

# PEEM Thermal Stress and Reliability



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**Project Duration: FY08 to FY10**

**DOE FreedomCAR and Vehicle Technologies Program  
Advanced Power Electronics and  
Electric Machines Projects  
FY08 Kickoff Meeting**

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*This presentation does not contain any  
proprietary or confidential information*

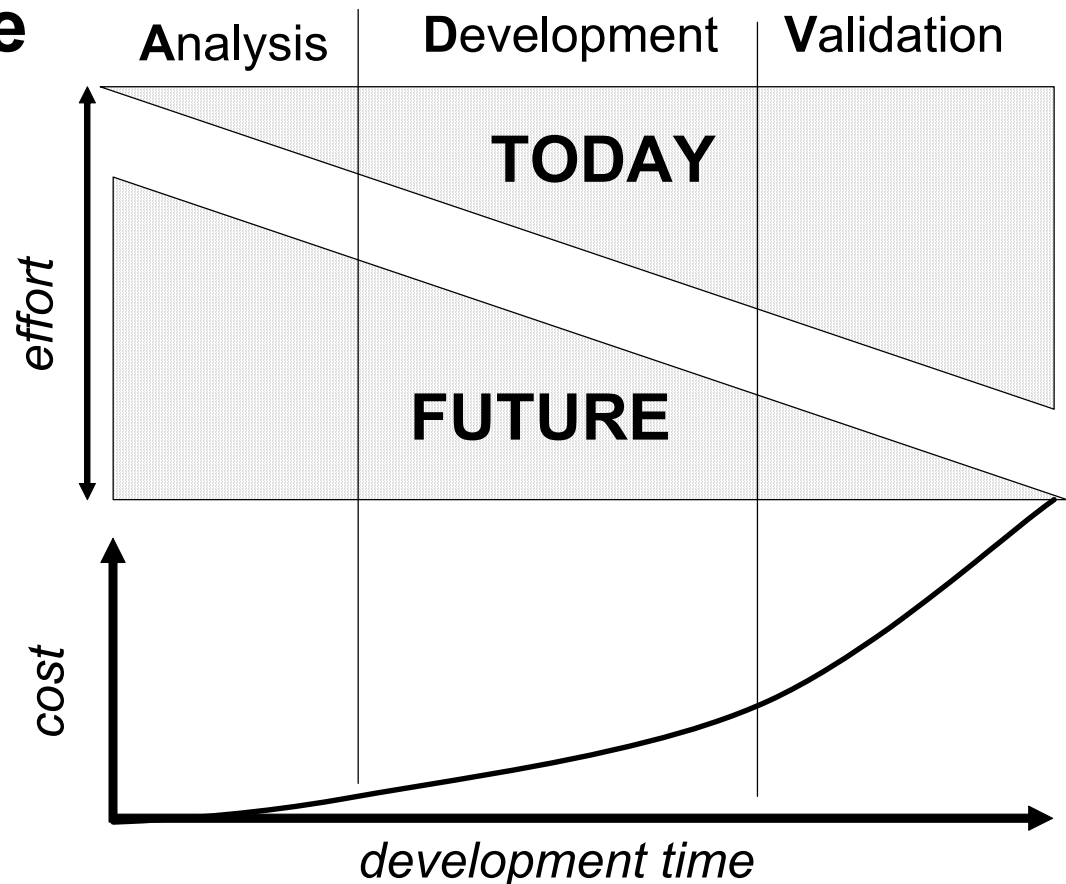


# The Problem

- **Fundamental concerns related to PEEM component usage and reliability**
- **Existing methods of addressing reliability are cost and time intensive**
- **For the DOE: Lack of method to quantify 15 year life target**

# Description of Technology

- Flexible reliability modeling tool(s) for automotive power electronics
- Allow life/ reliability to be addressed earlier in the design phase



