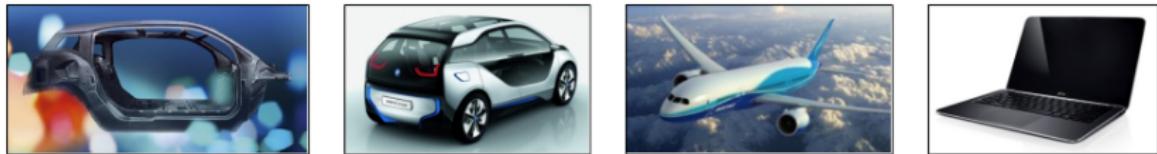


Meso- and macro scale permeability simulations on the Pan cluster

Bart Verleye, Elinor Swery, Piaras Kelly



Introduction: Composite material



Composite material

Two or more constituent materials with significantly different physical or chemical properties, that when combined to produce a material with characteristics different from the individual components:

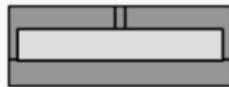
- ① Reinforcement e.g. carbon fiber;
- ② Matrix e.g. hardened resin.

Production process

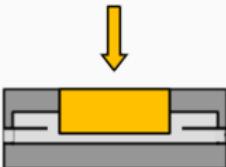
Liquid Composite Moulding



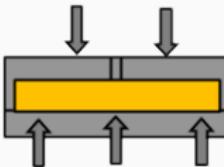
1) Preform Manufacture



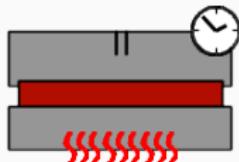
2) Preform Compression



3) Resin Injection



4) Compaction



5) Curing and De-Moulding

Outputs of simulations are used to optimise the process by selecting:

- Injection times
- Injection locations
- Vent locations
- Injection pressures
- Press size
- Energy consumption

Permeability

Definition

Permeability characterises the ease with which a fluid can flow through the reinforcement

Permeability depends on:

- Fibre volume fraction
- Compaction applied
- Stitching
- Reinforcement architecture
- Laminate structure and nesting
- Geometric variability

Textile Modelling:

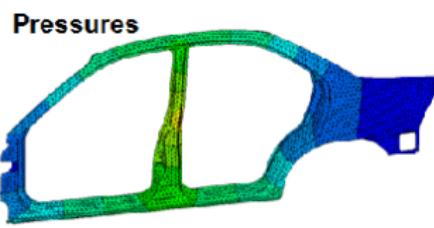
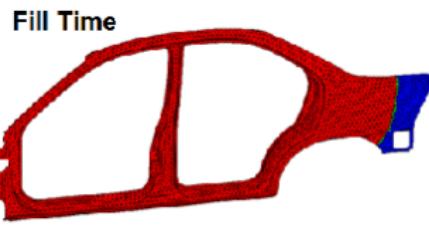
- Automatic
- Repeatable
- Complex fibre architecture
- Computationally Intensive
- Requires validation

Experiments:

- Complex fibre architecture
- Capture nesting
- Time consuming – User intensive
- Difficult to perform accurately

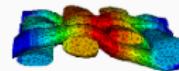
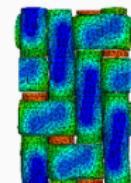
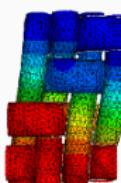
Meso vs. Macro scale

