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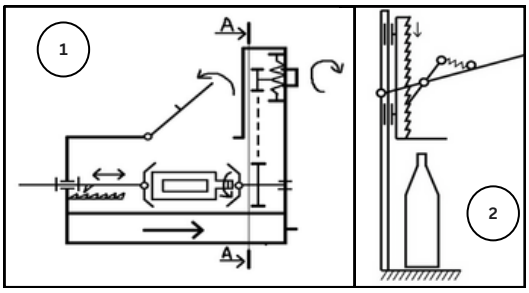
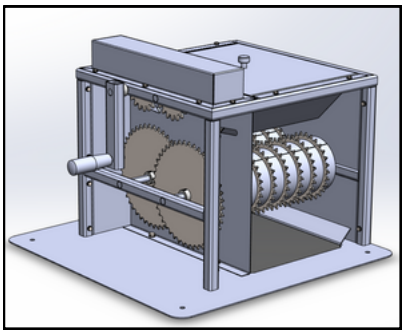
PMD volume reducer





What?

- Design and manufacture a tool that enables the volume **reduction** of PMD waste **by 60%**
- Perform market & safety regulations analysis

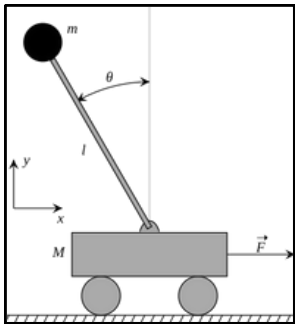
How?

- **Roller-based** mechanical tool with max. 20N manual force using **SolidWorks** and morphological design.
- **Laser cutting**, **welding**, and chain-driven **transmission**, incorporating funnel guides and safety panels.

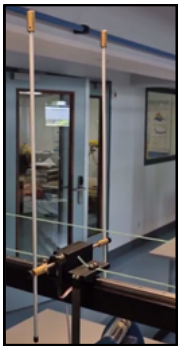
Result

- Visually achieved up to 80% volume reduction of PMD waste (cartons, bottles, cans)

Inverted pendulum control – LQR & MPC



MATLAB
SIMULINK®



What?

- Design and implement advanced controllers for stabilizing the pendulum at upward equilibrium point
- Good **disturbance rejection** and **reference tracking**

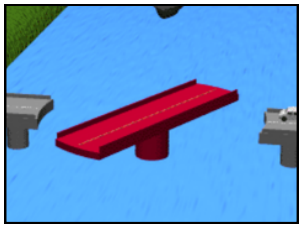
How?

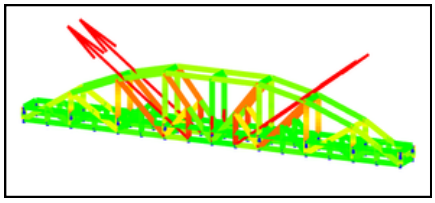
- Identified system parameters using MATLAB's **grey-box system identification** toolbox.
- Designed **LQR** and **MPC** controllers using **Simulink** and **Kalman filtering** for state estimation.

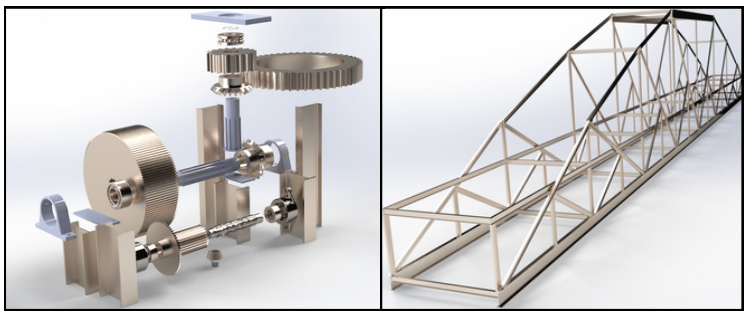
Result

- Disturbance rejection takes ~20 seconds
- Both controllers show steady state error of 5cm

Double-deck swing bridge







What?

- Design and analyze a double-deck swing bridge that withstands 600 ton of load
- Pick a suitable material for every part

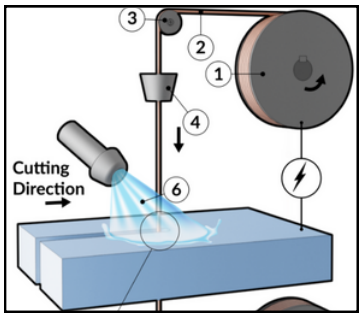
How?

