CMTS (Continuous Multi-Tow Shearing) for High-Volume Production of Complex Composite Parts

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Birth of Engineering Composites
Composite Materials

Composite = Matrix + Reinforcement
High-End Applications
Where are we now?

- **An Intelligent Airframe**
  - 53% COMPOSITE
  - 19% AI/AI-LI
  - 6% Steel
  - 14% Titanium
  - 8% Misc

- **Passenger fleet > Double**
  - 2014: 17,354
  - 2034: 35,749
  - Increase: +18,395

Aerospace Industry - Automation

- ATL (Automated Tape Laying)
  - Wide tapes 70 - 300 mm
- AFP (Automated Fibre Placement)
  - Narrow tows 3.2 - 12.7 mm

MAG Cincinnati (USA)

Electroimpact (USA)
Geometry determines method

ATL

MTorres (Spain)

MAG Cincinnati (USA)

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The Quest for Structural Efficiency

Composite → Strong in Fibre Direction

Layer Stacking → Tailor Global Stiffness

We are employing composites in straight fibre arrangements
Manufacturing for Design

Exploit Anisotropy in Composites Design – Escape Straight Fibre Paradigm

New Manufacturing Methods = New Possibilities
Tow Steering

- Lay-up on complex doubly curved moulds
- Structural efficiency through variable-stiffness structures

Could this be a step closer?
Limitations of Current Technology

- In plane bending of tapes ➔ defects:

  ![Fibre Buckling](image1)

  Minimum Steering Radius
  - ATL: 6000 mm for 150 mm wide tape
  - AFP: 630 mm for 3.175 mm wide tow [4]

  ![Width affects steering abilities](image2)

Continuous Tow Shearing (CTS)

- Minimum steering radius ➞ 30 mm for 8 mm wide tow
- Decoupling of width and minimum steering radius

Continuous Multi Tow Shearing (CMTS)

Tape laying machine capable of
- **High Quality** steered laminates
- **High Production Rates**.
Operation of CMTS Prototype

Steering Radius: 300 mm
for 90 mm wide tape

cf. ATL: 6000 mm for 150 mm wide tape
AFP: 630 mm for 3.175 mm wide tow
Material Parameters affect Quality

Resin Pocket Areas vs Position

Percentage of Resin Area (%) vs X Position (mm)

Tows 31-40
Tows 11-30
Tows 1-10

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A Glimpse to the Future

- Nature has mastered the design of composites
  - Escape the straight fibre paradigm

- Tow Steering
  - Complex shapes
  - Optimised Designs

- Continuous Multi Tow Shearing
  - Improve structural efficiency
  - Meet productivity needs
Thank you for your Attention!

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