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Using Finite Element Analysis as a Design Tool for Rotamoulded Parts

25th April 2013

British Plastics Federation
Rotamoulding Tooling Seminar

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- Hashim Bhabha.
- Background in mechanical/automotive engineering (BEng).
- Currently researching new materials for rotamoulding at MMU, in collaboration with Rotomotive.

Take-outs

1. Overview of the project.
2. Introduction to FEA and the safety step.
3. Experimental considerations.
4. Results and analysis.
5. Conclusions.

Project Overview

Developing next generation materials for the rotamoulding industry:

Possible benefits

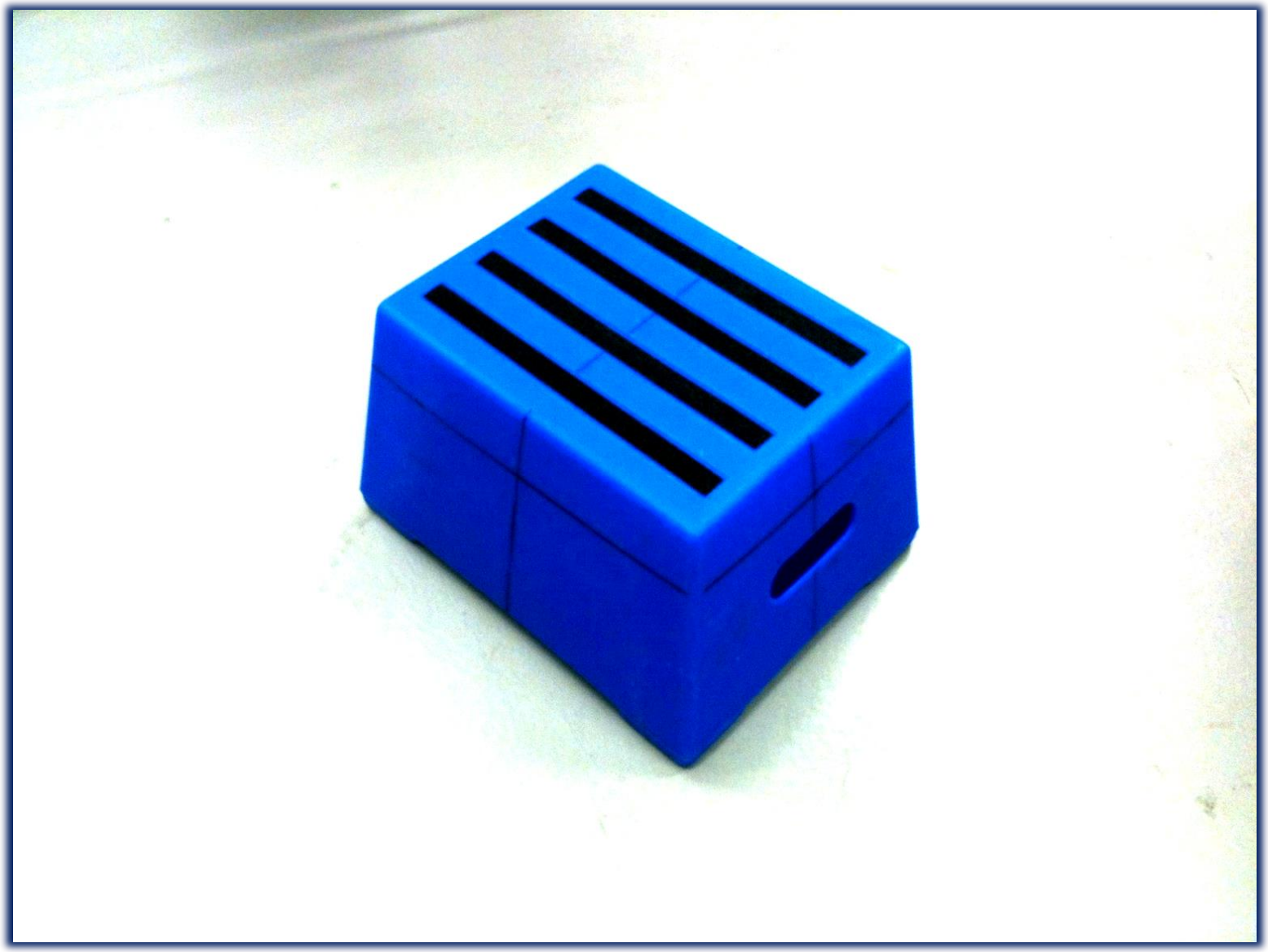
- Increased strength leading to decreased part thickness, cost reductions, access to new markets ...

