Iowa State University
College of Engineering

Wind Energy Initiative (WEI)

Development of an Automated Fabric Deformation System for Composite Wind Turbine Blade Manufacturing

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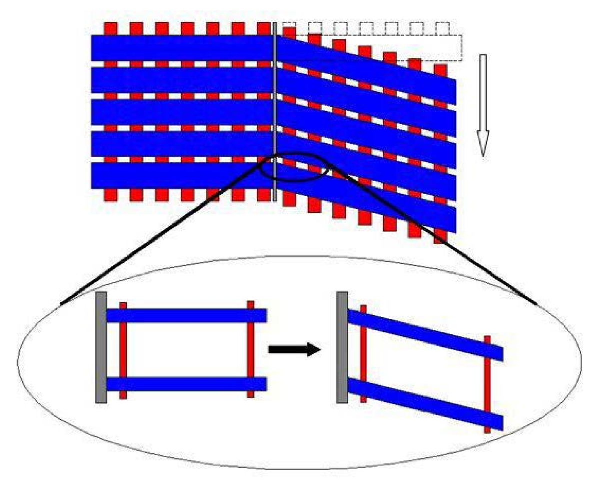
Fiberglass Fabric Shifting

Objective

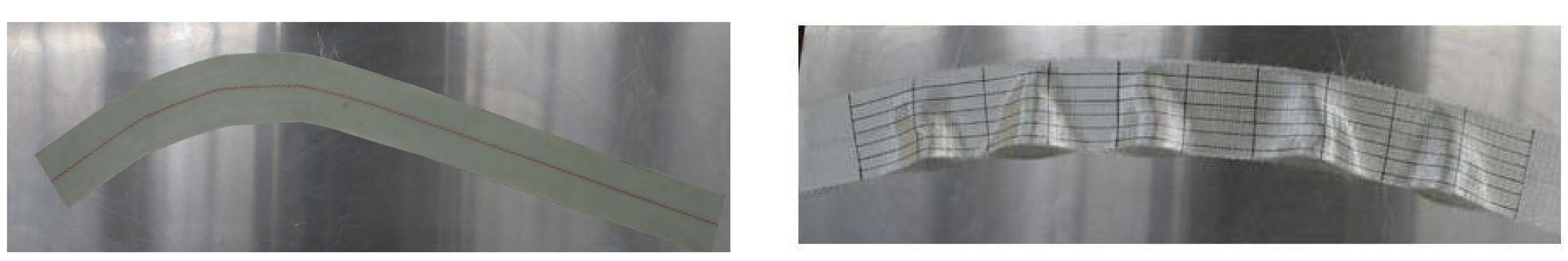
The objective is to automate the method of fiberglass fabric shifting and test whether or not it is a feasible manufacturing method for wind turbine blades. Shifting can make fabric bend around curves in wind turbine blade molds to improve the fabric's ability to seat in the mold and decrease the amount of labor required, which will translate into decreased blade manufacturing costs and increased blade fatigue life.

Shifting

"Shifting" unidirectional fiberglass fabric prevents out of plane deformation by allowing all fabric tows to remain parallel.



