



Modelling of Mechanical Methods of Increasing the Efficiency of an Internal Combustion Engine

Morgan Scrivens

Malcolm McDonald

School of Engineering

BEng Motorcycle Engineering

Introduction

Variable compression ratio and cylinder deactivation systems were studied and assessed as methods of improving the efficiency of the Suzuki SV650 engine. A numerical method of returning a valve lift profile from the camshaft profile was also developed as a change to rocker valve actuation would allow for a more appropriate cylinder deactivation design to be used.

Aims

The project centred around the Suzuki SV650 engine and consisted of three main aims;

1. Assess variable compression systems
2. Assess cylinder deactivation system
3. Develop a numerical model of a rocker actuated valvetrain

Methodology

The operation of the mechanical systems in this project were established by studying patents assigned to their manufacturers. The dimensions for the Nissan engine were measured from an image of a cutaway demonstrator engine. Trigonometry was then used to establish the unknown angles and displacements of each component. This information was then used in the valvetrain model to establish a match of slope and coordinates between rocker and cam surface.

The numerical models were verified against CAD models.

Cylinder deactivation system designs were based on standard SV650 valvetrain components to produce a design to fit the original cylinder head. Solenoid actuation was not considered as incorrect timing could lead to significant engine damage.

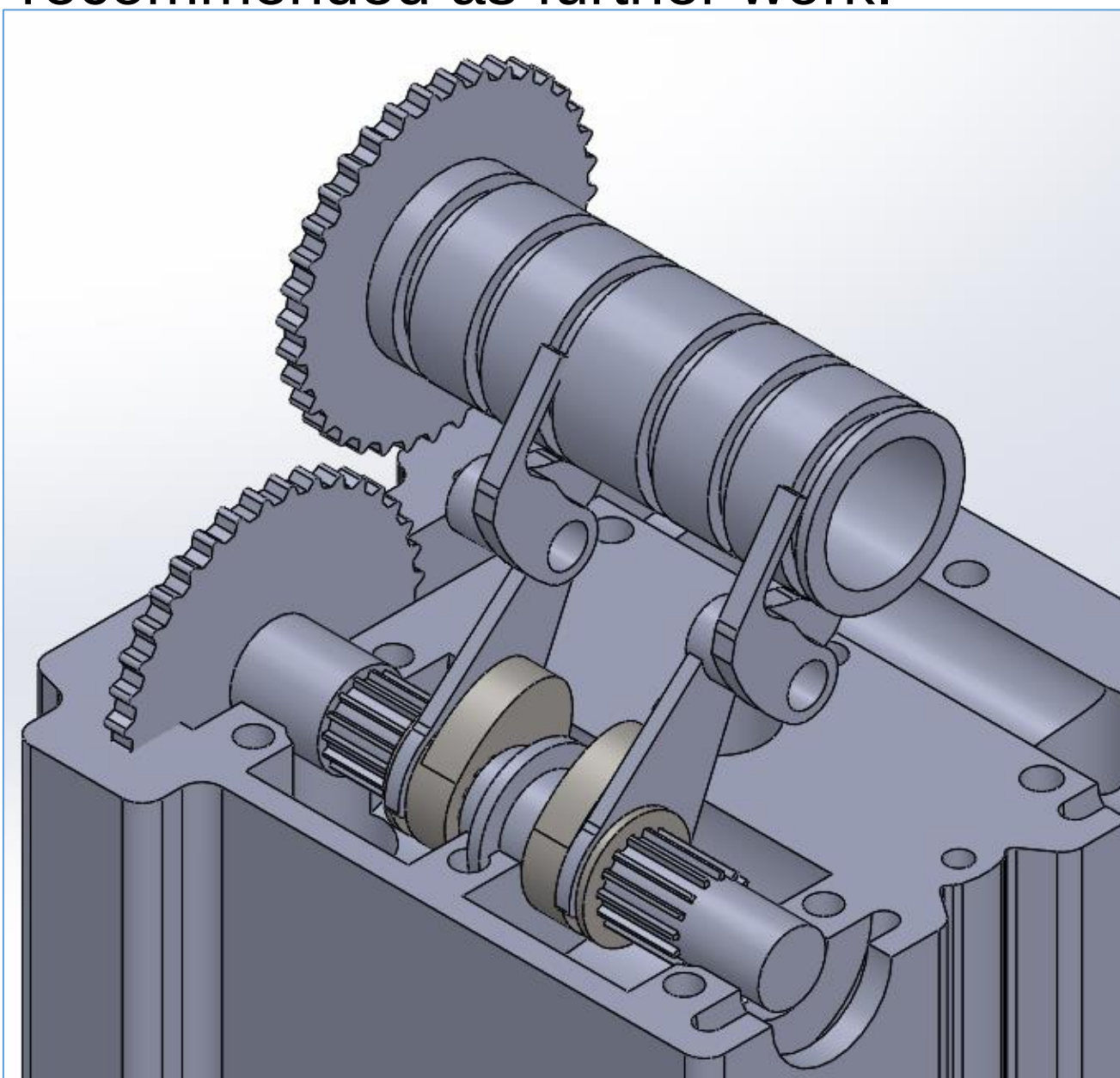


Results

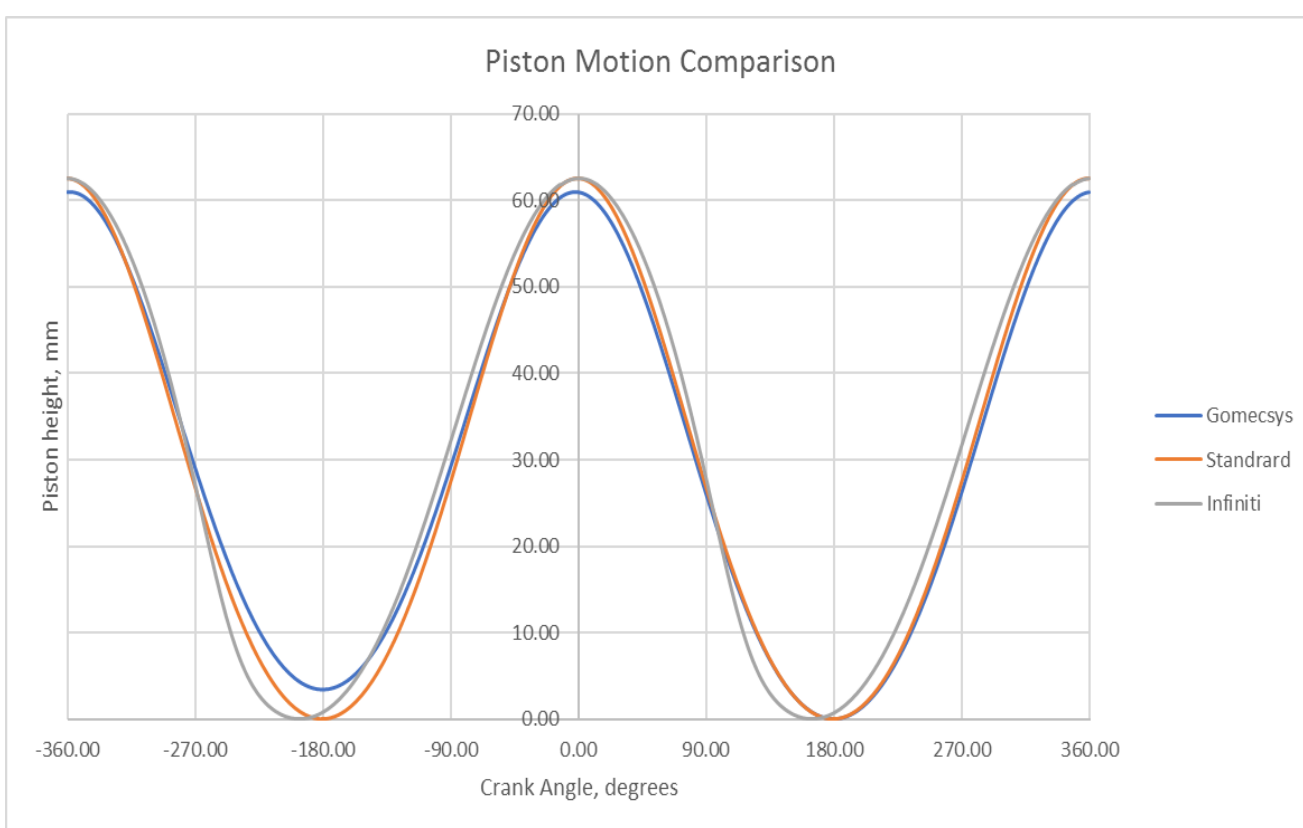
The numerical models of the variable compression ratio systems and valvetrains produced are accurate to within 0.09mm.