New materials

- To be fully characterised and understood. Moulders require total confidence.

Design engineers

- Require realistic materials data for FEA modelling of products made from proposed new materials.



Finite Element Analysis

Numerical modelling of 3D designs to approximate behaviour

- Stress - strain , thermal, frequency response..

Model split into individual elements, connected to form a mesh

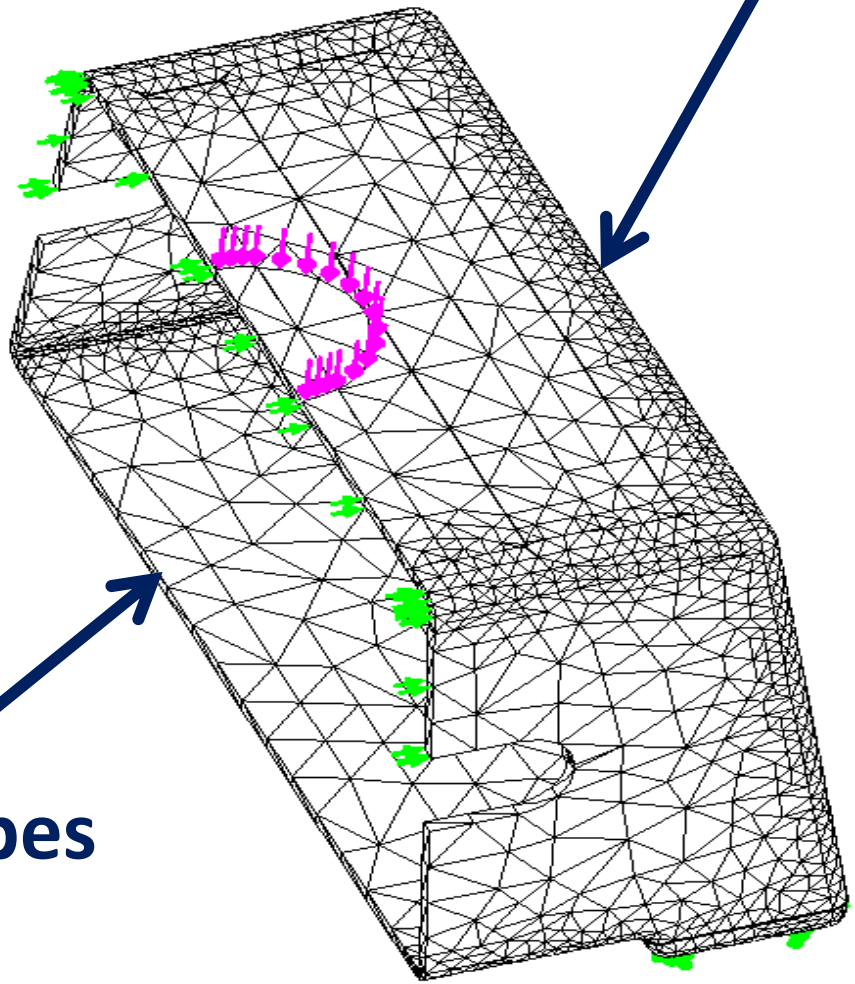
- Calculations applied on individual elements. Solution approximated for the whole object.

Useful for approximating location of structurally weak areas

- E.g. Sudden changes in angle or wall thickness.