MACRO



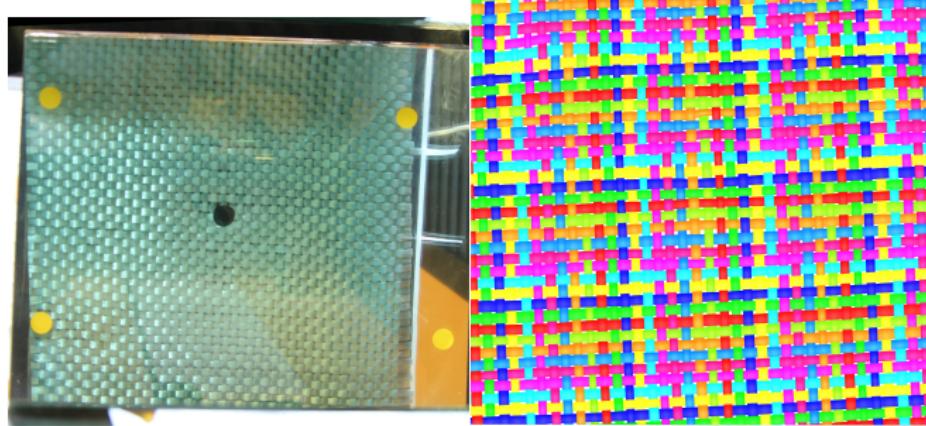
Walbran, A., SimLCM 2011

MESO



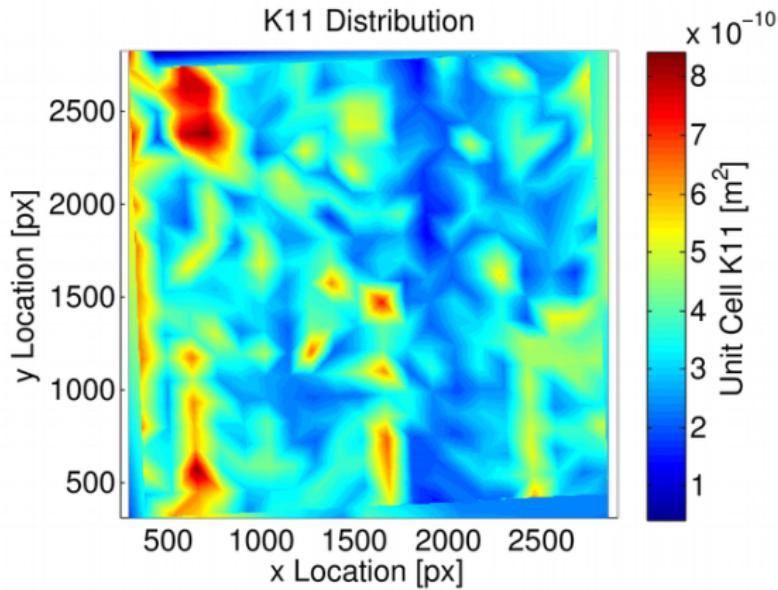
Lin, H. TexGen 2011

Macro scale

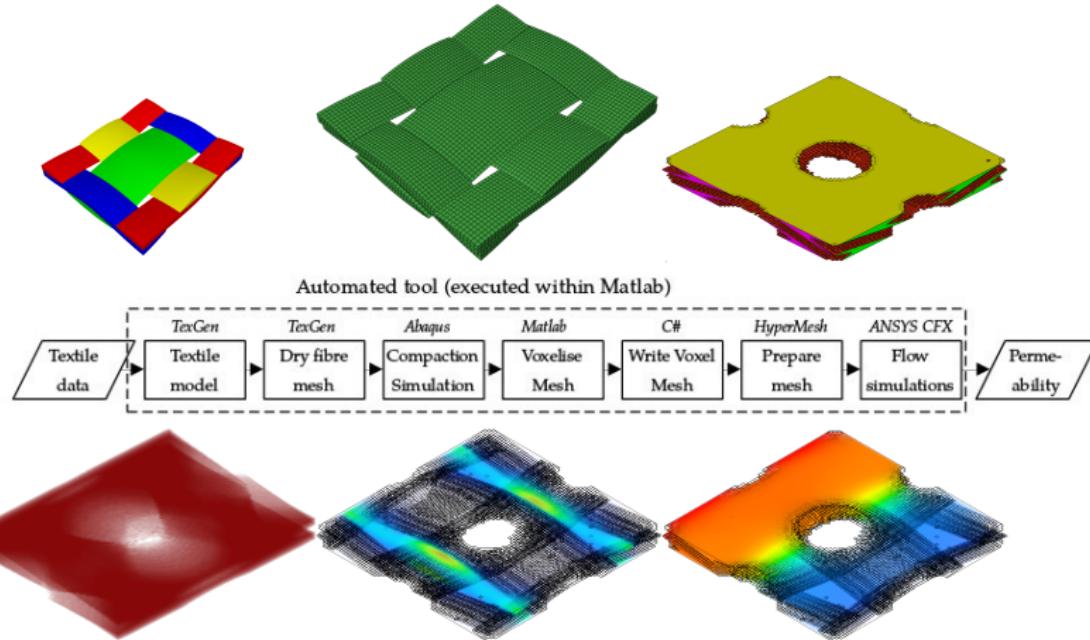


Meso and Macro

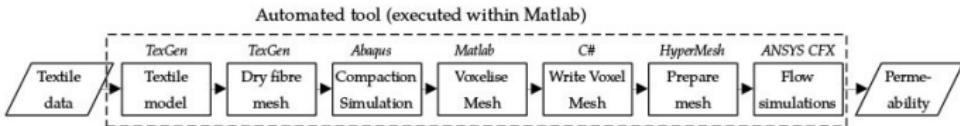
- A full CFD simulation on a macro-scale model is almost impossible and would take too much resources.
- Solution: (many) Meso-scale simulations that provide input for an easier macro-simulation.



