Material Determination Station

Context & Design Brief

This project was developed within TU Delft's Understanding Product Engineering (UPE) course, where first-year students learn about material properties and their role in design. While theory is well-covered, limited resources and large class sizes have made hands-on learning increasingly difficult. As a result, key concepts like stiffness often remain abstract and disconnected from real-world experience.

The original brief called for low-tech tools to help students identify unknown materials through sensory testing, aiming to build material intuition without needing lab infrastructure or supervision. However, early testing and course analysis revealed a deeper issue: students struggled not just to name materials, but to reason about their mechanical behavior.

The brief was therefore redefined to go beyond exploration and support structured understanding. The revised goal: enable students to interact with real materials and measure them, building both intuitive and analytical skills in material stiffness

Final Setup

The final result is a single setup with two sides, each designed to support a different stage of learning. On one side, students interact with a set of intuitive tools that let them explore basic material properties such as hardness, density, and magnetism through hands-on trial. These tools are intended to trigger curiosity, encourage early reasoning, and help students confront their assumptions about materials.

On the other side, a structured device invites students to dive deeper. Using a compact three-point bending setup, they measure force and deflection, calculate an effective modulus, and discover that theory alone doesn't always match what materials do in practice. The numbers seen in theory assignments or exams don't always hold up when real materials introduce variation, uncertainty, or unexpected behaviour, and that experience is central to the learning goal.

The setup is built from a combination of lasercut wooden parts, 3D-printed components, and affordable off-the-shelf electronics. All parts are easy to produce and assemble, making the design scalable for classroom use without specialised equipment or supervision.

Why It Works

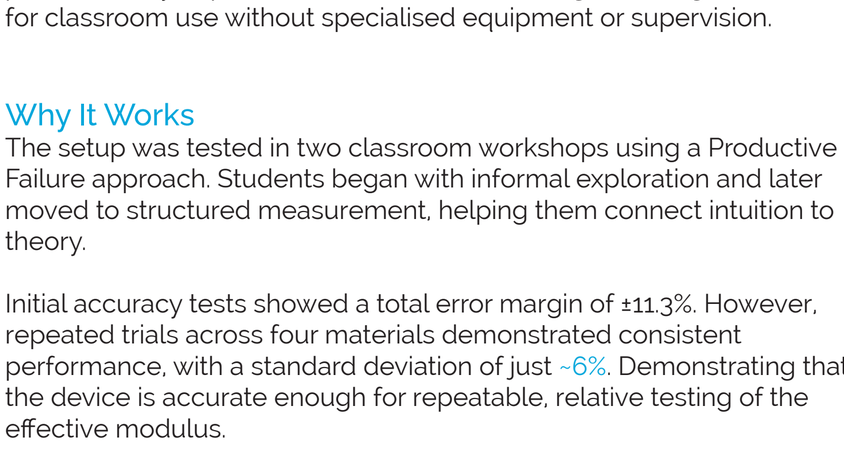
The setup was tested in two classroom workshops using a Productive Failure approach. Students began with informal exploration and later moved to structured measurement, helping them connect intuition to theory.

Initial accuracy tests showed a total error margin of ±11.3%. However, repeated trials across four materials demonstrated consistent performance, with a standard deviation of just ~6%. Demonstrating that the device is accurate enough for repeatable, relative testing of the effective modulus.

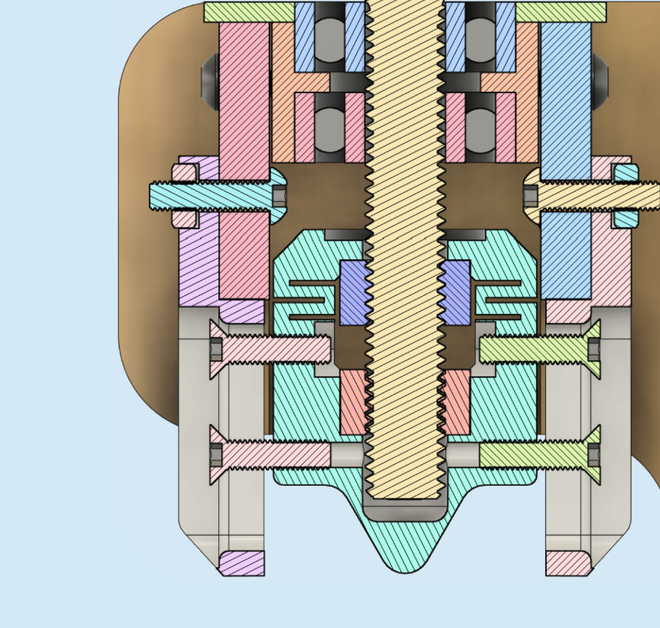
Looking Ahead

The setup is ready for implementation in the UPE course. Small improvements to instructional clarity and sensor mounting are recommended before full rollout. There is interest to test the setup in the official course structure, and there is potential for broader use in other educational contexts where hands-on material testing is relevant.

Structured Device



Intuitive Tools



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