



Intro to FEA



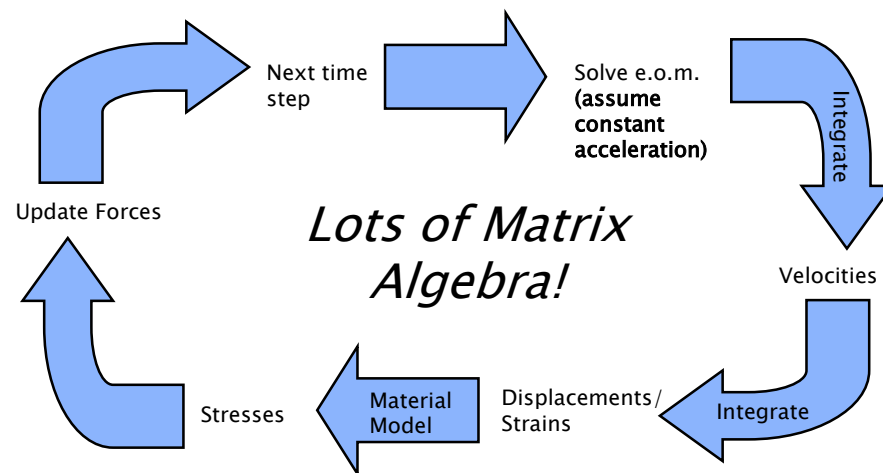
Introduction

- What is FEA?
 - Take a complex problem and split it very small pieces which can be approximated and solved to get a solution



- What is the theory behind it?
 - Implicit – Non-linear equations solved by iteration
 - Explicit – Assume acceleration is constant over each timestep

- What are the basic principles?
 - FEA made **SIMPLE**





Splitting a complex problem into small ELEMENTS

Interpret the geometry

Material Information

Physical Property

Loading

Evaluation of results



FEA made SIMPLE

Splitting a complex problem into small ELEMENTS

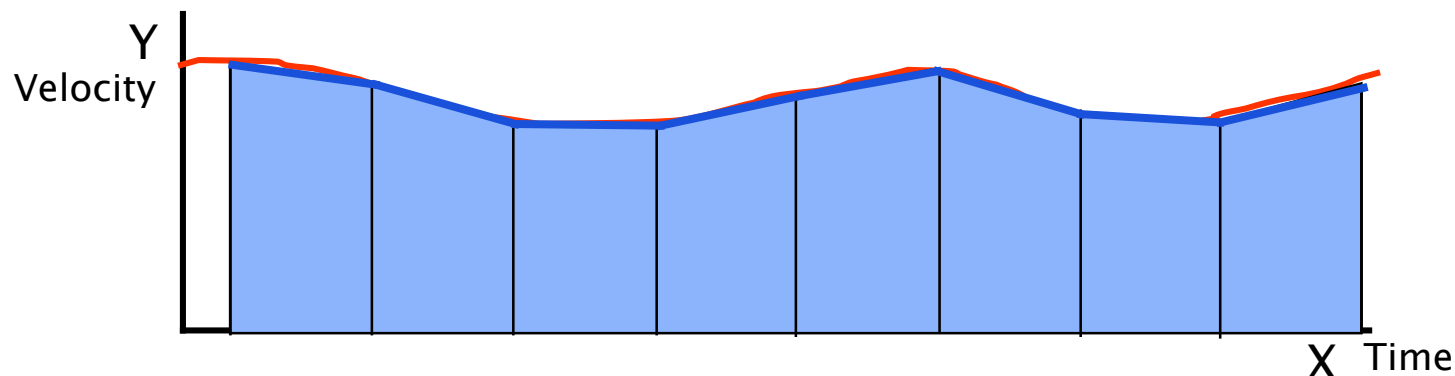
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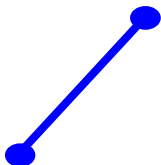
Evaluation of results



If Δt is small enough then the assumption of constant acceleration over that time is valid.

