



The Importance of System Dynamic Modeling for Small Wind Turbines

Part 2: Pika T701 Case Study

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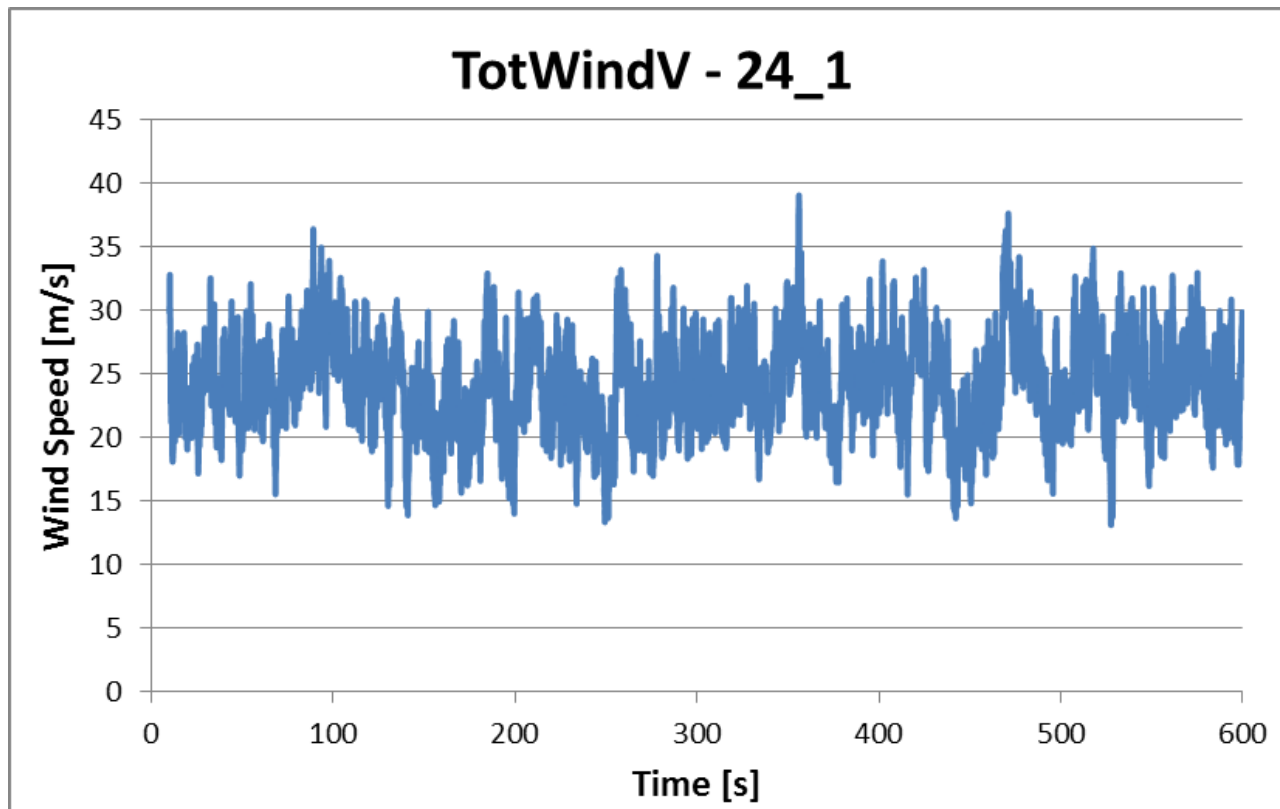
FAST Simulations Aimed at Improving Pika T701 Dynamic Performance

- Extreme lateral deflections with unacceptable damping were observed.
- What configuration changes can be made to correct the situation?



