Smart Rotors for Wind Turbine Blades - Materials and Structure -

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UpWind

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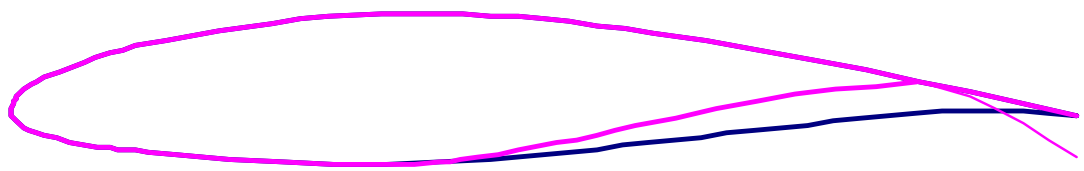
Introduction

Presentation outline:

- Introduction
- Structural concepts for adaptive TE geometry
- Integration
- Possible active surfaces
- Conclusions

Possibilities for adaptive trailing edge

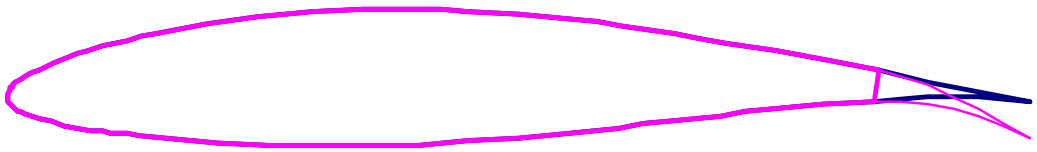
1. Reduce the chord ('chordwise compression') and add flat bender



Issues:
1. Aerofoil (re)design
2. Structurally not optimal: only same nose shape as unmodified aerofoil.

Possibilities for adaptive trailing edge

2. Reduce the chord ('truncated aerofoil') and add deformable geometry with baseline shape



Issues:
1. Larger deformable chord is needed
2. Two simple deformable surfaces will not suffice

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Integration

In all cases:

- Reduced lead-lag bending stiffness
- Reduced torsional stiffness

Therefore:

- Adding elements and material
- Transition for unmodified to modified shape

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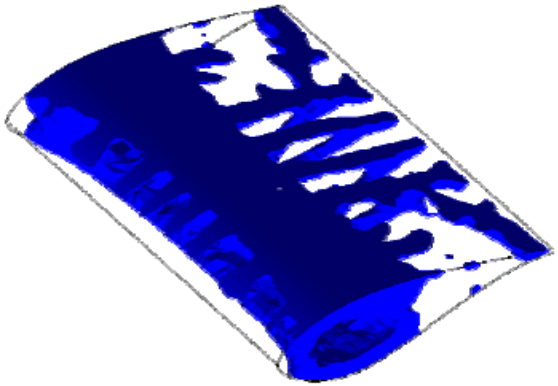
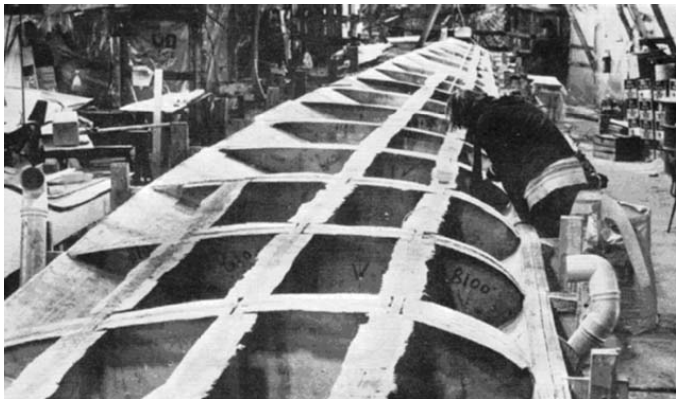
Integration



Adding elements

Adding ribs



Rib-spar design,

in combination with **TPC material system**

Through-out the whole blade: structurally more feasible??

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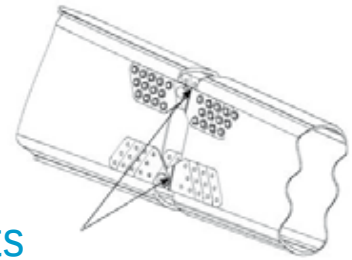
Rib-spar, TPC design through-out the whole blade: structurally more feasible??

1. (100%?) reduction in foam,
2. More easy assembling through welding,
3. Load paths,
4. Possibly added value for sectional blades.



