Composites 2.0: Optimal design

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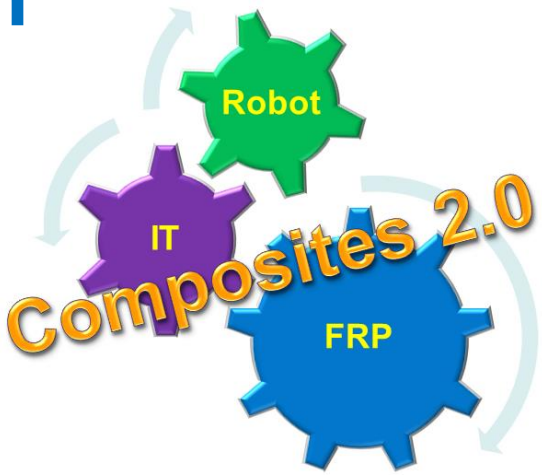
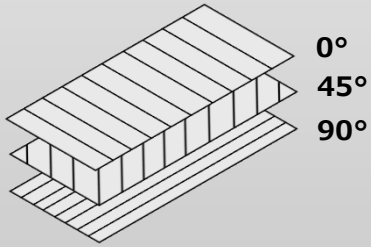


What is “Composites 2.0”

Composites 1.0

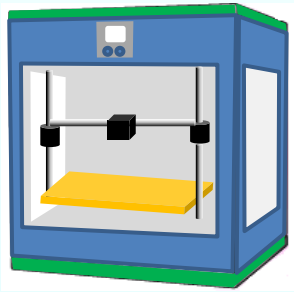
Hand-made analog technology



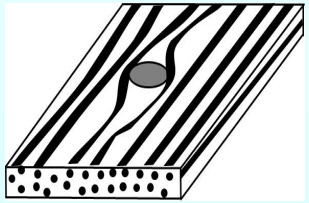
Stacking plies

Structure of 2D

Composites 2.0



Digital manufacturing

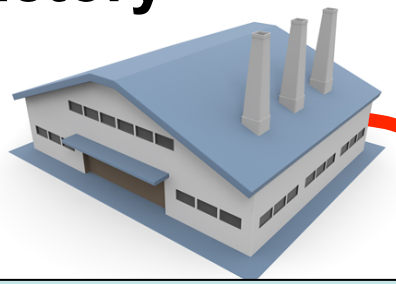


Shape（3D）
+
Direction
Density
= 5D

5D automatic manufacturing

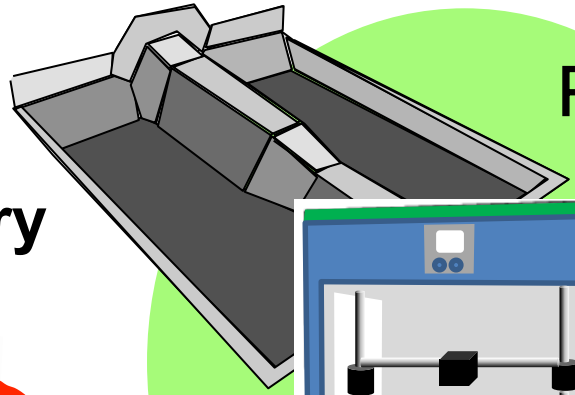
New industrial revolution by Composites 2.0