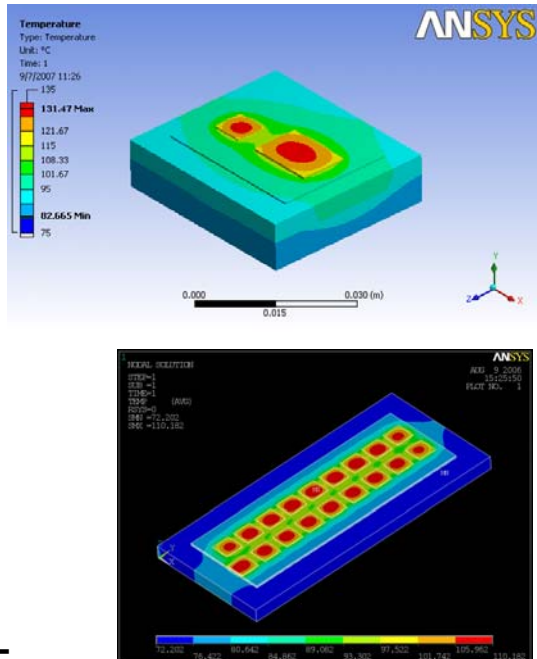
# Uniqueness of Project and Impacts

- **Develop critical areas not being addressed**
- **Integrate, leverage, and coordinate**
  - testing at ORNL, ANL, and INL
  - thermal modeling at NREL
  - physics of failure experts
  - knowledge from automotive OEMs and suppliers
- **Impacts**
  - Assess 15 year life target for DOE R&D
  - Empower designers and integrators to address life/ reliability earlier in the design cycle

# Accomplishments to Date

(for projects funded in prior FYs)

- Project discussions initiated in FY07
- Discussion of project with industry ongoing
- Thermal system models built

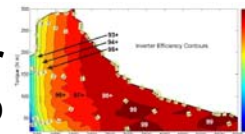


Vehicle Test  
Data

PSAT  
Prius  
Model

MG2 Shaft  
Torque and Speed

ORNL Inverter  
Loss Map



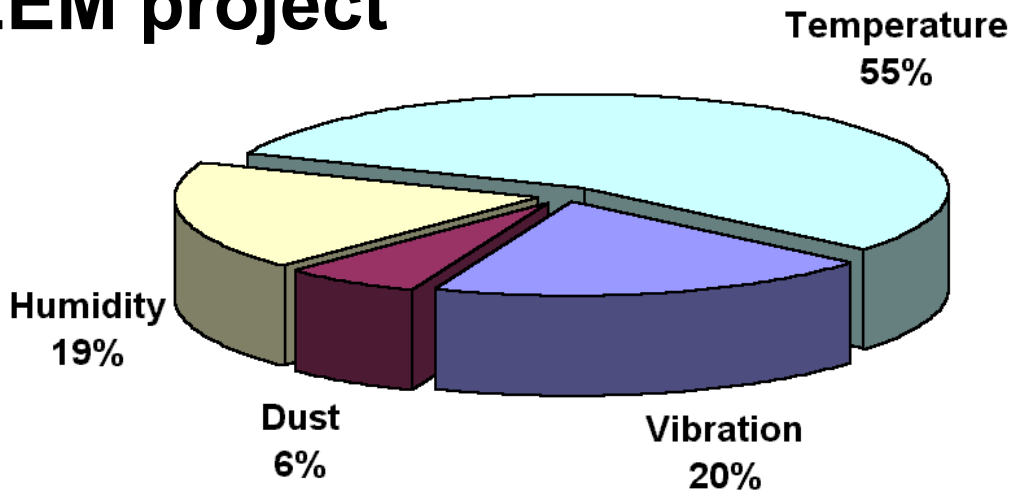
?  
Reliability  
?

Temperatures

Heat  
Generation

# Project Objective for FY08

- Develop a computer tool that can be used by industry and DOE program to predict reliability of PEEM components
- Use the tool to assess one aspect of the life target for an APEEM project