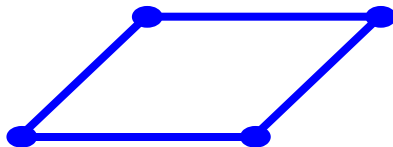
Also the geometry of a complex object can be represented by small ELEMENTS...

1D Beam



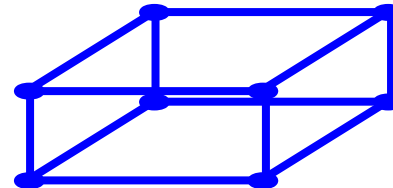
- Define cross section

2D Shell



- Define thickness
- **Most commonly used for automotive components**

3D Solid



- All properties defined by geometry of element



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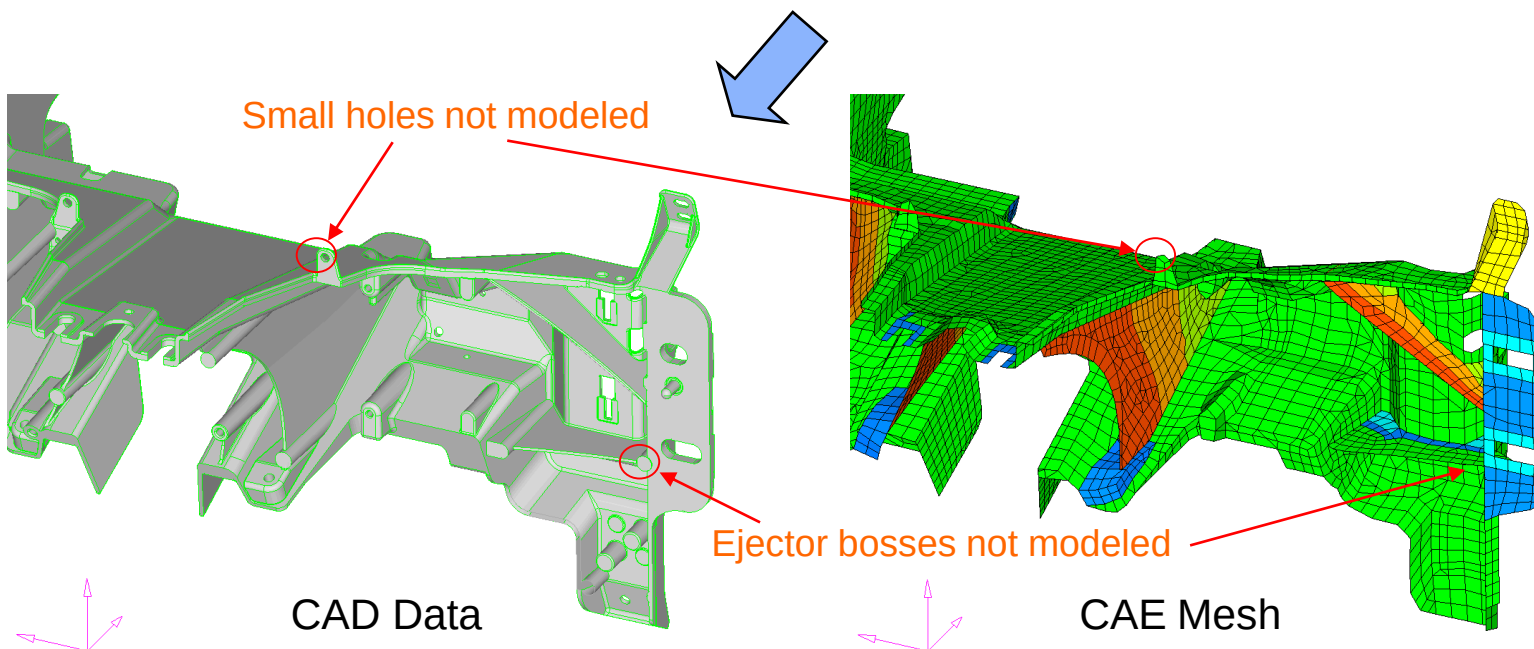
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Evaluation of results

- Does the geometry affect the structural performance of the component in the analysis?
- How should it be modeled?





