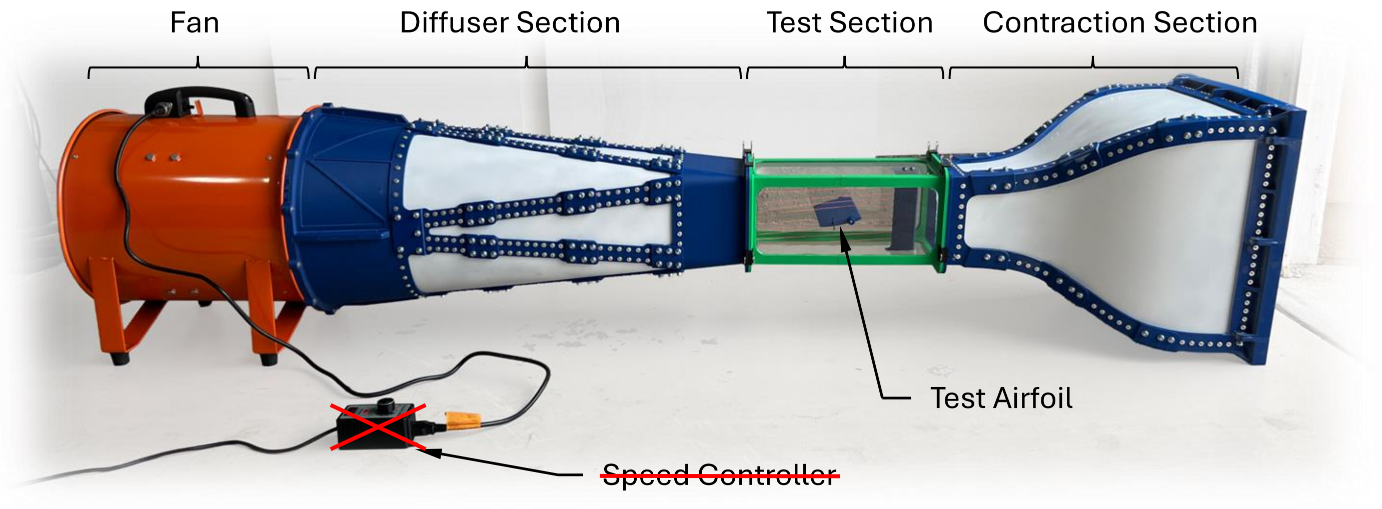
GASSSS Wind Tunnel



A **wind tunnel** is a specialized testing device used to study how air flows around objects. Engineers, scientists, and students use wind tunnels to observe aerodynamic forces—lift, drag, stability, and turbulence—under controlled conditions. By understanding how air moves, they can improve the performance of aircraft, rockets, vehicles, drones, and a wide range of engineered systems.

The fully assembled wind tunnel measures 94.5 inches in length. The convergent test section is 20 × 20 inches in frontal area, and the fan case diameter is 16.5 inches. The constructed is a bolted and riveted assembly utilizing **5052 aluminum sheet** for structural strength and corrosion resistance. Custom fittings, alignment blocks, and mounting interfaces are fabricated from **3D-printed PLA**. The fan sub-assembly incorporates epoxy resin bonded flange components with captive nuts, allowing the diffuser section to be securely fastened while still permitting easy disassembly for transport or maintenance. The tunnel was intentionally designed as a **modular system**, enabling the test section to be swapped out for alternate configurations or experimental setups as needed by the presenter. GASSSS maintains access to all Siemens NX CAD models of the wind tunnel, allowing rapid modification, adaptation, or re-printing of components for future demonstrations. While the tunnel is fully capable of handling expected operational loads, care should be taken to avoid dropping or striking assemblies, as printed components, flanges, or alignment features may be damaged if mishandled.