Source: U.S. Air Force Avionics Integrity Program  
Reynell, M. 1990

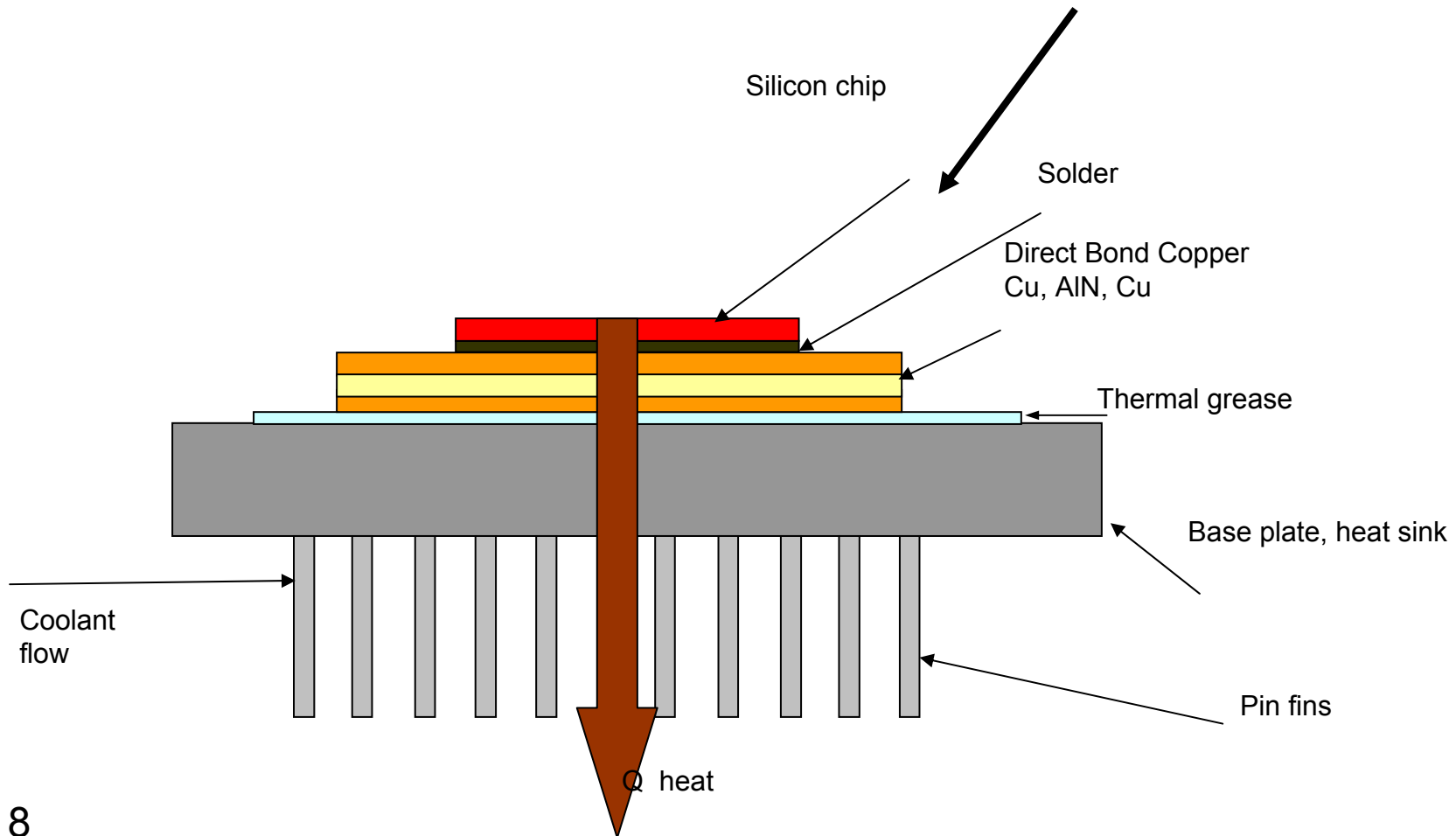
**MAJOR CAUSES OF ELECTRONIC FAILURES**  
(note: not POWER electronics)

# Technical Approach for FY08

- **Develop detailed plan of action for project (03/2007)**
- **Milestone: submit report on project plan (06/2007)**
- **Integrate one working model into the tool suite (09/2008)**

