

Project Portfolio

Šimon Hudínek

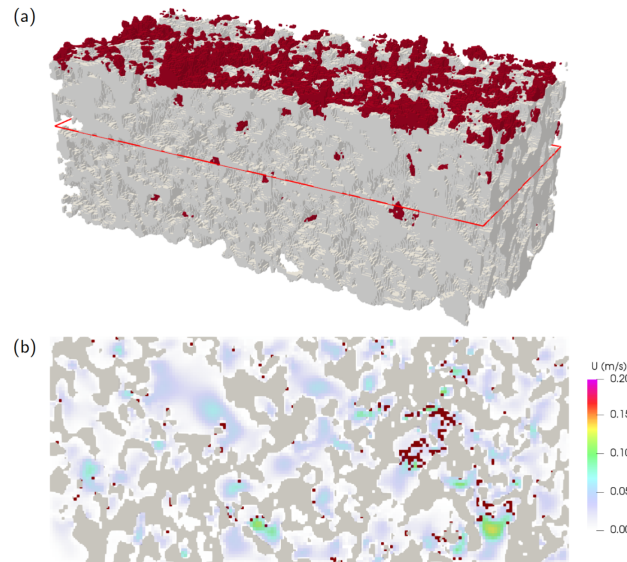
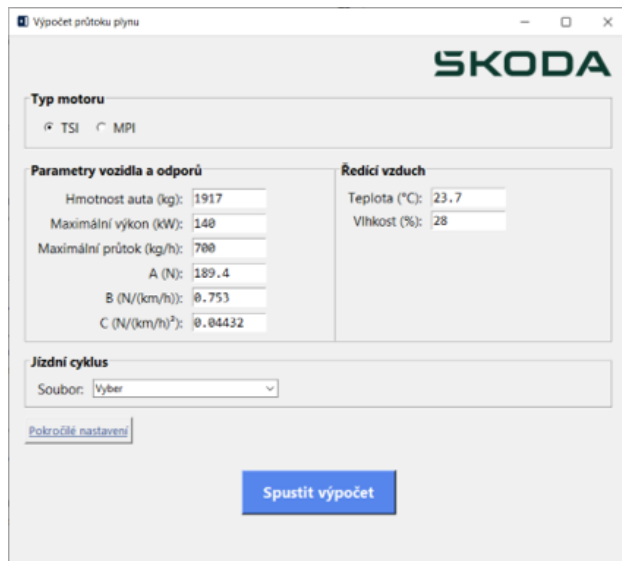
Škoda Auto Internship

Period: 03/2025–08/2025

Dept.: EPS/3 – Emission Laboratory

Developed and implemented a Python-based simulation tool for humidity management in CVS emission testing systems. Validated the model using PEMS data and created a user interface for operators to tune test parameters and prevent system failures. The solution will be integrated into future Škoda Auto testing procedures.

Skills: Python, modelling, GUI design, system validation.



Bachelor Thesis – DPF Model

Improved mathematical models of particulate filters (DPF/GPF) by integrating the effect of soot layers and introducing a new parameter χ to describe uneven gas flow through pores. These extensions significantly improved alignment between simulation and experiment and deepened understanding of particle capture mechanisms.

Skills: Numerical modelling, 1D–3D coupling, simulation.

ESP32 – Smart Bottle

Created a smart bottle measuring water level via capacitive sensing using a Wemos S2 mini. Data are logged to Firebase and visualized in a web interface showing hydration patterns. The firmware manages Wi-Fi connection, power saving, and local buffering when offline.

Skills: ESP32, Arduino C++, Firebase, web dashboard.



Master's Thesis – SCR for Diesel Generators

Topic: Model-based design and control of urea dosing in SCR systems.

Using the DPF/aftertreatment model from previous research, I designed a complete aftertreatment solution for stationary diesel generators. The work focuses on optimizing injector control with Model Predictive Control (MPC) to minimize NH_3 slip and improve overall conversion efficiency. I also verified and improved a commercial SCR setup, calculated optimal system sizing using model predictions, and integrated the new dosing control logic.

Skills: MPC, control design, simulation, hardware verification.



Test Rig Restoration – LabVIEW

After a measurement card failure, the testing rig became incompatible with the new hardware. I restored full functionality by remapping wiring, updating the LabVIEW configuration, and re-working control logic for stability and clarity. The repair minimized downtime and resulted in a more robust system setup.

Skills: LabVIEW, instrumentation, troubleshooting, control systems.

Leadership in Historical Fencing

Active member for 11 years and head instructor for multiple age groups. Organized week-long seminars and historical fencing tours (e.g., around Telč Castle). This long-term engagement has shaped my teamwork, discipline, and leadership skills, and taught me how to lead and inspire others.

Skills: Team leading, communication, discipline, organization.



R&D Team Project: Multi-Platform Water Control

CTO Role & MPC Architecture

Project Overview: I directed a team of 8 engineers to develop control architectures for dual water tank stations. My role combined high-level system design with hands-on development of nonlinear Model Predictive Control (MPC) algorithms and Digital Twin validation.

System 1: Advanced Control (NI-DAQ)

This branch focused on research and advanced control strategies, bridging Python software with physical hardware.

- **Control Logic (My Core Contribution):** I programmed the **MPC controller** using **do-mpc** and **CasADi**. The system performs real-time nonlinear optimization to manage water levels and flows against constraints.
- **Hardware Interface:** Direct control via **NI-DAQmx** card, allowing high-frequency data acquisition and actuation.
- **Software Stack:** Python, PySide6 (SCADA GUI), Flask (Web Editor), and threading for non-blocking operation.

System 2: Industrial Control (PLC)

Parallel development of a robust, industry-standard control solution.

- **Architecture:** Designed the system around a standard PLC unit using PID regulation.
- **Functionality:** Handles sensor signal conditioning, pump actuation, and safety interlocks.
- **Role:** I supervised the hardware integration and validated the system design, ensuring the PID logic was optimized for maximum reliability and performance.

Leadership & Repository

Coordinated parallel workflows to ensure seamless integration and timely delivery of both systems.

- **Workflow Management:** Actively generated and assigned issues to track progress and distribute workload efficiently.
- **Outcome:** The project was delivered on schedule, with final functionality exceeding the original customer requirements.

Repo: github.com/StabiliTeam/control...

Status: Completed (12/2025)

