University of BRISTOL

EPSRC Industrial Doctorate Centre in COMPOSITES MANUFACTURE

NATIONAL COMPOSITES CENTRE

Bristol Composites Institute

A Qualitative and Quantitative Benchmarking Review of Resin Infusion Simulation Software

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BCI Annual Symposium 2025

bristol.ac.uk/composites

“The Industrialisation of Large-Scale Resin Infusion Simulations”

“Chapter 1: Selection”

“Chapter 2: Simplification”

“Chapter 3: Acceleration”

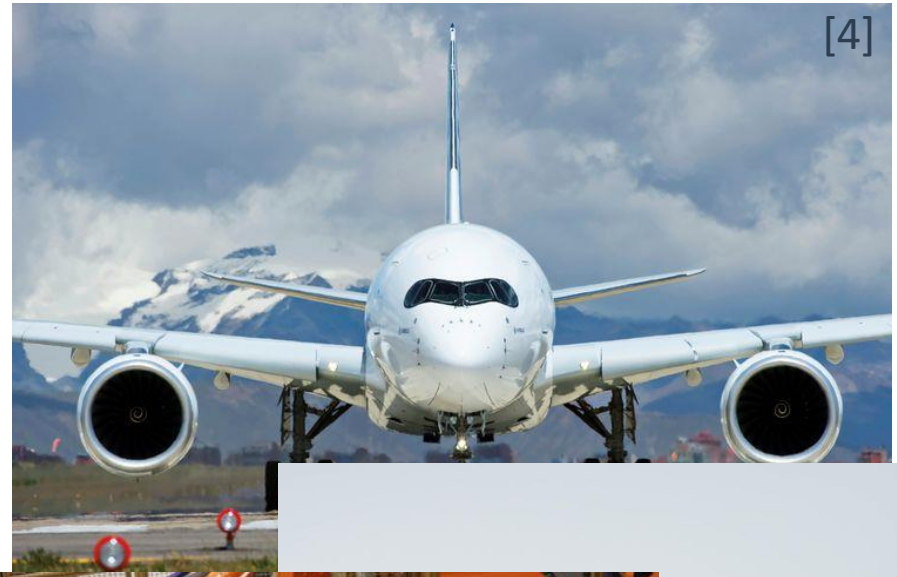
“Chapter 4: Actuation”

Presentation Contents

- Project Background
- Software Identification and Classification
- Qualitative Comparison
- Quantitative Comparison
- Next Steps and Future Work

Why?

- Composites have desirable properties for Aerospace, Wind, Automotive, and Maritime
- Parts are growing in size and number for both economics and environment
- This is a problem for conventional manufacturing methods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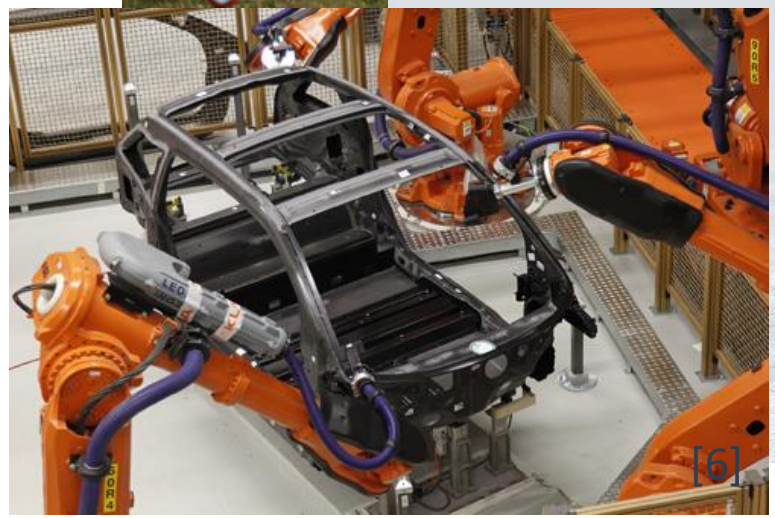
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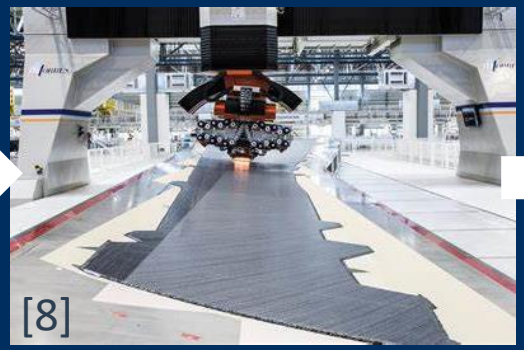
[5]

