Review of the **Doctoral Thesis**

**1-D Model of Roots-type Supercharger**

Submitted to the Department of Automotive, Combustion Engine and Railway Engineering, Faculty of Mechanical Engineering, Czech Technical University in Prague

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Research work described in the submitted Doctoral Thesis develops **predictive simulation model** of the Roots-type supercharger, inclusive shock like compression, heat transfer and leakage phenomena and represents a **unique tool** considering industry standard map-based approach. Model enables **design optimization without** engaging time consuming **3-D CFD** simulation and **before a real hardware is available** as well as it allows **analysis of noise suppression** measures. **Modular** 1-D supercharger **object** should enable connection to a combustion engine model in the commercial tool **GT-SUITE** for further **powertrain optimization**. Details of the research were **published** couple of times at **SAE** and **FISITA** congresses.

A specific **test rig** has been **developed** for supercharger characterization and model calibration with help of **instantaneous pressure** measurement in the inter-teeth gap along the supercharger casing. **Temperature** of compressed air and supercharger **efficiency** was **correlated** using heat transfer coefficient and teeth wall temperature. **Two types** of Roots **supercharger**, “R” & “M”, were measured and modeled to **confirm model** validity.

Doctoral **thesis meets** all **objectives** set at the beginning and Ing. Brynych demonstrated, also considering his published papers, an **expertise** in 1-D modelling of **vehicle powertrains** as well as **component testing** together with his ability to process cross functional assignments in a scientific way with **high quality**.

**Thesis**, written in **English**, is well structured, **readable** and accompanied with many supercharger cross sections done in Catia together with illustrative figures and diagrams **fairly** placed in the **text flow**.

Therefore, I am **recommending** the Doctoral Thesis **for defense presentation**.

Following paragraphs list possible discussion topics during the defense presentation I would be interested in.

1. Have some simulation trials with developed supercharger model been already run in connection with the combustion engine? Even if limited data is available, could Author conclude either on model precision, computation time or another benefit of such powertrain system simulated vs. state of the art map-based approach? What are the must have vs. nice to have parameters to be fed into the supercharger model to assess the technology vs. next best alternative?

2. Chapter on model calibration elaborates on “R” and “M” type of Roost supercharger and recommends clearance ratio of 12. What were the parameters in the 1-D model which were changed to keep that ratio and to align reciprocating piston movement in the model with rotary movement of supercharger lobs in reality? Additionally, R-type was approximated with mean value discharge coefficient of 1.1 vs. M-type with coefficient of 0.75. What is causing such difference in Authors opinion and how he is explaining discharge coefficient higher than 1 for R-type?

3. For upcoming legislation and social pressure, electrification of vehicle powertrain is inevitable. Attempts to maximize ICE efficiency goes hand in hand with application of various hybrid topologies. What is Author’s opinion on using mechanical supercharger in such powertrains (enabler for advance combustion? low end torque and power recovery for gasoline engine with Lambda=1? recuperation? better catalyst light off?) vs. other boosting technologies (waste gated turbo, variable turbine geometry turbo and electrified turbo) and vs. naturally aspirated powertrain?
   Could the mechanical energy of the supercharger be recovered in deceleration events? Considering the literature research done, what would be Author’s guess on the most promising boosting architecture for hybridized powertrain under EU7 boundaries post 2023?

Brno, 23rd March 2019

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