The linkage engine design proposed fits the SV650 engine but would produce asymmetrical piston motion.

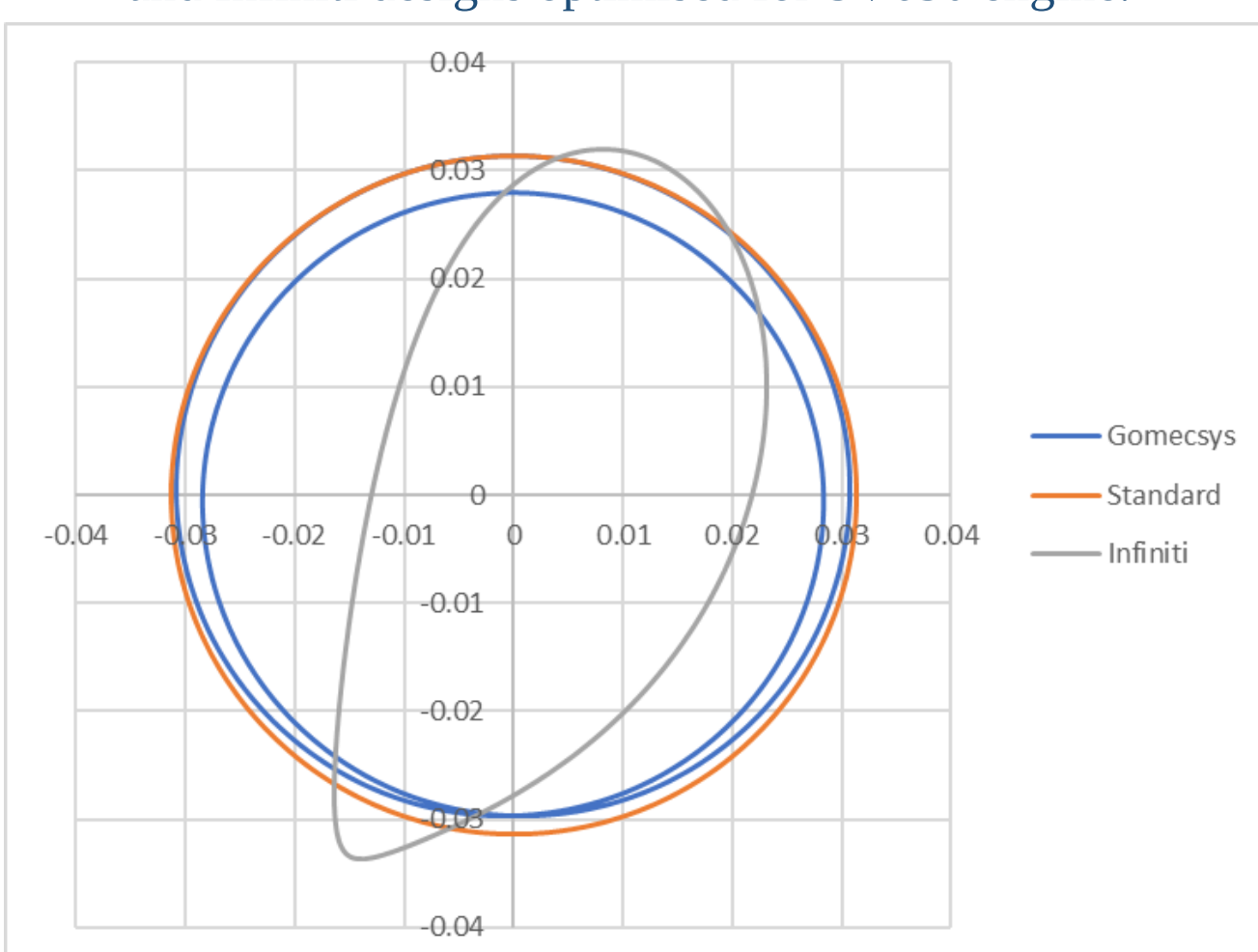
A cylinder deactivation system to fit the original cylinder head without significant modification was designed but deemed to be too large and complex. As a result, a change to rocker valve actuation was recommended as further work.