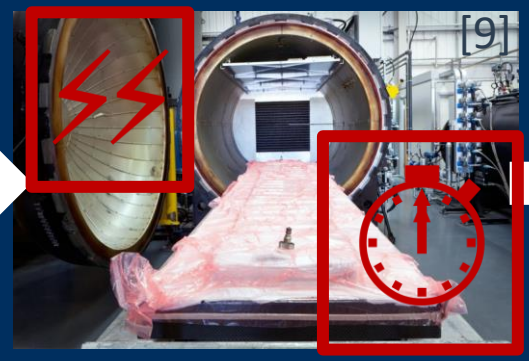
Prepreg [1]

Raw Material

Deposition



Consolidation/Curing



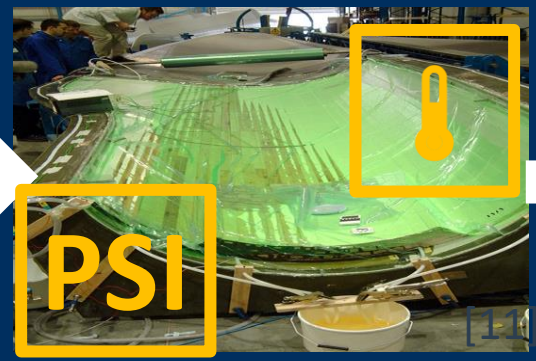
Machining/NDT

Resin Infusion [2]