Model name: 1step
Study name: Solid
Mesh type: Solid mesh

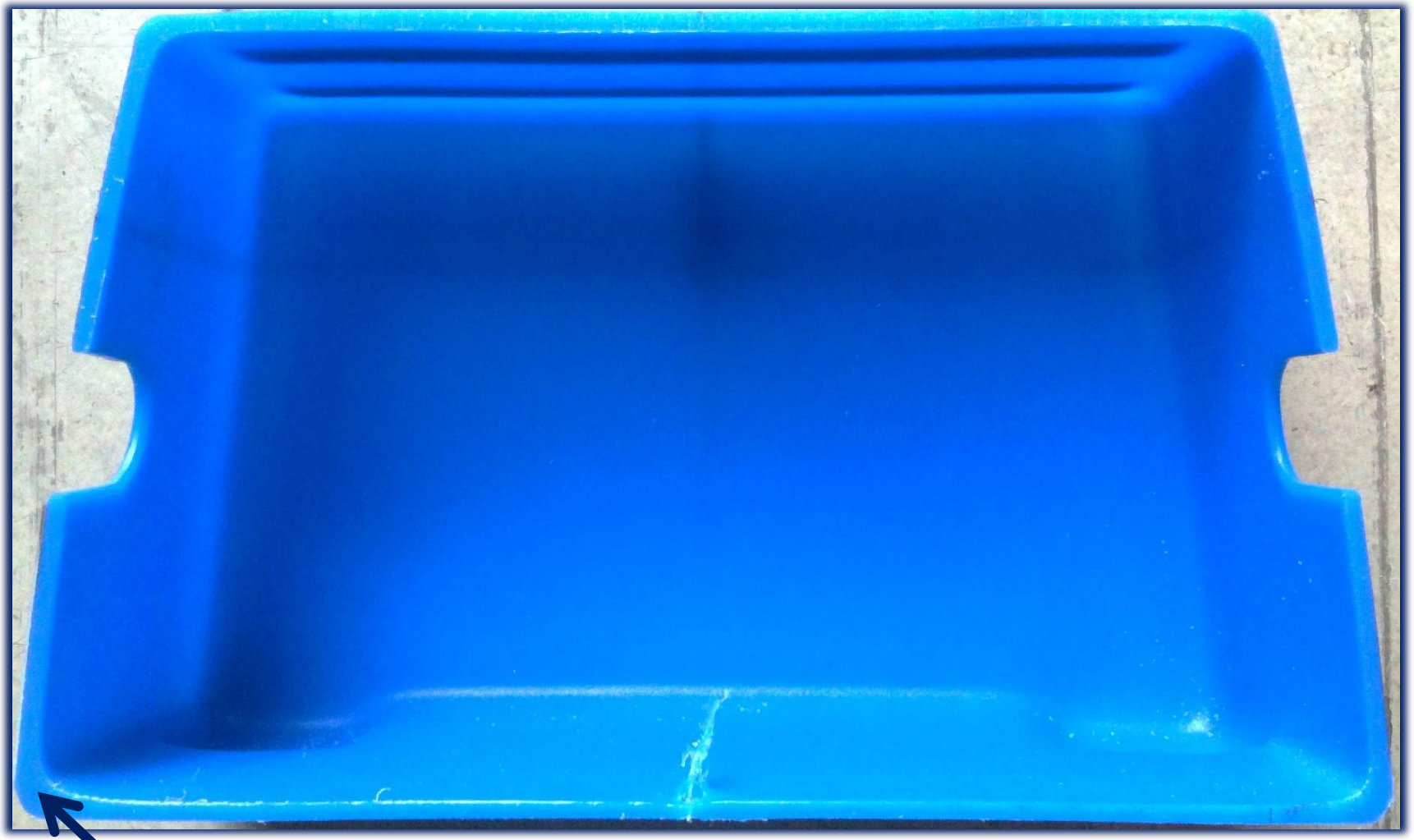
Finer Mesh around edges



Simple shapes

Safety Step

- Simple, compact product for tensometer.
- Initial comparisons between FEA approximations and real response can be made easily.
- Tested to British standards for acceptable stiffness (BS EN 14138: 2003 E).
- Wall thickness variation can be easily assessed; this has a significant impact on mechanical performance.



