**Design Notes**

**Lesson One: Use Nuts and Bolts**

#4 x ½” Flat Head Phillips Zinc Plated wood screws were used to secure the original eight stays that ran longitudinally from front to back and measured ¼” x ¼”.

Wood/machine screws, even when combined with various adhesives did not provide adequate clamping force relative to through hole nut and bolt style fasteners.

Bottom Line: Use nuts and bolts that provide clamping force. Bolt heads can be flat headed, countersunk so as to be flush with the surface.

**Lesson Two: Use flat flexible strips for stays.**

The original stays were hardwood square stock and fractured easily. The second set of stays were rectangular in cross-section and lay flat on the rings. These stays were not only stronger, but much more durable in repeated flexion and never broken even during tests to near destruction that fractured the square cross sectional stays. The rectangular stays were made of spruce, but could be made of laminated carbon fiber as well.

**Lesson Three (from Marilyn): Use a second ring to capture the sail**

And provide a quick release mechanism. This allows quick reefing in high-wind conditions, and enables easy installation, servicing and replacement of sails.

**Lesson Tower Philosphy**

MessageFrom: L. Van Warren [van@wdv.com]

Sent: Wednesday, July 16, 2008 4:44 AM

To: van@wdv.com

Subject: notes on height

The tower exists not so much for variation of wind speed with height, but rather as setting a minimum height for clearance of obstacles and turbulence generators.

The tower must be such that the center of the hub is 20 feet taller than any feature for 300 feet, especially in the prevailing wind direction.

The variation of wind speed with time is much more significant to use than variation of wind speed with height, we modulate height to maximize clearance from wind shadow during times of low wind, and to utilize wind shadow during times of high winds.

**Lesson Four (from Kuznetsov): 8/14/08**

Nothing is more important than the tower not falling down.

Make sure you analyze the tower both theoretically and practically.

If possible instrument the tower so that it does not exceed acceptable stress levels.

Key Loads:

1. Load 1: Tower Bending Load

The bending moment on the tower due to the air resistance of the vTurbine™.

1. Load 2: Turbine Aft Heavy Moment

The moment on the tower due to the aft-heavy turbine + lift or downdraft forces.

1. Load 3: Tower Atlas Load

The compression on the tower due to the aft-heavy turbine.

1. Dynamic loads due to oscillation

Must watch the spring-mass-damping distribution in the vSail™ mounts.

See email to Kuznetsov on structural details: 8/14/08