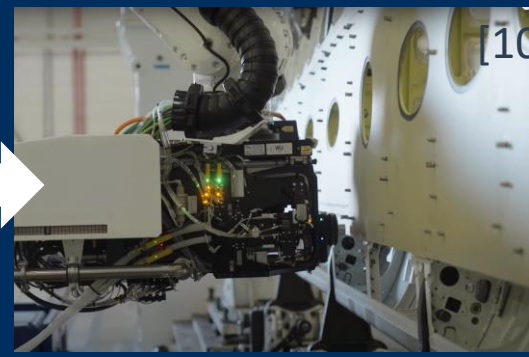
Raw Material

Deposition

Resin Infusion/Cure

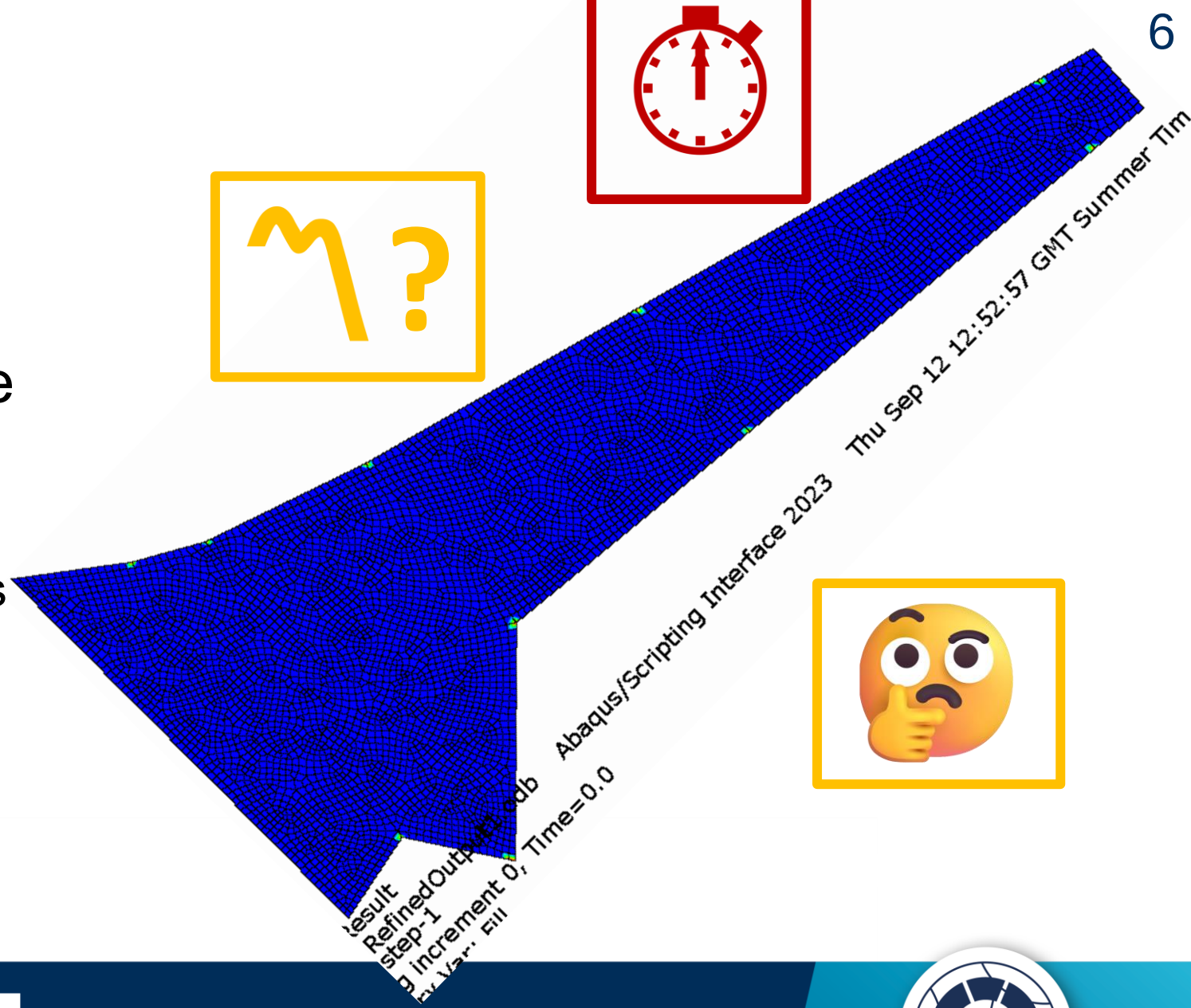


Machining/NDT



Simulation

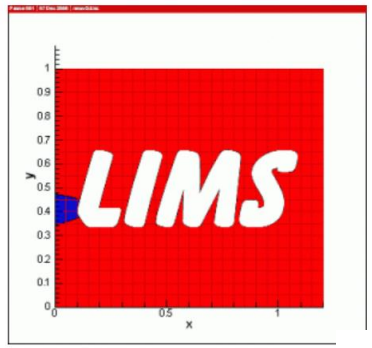
- Simulations attractive as Physical Testing becomes exhaustive and impractical
- Problems with practical usage
  - Excessive Computational Cost
  - Uncertain Material Properties
  - Difficulties modelling fine details
- Overall Low trust and low transparency of capabilities/accuracy [3]