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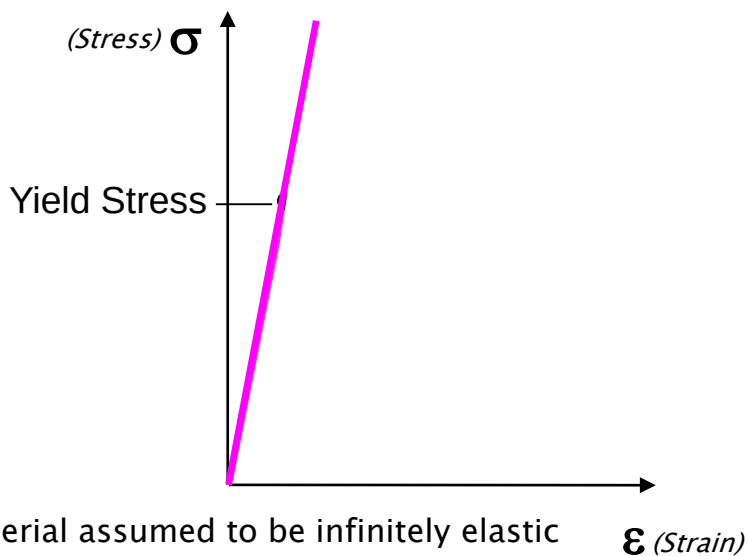
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LINEAR (Statics and NVH)

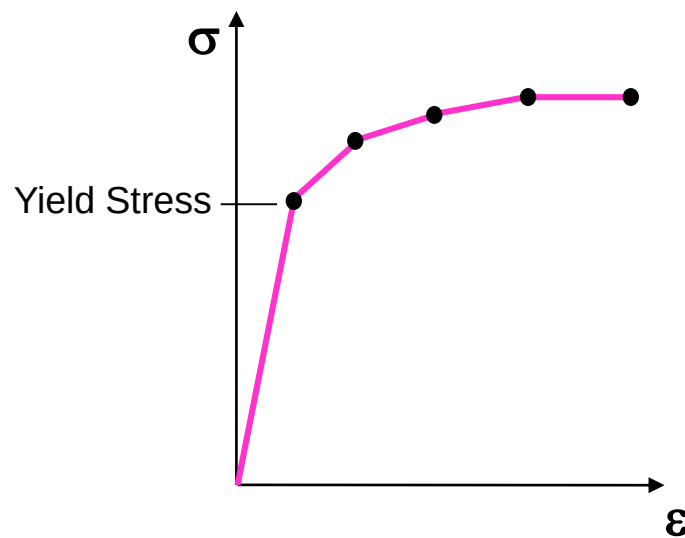


- Material assumed to be infinitely elastic

- Generally Define..

- ☐ Young's Modulus = $\frac{\sigma}{\epsilon}$
- ☐ Poisson's Ratio = $-\frac{\text{Lateral} \cdot \text{Strain}}{\text{Direct} \cdot \text{Strain}}$
- ☐ Density

NON-LINEAR (CRASH)



- Non-linear properties of material are also defined



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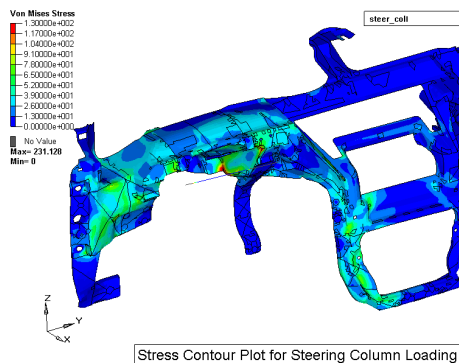
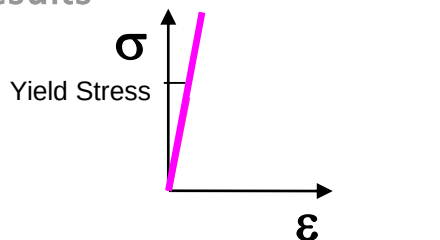
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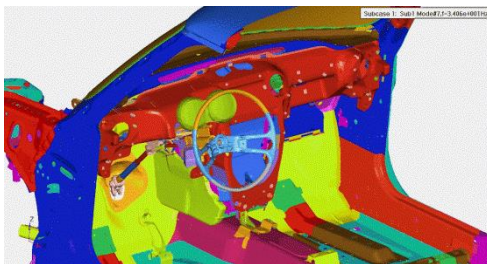
■ Linear: Statics