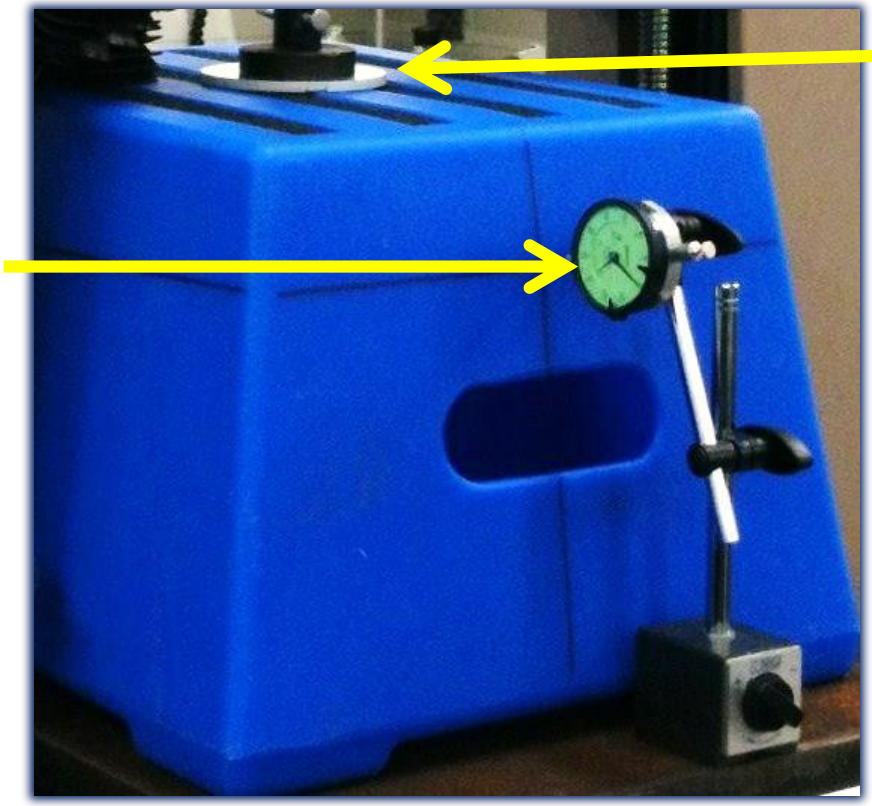
Increased thickness in corners

Experimental Considerations

- Product CAD file **- ensure dimensions and features are well defined.**
- Confirm FEA calculations **- familiarise with how the software calculates parameters.**
- Initial FEA to identify areas of maximum deflection - **for measurement of deformations in other localities during physical testing.**
- Measure wall thickness variation - **for inclusion within the FEA model.**
- Test setup and assumptions **- ensure representative loading scenario in FEA, simplify the model for speedy solutions, input realistic material properties, determine tensometer stiffness..**