Identification

- 9 Initial software identified and assessed

Moldflow



Moldex3D
MOLDING INNOVATION

MYRTM

Polyworx

esi
get it right

LMAT

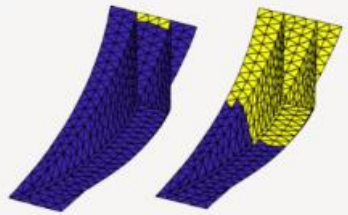
CONVERGENT
MANUFACTURING TECHNOLOGIES

Commercial Solvers

LMAT

esi get it right

OpenSource Solvers

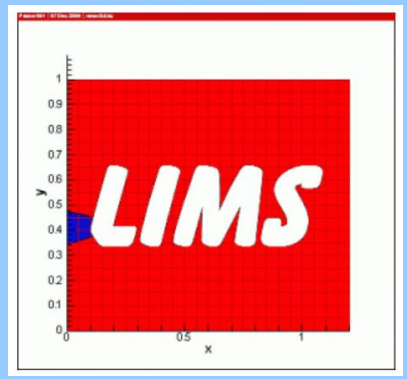


RTMsim

MYRTM

Research-Origin Solvers

Polyworx



Not Directly Relevant

Moldex3D MOLDING INNOVATION

Moldflow

CONVERGENT MANUFACTURING TECHNOLOGIES

Qualitative

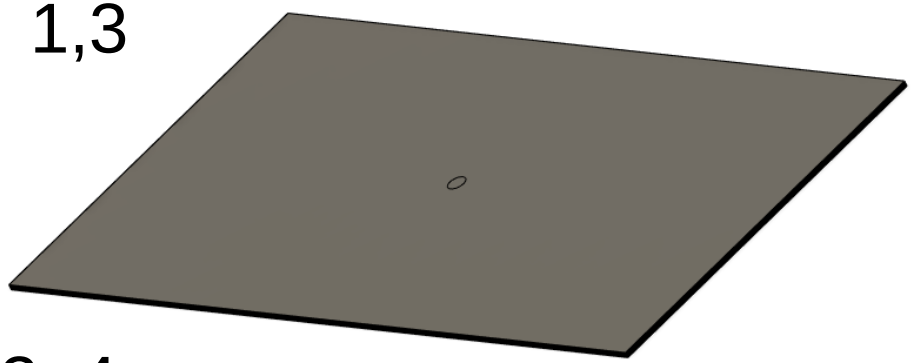
Key:	✓✓ Supported	✓ With Workarounds	x Not Supported

Software/ Parameter	Forming Effects	Viscosity Evolution	Cure Integration	Defect Modelling	Control	Scripting	3D Layer Flow	Gravity	Multi-Core
PAM-RTM	✓✓	✓✓	✓✓	✓✓	✓✓	✓	✓✓	✓✓	✓
LMAT	✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓
LIMS	✓	✓	x	✓✓	✓✓	✓	✓	x	✓
RTM-Worx	✓	✓✓	✓	x	✓✓	✓	✓	x	x
RTMsim	✓	x	x	x	✓	✓	✓	x	x
MyRTM	x	x	x	x	x	x	x	x	x

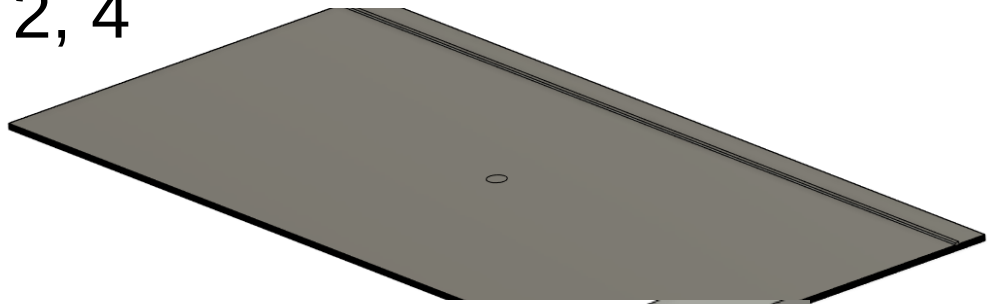
Quantitative

- Assessment of Infusion modelling Accuracy vs Computational Cost
- 5 Test Cases Considered
  1. UniDirectional (UD) Flat Panel
  2. UD Flat Panel + Racetracking
  3. Perpendicular Layer Flat Panel
  4. Perpendicular Layer Flat Panel + Racetracking
  5. Flanged Web Infusion

