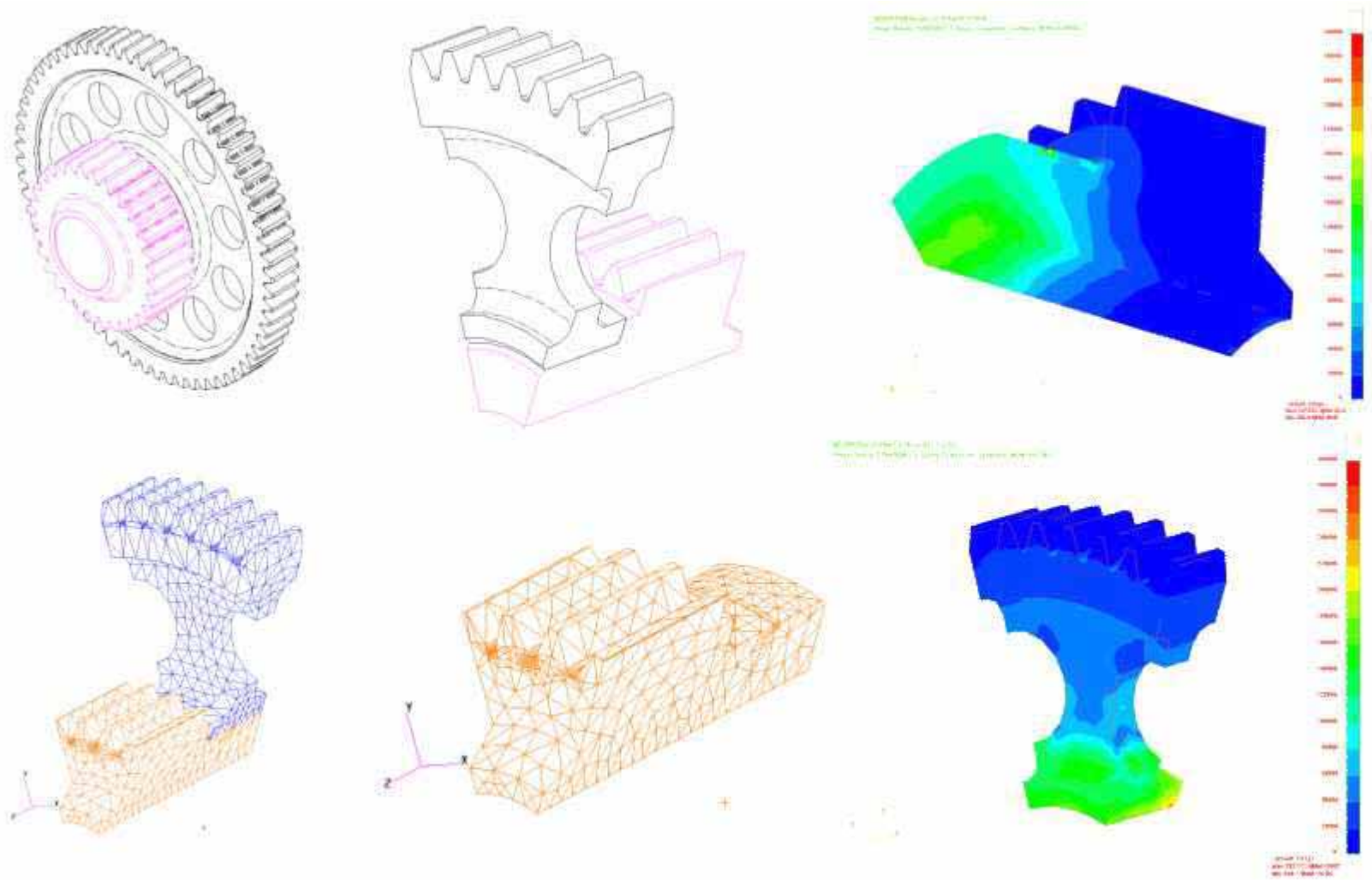
# Gear Tooth Finite Element Analysis

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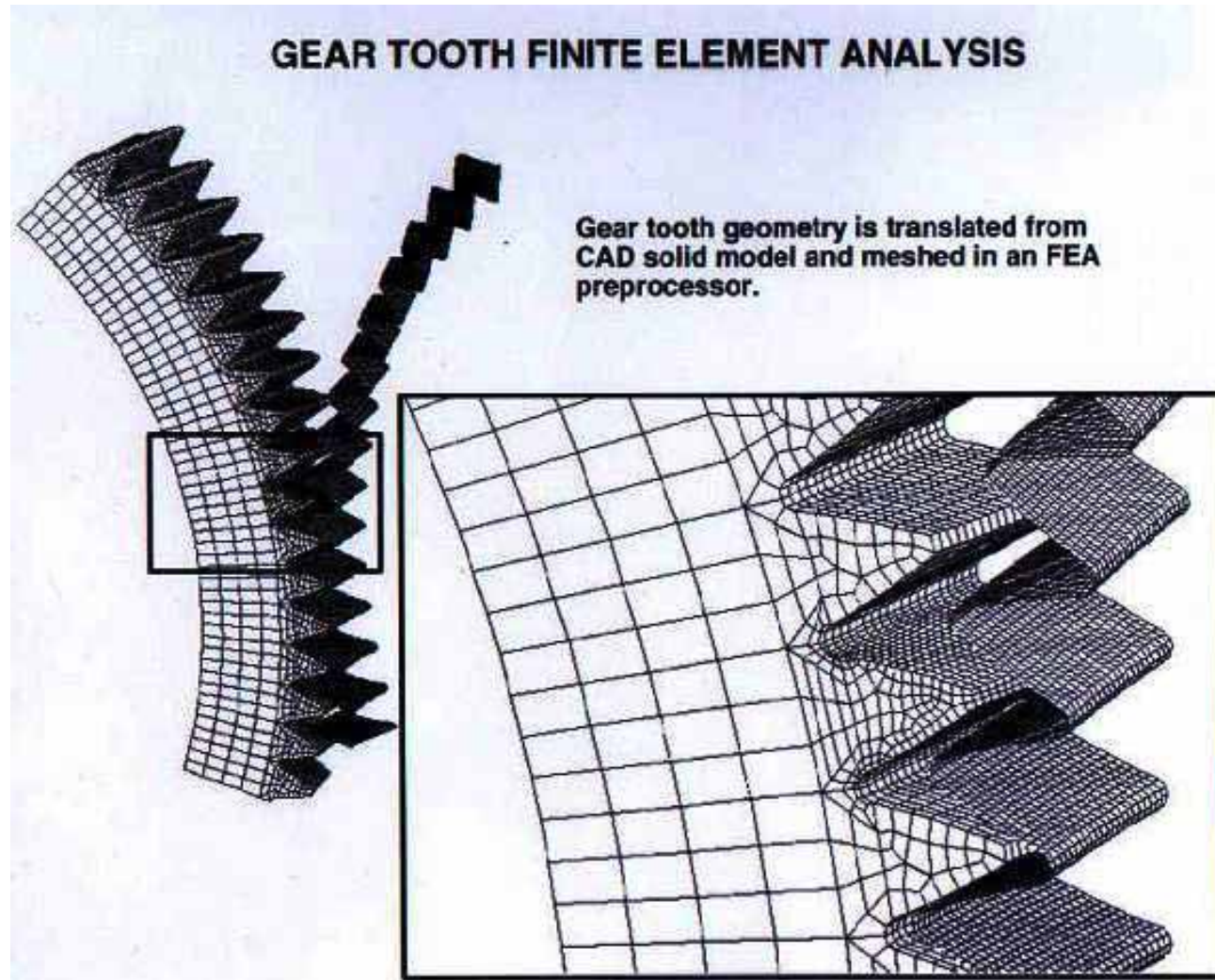
- ¥ **Gear Tooth Geometry is Imported into a FEA Preprocessor**
- ¥ **Non-Linear Large Displacement Theory w/Contact**
  - > **Finite Sliding**
  - > **Contact Softening**
- ¥ **Fillet Stress Projection**