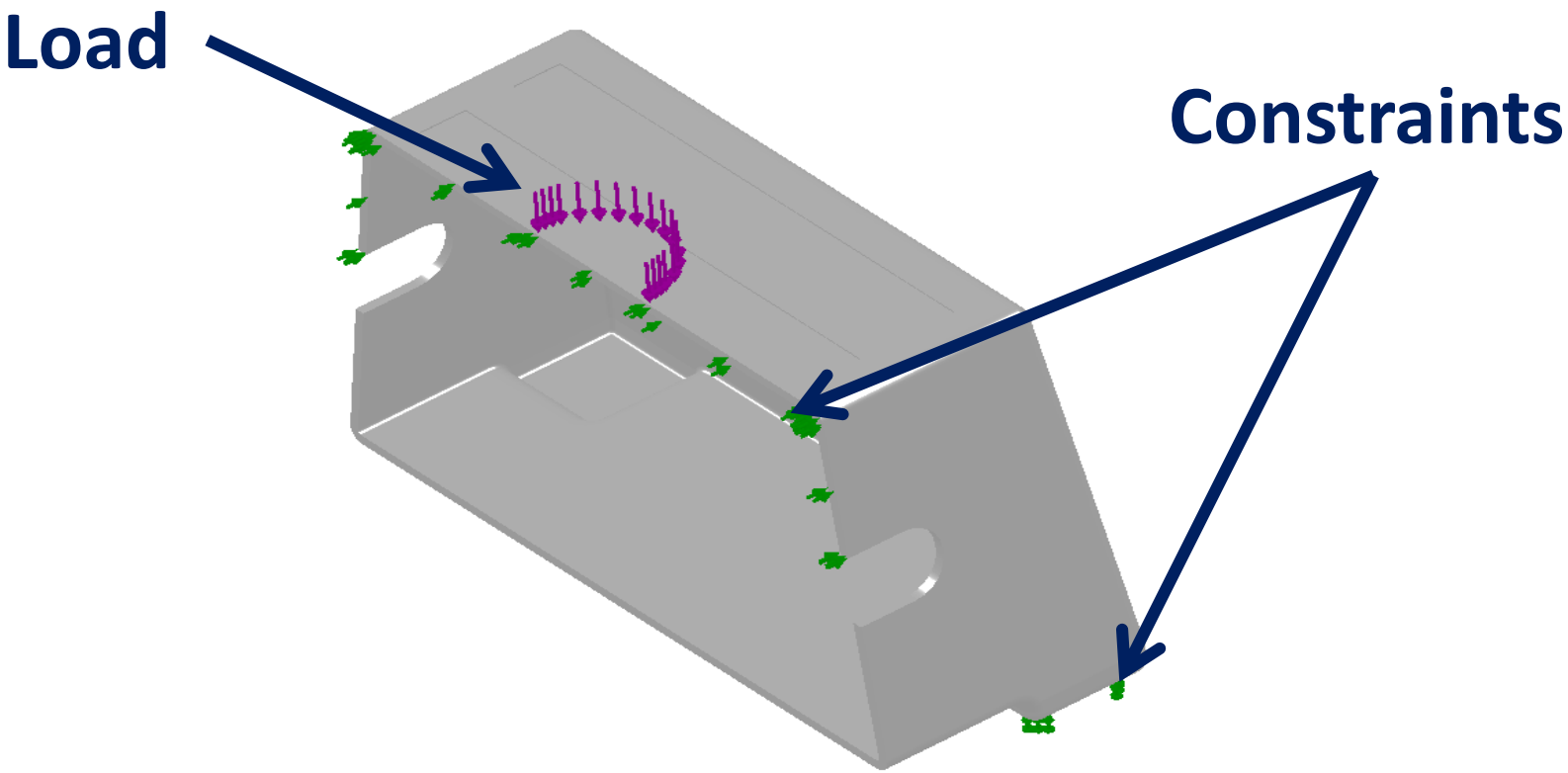
Tensometer Setup

Dial Test Indicator for Sidewall Deflection Measurement



Maximum applied force of 600N with a 100mm diameter disc. DTI's front and rear for sidewall deflection measurement.

FEA Test Setup



Model split symmetrically. Force of 300 N with a 50mm radius semicircle or displacement of 13mm applied. Constraints to feet stabilised using springs.

Results and Analysis

FEA model:

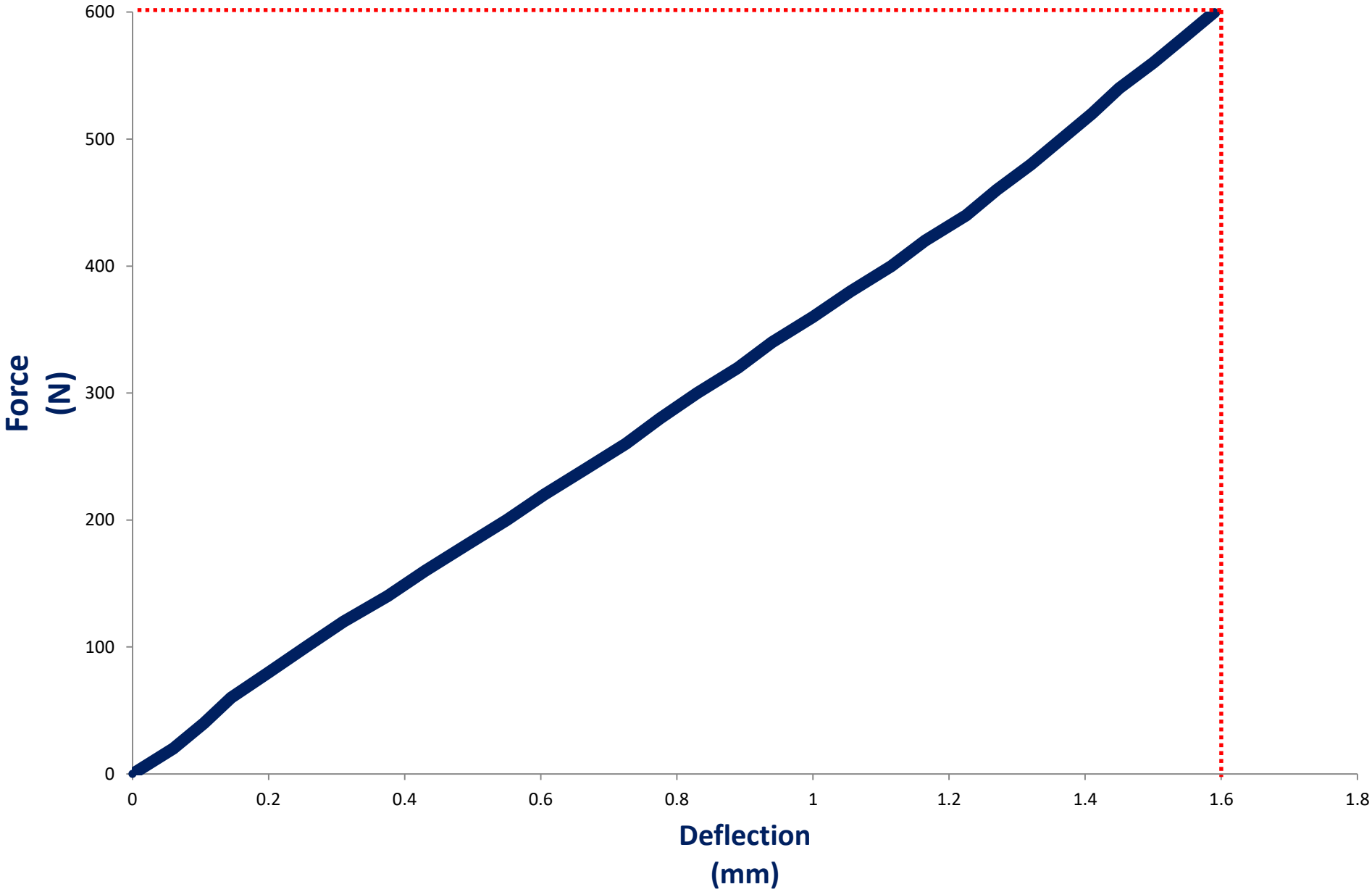
- Solid Body with a geometrically defined thickness.