1,3



2, 4



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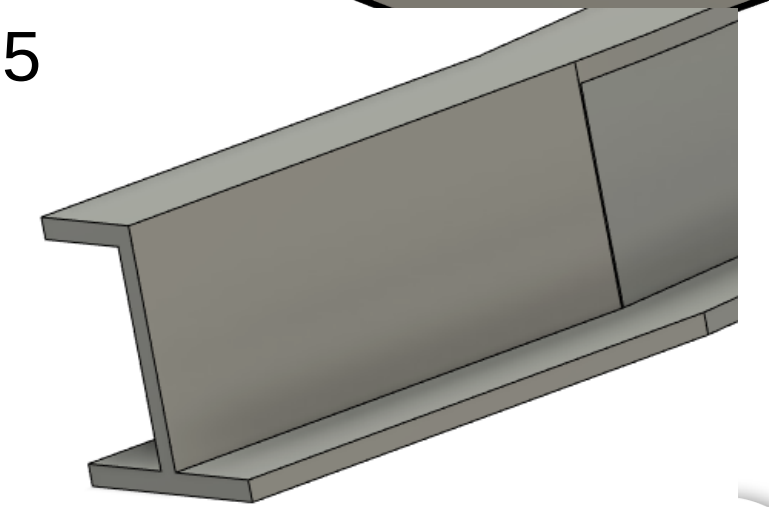