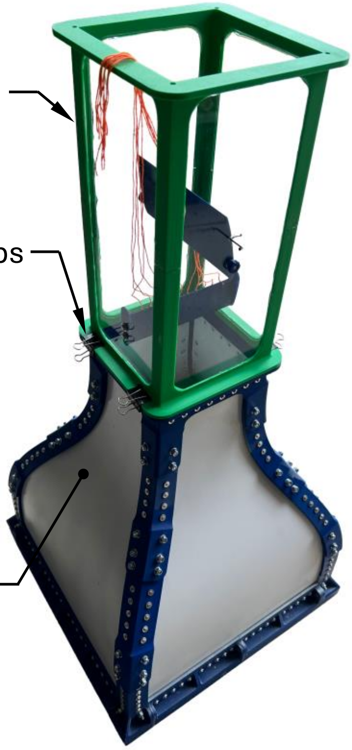
This wind tunnel was built in the spring of 2025 for the **Deer Canyon Elementary School STEAM Night** to provide students with a hands-on demonstration of fundamental aerodynamic principles. The system is powered by a **5,500 CFM fan**, which draws air through three primary sections: the **contraction section**, the **test section**, and the **diffuser section**. Although a variable speed controller was originally planned, the fan's operator manual explicitly forbids external speed control. As a result, airflow is managed using the fan's built-in **two power level settings**.

In operation, air first enters the **contraction section**, where the narrowing geometry increases airspeed and smooths the flow. It then passes through the **test section**, where models can be placed for observation or measurement of airflow behavior. Finally, the air expands through the **diffuser section**, which helps recover pressure and stabilize the exit flow.

The design provides a stable and highly visible airflow field, making it an effective educational tool for introducing students to aerodynamics and engineering design. However, because the **fan cannot be paired with a variable speed controller**, the tunnel operates only at its two fixed power settings. As a result, airflow cannot be proportionally varied, and the integrated streamlines and flow-visualization features represent the primary limits of its educational capability. Despite this, the tunnel remains a clear and engaging platform for demonstrating fundamental airflow behavior.