FEA Scenarios:

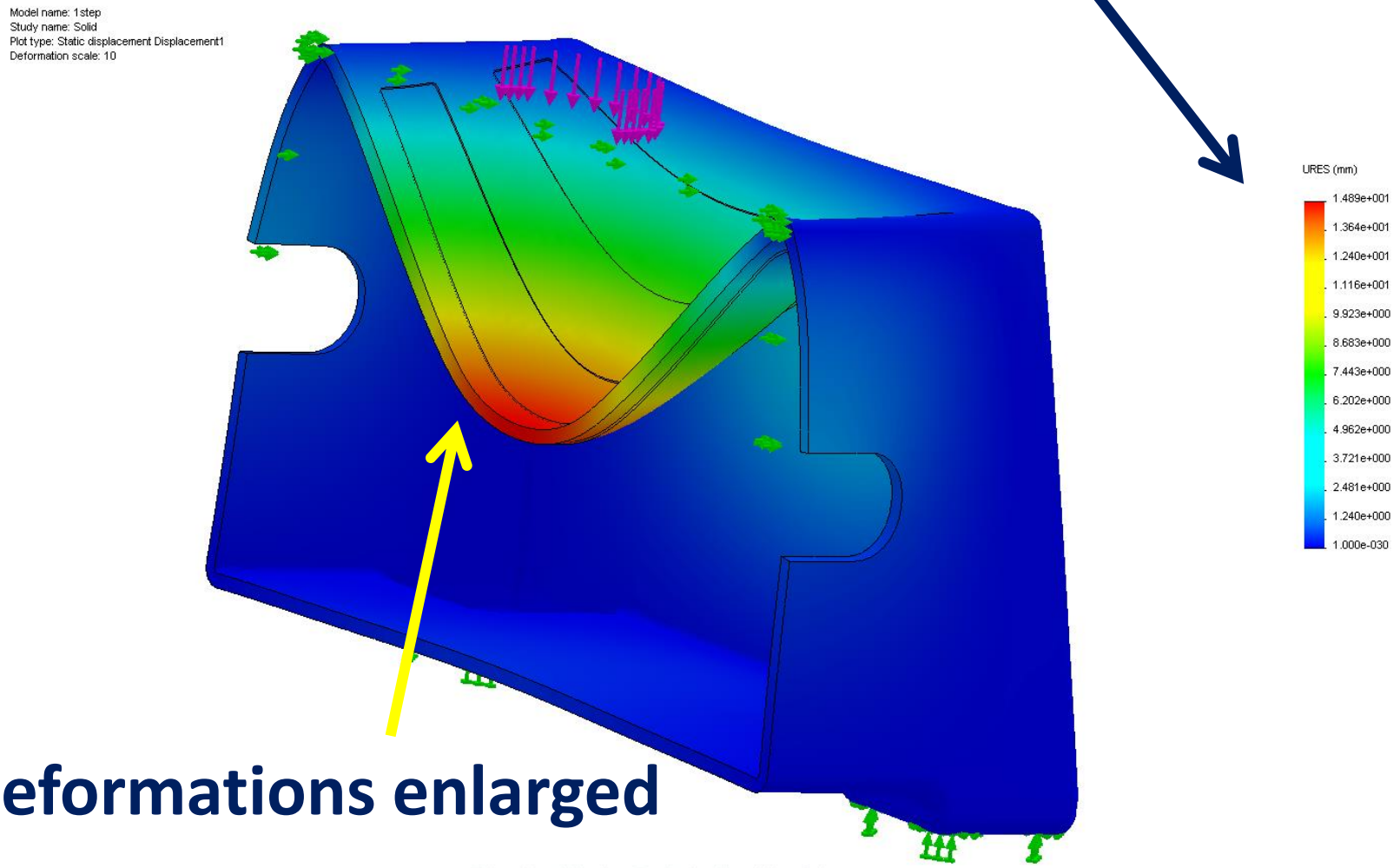
- Applied a force of 300 N or a displacement of 13mm with 50mm radius disc using both linear and non-linear stress-strain data.

