Imperial College London

Biofuel Conversion of An Internal Combustion Engine
Intake and Fuel Group

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Project Brief

Biofuel Conversion of an Internal Combustion Engine

Liquid biofuels (plant-based fuels) are commonly used in countries like the US, Brazil, and Sweden. Biofuels, such as ethanol (E100) are used for their renewable nature and low CO2 emissions, greatly reducing transport-related green-house gas emissions.

Main challenges:

- Turbocharging Honda CBR600F4i engine
- Design and manufacture of new intake manifold
- Overcoming difficult chemical and thermodynamic properties of E100

GT Power – 1D Engine Modelling

- GT Power used to optimise the runner length
- Runner lengths can be tuned to force more air into the cylinders when the intake valves open

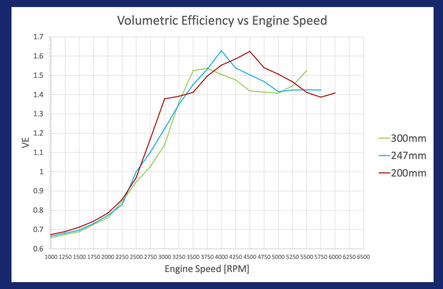
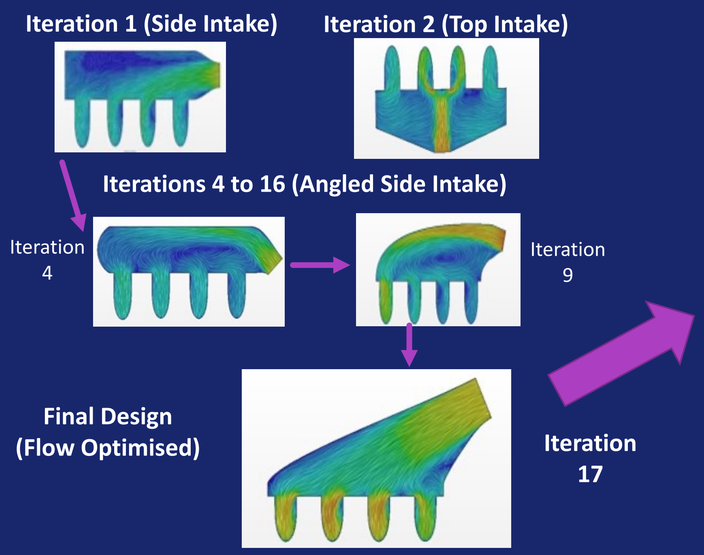
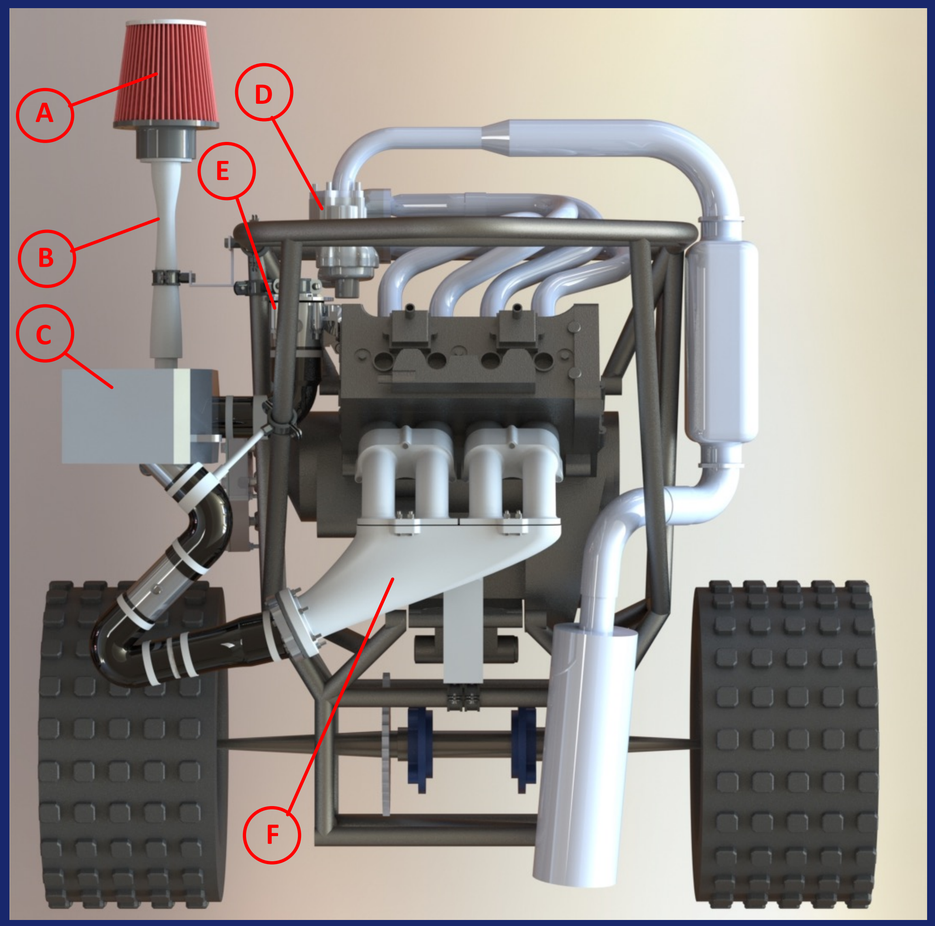