- How stiff is a component?
- Will it yield?
- Stress Distribution in Components for Static Load Cases



■ Linear: Noise Vibration and Harshness (NVH)

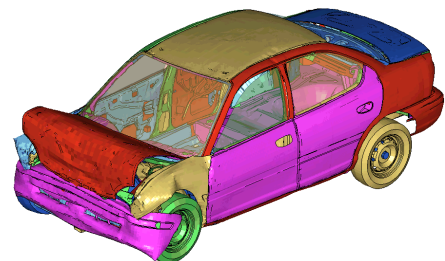
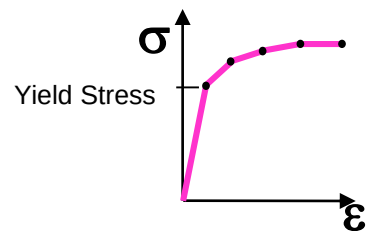
- Frequencies of natural modes?
- Visualise mode shapes
- Determine areas of structure that are strained if mode is excited



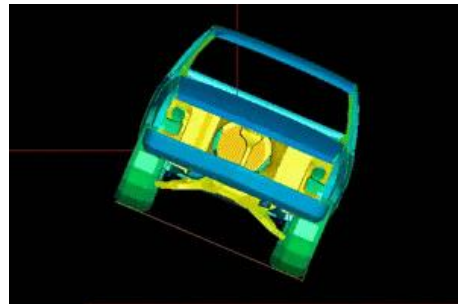
■ Quick and 'Cheap'

■ Non-Linear: Crash

- Plastic Stresses and strains at any point during an impact event
- Takes account of material yield and failure
- Takes account of surfaces coming into contact during the impact event