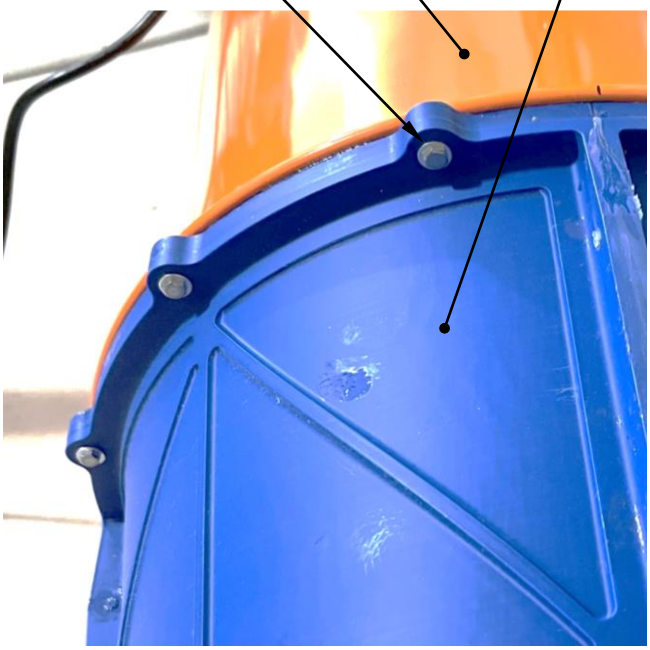
HANDLE WITH CARE

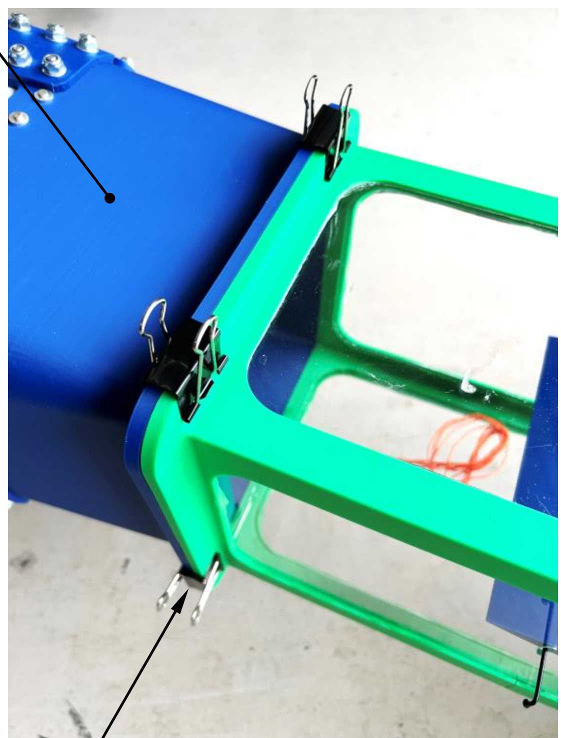
Includes 3D printed parts



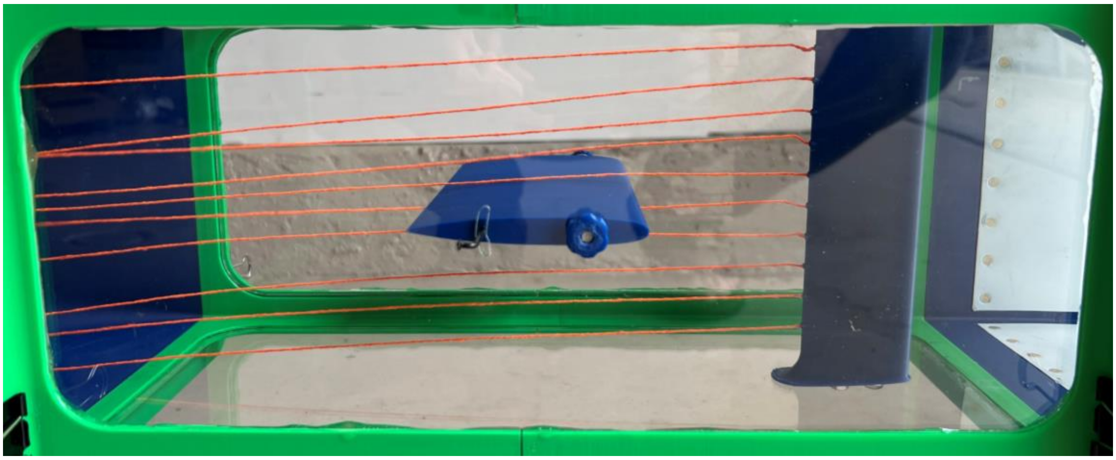
Assembly Instructions

1) Stand the Contraction section up vertically, so it is resting on the inlet face.
2) Place the Test section on to the Contraction section, keeping sure to insert the alignment pins (quantity 4) into the test section
3) Secure the test section to the convergent section using binder clips (quantity 4). You have now completed the Contraction section / Test Section Assembly.
4) The Diffuser / Fan Assembly is assembled with10-32 x 1 bolts (quantity 12) and captive nuts in the fan flange. To install, First stand the fan up vertically. Get all bolts started before tightening down. It may be necessary to 'jiggle' the diffuser section to engage all threads. **Hand tighten with screwdriver torque only, do NOT use socket wrench.**
5) Tilt Contraction section / Test Section Assembly and Diffuser Section / Fan Assembly down onto their sides so they are facing each other. The airfoil should be horizontal in the test section.
6) Slide the Test section / Contraction Section Assembly onto to the Divergent section, being mindful of the alignment pins.
7) Secure Test section / Convergent Section Assembly to the Divergent Section assembly using binder clips.