6 different programs



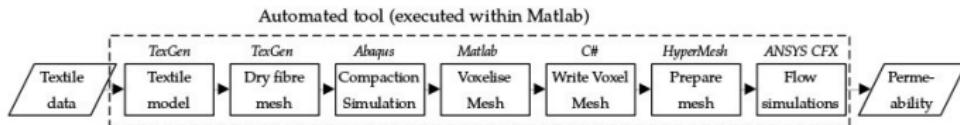
6 different programs



To make the tool work on Pan, following steps were undertaken:

- ① Install TexGen and compile the C# software. Abaqus, Matlab, ANSYS and Hypermesh are available modules on Pan.
- ② Define the correct command lines for all the software. In case of HyperMesh, this was only able to be completed with help from the supplier.
- ③ Adapt the scripts and input files for a Linux system, including changing hard coded paths.
- ④ Split up the main script and provide a Slurm scheduler input file for every step. This is important for the macro-scale simulation (see further).
- ⑤ Write a script that submits all Slurm files as a chain job.

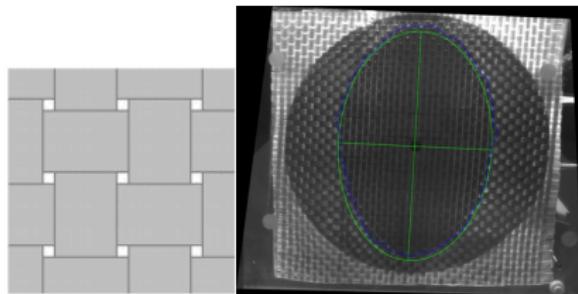
6 different programs



The different steps have different requirements:

- TexGen, Hypermesh and C# only run serial.
- Abaqus and ANSYS can run parallel.
- Solution: 6 different SLURM jobs with dependencies.

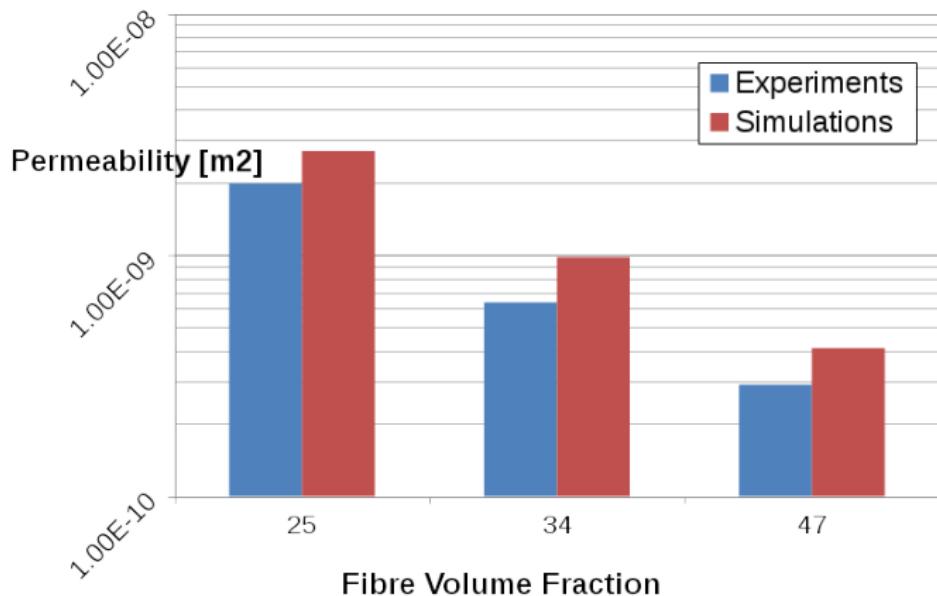
Experiment



2D in plane single layer

- Different thicknesses: 1.2, 0.9, 0.7 mm
- Different volume fractions: 0.25, 0.34, 0.47 %

Results



Questions & Answers

