



UAM Noise Working Group: Subgroup 1 Update

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Virtual Meeting: 05 November 2020



Previous Meeting Summary

Previous meeting items (09 Apr 2020):

- There were no slides for that meeting for Subgroup 1.
- However, had brief oral discussion of:
 - White paper status.
 - Efforts to create BANC-like dataset for Subgroup 1.



Disposition of Previous Meeting Items

White paper:

- Has been published as NASA-TP-2020-5007433.

Prior efforts for **Benchmark** problems for **Airframe Noise Computations (BANC)**-like dataset:

- Earlier experimental data acquired at NASA used commercial blades because:
 - They were cost effective.
 - They could be acquired quickly.
 - They did not require design efforts.
- However, dissemination has been hampered because of proprietary (detailed blade geometry) concerns.



Path Forward

Mitigation of proprietary issues:

- To alleviate the proprietary issues, NASA has been designing and building small rotors/blades to test in NASA facilities.

Example of things NASA has addressed:

- Ideally twisted rotor.
 - “Ideal” means built-in twist aimed at constant induced velocity across the span. So, twist is inversely proportional to the span station.

Other sources:

- If you are interested in sharing data, please let SG-1 know.



Ideal Twist

Ideally, radially constant induced inflow to minimize induced power.
From Blade Element Momentum Theory in hover:

$$\lambda(r) = \frac{\sigma C_{l\alpha}}{16} \left(\left(1 + \frac{32}{\sigma C_{l\alpha}} \theta r \right)^{1/2} - 1 \right)$$

To make induced inflow constant twist:

$$\theta = \frac{\textit{Constant}}{r}$$



Ideally Twisted Rotor

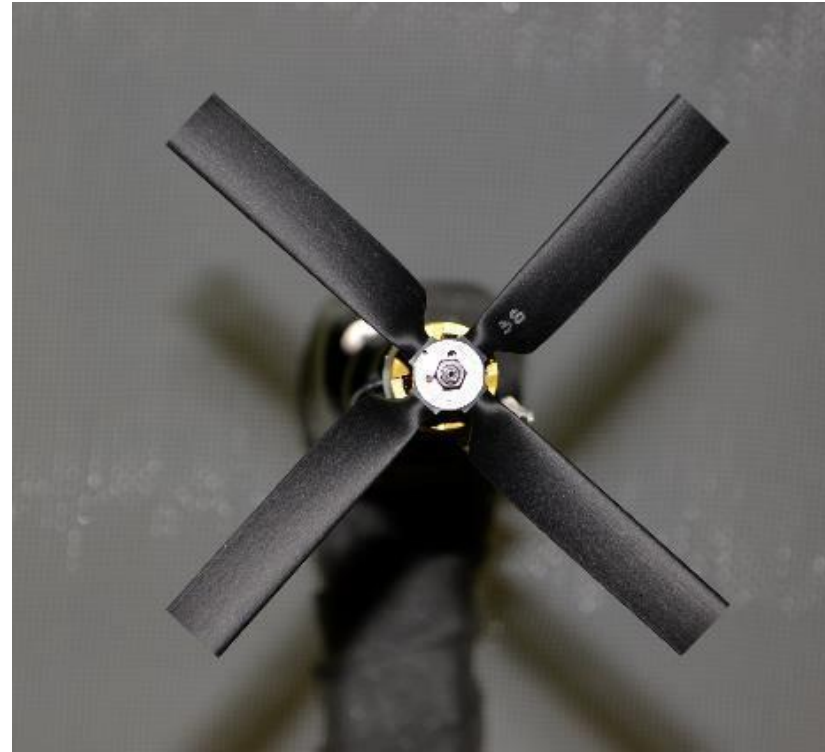
Rotor dimensions:

- Radius = 0.15875 m = 6.25 inches.
- Chord (constant) = 0.03175 m = 1.25 inches
- Number of Blades = 4
- Solidity (σ) = 0.255
- Airfoil = NACA 0012 with trailing edge modification:
0.5mm constant thickness.

Nominal Conditions:

- Nominal RPM = 5500
- Nominal Tip Mach = 0.27
- Design C_T = 0.0137 ($C_T/\sigma = 0.0539$)

Rotor Images



Examples of rotors built

Rotor in Small Hover Anechoic Chamber (SHAC)
at NASA Langley Research Center



Test Conditions and Data

Test Conditions:

- RPM sweep.
- Collective pitch (manually adjusted between runs)

Potential data available:

- Thrust.
- Torque.
- Acoustics at a various microphone locations.

Data not currently measured:

- Blade deformation.
- Blade pressures.



Availability of Data

Data should be available after publication of paper:

Title: “Acoustics and Performance Characteristics of an Ideally Twisted Rotor in Hover” [AIAA Paper Number TBD]

Authors: Pettingill, N.A., Zawodny, N.S., Thurman, C., Lopes, L.V.

Where: 2021 AIAA SciTech Forum (January 2021)



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