Marshall Problem Statement/ Senior Design Topic

Problem Title: **MSFC/ARF TWT ROLL POD DESIGN**

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Indicate which discipline/sis/are most appropriate to work on this problem, e.g., aerospace, mechanical, electrical, chemical, industrial, civil, computer, physics, materials, test, nuclear, earth science, other
Mechanical/Electrical

Marshall Problem Statement

Background: The big picture with references to previous work (Why would a senior design student be excited about this work?)

The MSFC Aerodynamic Research Facility (ARF) I 4-inch Trisonic Wind Tunnel (TWT) is an intermittent, blow-down wind tunnel that operates from high-pressure storage to either atmospheric or vacuum exhaust. It was designed and constructed from I 954 through I 955 and has been functional since early 1957. Since its beginning, the facility has played a vital role in the research and development of aerospace vehicles and is used for basic research of cutting edge design. The TWT has an automated hydraulic sector that pitches between nominally ±9.5° total angle of attack. Various offsets can be installed to achieve higher total angles of attack while still remaining within sector limits. The TWT currently has no automated roll mechanism. Therefore, roll angle changes must be performed manually. To facilitate roll and configuration changes, the pitch sector and diffuser telescope to allow access to the - test section and model. Previous work has been performed to develop a roll pod design to incorporate with the pitch sector and mock-ups or prototypes developed to assess functionality and/or potential impact on data quality. However, sufficiently small packaging to satisfy the desired specifications has been elusive.

Recent/on-going research on the problem (What resources, if any, are available to the senior design team, such as equipment, software, facility utilization)

Basic tunnel layout information is available to the design team, as would be information garnered from previous attempts to provide a valid design. Specifications of the desired operating characteristics is also available.

Details of the problem; design constraints, requirements (if any), outcome expected (one semester Senior Design course lasts 15 weeks; two semester course lasts 30 weeks.) (What do you expect the senior design team to accomplish?)

Final design layout, fitting the performance specifications and operating criteria, suitable for fabrication would be the desired outcome. Detailed requirements follow:

- **Roll control shall be performed during run setup. It is also desired that the system can perform roll control during a test run.**
- **The roll position shall be controlled to ±18I degrees from the nominal position. It is preferred to use an absolute position measurement, perhaps by absolute encoder or incremental encoder with a home switch. It is also preferred to measure the test article position, rather than any derived or mechanically linked position.**
- **The system provided must be removable from the sector. Preferably, it uses the existing sector chuck. If modifications to the sector are made, the provided unit must be removable from the sector.**

- **The initial mechanical design will be presented to ET20 management at the earliest opportunity so that it can be evaluated for wind tunnel blockage. ET20 will provide feedback to the design, based on analysis. The design needs to fit in the existing envelope and accommodate existing sector range of motion (±9.8 degrees). Physical clearance must be evaluated for the full range of motion.**
- **The mechanical design shall allow for balance signal and excitation wires to get from the balance out to the breakout box located on the side of the wind tunnel. The current, and preferred,**
  method is to run the wires down the center of the supporting hardware. Care shall be taken to minimize electrical noise exposed to the instrumentation wiring.
- **The system shall allow base pressures to be mounted and maintain relative spacing to the test article during rotation. The design must not interfere with tubing routing from the measurement location to the exit of the wind tunnel.**
- **The total rolling load on the balance is the inertial load plus the running aerodynamic load. The sum of these must not exceed the balance limit (50 in-lbs). Historically, maximum aerodynamic loads (achieved at startup and shutdown) do not exceed 10 in-lbs. The Senior Design Team must calculate, provide, and get concurrence on the maximum test article mass (moment of inertia) allowed for the acceleration rate to be used, in keeping the torque below the balance limit.**
- **The design of the drivetrain shall be made as stiff as possible, to minimize torsional resonance.**
- **The Senior Design Team will recommend the motion control hardware, but not the motion control platform or software for this effort. Motor, feedback device and mechanism are subject to the approval of ET20 management and controls engineer. A closed-loop, realtime motion control platform and software will be provided by ET20.**
- **Mechanical Limits:**
- **±I 81 degree range of motion from 0 (vertical), mechanical hard stop in each direction**
- **Accuracy ±0.05 degrees of setpoint**
- **Minimum of 50 inch*lbs of torque**
- **Speed variable from 0.5 to 30 deg/sec, mechanical design of the drivetrain must limit output speed to 30 deg/sec at max imum speed of motor**
- **Environmental Limits:**
- **Pressure operating range from 0.16 to 50.0 PSIA**
- **Temperature operating range 0 to 140 deg F**
- **Exposure time to a and b is <60 seconds.**

Senior Design Project Rules:

l. Weekly telecons will be scheduled to maintain proper progress and prevent dead-end ventures.

2. Deliverable /s required (e.g. one semester course - a written final report; two semester course - written final report and a prototype/model (if practical))