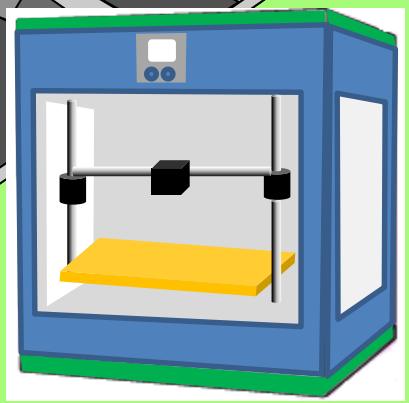
Factory



Delivery

Products



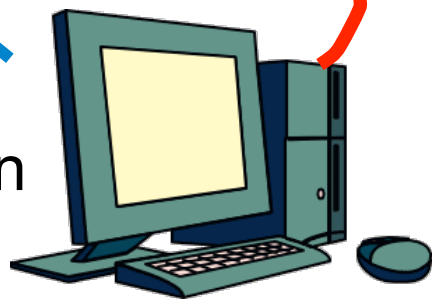


3 D Printer

3D CAD Data
Loading condition

Internet

Optimization
Fabrication simulation



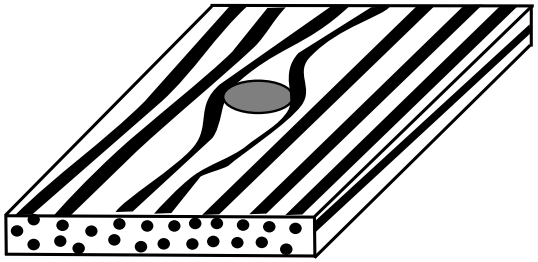
Internet

Optimization of fabrication process

New design space by fiber curvature

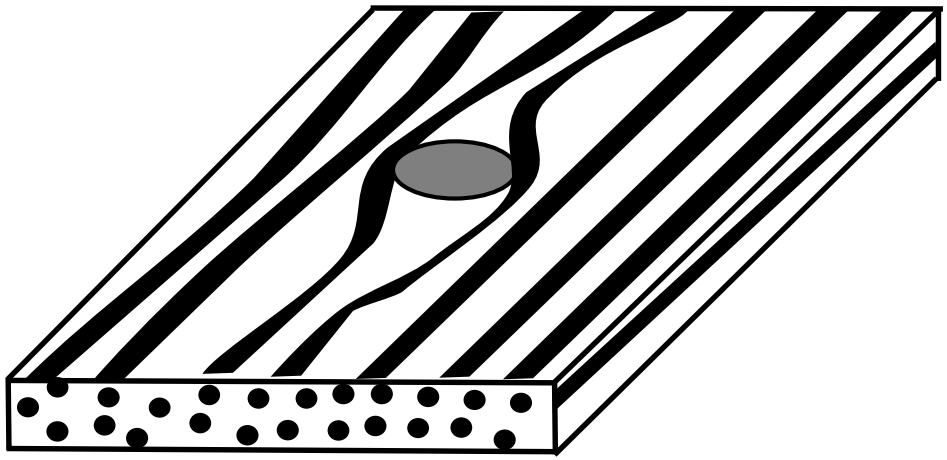
Digital control of fabrication process

Sensing & simulation of fabrication process



(2) Example of Optimal design

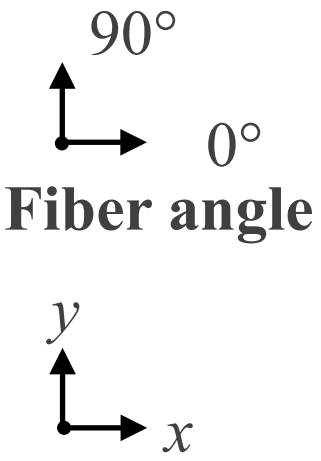
Does the composites with curved fibers really have superior properties?

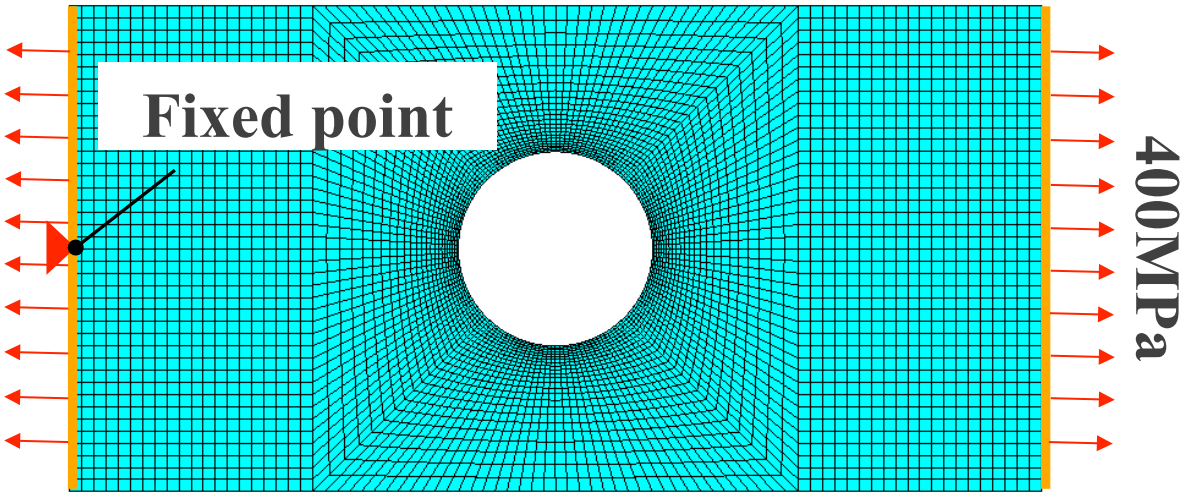


Fracture Index (Tsai-Wu fracture rule)