Cylinder Deactivation Design



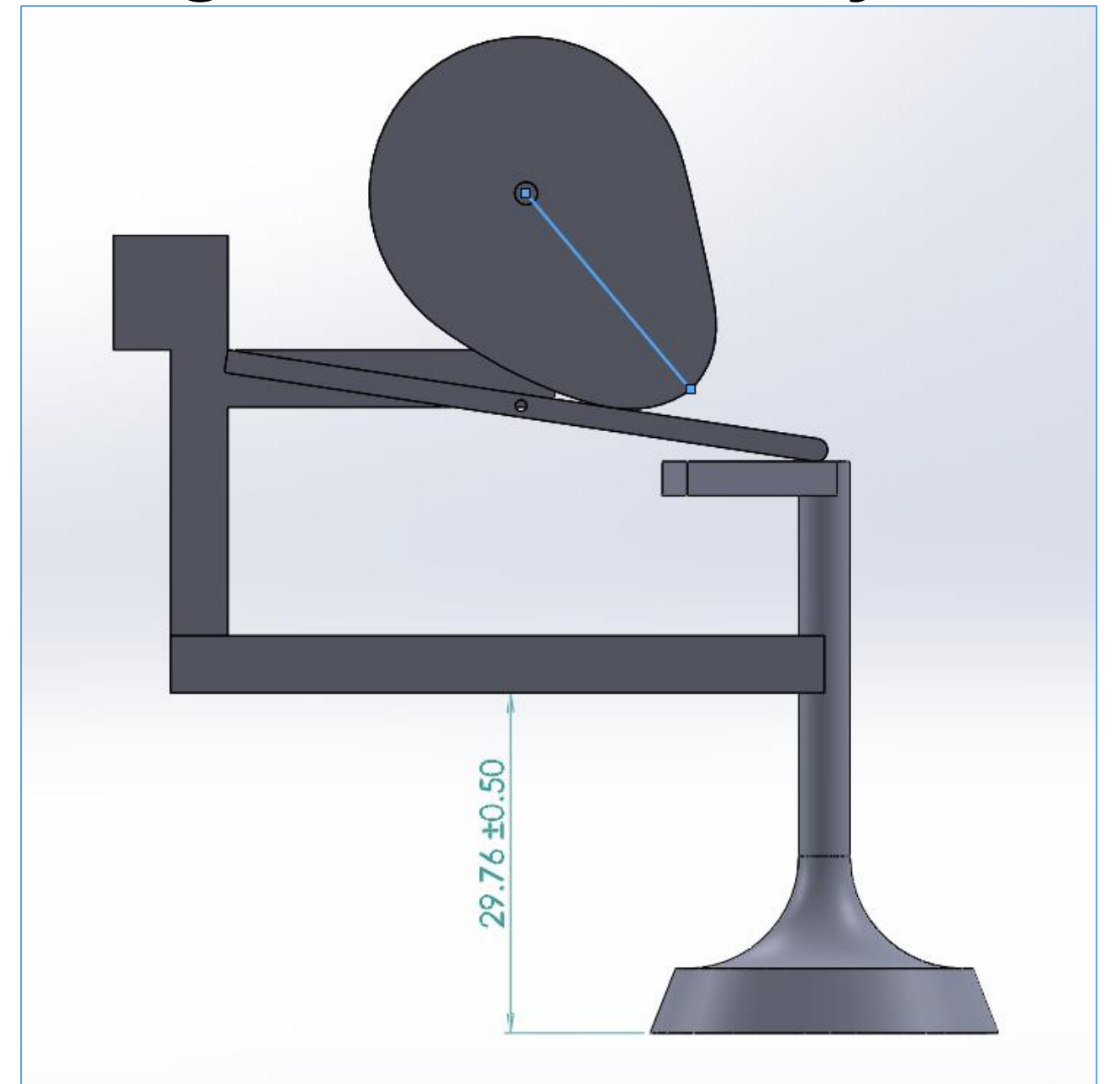
Comparison of piston motion between standard, Gomecsys and Infiniti designs optimised for SV650 engine.