# Gear Tooth FEA

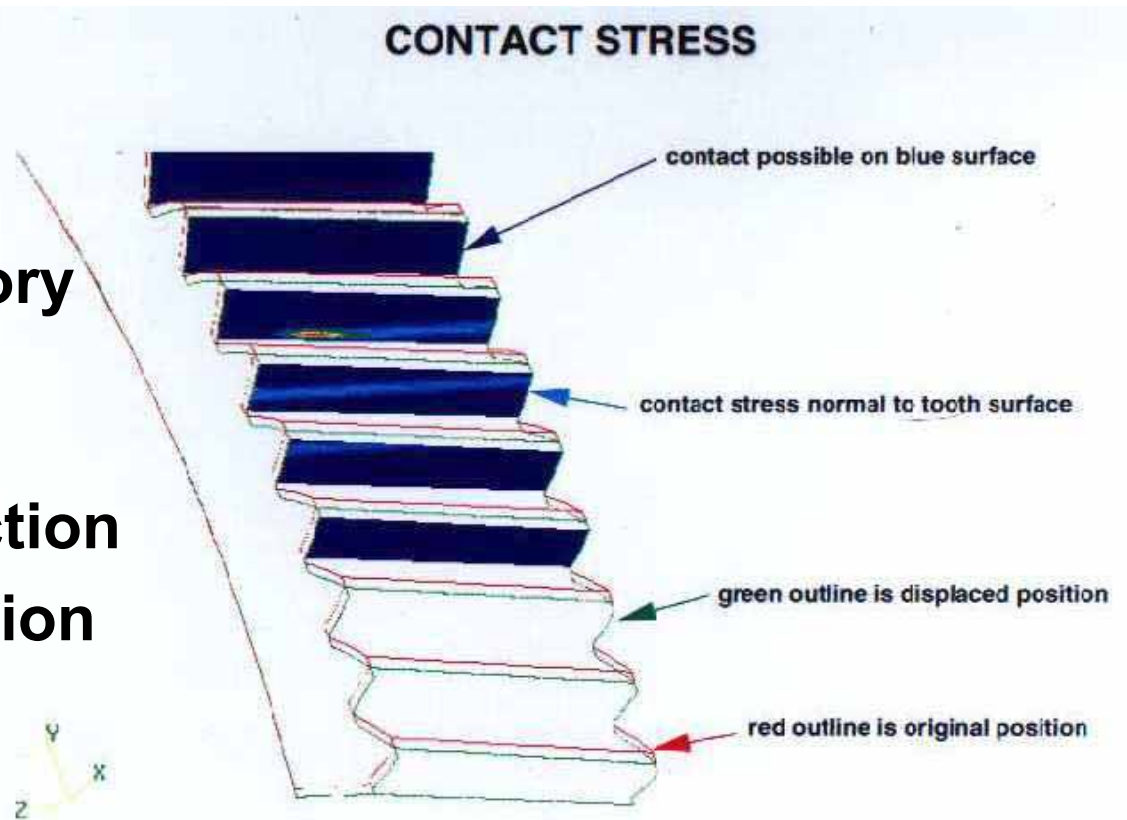


# Contact Stresses



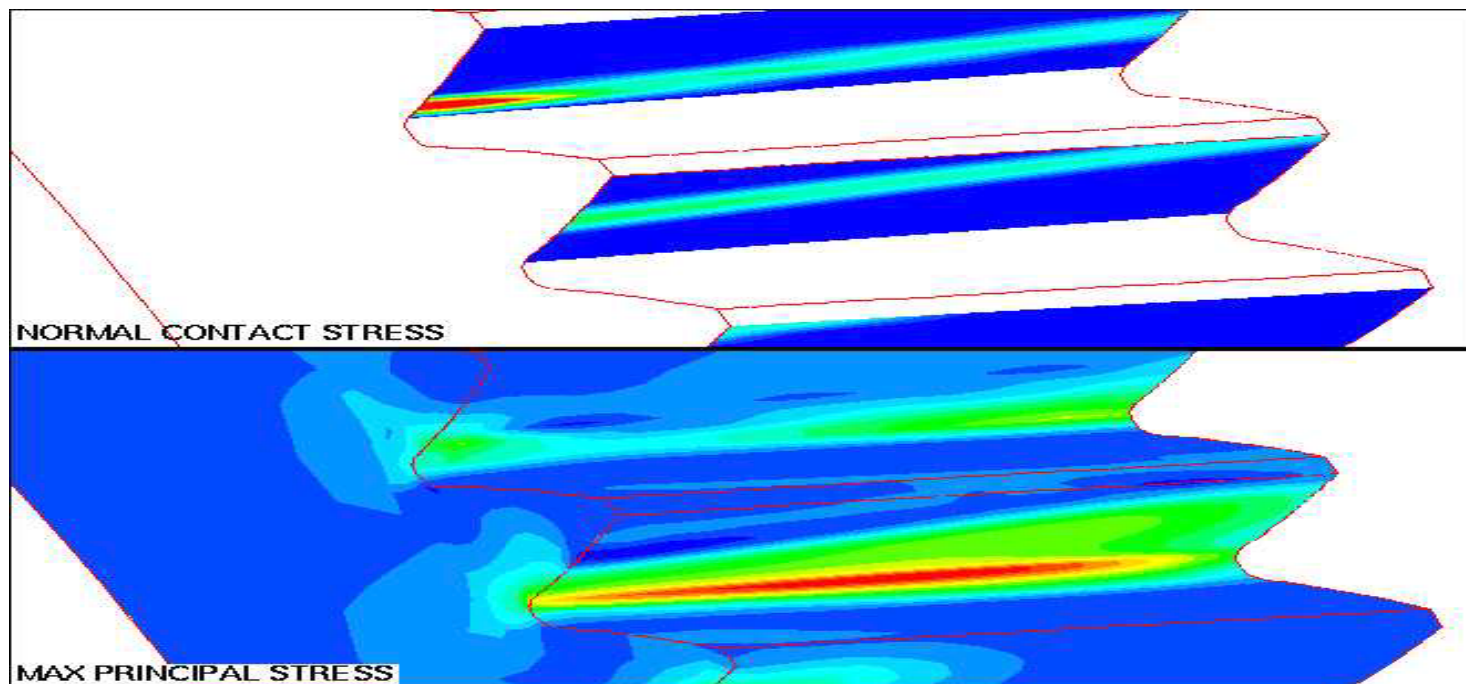
# Gear Contact Stresses

- ¥ Gear Tooth Geometry is Imported into FEA Preprocessor
- ¥ Non Linear Large Displacement Theory
  - › Contact Softening
  - › Finite Sliding
- ¥ Fillet Stress Projection
- ¥ Gear Tooth Deflection



# Gear Simulation

- ¥ Gear Capacity Projection
- ¥ Tooth Strength Rating
- ¥ Surface Durability Measure
- ¥ Scoring Hazard Rating