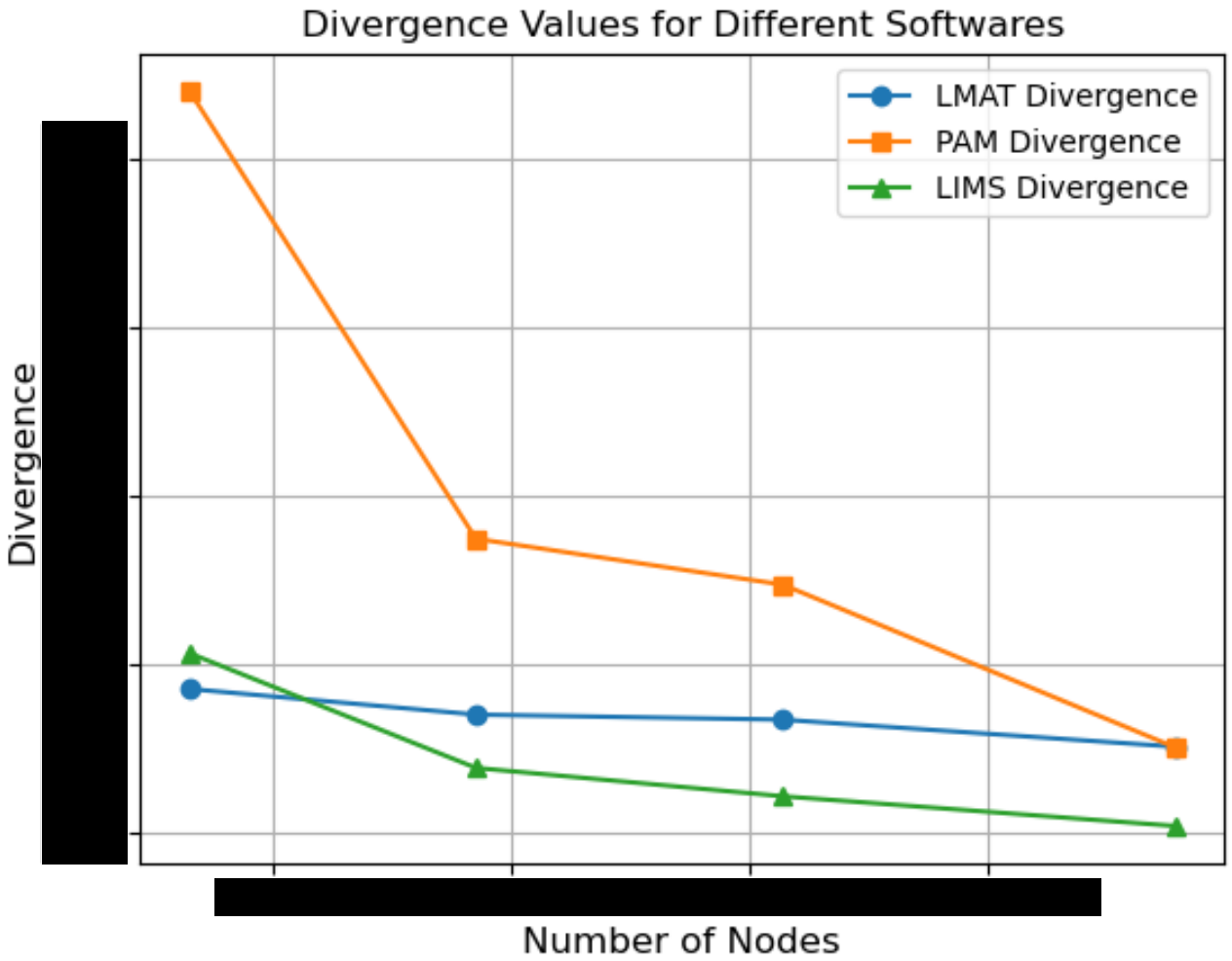
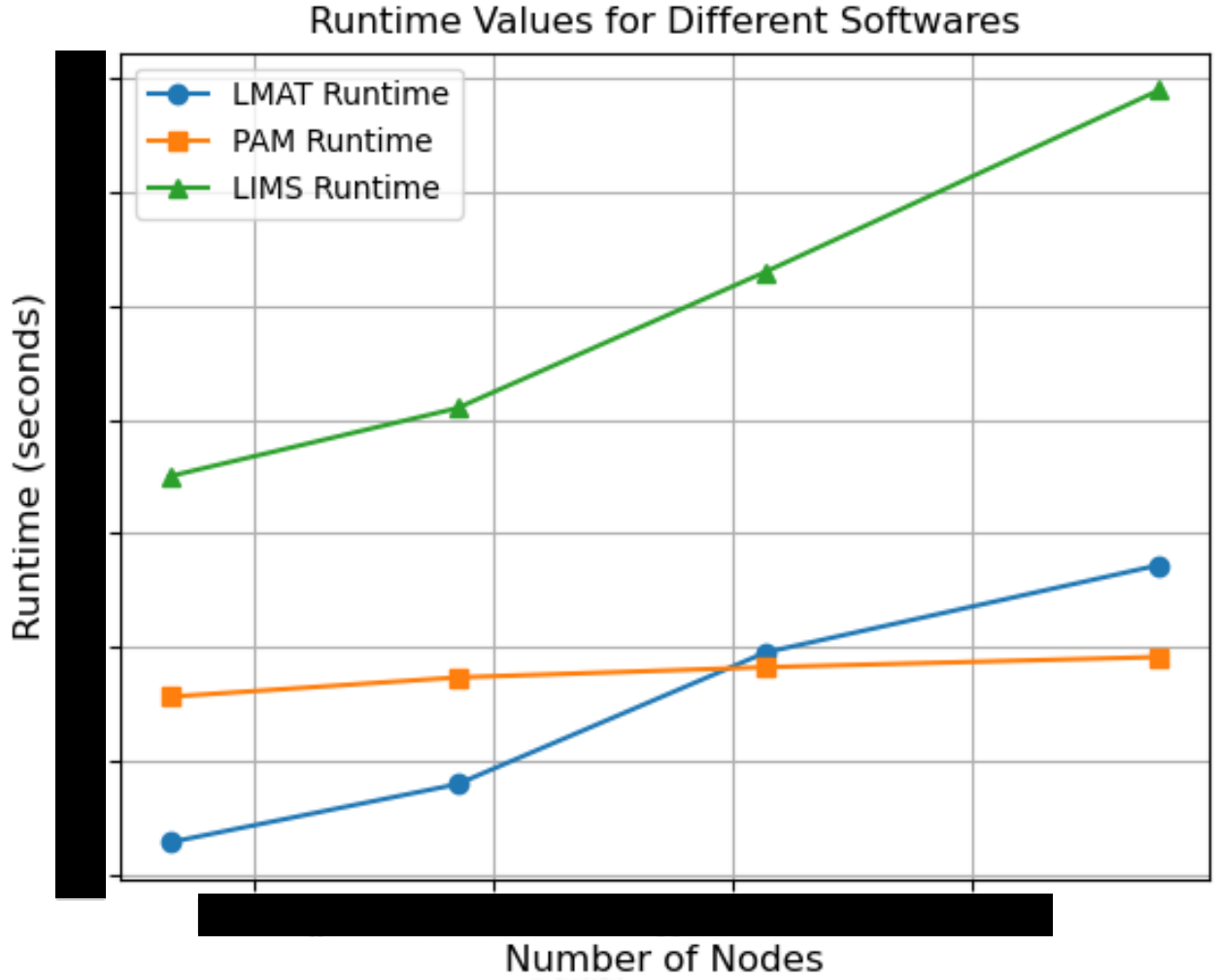