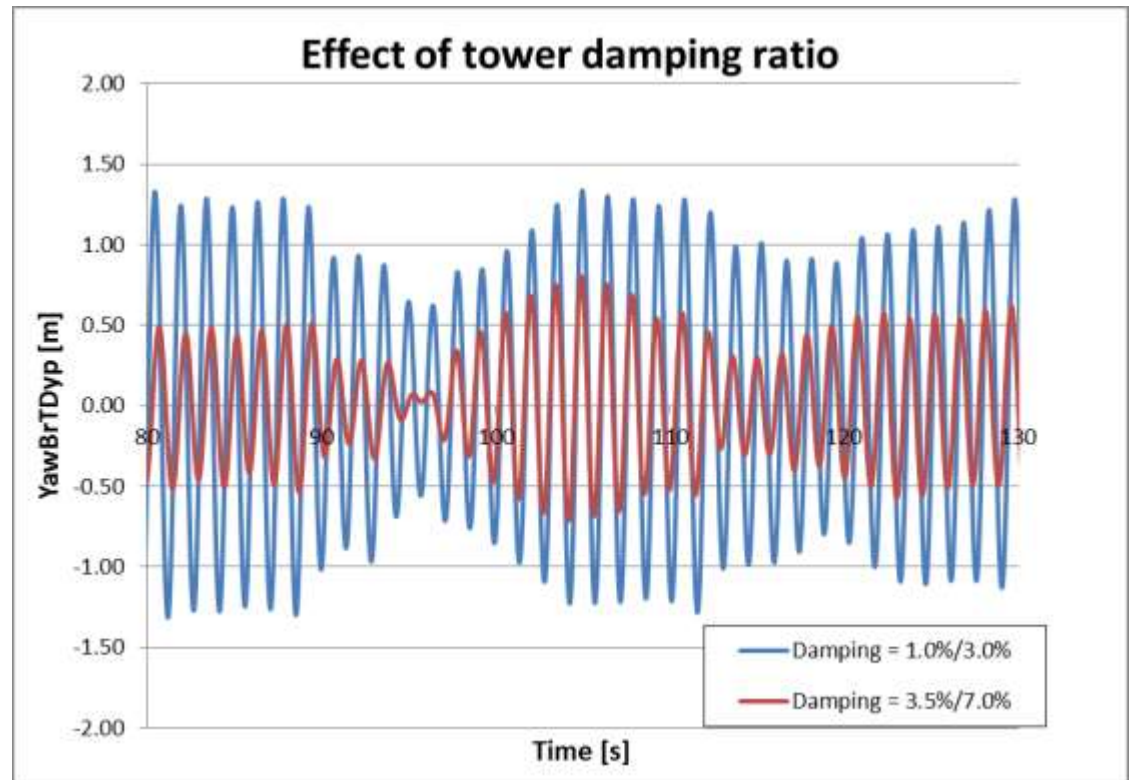
Typical Wind Input Simulation

- One of several trials



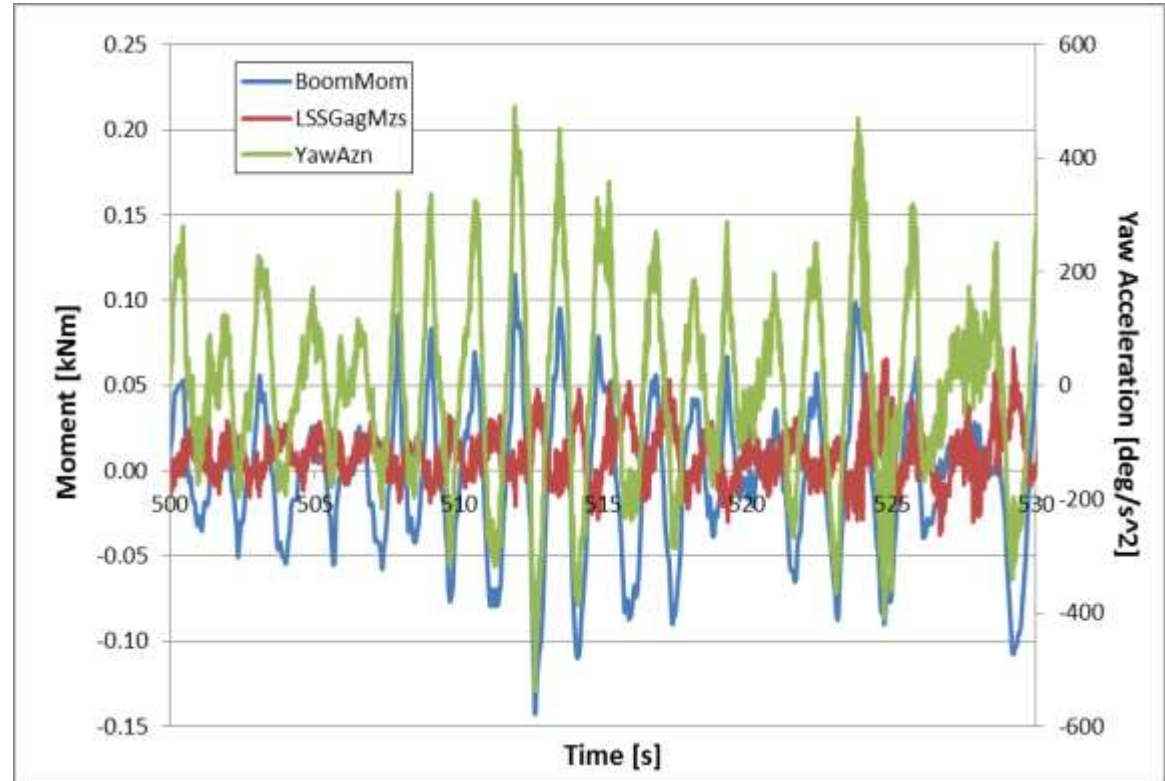
Tower Top Deflection – Effect of Tower Damping Ratio