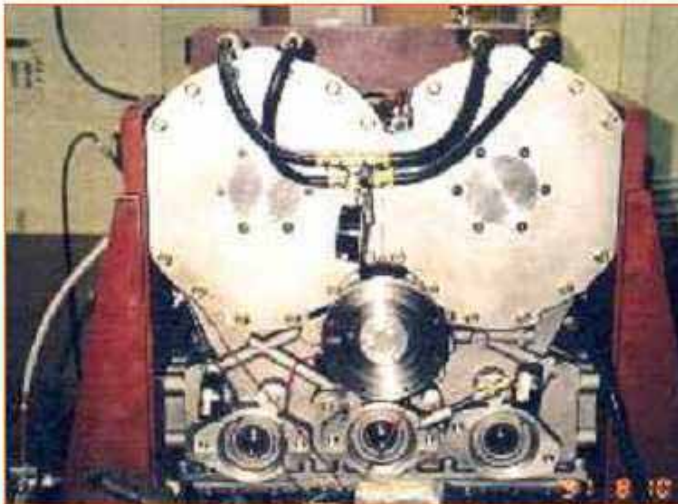
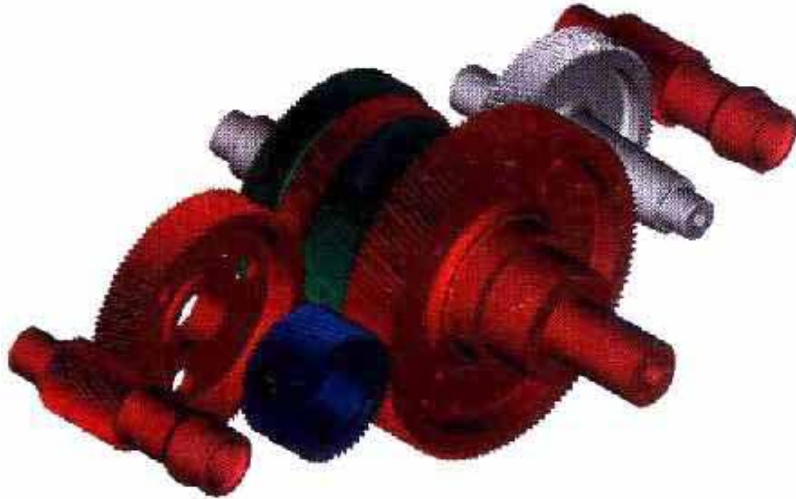


# SwRI Fabrication Capabilities

- ¥ **Mechanical**
- ¥ **Welding**
- ¥ **Machine Shop**
- ¥ **Hydraulics**
- ¥ **Electrical**
- ¥ **Electronics**
- ¥ **Controls**
- ¥ **Casting**
- ¥ **Forging**
- ¥ **Machining**
- ¥ **Circuit Board Fabrication**
- ¥ **Wiring Harness Fabrication**