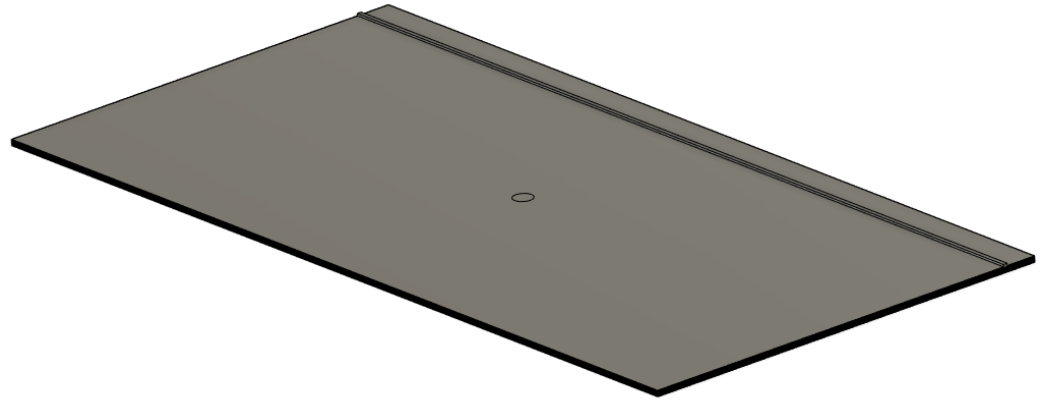
Quantitative

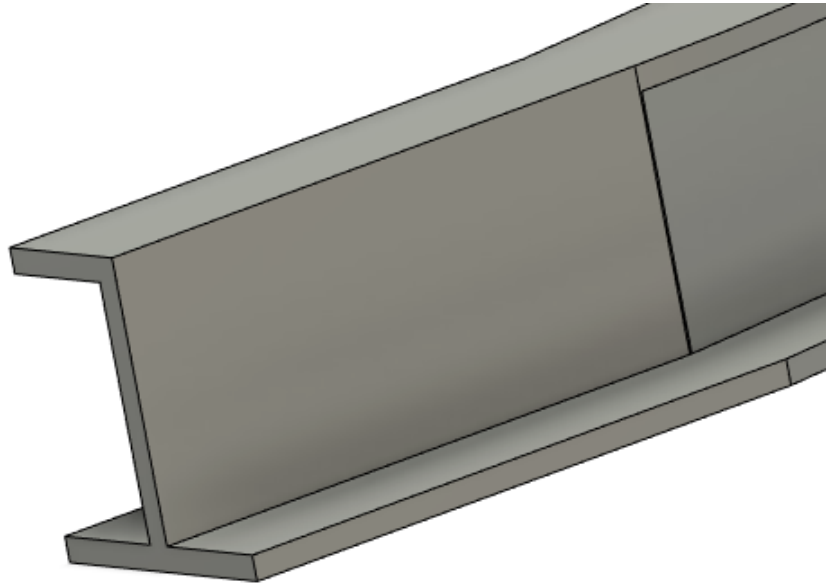




Future Work

- Continue testing with more geometries
- Continue conversation with ESI and LMAT on developing their software
- Use selected software to develop further research
  - Fine Detail Homogenisation
  - Machine Learning Models
  - Robust Optimisation + SemiActive





Questions?

Bristol Composites Institute

References

Literature:
[1] Design and Manufacturing of Aerospace Composite Structures, State-of-the-Art Assessment | Journal of Aircraft. (2025). Journal of Aircraft. https://doi.org/10.2514/ja.2002.39.issue-4;page:string:Article
[2] Wang, J., Andres, & S.G.Advani. (2012). Use of Flow Simulation to Develop Robust Injection and Vent Schemes that Account for Process and Material Variability in Liquid Composite Molding Process. Computer Modeling in Engineering & Sciences, 88(3), 155–182. https://doi.org/10.3970/cmes.2012.088.155
[3] Grössing, H., Stadlmajer, N., Fauster, E., Fleischmann, M., & Schledjewski, R. (2015). Flow front advancement during composite processing: predictions from numerical filling simulation tools in comparison with real-world experiments. Polymer Composites, 37(9), 2782–2793. https://doi.org/10.1002/pc.23474

Images:
[4] Airbus. (2024). A350 Family | Airbus Passenger Aircraft. Www.airbus.com. https://www.airbus.com/en/products-services/commercial-aircraft/passenger-aircraft/a350-family
[5] Siemensgamesa.com. (2019). *Wind turbines and services - Wind farms | Siemens Gamesa*. [online] Available at: https://www.siemensgamesa.com/global/en/home/products-and-services.html#Offshore-Wind-Turbines-tab-1
[6] The making of the BMW i3. (n.d.). Www.compositesworld.com. https://www.compositesworld.com/articles/the-making-of-the-bmw-i3
[4] *XC110 416g 2x2 Twill 6k Prepreg Carbon Fibre 1.25m - Easy Composites*. (n.d.). Www.easycomposites.eu
[7] *Modeling structural strength*. (2020, November 1). Aerospace America. https://aerospaceamerica.aiaa.org/departments/modeling-structural-strength/
[8] *high performance composites, bespoke composites, components*. (2020, March 4). Pentaxia. https://pentaxia.com/high-performance-composites/
[9] Spirit AeroSystems. (2022, September 22). *A220 Wing Factory Tour*. YouTube. https://www.youtube.com/watch?v=tDDrgGSiW3A
[10] *Wind Turbine Resin Infusion – FLiNK*. (2024). Flink.online. https://flink.online/projects/wind-turbine-resin-infusion/