# Bachelor: Automated Engine Mapping for DTU Roadrunners

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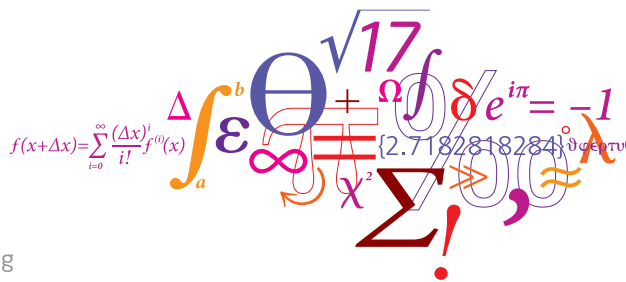



DTU Electrical Engineering
Department of Electrical Engineering

# What is DTU Roadrunner's

- Shell Ecocar Marathon
- Energy efficient driving
- Internal combustion engine

# UN World Goals

- Energy efficiency
- Increase mileage
- Reduced fuel consumption

# Engine Tuning

In general

- Adjust or modify internal parameters of engine calculations
- Can be used to optimize the output of the engine

In our case

- Tune for fuel efficiency
- Injection lengths are changed
- Linear interpolation is used to find injection lengths between indices
- Done by measuring air/fuel ratio (lambda) and manually adjusting the injection times for each index

| RPM | Injection 1 Length [µs] |
|---|---|
| 0 | 6000 |
| 250 | 6000 |
| 500 | 6000 |
| 750 | 6000 |
| 1000 | 4500 |
| 1250 | 4500 |
| 1500 | 4500 |
| 1750 | 4000 |
| 2000 | 4100 |
| 2250 | 3900 |
| 2500 | 3700 |
| 2750 | 3750 |
| 3000 | 3850 |
| 3250 | 3900 |
| 3500 | 3950 |
| 3750 | 3900 |

# Goals of our project

- Improving quality of Map
- Improving ease of Engine Tuning

# Improving quality of Map - method

Possibilities of automated alternatives to engine map:

- Multi-dimensional LUT based on engine measurements
- Software based engine model
- Multi-dimensional LUT based on outputs of engine model

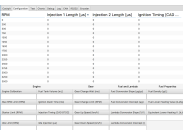
Restrictions of the project:

- No precise engine model
- Only two vectors of control: ignition timing and injection length
- Only measured/measurable variables: Lambda (air/fuel ratio in exhaust) and temperature (intake air, oil, water (coolant), exhaust)

Choice: expanding injection length LUT to 2 dimensions, crank rotation speed and water temperature

# Improving ease of Engine Tuning

Previous manual tuning setup



Two aspects of improved functionality:

- Simple: Press button on ECU, brake when prompted, car will tune itself and stop when done
- Complicated: Connect to UI on computer, start and stop Tuning and see live graphs from in there.

# Challenges

- Engine modelling
- Hardware restrictions
- Continuing software projects
- Mechanical problems
- Controlled testing

# Results I

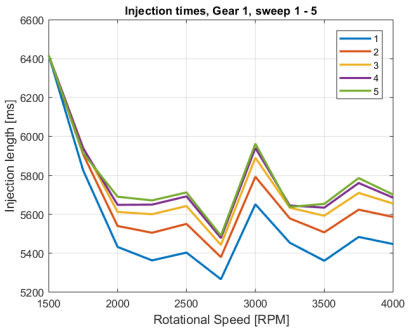



Figure: Example of injection times as they change during an ordinary tuning

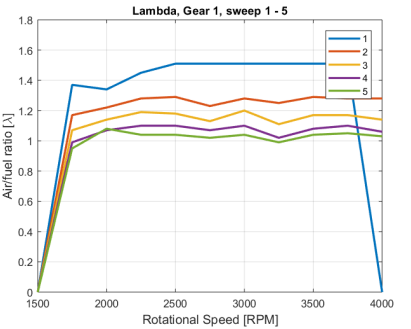



Figure: Example of lambda values as they change during an ordinary tuning

# Results II

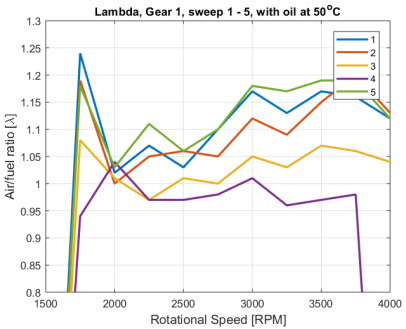



Figure: How lambda changes, when we try to keep the oil temperature constant, without changing the injection times

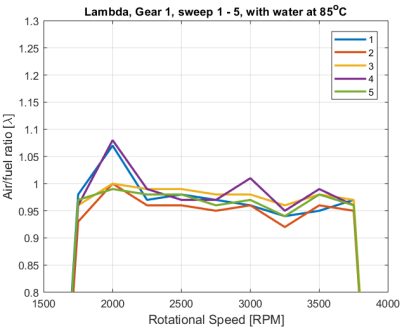



Figure: How lambda changes, when we try to keep the water temperature constant, without changing the injection times

# Conclusion and final month of work

| | |
|---|---|
| 19-22/6 | Finalizing implementation and first tests of the temperature and rotational speed of the engine crank |
| 23/6 | Full system test of the car on Sjællandsringen |
| 24-27/6 | Final adjustments and tests, final implementation of UI |
| 28/6-6/7 | Shell Eco-marathon in London (data gathering and documentation) |
| 7-14/7 | Finalizing writing of Bachelor |
| 15-22/7 | Defense preparation |
| 23/7 | Defense |

# Thanks for your time