Pin joints
(UpWind WP1B1)

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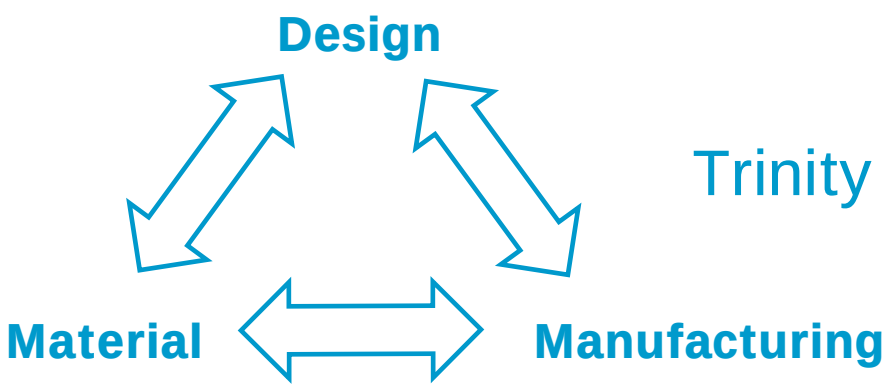
Therefore: three overlapping developments:

1. New design that becomes feasible with TPC material system
2. Create Load paths and section reinforcements for 'reduced chord' sections
3. Tough materials (TPs!) for deformable surfaces

Topics: HAWT blades, 'smart' structures & TPC



Trinity essence

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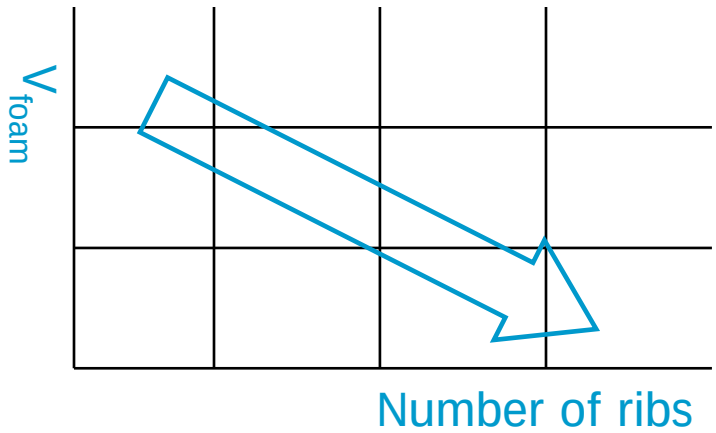
TPC redesign

Step 1. Parameter study



Constant mass,

Evaluate stiffness, stresses, critical buckling load (under aerodynamic loading and full stop)

Step 2. Rib distribution

Goal: 1. Reduce amount of foam and possibly composite material.
2. Obtain better blade

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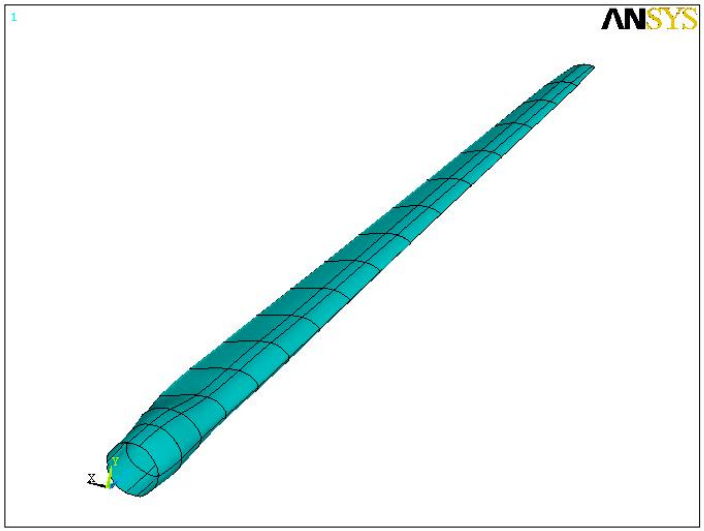
TPC redesign

Parametric blade model in Ansys.

1. **Geometry and laminate from the UpWind reference turbine blade (5MW)**
2. **Materials and ribs can be varied**

In progress, as is redesign of transition section, which is addressed separately.



