Blade Runner

Publishable Executive Summary

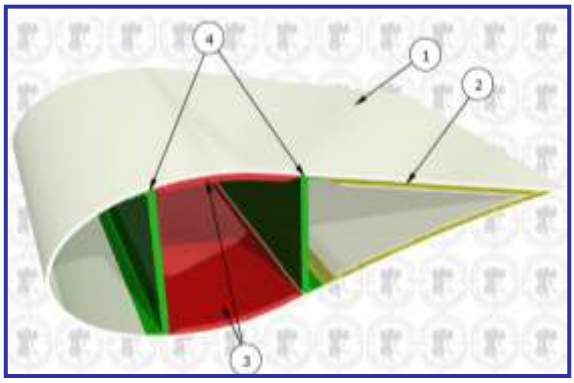
Wind turbine blades have lightning conductors incorporated into their structure. However, the presence of these conductors leads to significant Doppler Effect on marine navigation, air-traffic control, and air defence system, radars. The radar interprets the blades as being fast moving targets. As a result of this a number of objections have limited the location, approval and construction of wind farms.

The main objective of the Blade Runner project is to develop a low-cost, impedance matched, composite, radar absorbing material (RAM). The innovative approach utilises yarns of differing electrical conductivity to produce a pre-form structure with continuously graded impedance which will be incorporated internally into the wind turbine blade during manufacture, replacing part of the existing structure. This will achieve Civil Aviation Authority approval by reducing the radar effect by 17dB within the S-band and X-band.

The Blade Runner partnership is lead by HITEK Electronic Materials Ltd, international suppliers and installers of RAM materials, and consists of five industrial partners who together form a comprehensive supply chain. These partners are supported by Pera which provides research and development expertise both as an industrial and academic partner within the project.

LEAD PARTNER	HITEK Electronic Materials	RAM suppliers and installers.
1	Amann Oxley Threads Ltd	One of Europe's largest independent thread manufacturers.
2	J&D Wilkie Ltd	Producer of woven goods for the industrial

		textile sector.
3	K S Composites	High quality state of the art composite manufacturers.
4	Banks Group	Researches and develops opportunities in the wind energy sector, specialising in obtaining planning permission and project finance; owns and operates wind farms.
RTD	Pera Innovation Network	R&D including software modelling.



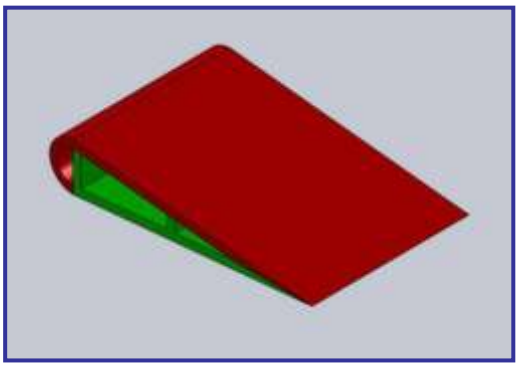
The initial technical work for this project focussed on identifying the location within the blade structure which would be most suitable for housing the developed Blade Runner composite material. Once determined this information was used to form a basis for the modelling work and prototype specification; particularly in regards to reasonable dimensions and compatible material selection.

A computer model was then developed to determine optimum parameters with regards to structure type and physical characteristics of the material. The software enabled the optimisation of structure design, dimensions and conductivity gradients in order to give maximum electromagnetic wave absorption within the S and X bands.

The developed model was validated experimentally using layers of conductive fabric. By arranging these sheets in a specific order and orientation these were used to simulate the modelled structures. The height of the structure was also adjusted by inserting non-conductive material between layers. These

were then subjected to electromagnetic radiation over a wide range of frequencies. The results showed that the actual performance of the material was superior to that expected from the modelling results giving a reduction in the S-band and X-band of 5-10dB.

Further optimisation of the radar absorbing structure was then performed. A method of producing yarns with specific ranges of conductivity was developed and a second software package was used to simulate how the conductive fibres could be woven to create a defined 3-D structure.



The final structure was again subjected to electromagnetic radiation and the absorption performance monitored. The optimised structure showed an improved performance with a reduction of up to 17dB in the S-band and X-band, matching the original target specification.

The conductive material was then impregnated with resin to form a composite structure which would be compatible with the standard materials used in wind turbine manufacture. This composite material was then integrated into a section of wind turbine blade and was tested again for its radar absorption performance.