



THE POWER OF KITE TECHNOLOGY

The power of kites is something one needs to experience to fully appreciate. Even a modest 6 square meter kite is able to produce enough force to warrant digging your heels into the sand. When you think about it, and we at ASSET do so every day, it is quite remarkable that something so light, so compact when folded and so cheap to produce can generate such an immense amount of force. The possibilities and applications for something like a kite are in principle endless.

Kites today do suffer from a stigma which labels them as "only toys". It is a very narrow view which doesn't do justice to the achievements of kites in the past and their possibilities for the future. In the past, kites

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have played an important role in science. To name just one, kites helped the Wright brothers identify roll as an important control motion. Before, only yaw and pitch were envisioned. Rolling an aircraft and thereby rotating its resulting lift vector was a major breakthrough in the development of powered flight. And it was made possible by experimenting with kites.

At ASSET (AeroSpace for Sustainable Engineering and Technology) kites have been a subject of study

for a number of years. Interest in kites grew out of the Laddermill project which envisions kites as a means of generating electricity by using the high speed winds at high altitude. Current wind turbines are all positioned close to the ground on large towers no more than 100 meters high. At higher altitudes, the winds are not only stronger; they are more consistent as well, ideal terrain for wind energy, if you can reach it.

Kites go up with relative ease. You have to be careful not to burn your hand as the line slips through your fingers. To get the kite back down you have to pull it down, spending energy. For aircraft, it is exactly the other way around. Airplanes need large engines to climb, but can glide down under idle power. The kites in the Laddermill are a combination of kites and airplanes. They go up as kites, and go down as airplanes. While going up, they pull a tether off a drum, spinning that drum. The drum is connected to a generator which generates electricity. On the downstroke, the kites are reconfigured for low tether tension and glide down. The cable is reeled back in, spending a little bit of energy. But because the tension in the tether is far greater on the up stroke than it is on the down stroke, you are left with a residual amount of energy after each stroke.

The system as described above is a simplified view which sketches its basic workings. In reality there are a large number of complexities which, if researched and managed properly, can result in an efficient high altitude wind energy system. Research on the Laddermill is a very multi-disciplinary affair. Research



on kites encompasses flight dynamics, aerodynamics, control and light-weight structures. Currently, new kite configurations are investigated. It is a field which allows for a large amount of creativity and out-of-the-box thinking. Furthermore, kite research is not limited to paper or the computer screen. We encourage our students and staff to realize their designs and test them either in our KiteLab or on the beach. Because kites are relatively cheap to build, there is a relatively short path from design to reality.

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Zooming in a little more on the control of kites, disciplines such as software development, electronics, mechatronics and control theory come into play. For energy generation, simply letting go of the kite and letting it ascend does not necessarily lead to the largest amount of energy generated. To create more pressure on the kite we use the principle of crosswind power. By flying the kite in controlled figure eight loops from left to right we can maximize the tension in the tether. During these maneuvers a ten square meter kite, which costs about \$100 in China, can reach speeds up to 100 kilometers per hour, generating up to 300kg of force. The shape of the flight path coupled with the reel-in and reel-out strategy of the ground station is of great importance to the efficiency of the system.

Our current ground station has a maximum capacity of 20kW. Mechanical, electrical and software engineers are required to keep it in operation, improve its control and expand it to larger capacities. Quite a bit of testing is still to be done which provides opportunities



for creative students who are not afraid to leave their computer and venture outside.

Our next big project will be done in cooperation with the harbor of Rotterdam. By placing a Laddermill system on a large ship, we aim to provide proof of concept for a Laddermill Ship. On board of this ship, kites generate electrical energy which is stored in a battery pack. This battery pack then powers all the systems and propels the ship using an electric motor. Using such a system, it is in principle possible to sail the ship straight into the wind. A feat no other sail boat can duplicate. There is strong interest from the harbor of Rotterdam to develop such a system and it will be our main driver for the coming two years.

The Laddermill ship creates a host of new possibilities for students. Placing a Laddermill on a ship brings with it a number of challenges which need to be researched. Operating a Laddermill from the deck of a ship requires engineering ingenuity, well-defined procedures and teamwork. Issues such as launching a kite from a ship need to be resolved. Can you launch a large 50 square meter kite from the deck? Or do you need to launch it from the water? What about retrieval of the kite? Furthermore the interface of the ground station with the systems on the ship deserves special attention; management of information from sensors requires stable software, ergonomics is involved in placing the systems on board and structural strength and stiffness is needed for the system to be durable.

The coming two years for ASSET are going to be characterized by expansion, exciting opportunities and great success. In the latter, you can play a large part! We offer positions for master thesis students within our projects. If you

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would like to come and support our team, please contact us so we can map out how best to apply your skills and competencies to our project.

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