Tsai-Wu value > 1 → Fracture

Tsai-Wu value is obtained with FEM



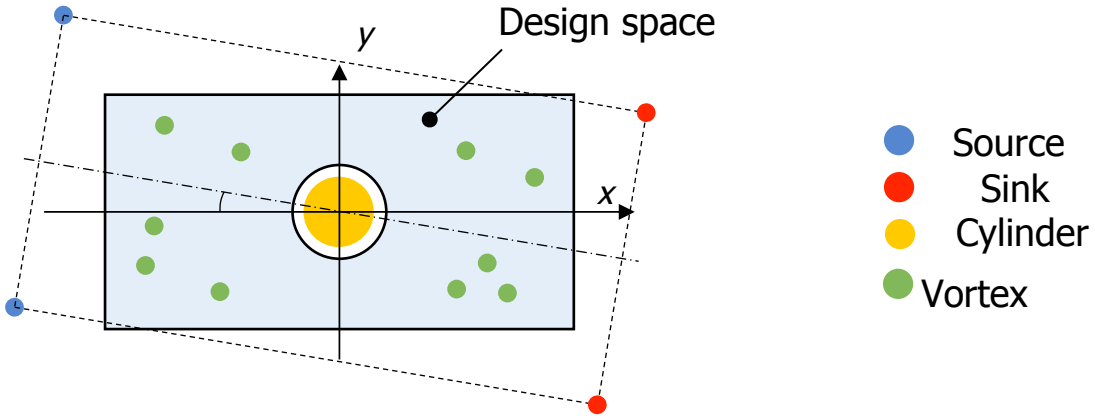


FEM model

Layout of fibers

Flow line model of perfect fluid

Source, sink and vortex



Advantages

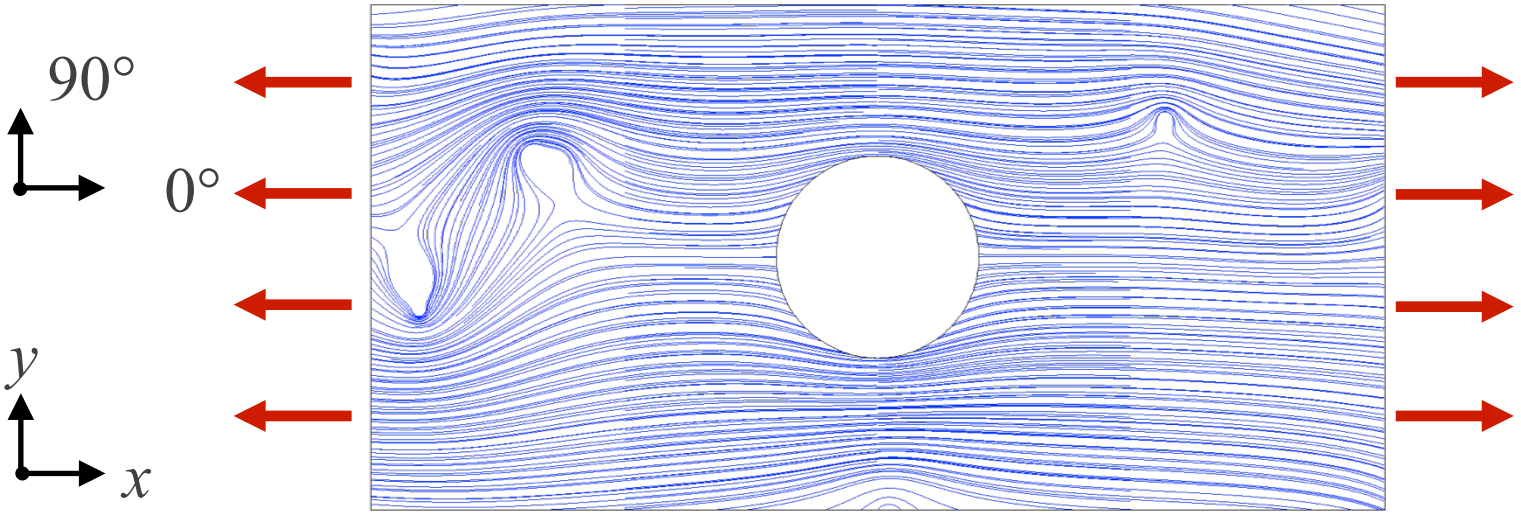
Smooth and continuous lines can be obtained

