# 2022 OSU Make Ohio AEP Challenge Pseudo Wind Tower

### Background

AEP is currently putting into service our North Central Energy Facility (NCEF). This is composed of three wind farms in Oklahoma. It will have a combined total capacity of nearly 1500MW, contain 531 wind turbines and cover an area of approximately 300,000 acres.

The management and maintenance of this facility to assure maximum production will be an enormous effort. As part of the project we have had an engineering team working to leverage sensor associated monitoring diagnostics and analytic software. This system will need to detect issues early, identify predictive maintenance and improve the overall efficiency.

### Challenge

For the Make 2022 challenge, the students will be provided with a small desktop fan. This fan will serve as a "pseudo wind tower". This will allow for "table top" experimenting with equipment monitoring. Various sensor can be used to measure the performance of the fan as well as correlating multiple sensor readings to identify equipment condition. Analytics can then be developed to display, analyze and diagnose equipment issues.

Small pieces of tape can be added to the blades to simulate damage or create balance issues. Cardboard could be cut/fitted to obstruct a portion of the inlet airflow into the fan to simulate wind-loading changes. Can the sensors and analytics detect these issues and identify the causes?

Students may focus on any aspect of this topic and are encouraged to use any other items they may have available. This includes the fan, sensors, microcontrollers, etc.

## **Project Ideas**

The following is a list of possible project ideas. This is not an assignment list, just some ideas to generate interest and stimulate thinking.

- 1) Speed Detection: Build a tachometer circuit.
  - a. Phototransistor/LED using the plastic bracket to "shoot across" the blades.
  - b. Mount LED and phototransistor together and detect a "shiny spot" on a blade.i. More compact method of sensing.
  - c. Build an external timing circuit or use the microprocessor.
  - d. Microprocessor: Loop timing vs use of interrupts.
  - e. Build LED array or 7 segment as speed tach display
- 2) Strobe Light: Use a "super bright" LED and flash synchronous with fan blade.
  - a. Very bright LED circuit.
  - b. Assure microcontroller board can power, if not, use a transistor as a driver.
  - c. Demonstrate timing delay to "move" the apparent position of the blades.
- 3) Vibration: Use accelerometers to measure vibration.
  - a. Depending on speed of measurements, can this be correlated to individual blades?
  - b. Investigate blade balance, speed correlation, etc.
  - c. Use FFT to do deeper analysis of vibration patterns.

- 4) Sound/Audio: Monitor acoustic signature and detect blade issues.
  - a. Establish baseline at different speeds/loadings
  - b. Alter blade with a piece of tape and compare
  - c. Could use FFT for more involved investigation.
- 5) Fan Motor Temperature: Measure motor case temperature.
  - a. Does this change with fan speed/load.
- 6) Temp/humidity: Measure atmospheric conditions, correlate with fan operation. (We have multiple weather stations at our facilities)
- 7) Camera: Automatic capture of blade images
  - a. Using the tachometer measurement and strobe, capture blade images.
  - b. Using blade speed, delay capture so that each blade can be imaged individually.
  - c. Integrate with a timer to trigger on a preset interval.
  - d. Integrate with an alarm level to trigger on a condition (vibration).
  - e. Unknown if the camera shutter speed is sufficient to get clear images.
    - i. May want to try a dark room with the strobe LED.
    - ii. Strobe pulse time could be adjusted to compare "blur" vs image brightness.
- 8) USB Power monitor: Monitor power provided to the fan. The fan is 5V USB powered.
  - a. This would involve modifying a USB cable to include a hall sensor or shunt resistor.
    - i. Note: Parts for this are not included and is a more advanced idea.
- 9) Wind speed/Direction: build a simple wind speed/direction indicator.
- 10) Fan position: Build a fan positioning system with data from the wind speed/direction sensor or simulated measurements.
  - a. Wind tower position is an important efficiency issue, for this tabletop example, an advanced team could use a servo or stepper motor and make a moveable base to position the fan to a measured wind direction.
  - b. Tracking/positioning error could then be monitored.

#### Data Analysis Ideas

- 1) Compare and monitor patterns/correlations between the different measurements during baseline conditions and simulated conditions (altered blades, obstructed flow).
- 2) Develop basic machine model. Predict power usage vs blade speed or airflow rate.
- 3) Can you detect correlation with atmospheric changes? (May be hard, but you could take outside)
- 4) Develop graphic presentation of data with alarms and operator prompts.

02/27/22 : wje