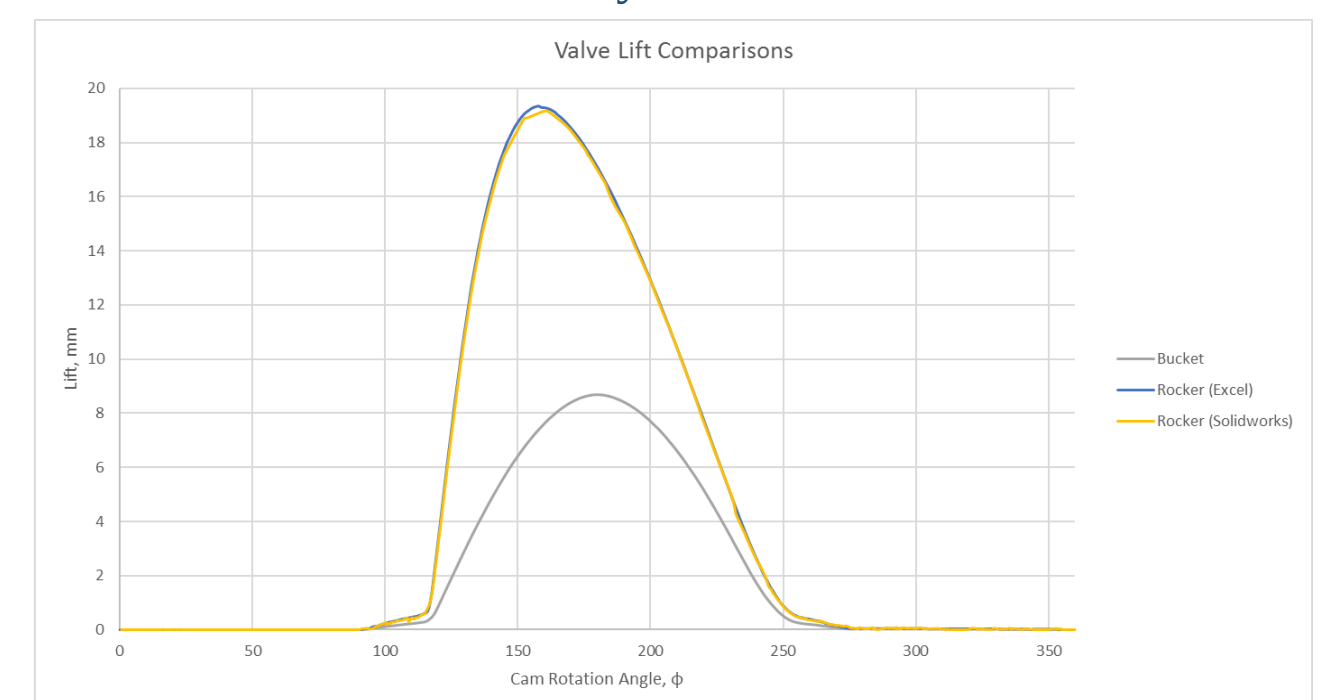
Path trace of big ends for variable compression ratio designs optimised for SV650 engine.

Acknowledgements

The author would like to thank Orthus Racing for the use of their engine.