No-cross lines

Smaller number of design parameters

Results of optimization(GA)

Fiber direction

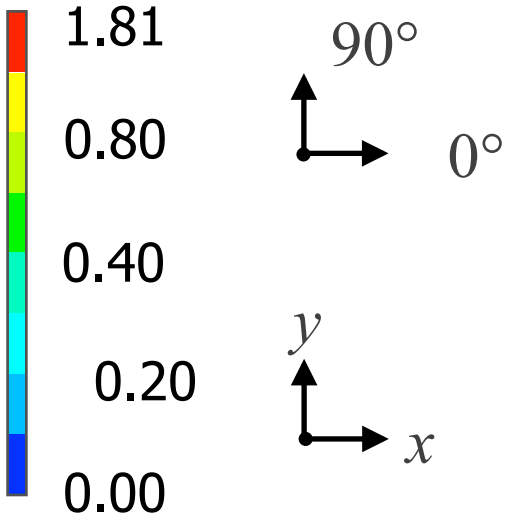


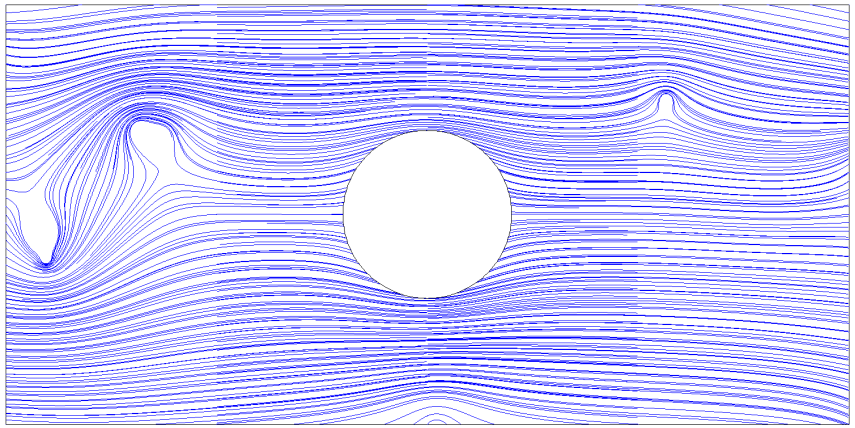
Comparison

Tsai-Wu values

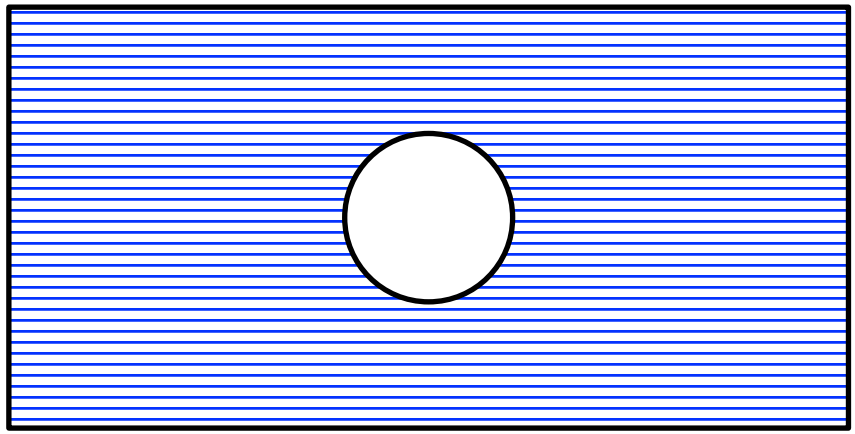
(a) 0.64

(b) 1.81





(a) Optimal



(b) 0° UD

65% decrease

Mile stones for Composites 2.0

- Static and cyclic failure of locally curved fibers
- Strength evaluation of entirely continuous fiber composites
- Limit of fiber curvature from fabrication process
- Fabrication process simulation considering void and thermal deformation

4. Conclusions

(1) Composites 2.0 is shown
(2) The possibility of superior results with curved fibers is shown.
(3) Mile-stone of composites 2.0 is shown

Perfect automated machines will be given after 15 years. However, product optimized processes will be shown within a year.