

Using hand layup techniques to inform the design of novel manufacturing processes

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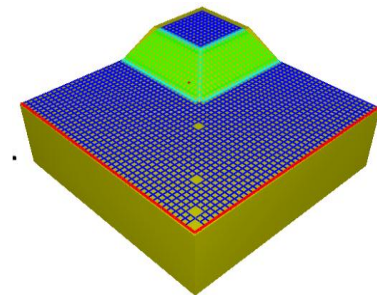
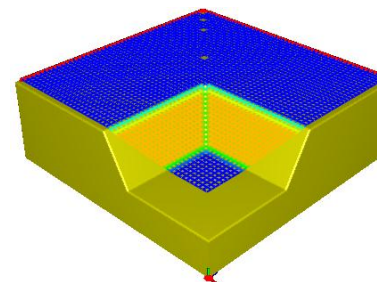
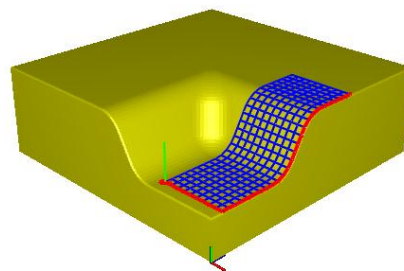
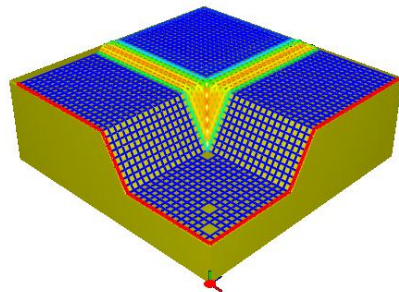
Supervisor – Prof Kevin Potter

Studying Hand layup

- Hand layup is used to make many composite components.
- Significant influence on the **Cost, Strength, and Quality**
- Lack of detailed understanding and research
- Optimise or potentially automate the process to some extent

