Faculty Small Grant Proposal:

Diagnostic equipment for the Red Dragon Wind Tunnel facility

Physics Department
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February 18, 2021

Project proposal

The Physics Department at SUNY Cortland recently completed construction of a small wind tunnel, a project that began in mid-January with financial support from the Physics Department's discretionary research funds. This facility will be used primarily in upper-division physics courses, such as PHY 357 – Intermediate Laboratory. We have also invited the other science departments to use it and may also employ it in introductory physics courses when discussing topics like drag forces. Additionally, we plan to show the wind tunnel to new and prospective students and use it as a talking point for recruiting.

Any scientific device is only as good as the measurements it can produce. Currently, our device has no measurement capability, either qualitative or quantitative. This proposal seeks funding to outfit the wind tunnel with a modicum of tools and sensors that will transform this first device into a real experimental facility capable of advancing student learning in both introductory and advanced classes. The addition of three types of measurement devices would transform this facility into a powerful pedagogical tool, being

- flow visualization using a smoke injector;
- flow speed measurement using pressure sensors;
- and a "balance" for measuring lift and drag forces on models.

The first of these tools is a simple smoke injector system, the device we commonly think of from images for wind tunnel testing. This is a great method for visualizing the flow of air around a model and can also illustrate where flows transition from laminar to turbulent. This type of measurement is perfect for building intuition about fluid flows, but is more qualitative than quantitative, and is best used in conjunction with other measurements that allow for comparison against theory. A simple camera, such as the GoPro unit recently purchased by the Physics Department, can be used to capture high-speed images of the flows. The proposal described here will use injection of a small amount of vaporized liquid nitrogen gas for flow visualization. This has clear health and safety advantages over smoke. A set of LED strips mounted internally to the test chamber will provide variable illumination for acquiring clear images of the flows.

The second and third device on the list will provide quantitative measurements that will allow students to compare the observed phenomena against theory. The pressure sensors will provide the upstream flow speed, which is the primary quantity in theories of lift and drag. We would like to purchase an electronic pressure transducer for these measurements.

The actual lift and drag forces will be measured using a two-axis force sensor, a device referred to as a "balance" in the wind-tunnel testing literature. This balance will be created in the spirit of the balance used by the Wright brothers, and will be an analog system using hanging weights routed over a system of pulleys. Remaining plywood from the construction of the wind tunnel will be used to create the mounting frame for this measurement device.

Project budget

No other sources of funding are being pursued at this time. Necessary funding in excess of the $500 requested by this grant will be provided from discretionary research funds that are still usable by the Physics Department (these funds come to us through the RF office and are not subject to the same state regulations on spending as the primary operating budgets).

It may be relevant to the larger considerations of funding transformative projects at SUNY Cortland that it is entirely feasible that we could pursue additional funding, of a substantially larger magnitude, to build a scientific-caliber wind tunnel facility. The experience gained through designing and operating this first toy facility will be invaluable in establishing ourselves as credible researchers in this area and helping us to craft a strong argument for a larger facility.

Item 1: Flow visualization

Liquid nitrogen dewar, $133
https://www.amazon.com/Minneer-Cryogenic-Container-Nitrogen-Canisters/dp/B08KD616SH

Cryogenic gloves, $34
https://www.amazon.com/Cryogenic-Waterproof-Temperature-Resistant-Protective/dp/B01L8WA1H0

LED strip, 2 meters, $70
https://www.adafruit.com/product/1948?length=2

Item 2: Pressure sensors for flow speed measurements

Pressure transducer, $210
https://www.omega.com/en-us/pressure-measurement/pressure-transducers/px180b/p/PX180B-001GV

Item 3: Balance for two-axis force measurements

10 pulleys for cable management, $19
https://www.mcmaster.com/3434T35/

Pack of 1” dowel pins for pulley axles, $12
https://www.mcmaster.com/95648A682/

Aluminum bar for constructing the balance arm, ¼” x ¼” x 48”, $9
https://www.mcmaster.com/9447T33/

Total: $487 (not including shipping fees)