■ Slow and Expensive





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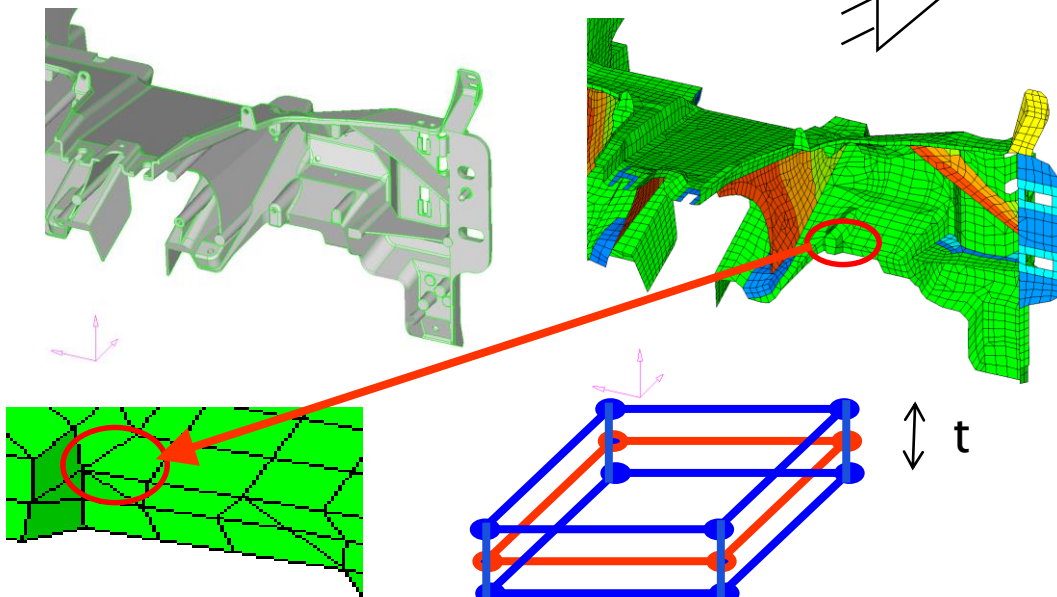
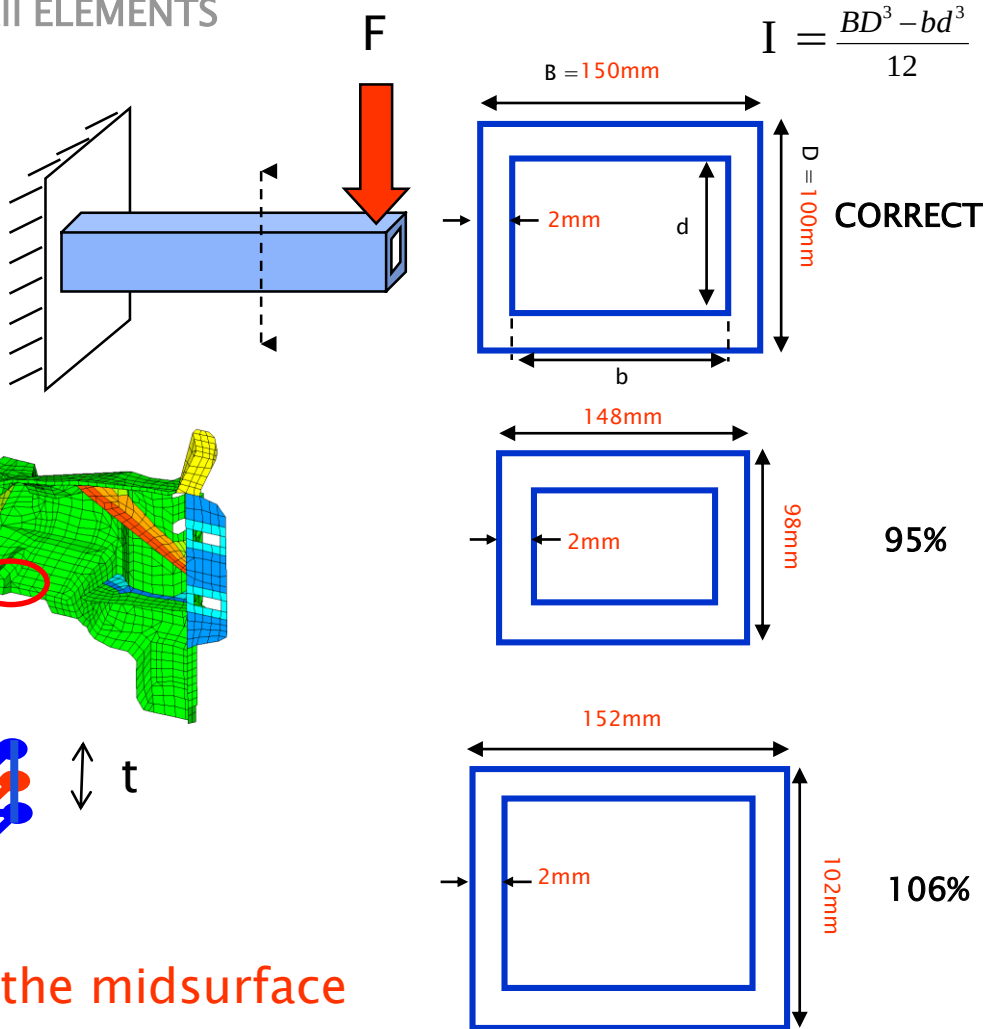
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Part modeled at the midsurface