- Lower damping ratio exhibits much larger deflections.
- But who knows what the real damping ratio is?



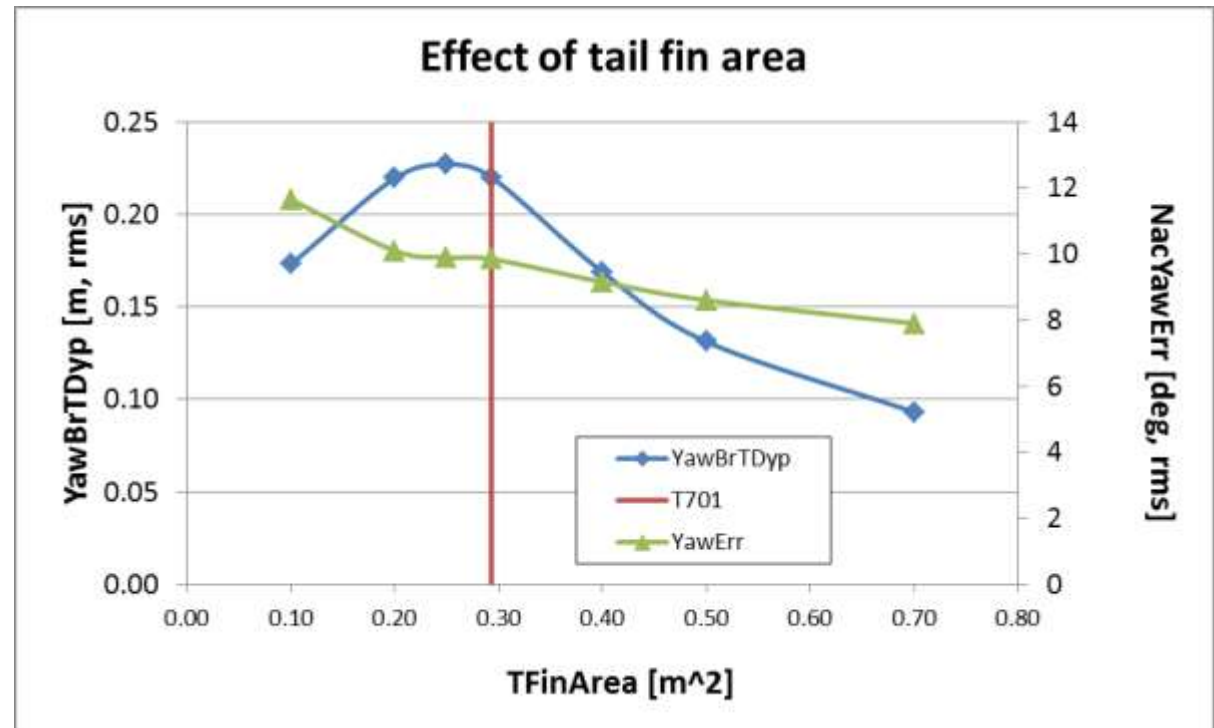
Helpful Parameters to Examine

- Yaw moment, yaw error, tower-top deflection time histories.
- RMS deflection and yaw acceleration as influenced by geometry.
- Note, for example, yaw moment generated by the tail is more significant than the yaw inducing moment on the rotor shaft.