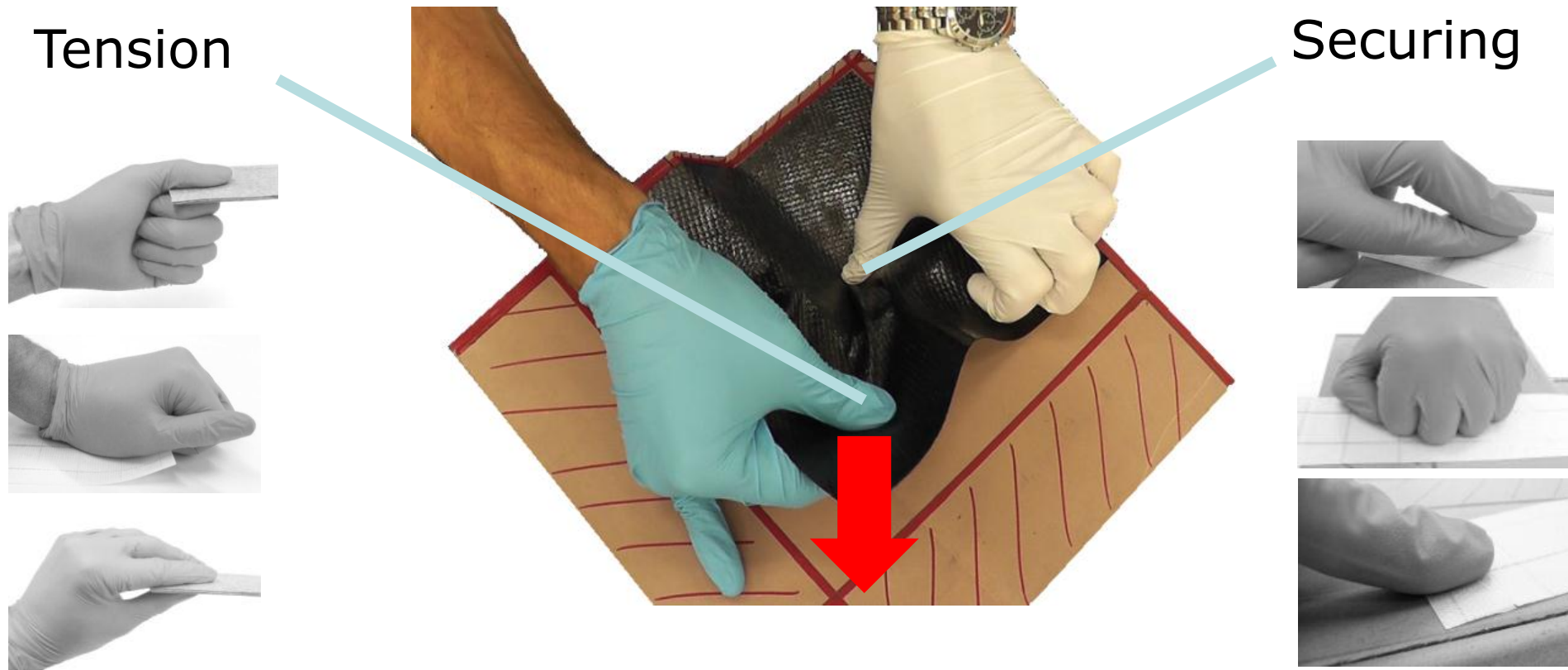


19 Layup trials - 7 Laminators



How is it done?

- 7 commonly used techniques were identified
- Example: ***Tension – Securing shearing,***

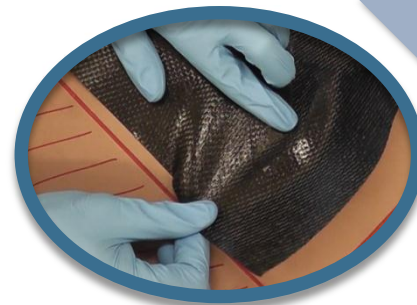
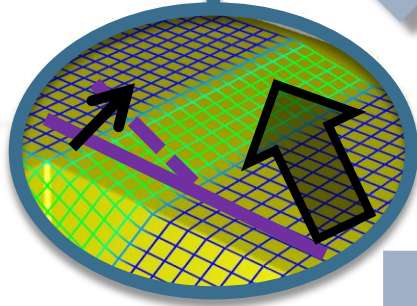
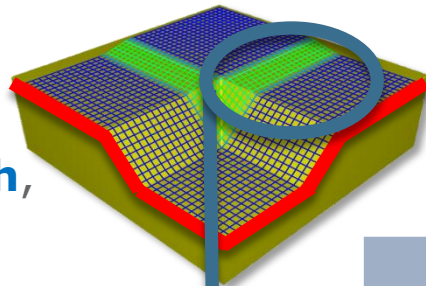


Discovering techniques

Starting point,
Undeformed cloth,
Sheared Cloth,

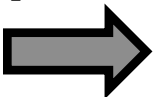
e.g. Fibres pivot
towards the free
edge.

Apply tension
directly.



1 Layup models: Use a kinematic modeller to predict shear deformation,

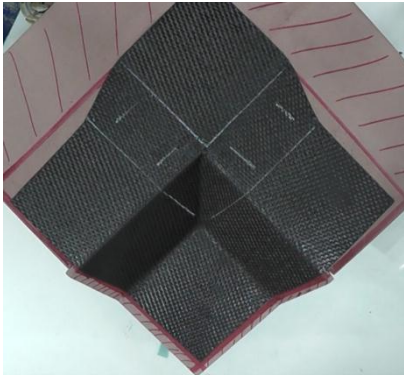
2 Feature analysis: Each feature can be classified by considering

- **Shear deformation angle,** 
- **Direction,** 
- **Location and local topology,**
- **Overall Drape direction.** 

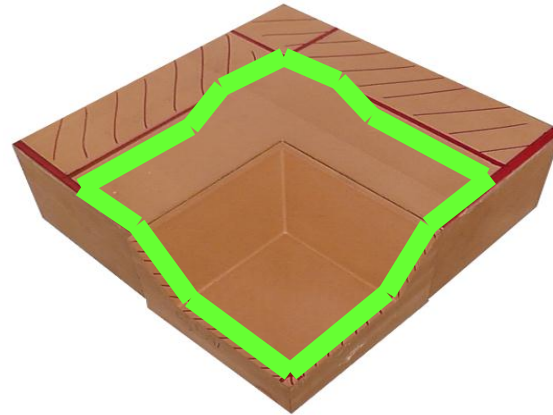
3 Discover the technique: The techniques most commonly used to shear the material can be predicted