Figure 1. Volumetric Efficiency curves of 3 different runner lengths

CFD of Intake Manifold





A Air filter
B Restrictor
C Intercooler
D Turbocharger
E Throttle
F Intake Manifold

Figure 2. Final 3D printed intake manifold

CFD Mesh Sensitivity Studies

Aim: to find the mesh grid resolution (cell size) that leads to grid-independent results

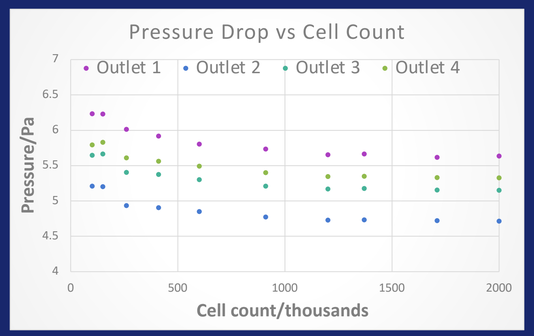


Figure 3. Pressure drop vs cell count in the runners

Results: mesh size of 1.2M cells would provide grid-independent results for flow in intake manifold

Intercooler

Air-to-air	→	Simple, cheap
Small frontal area	→	Low drag
Thick core	→	Higher heat dissipation rate
Side-mounted	→	Short piping

Incorporation of an intercooler was necessary to cool intake air post-compressor from 127°C to near ambient (based on GT Power).

Figure 4. Darkside Developments. (2021) *Upgraded Side Mount Intercooler for 1.9 8v TDi Engines.* Available from: https://www.darksidedevelopments.co.uk/products/upgraded-side-mount-intercooler-for-1-9-8v-tdi-engines.html [Accessed 31st May 2021].

Testing

1. Fuel and air leakage tests
2. Verify ability of intercooler to sufficiently cool turbocharged air before entering intake manifold
3. Measure pressure drop across intake system and compare to CFD and hand-calculations

Redesign and Improvements

Redesign will be based on the testing results of the First Iteration, which will be available **latest** by 11 June

Based on the **current** plans, improvements will include:

Heated fuel rail	Improved plenum design based on more comprehensive CFD	Improved restrictor design based on CFD	Tuning GT Power model to improve validity of results

Figure 5. Glow plugs from Bosch heated fuel rail

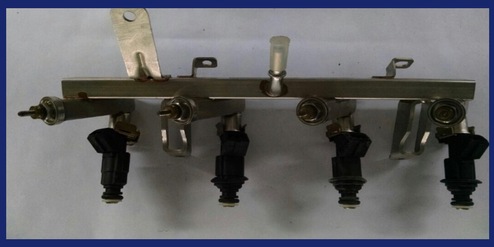


Figure 6. Bosch heated fuel rail