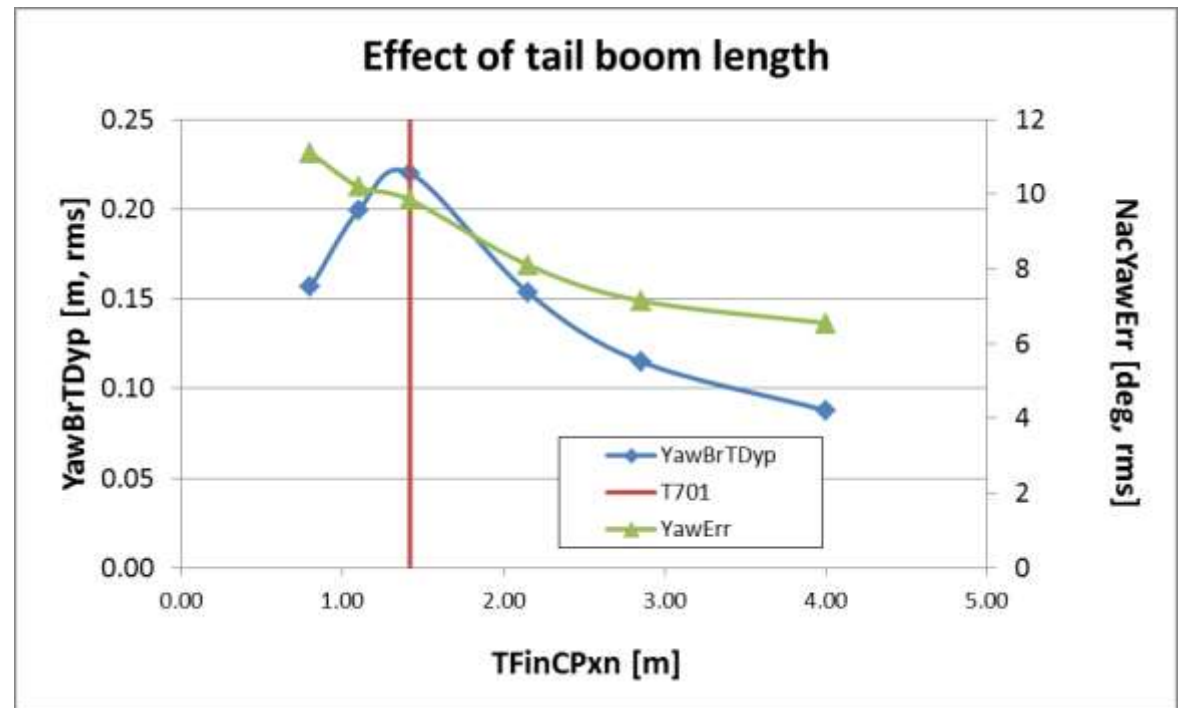
RMS Tower-Top Deflection and Yaw Error Effect of Tail Area

➤ More tail area is needed.



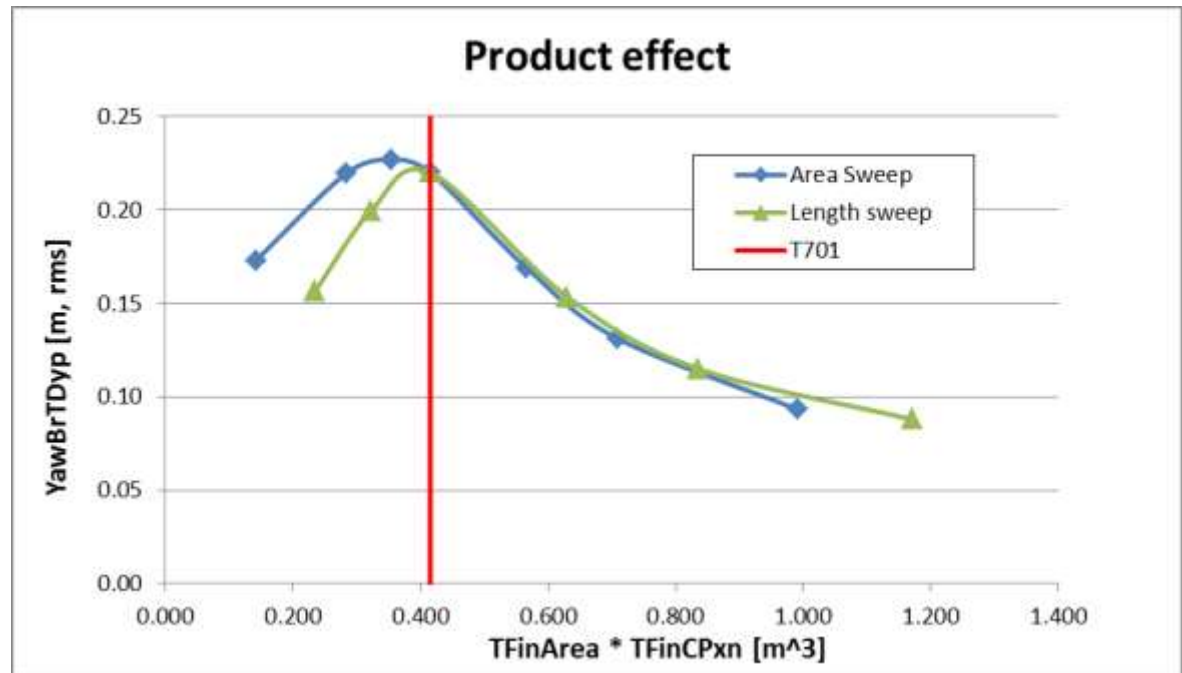
RMS Tower-Top Deflection and Yaw Error Effect of Tail Arm

- More tail arm is needed.