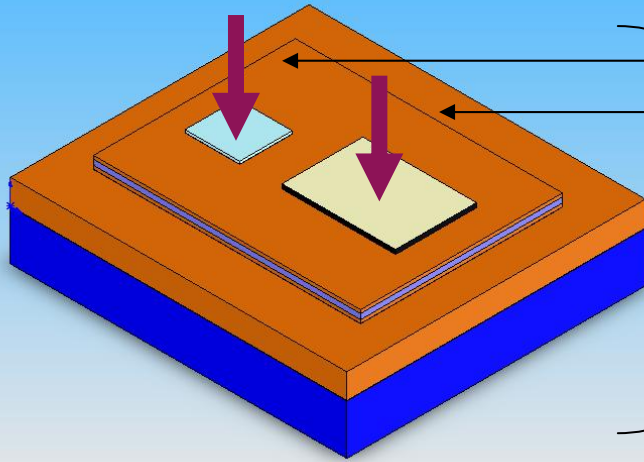
# Vision for Reliability Tool

User specifies heat input, loadings  
materials and architecture



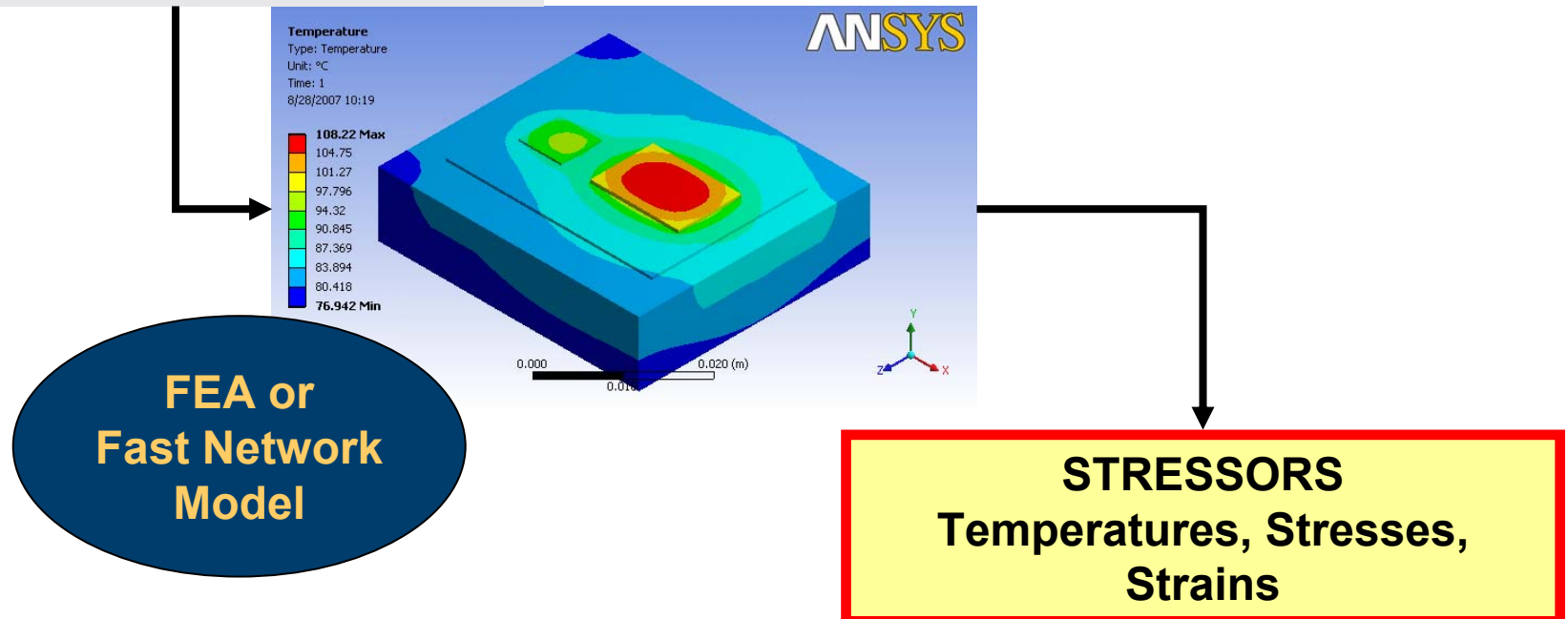


# Thermal models can map loads to stressors

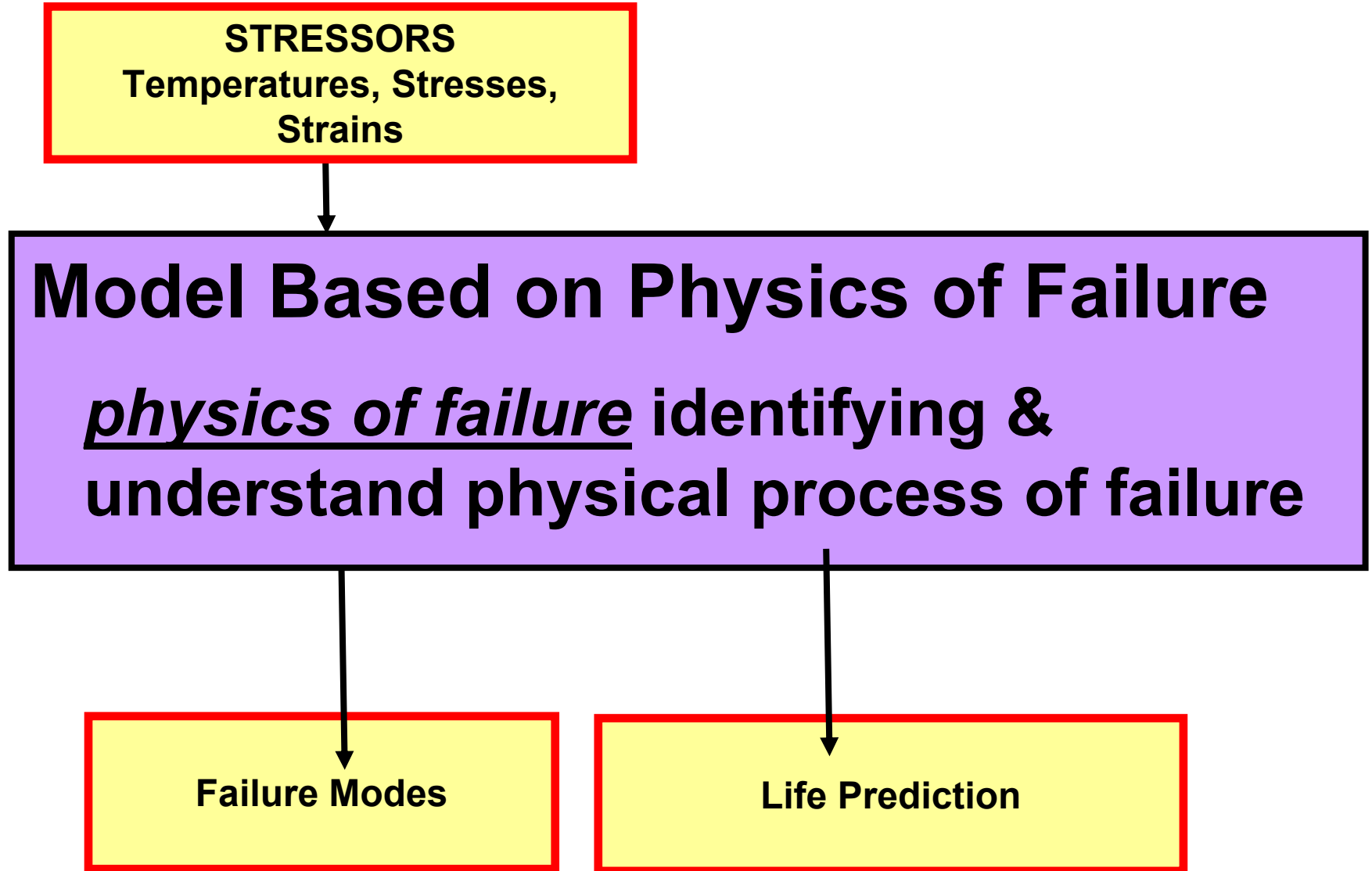


**Thermal Loading  
(HEAT GENERATION)**

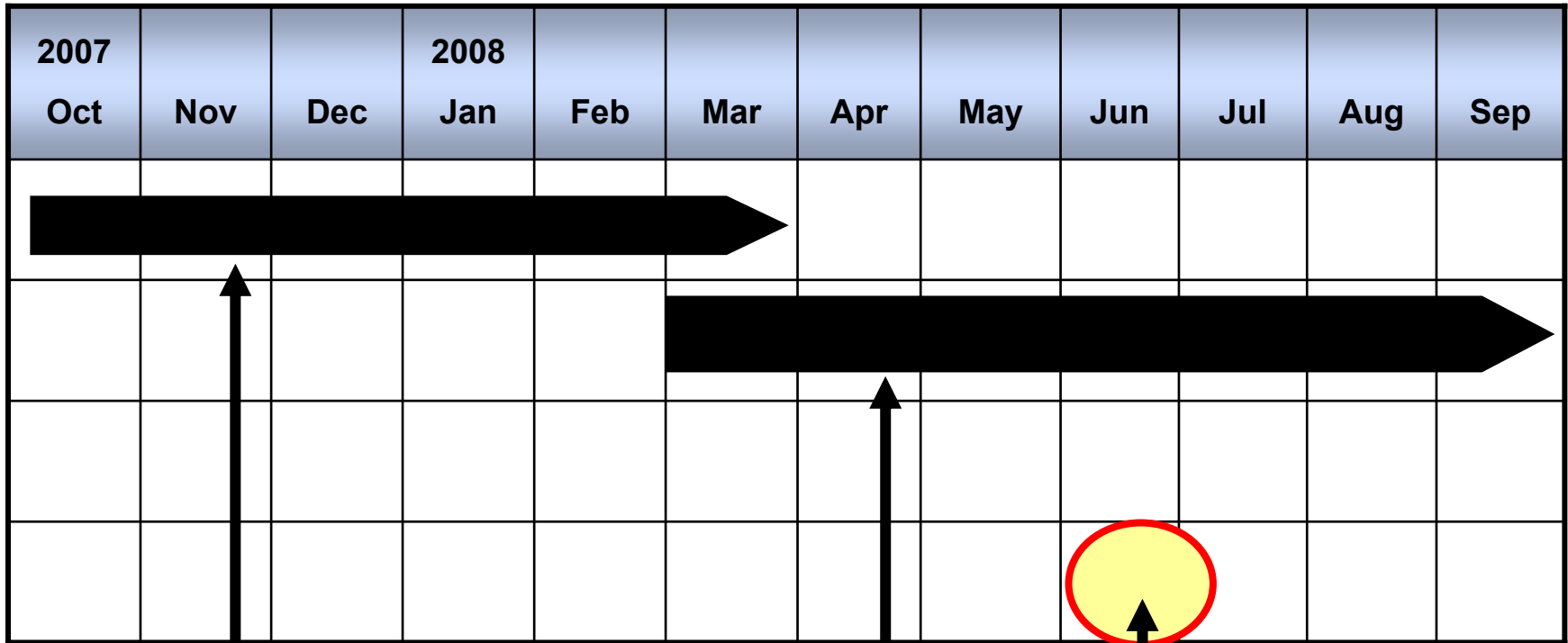
**Design Information  
(Geometry & Materials)**



# Life is predicted with physics of failure models



# Timeline



**IDENTIFY AREA TO ADDRESS**

**BUILD FIRST TOOL**

**MILESTONE: RESEARCH PLAN**

# The Challenges/Barriers

- **Integration and coordination of various engineering software tools**
- **Validation of models (availability of data)**
- **Complexity of problem**
- **Validation of predictions**

# Beyond FY08

- **FY09**

- **Application of tool to APEEM program**
- **Expansion of tool to cover more areas**
- **Validation activities**

- **FY10**

- **Finish validation and development activities**

# Summary

- **Develop Automotive PEEM Reliability Tool**
- **Process:**
  - Starting slow
  - Create a working example early on
  - Adjust as we go
  - Identify opportunities to validate
  - Review progress periodically with DOE and National Laboratory team, OEMs, suppliers and other stake holders

# Questions