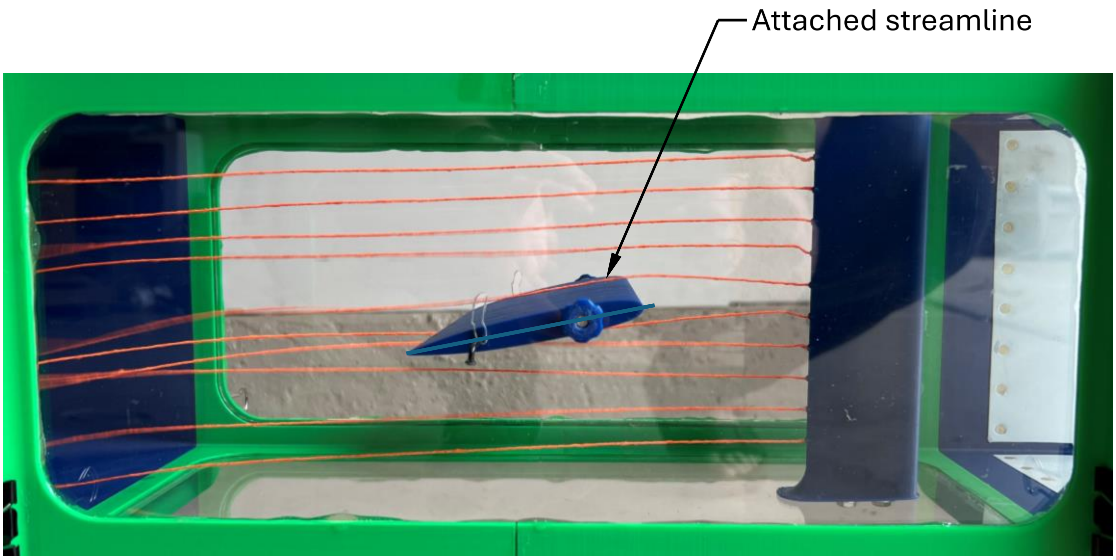


Tunnel Operation



0° AoA

During operation, the test section contains brightly colored streamline threads that make airflow behavior easy to observe as models are introduced, as shown in the accompanying images. With the fan operating at its higher setting, and accounting for approximately 30% system losses, the 7-inch by 7-inch test section produces a nominal airflow speed of **about 190 ft/s (≈130 mph)**. When an airfoil is held level in the flow—as illustrated in the first image—the streamlines remain straight and evenly spaced, demonstrating stable, uniform flow. Increasing the airfoil's angle of attack, shown in the second image, causes the streamlines to deflect downward, visually conveying lift generation and the effect of changing AoA. For demonstrations, multiple airfoil geometries are provided, including a **NACA0012**, **Clark-Y**, a **Wortmann fx63-137**, and a **Clark-Y based multi-element airfoil**. Each exhibits distinct aerodynamic characteristics, allowing students to compare how shape, camber, thickness, and configuration influence airflow in real time. These hands-on visualizations make the tunnel an engaging, intuitive tool for exploring fundamental aerodynamics.



11° AoA

Clark-Y

Wortman fx63-137

Multi-element – Clark-Y based

CAUTION!
Hearing Protection Required

The fan produces **80–90 dB** of sound during operation, loud enough to require hearing protection for all participants. Sounds in this range are comparable to a lawnmower or leaf blower. Although a few minutes of exposure typically does not cause permanent harm, even short exposure can cause **temporary threshold shifts**, where hearing becomes muffled or "dull," indicating stress on the inner-ear sensory cells. Repeated exposures can accumulate into long-term hearing damage, making proper protection essential.

Because young children are more sensitive to noise and often stand close to the tunnel during demonstrations, **over-the-ear hearing protection is strongly recommended**. Foam in-ear plugs are generally unsuitable for elementary students due to discomfort, sensory sensitivity, and the need for repeated insertion and removal between demonstration runs. Over-the-ear earmuffs are easier to apply, remove, and adjust, making them a safer and more practical option. *GASSSS* may having funding to facilitate the purchase of appropriate hearing protection for demonstrations.

To maintain hygiene, **alcohol wipes should be used to clean the earmuffs between groups**.
For general safety, a **physical barrier**—such as a "**Safety Line – Do Not Cross**" boundary or lightweight stanchions—should be placed around the operating area to prevent students from approaching the tunnel while it is running. This helps maintain a predictable and controlled demonstration zone.

Additionally, if small children are present, it is advisable to assign a **spotter** positioned just outside the safety boundary. The spotter's role is to monitor the audience, ensure that no one crosses into the restricted area, and provide an additional layer of situational awareness for the operator.
Before running the tunnel, the operator should also review **clear hand signals or visual cues** with students to indicate when hearing protection must be **put on**, when it must **remain on**, and when it is **safe to remove** the earmuffs after the fan has completely stopped.

This combination of hearing protection, physical barriers, spotter support, and clear communication ensures a safe and engaging wind tunnel demonstration for all participants.