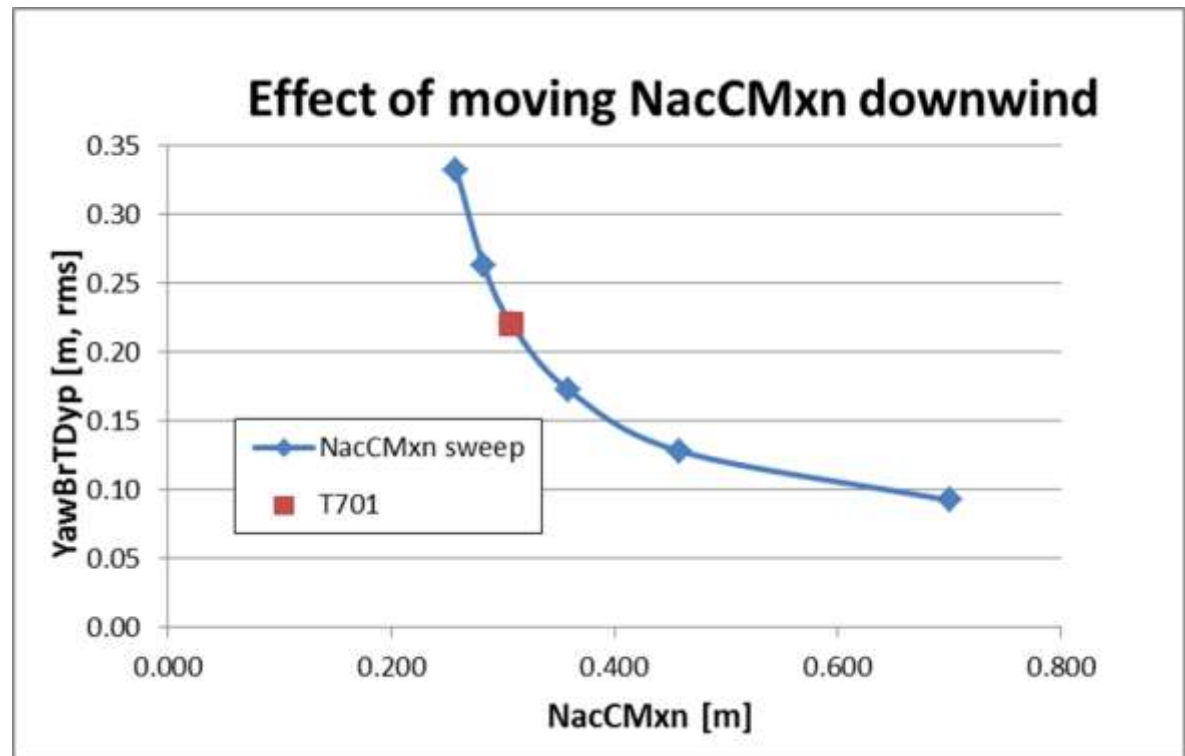
RMS Tower-Top Deflection Effect of “Tail Volume”

- “Tail Volume” is the product of tail area and tail arm.
- Analogous to directional stability in aircraft design.



