# Modelling of a Rotary Kite Airborne Wind Energy (AWE) System

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## Introduction

- A PhD investigating a novel rotary kite airborne wind energy (AWE) system. The aim is to achieve safe and efficient operation through control.
- The Daisy Kite system has been developed by Windswept and Interesting Ltd. Through the production and testing of various prototypes the design has been refined.
- The PhD will initially focus on the development of a computer model of the Daisy Kite system.

*The most recent prototype undergoing testing. Photo taken by Rod Read, founder of Windswept and Interesting Ltd[1].*

- The motivation behind AWE is to produce lightweight energy harvesting devices capable of reaching higher altitudes than conventional horizontal axis wind turbines at a lower cost of energy.
- At present the only commercially available device is the SkySails[2] towing kite. The product pulls sea going vessels and is capable of replacing 2MW of engine power.
- In recent years AWE has received an increasing amount of attention from industry and academia. Kite Power Solutions[3] (KPS) has recently received permission of test their 600kW device in Southern Scotland.

## Daisy Kite System

- The Daisy Kite design is very different to most other AWE systems. It uses the effect of autorotation to create lift and usable shaft power.
- The device uses a cylinder of tensioned tethers held apart by a number of rigid rings. This system transmits the rotational motion created by the airborne kites down to the ground station to drive the generator.
- The current prototype can produce up to 300W of electrical power.

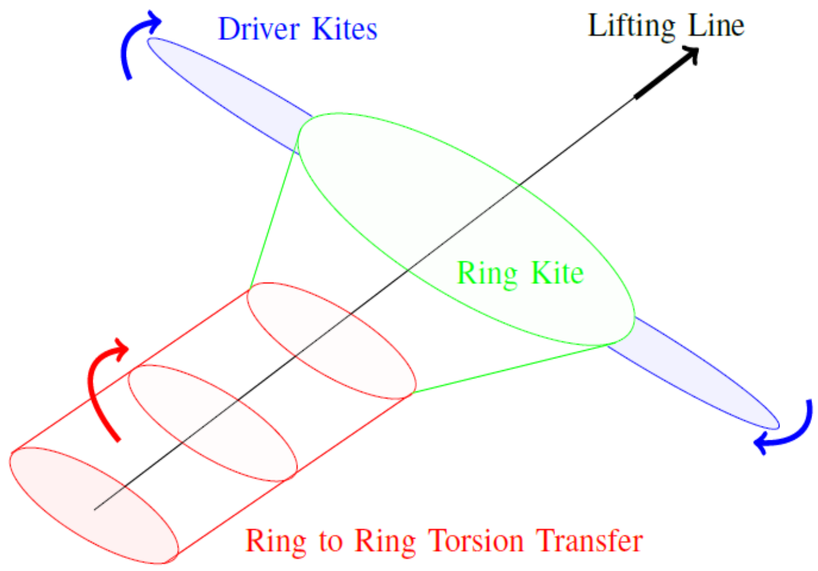
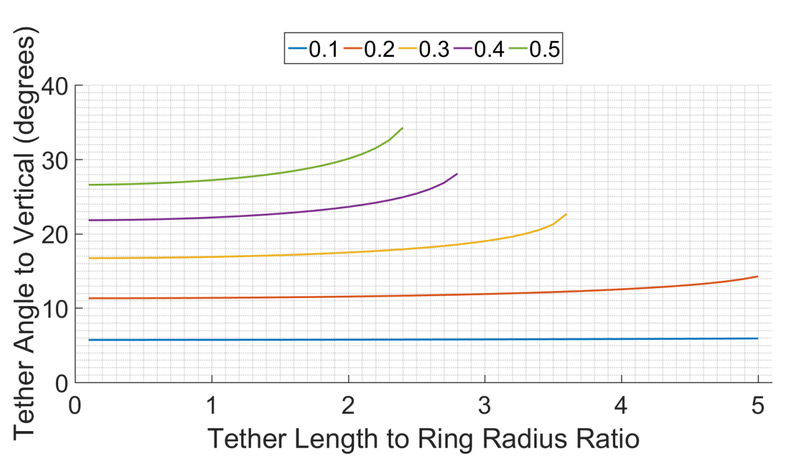
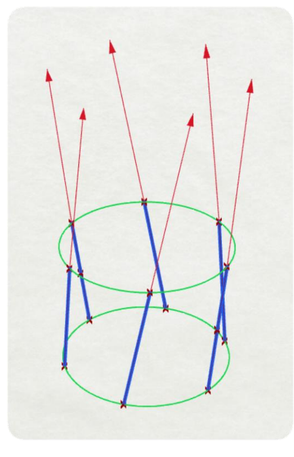



*Diagram showing the main components of the Daisy Kite system.*

## Torsion Transfer Analysis

- The torsion transfer system has been analysed by creating the model shown below. The force vectors (red) show the lift and rotational force produced by the kites. The tethers (blue) are modelled as springs.
- The ratio of tether length to ring radius and the ratio of rotational force to lift force were varied. The results are shown in the graph.
- The angle between the tethers and the vertical is used to compare different simulations. The greater the angle the closer the system is to failure, the point at which tethers cross and become tangled.
- A lower rotational force and smaller tether lengths result in smaller angles and therefore a more robust system.



*Right – Image of the torsion transfer model*
*Left – Graph of the obtained results*

## Conclusions and Future Work

- A basic analysis of the torsion transfer system has been achieved.
- Future work will be to refine the torsion transfer model and develop a model of the kites.
- A new prototype is to be produced so that experimental data can be collected and compared to the computer models.
- The computer model will be used to asses the systems performance, aid the device's development and design the control strategy.

[1] – R. Read. Windswept and Interesting LTD. [Online]. Available: http://windswept-and-interesting.co.uk/
[2] - SkySails. [Online]. Available: http://www.skysails.info
[3] - Kite Power Solutions. [Online]. Available: http://www.kitepowersolutions.com/

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