Actual thickness



FEA made SIMPLE

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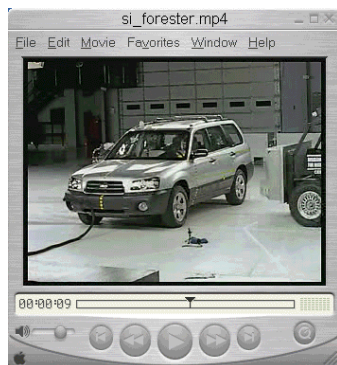
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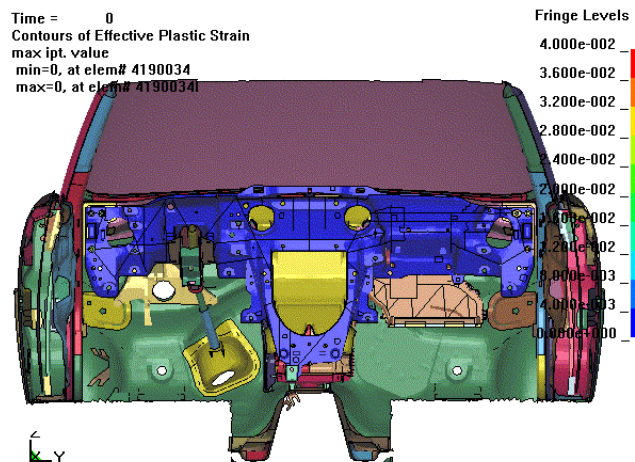
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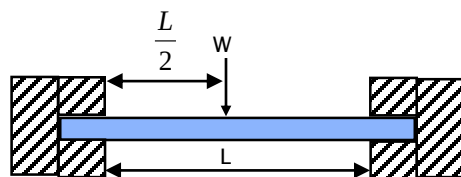
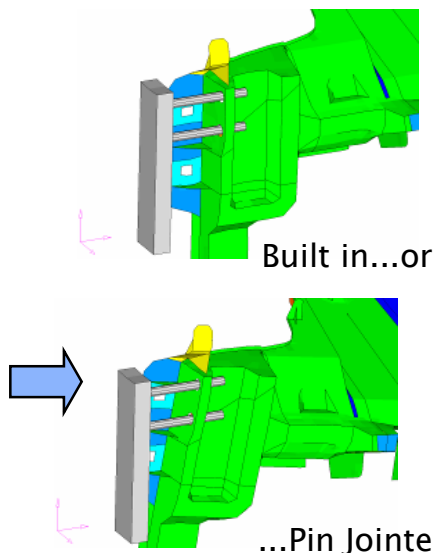
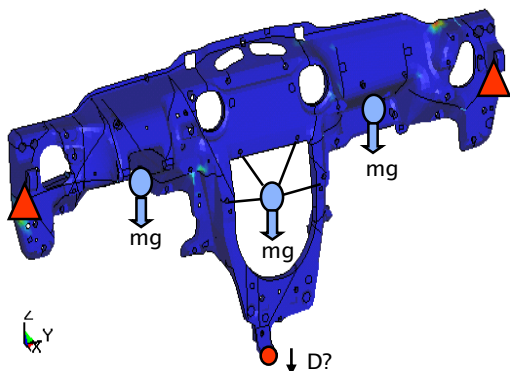
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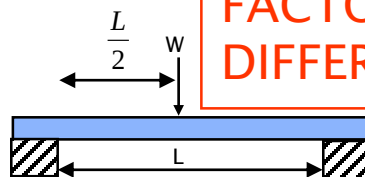
30mph Truck



Boundary Conditions



$$D = \frac{WL^3}{192EI}$$



**FACTOR OF 4
DIFFERENCE!**

$$D = \frac{WL^3}{48EI}$$



FEA made SIMPLE

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Evaluation of results

- Results are NOT exact – they are based on a **SIMPLE** problem
- Have our ASSUMPTIONS changed the results?
- Use Engineering Judgment!



Remember this...

FEA is SIMPLE...

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