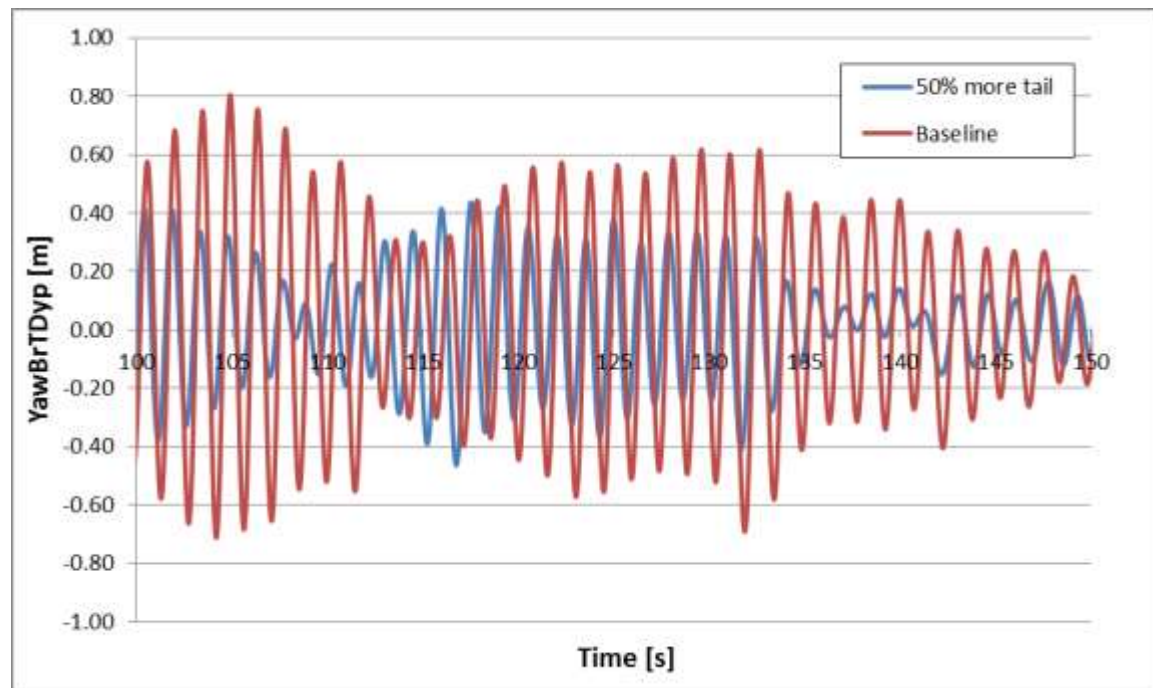
RMS Tower-Top Deflection Effect of Center of Gravity

- Moving C.G. downwind causes a significant decrease in tower top motion.

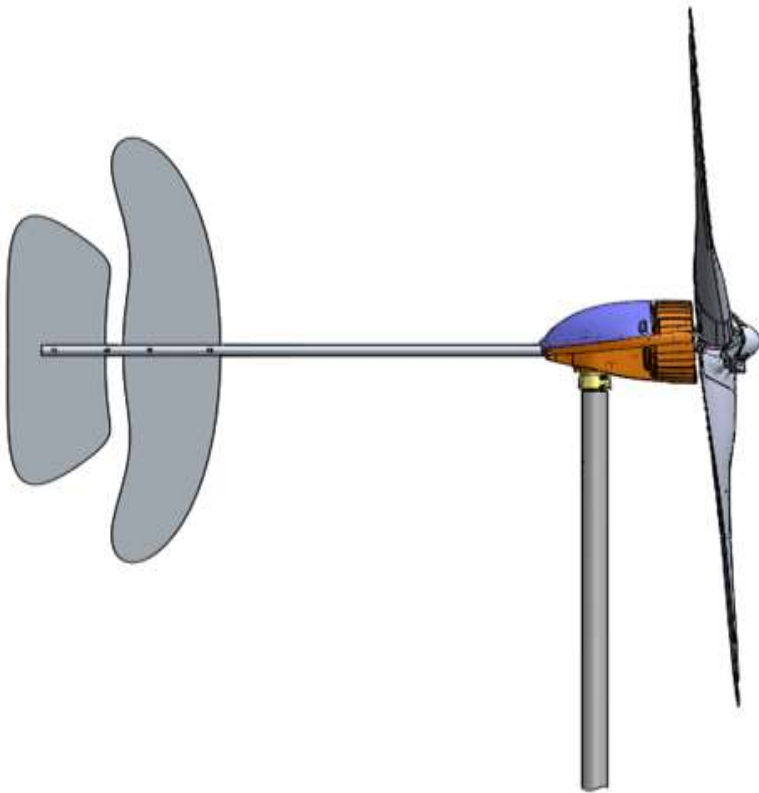


Trial Run

- Add tail area.
- Additional improvements may result from C.G. movement and adjustment of operational controls.



Results and Conclusions



- Using FAST modeling, a parametric variation of configuration variables pointed the way to a new tail and other modifications of the Pika Energy T701.
- The dynamic performance of the modified turbine is far superior to the original.
- In spite of the limitations of FAST it has proven to be a useful design tool.
- More work is necessary to verify the reliability of FAST for such purposes.