Future work:

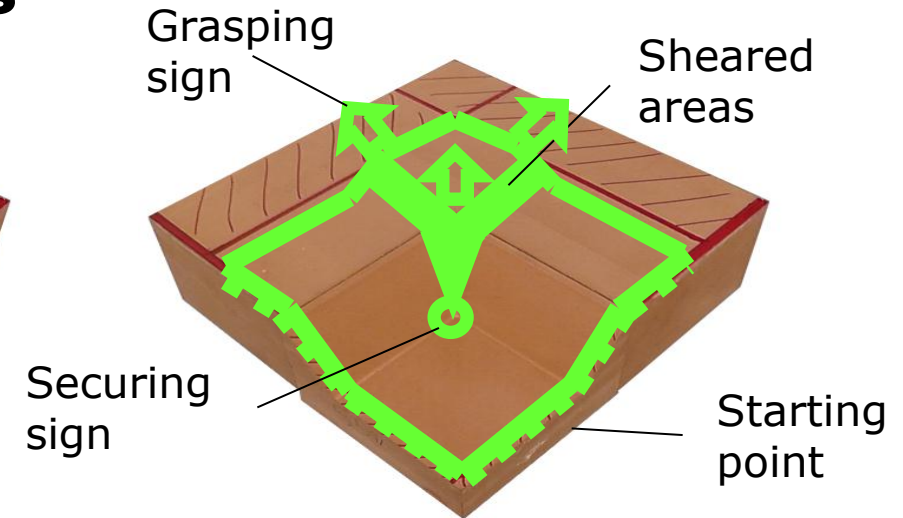
- 1. **Layup Information systems**



Complete ply



Current layup
Information

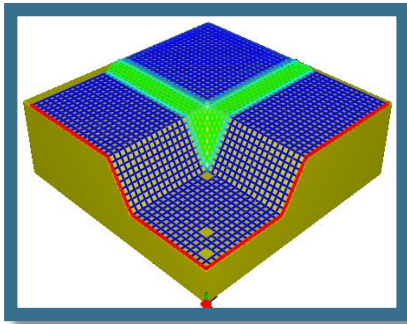


Schematic of potential
improved guide

- 2. **Alternative Hand layup process:** Apply new knowledge of layup to the design of novel manufacturing processes

Pre-shearing

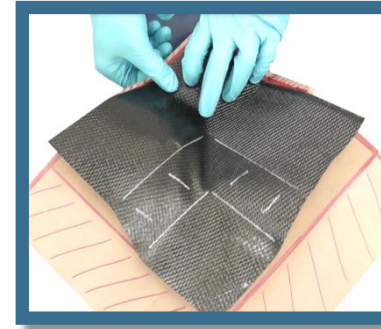
The layup process is changed significantly by deforming the cloth prior to layup:



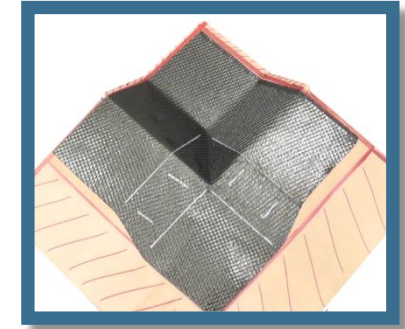
Starting with a kinematic model



Apply shear prior to tool contact.



Ply already fits into tool and deforms easily



Reduced Layup time and effort.

- **60% reduction in *on tool* layup time**
- **Significant reduction in defects**
- **Subject found lamination had become 'easy'**

Opens up potential to split up or semi automate the process.

Thanks you for listening.

Any Questions or ideas?

Acknowledgments:

- Dr Carwyn Ward
- Dr Anna Chatzimichali and Dominic Bloom