# Hybrid Bus Transmission



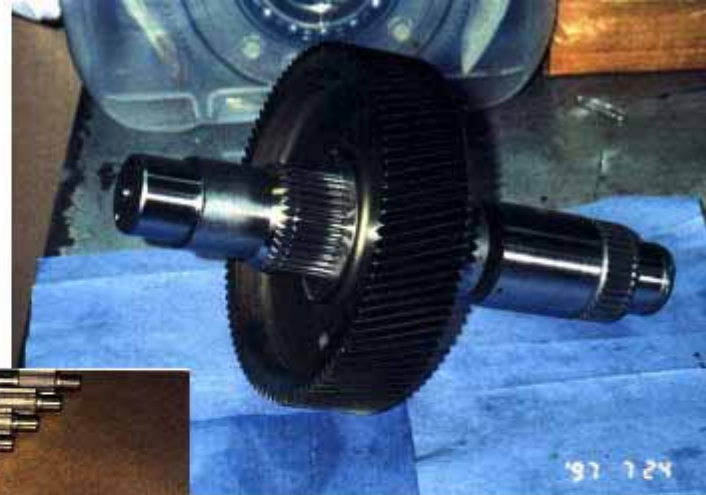
# Gear Fabrication



# Hardware Fabrication

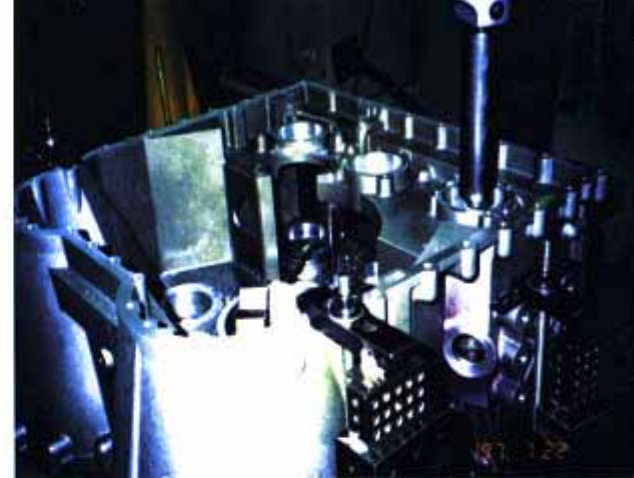


# Gear Fabrication



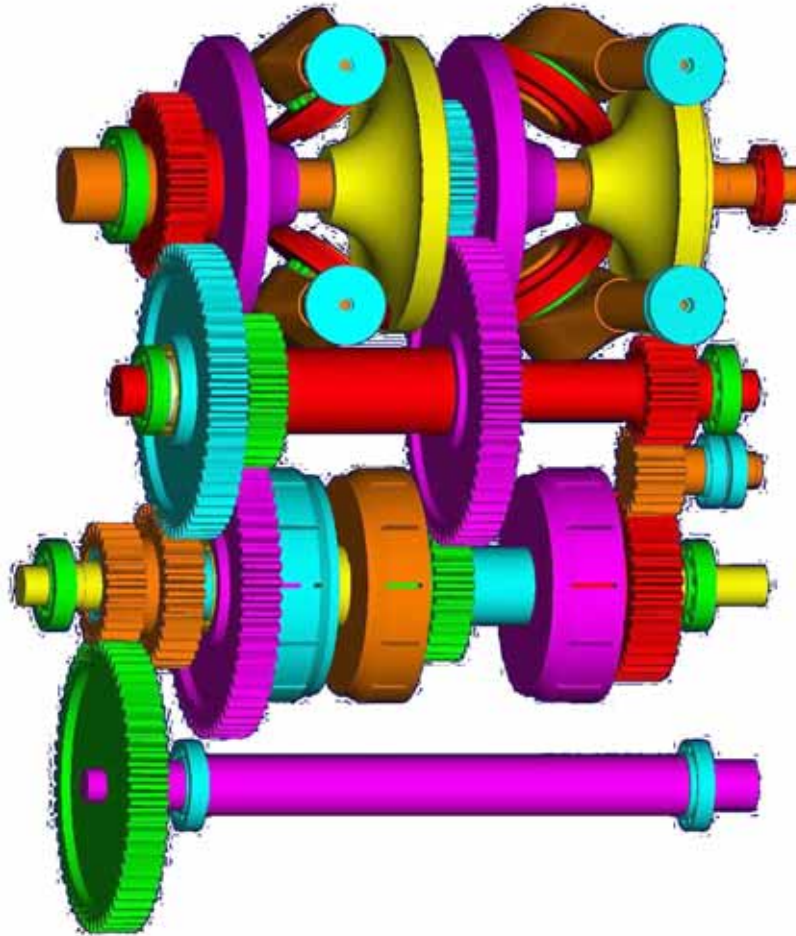
# Housing Fabrication

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# Drivetrain Design

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**High Torque Toroidal CVT**



# Bell Housing Design and Fabrication

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- ¥ Shell Element Model
- ¥ Mode Analyses/Superposition
- ¥ Stiffness Evaluation
  - > Y, Z, and  $\tilde{A}$  Direction



# Cast Iron Motor Carrier Design and Fabrication

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- ¥ 2<sup>nd</sup> Order 10 Noded Tetrahedron /elements
- ¥ 25,000+ elements
- ¥ 50,000+ nodes



# Cast Iron Clutch Drum Design and Fabrication

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