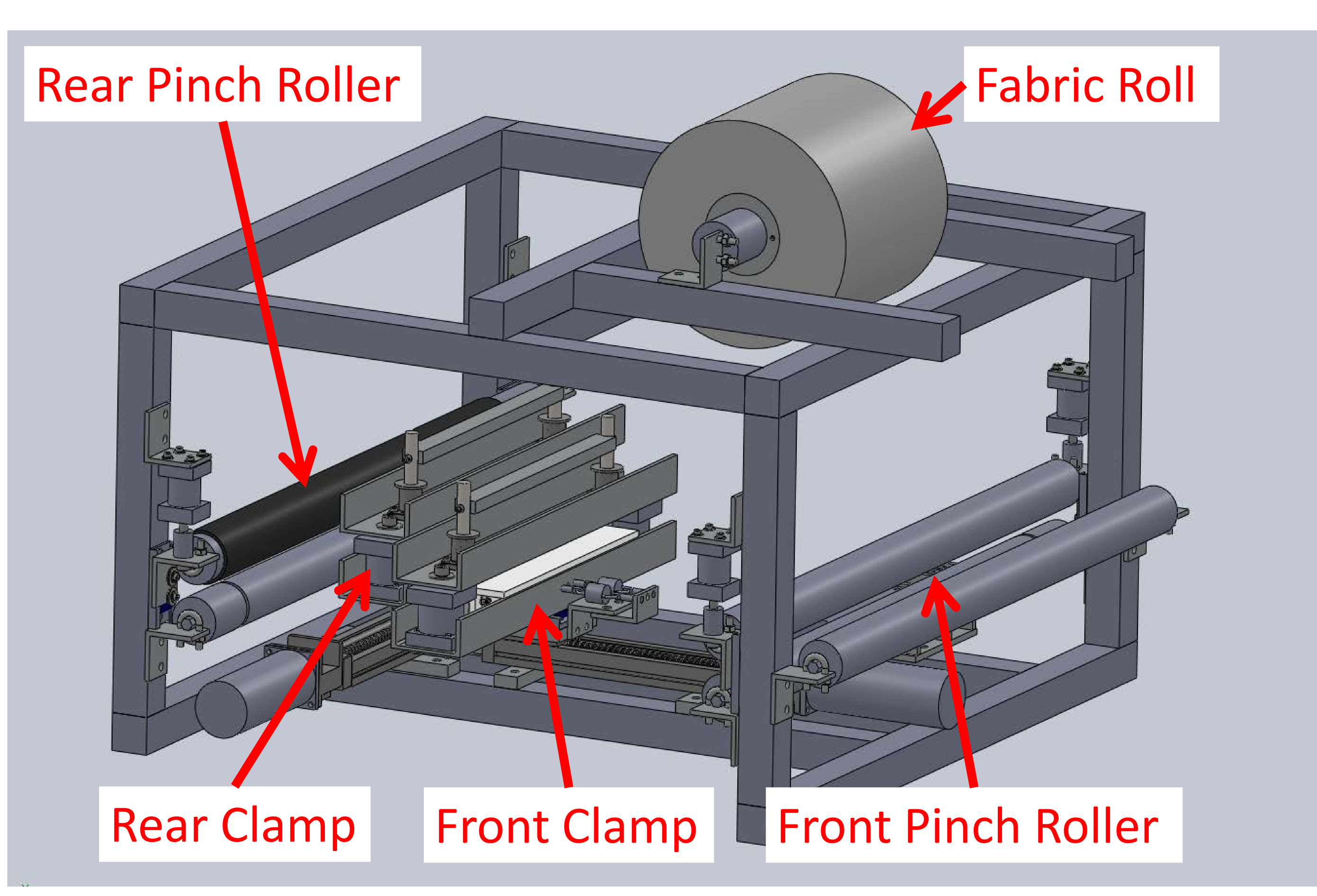
Visual representation of what shifting does to unidirectional fiberglass fabric. [1]



A shifted fabric sample (left) compared to a steered fabric sample (right). [1]

Multiple shifts with varying spacing and shift angle can closely approximate smooth curves while preventing out of plane deformation.