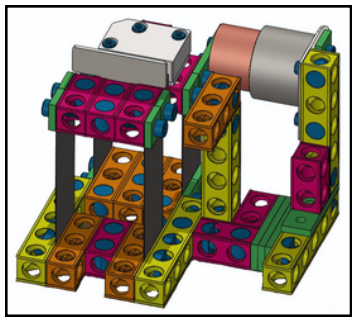
- Implemented custom **Finite Element Analysis** in **MATLAB** on various truss types
- Designed a **transmission box** according to hand books
- Materials selected with **Ansys Granta** and deriving performance indices

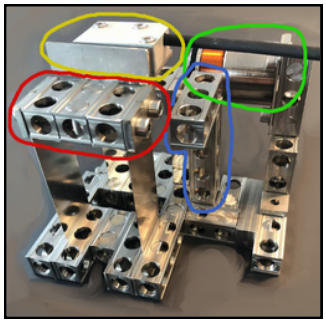
Result

- Bridge rotation of 90° achieved in ~**2.5 minutes**.
- All components met safety, durability (50+ years), and operational requirements.
- **Materials used**: cast iron, structural steel, stainless steel
- **4-stage** gearbox with total transmission ratio of 17

Active vibration compensation system for Wire EDM - PID controller







What?

- Design a mechatronic system to actively cancel wire vibration in Wire EDM machines.
- Precisely track 10 Hz oscillations of the passive stage within ±60 µm error.
- Achieve fast, accurate motion of an active stage using a VCM and magnetic encoder.

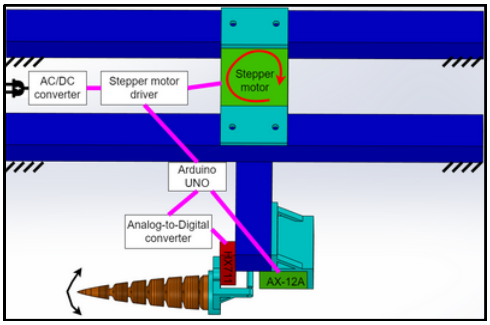
How?

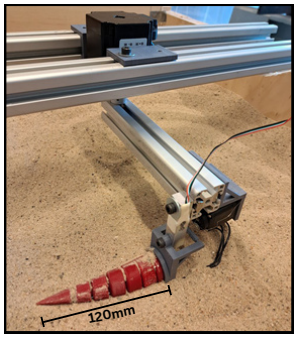
- Designed with leaf springs, SolidWorks modeling, and flexure-based motion guidance.
- Discretized **PID** controller with anti-windup and **low-pass filtering**.
- Extensive simulations in **Spacar** and **Simulink** including sampling, delay, and quantization effects.

Result

- Tracking error of 43 µm post-release, but limitations at full ±5 mm displacement due to high spring stiffness.
- Demonstrated frequency tracking, control system stability, and real-time integration of sensors, actuators, and software.

Steerable flexible robot worm tip for underground exploration





What?

- Develop a bio-inspired, steerable robotic tip with **high aspect ratio** (AR = 4) for local underground soil investigation.

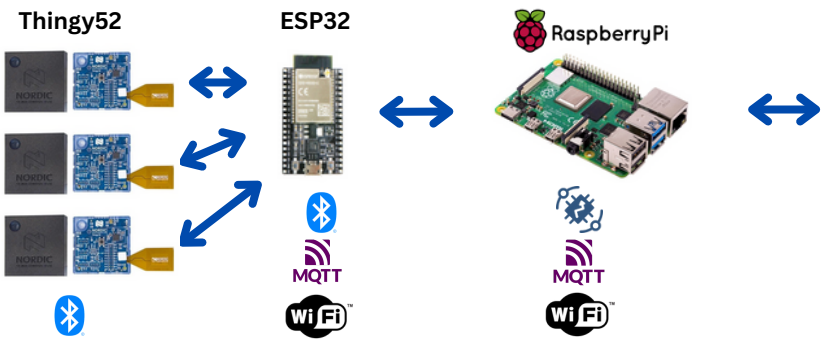
How?

- Created two design concepts inspired by and used FEM analysis (**SolidWorks**) to simulate bending and stress.
- Designed a control mechanism with **Arduino** and steel wires.
- Built and tested a custom setup with sand to measure force required during turning maneuvers.

Result

- Concept prototypes achieved bending **over 20°** in bending tests.
- FEM predictions matched physical behavior

Sensor data collection and visualization using BLE, MQTT, and ThingsBoard



What?

- Implement an **IoT pipeline** to collect, transfer, and visualize environmental data.
- Aimed to connect multiple low-power sensors (Thingy:52) wirelessly and display temperature and humidity in real-time on a cloud platform.

How?

- **BLE** (Bluetooth Low Energy): Used to wirelessly send sensor data from 3 Thingy:52 devices to an ESP32.
- **ESP32**: Acts as the central hub, collecting BLE data and publishing it via MQTT.
- **MQTT** Protocol: Efficiently transmits data to a Raspberry Pi acting as an MQTT broker.
- **ThingsBoard**: Open-source IoT platform used to visualize live data in dashboard format.

Result

- Reliable end-to-end BLE → ESP32 → MQTT → Raspberry Pi → ThingsBoard pipeline
- Live data transfer and real-time visualization from 3 wireless sensors