CAD model used to verify valvetrain numerical model.



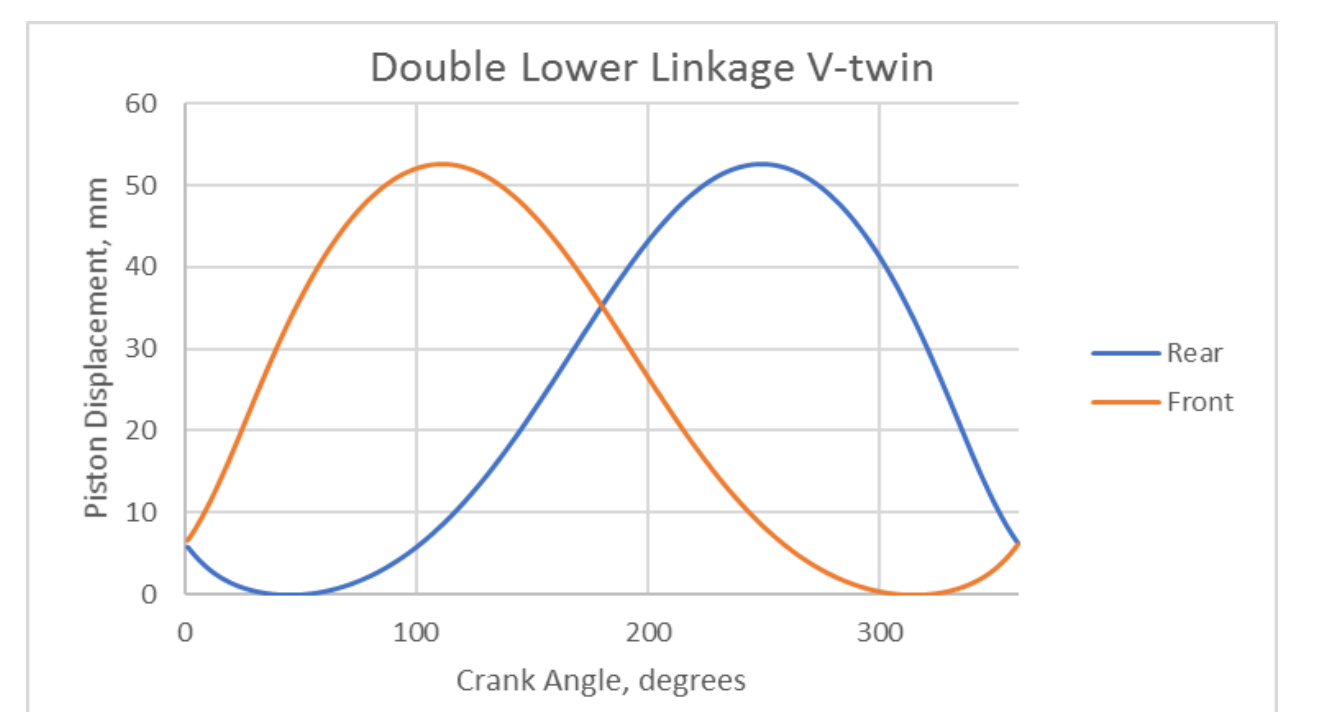
Comparison of valve lift profiles; numerical and CAD.

Conclusions

The linkage type engine could be fitted into the SV650 crankcases; however the V layout means that the design created for this project would lead to asymmetric piston motions between the two banks. This would likely mean challenges in reducing NVH and fuel and ignition mapping. It would be feasible to manufacture and fit a cylinder deactivation system to the SV650 engine without changing the cylinder head casting; although a system that is mechanically timed to valve position would be bulky and negatively affect serviceability of the engine. A change to rocker valve actuation would allow for different methods to be considered, significantly reducing the systems size and complexity.

The numerical model of a rocker valvetrain produced for this project forms a useful and accurate tool in the design and analysis of valvetrains.

Further work to the numerical models created for this project is now possible due to the knowledge gained in their creation.



Piston displacements for linkage type design in SV650 engine.