- A Young's Modulus of 500 MPa (derived from tensile test data) and a Poissons ratio of 0.3 was applied for linear analysis.

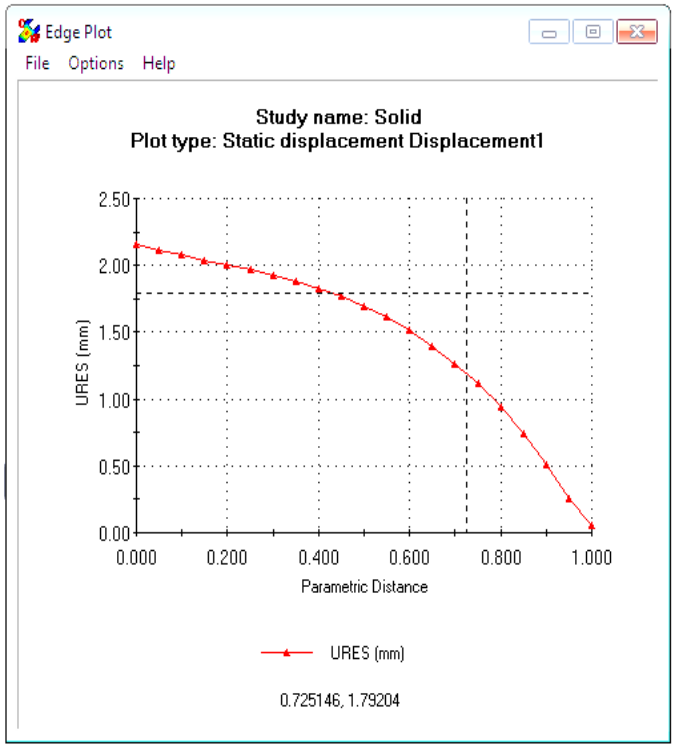
Compression Response: Sidewall

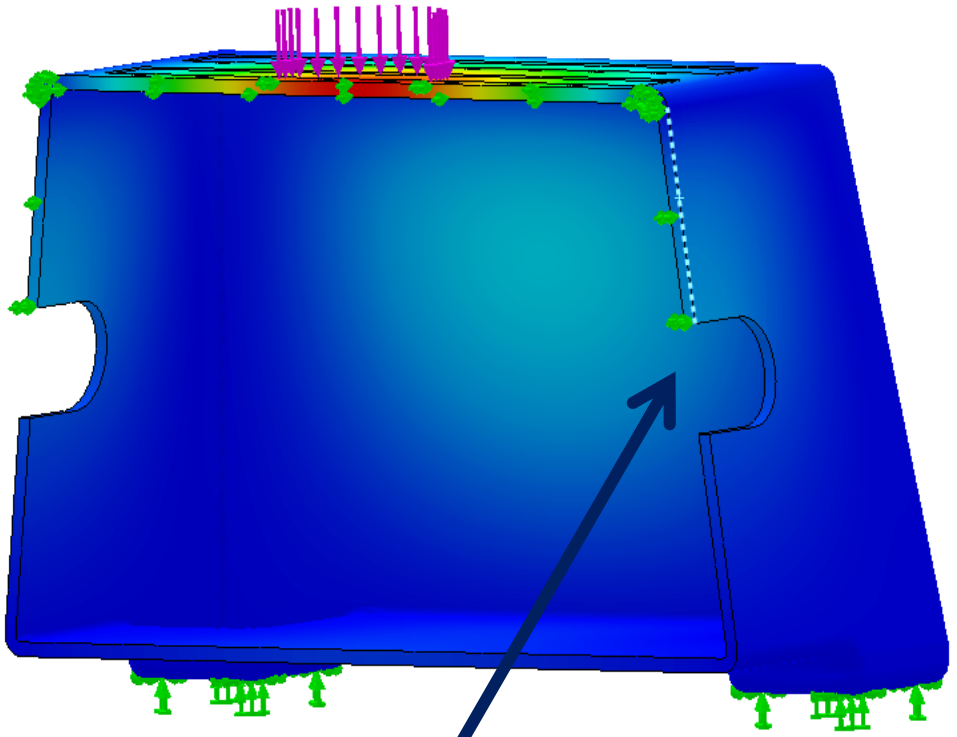


Colours highlight intensity



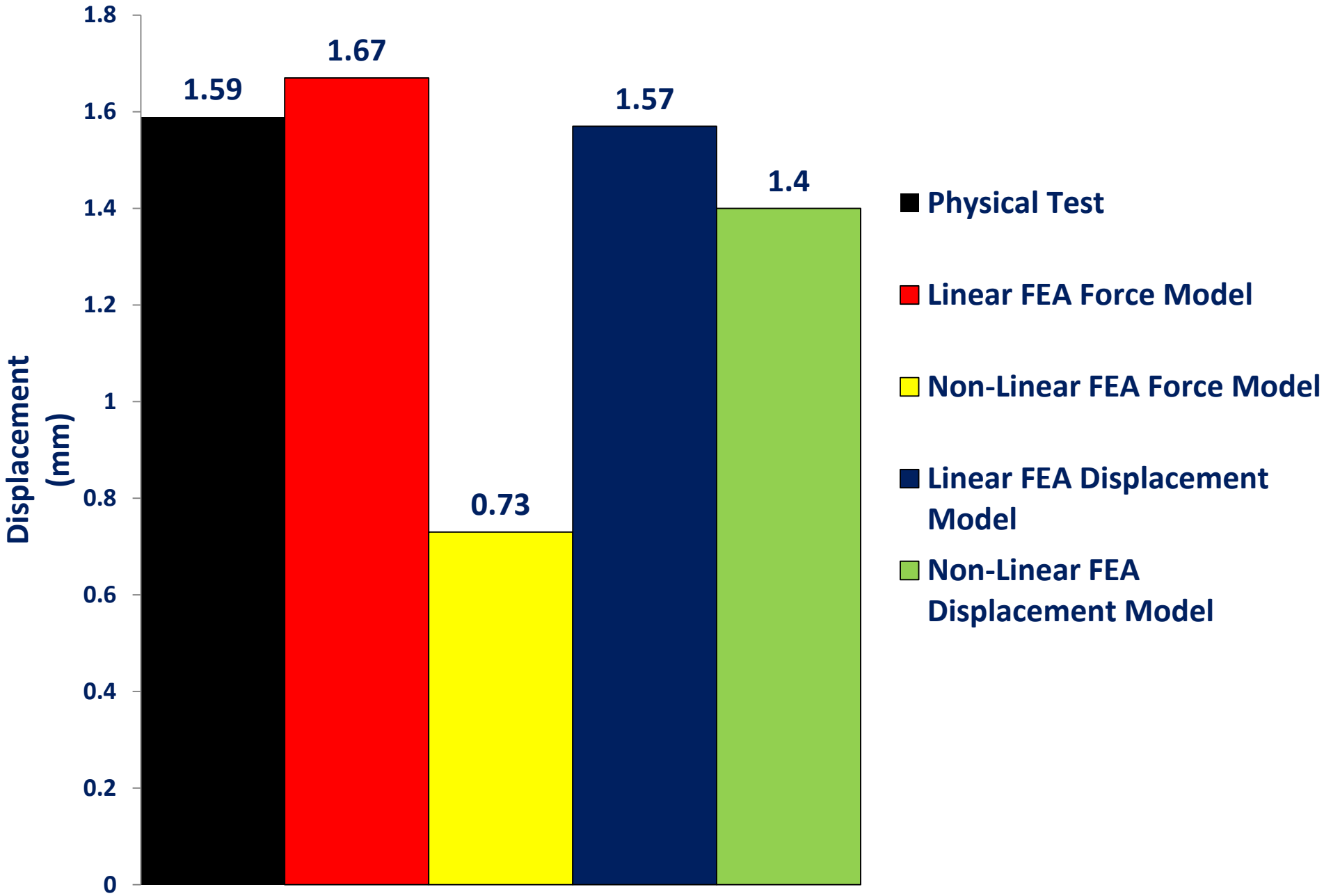
Deformations enlarged





Sidewall deflection highlighted and “probed”

Sidewall Deflection



Analyses

- Measured values of maximum deflection at the sidewall coincide well with FEA predictions. Non-linear force model approximations were significantly less; probably due to the assumption that linearity of the load-deflection curve is retained in compression.

- Thus far, the non-linear analyses have not shown a significant increase in accuracy, even though simulation time was considerably longer.

Conclusions

- The variation in predicted deflection relative to actual deflection may be due to material properties; the properties of polymeric materials can change simultaneously with load.

- The extent of variation could be decreased by modifying the Modulus and calculating a specific Poissons ratio.

- Increases in test accuracy may not lead to significantly improved prediction of product performance. In fact, It may just increase solution time.

Thank you for listening

Special thanks to:

- Crossfield Excalibur
- Excelsior
- JSC Rotational
- MMU Supervisory Team
- Rotomotive