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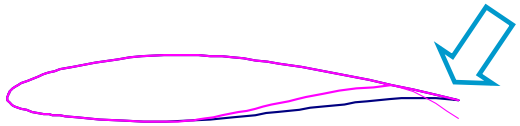
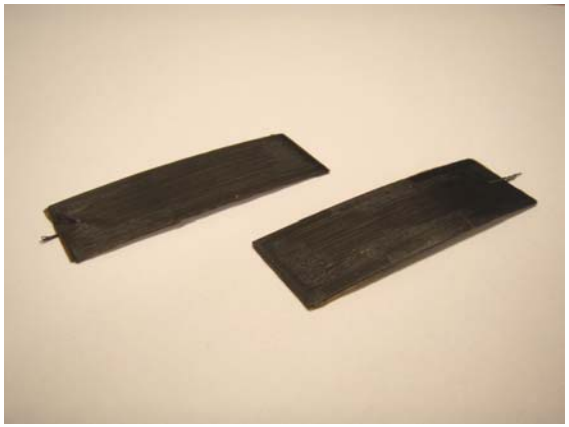
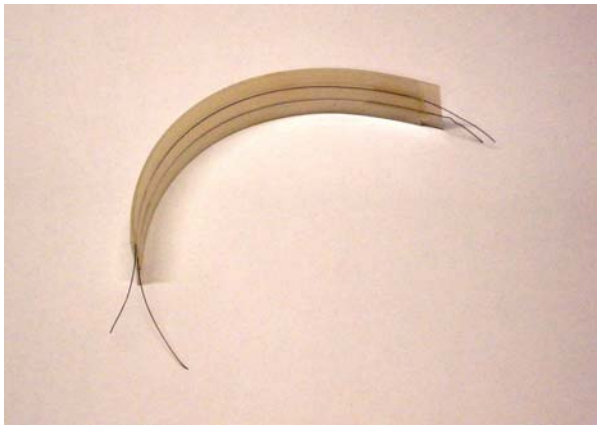
Active surfaces

Piezo-electric or SMA activated







1. **Completely different issues**
2. **SMA feasibility depending on actuation rate (1 or 3P?, the bigger the turbine, the better)**
3. **Most easily applied as flat extension**

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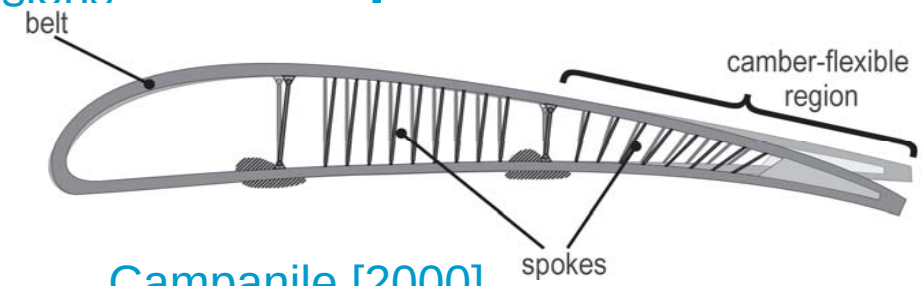
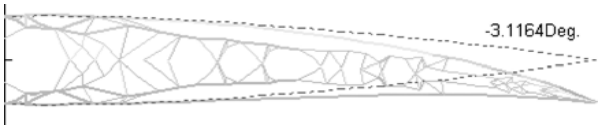
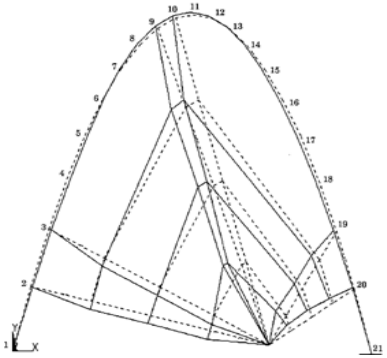
Deformable trailing edge: Compliant mechanism



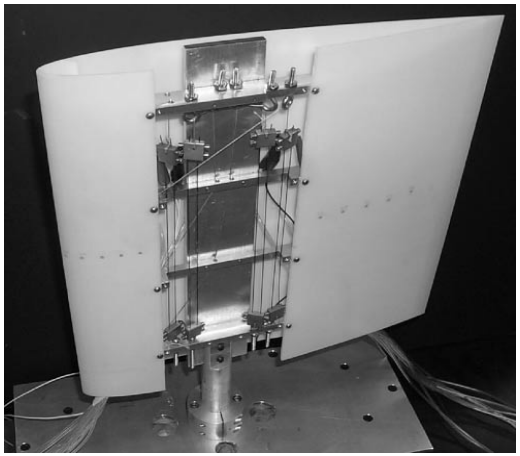
Campanile [2000]

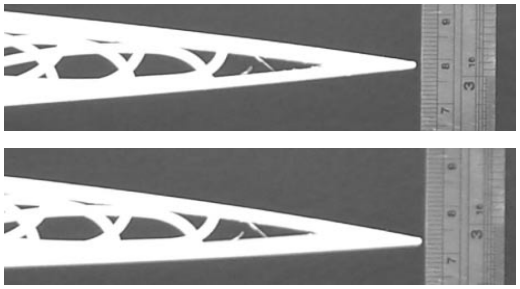


Inthra et al. [2005]



Saggere & Kota [1999]





Strelec et al. [2003]

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Rib-spar design seems feasible from topological point of view: detailed study in progress.

Integration of several developments: new material system, need for load paths (adaptive sections, sectional blades).

Active surfaces based on TP and 'smart' materials (piezo electrics and SMA).

Flat (2D) surface most feasible, compliant structure for 3D TE geometry.