Automated Shifting Machine

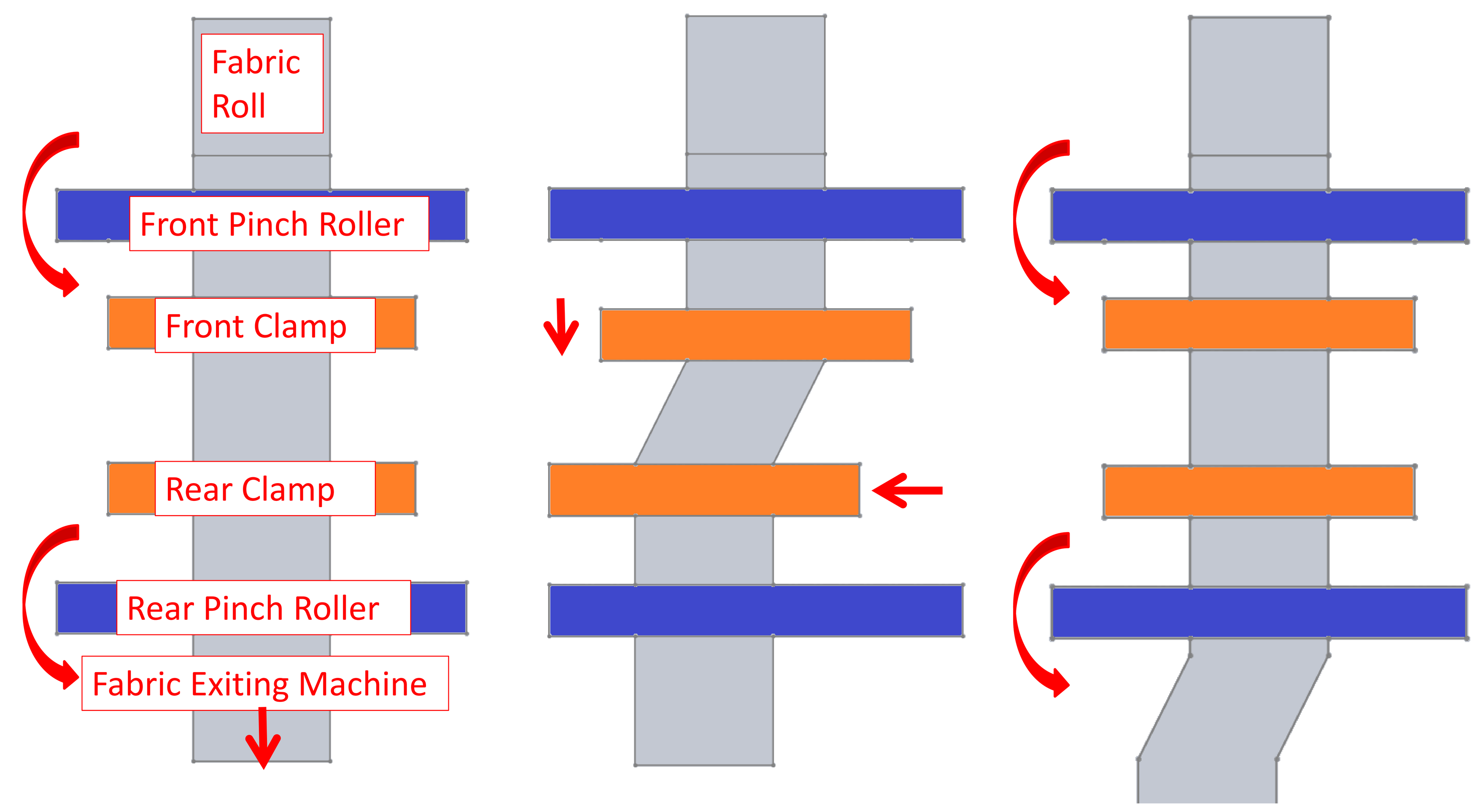


A solid model of the "shifting head" that is currently under construction.

When complete, the shifting head will be carried by a programmable gantry. As it moves over the wind blade mold, it will deposit shifted fiberglass fabric.

Automation and Validation

How it Works



Step 1: The front and rear clamps are open while the front and rear pinch rollers pinch the fabric and advance it into position.

Step 2: The front and rear pinch rollers release the fabric while the front and rear clamps grasp the fabric. The rear clamp moves laterally while the front clamp moves toward there rear of the machine.

Step 3: The front and rear clamps release while the front and rear pinch rollers pinch the fabric and advance it to the next shift position.

Validation

To validate the automated shifting process, the following questions will be answered:

1. Was the machine able to produce samples similar to that of Magnussen's shifting table?
   - Yes if the machine can produce a sample of the same fabric and curve it 53°, with a curvature of 0.72 m^{-1}.
2. Did the samples produced have negligible out-of-plane deformation, comparable to that of Magnussen?
   - The laser scanning method used by Magnussen will be replicated. The out-of-plane deformation should be negligible.
3. How much force was required to uniformly shift the fabric?
   - The force will be measured using the deformation distance of a spring with a experimentally tested spring constant.
4. How much spring-back occurred after the samples were deposited?
   - The shift angle of the samples deposited by the machine will be measured and compared to the angle at which the clamps shifted.

References
[1] C. J. Magnussen, "A fabric deformation methodology for the automation offiber reinforced polymer composite manufacturing," M.S. Thesis, Dept. Mech. Eng., Iowa State Univ., Ames, IA, 2011.

Acknowledgements
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