



Technical Lecture review

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Computational simulation as an engineering tool - Introduction

When a manufacturer or company decides to make something, there is an expectation that it will work.

One such method to achieve this goal is through Computational Simulation.

There are various applications of this, which range from stress tests to Formula 1 driver simulations.

- Consumer expectations drive companies to ensure their products function correctly, and to the appropriate standards for what the part have been designed for.
- Computational analysis and simulation have allowed manufactures to test their parts in different ways than ever before, while also fundamentally changing the time requirements and costs of aspects such as stress testing by allowing them to examine aspects of their components before even making a prototype.
- Companies previously would have to make the part, then test it over months and even years to ensure accurate results.
- The cost of making these parts and testing them can be redirected to the process of running the designs through a simulation, which allows hundreds or even thousands of test scenarios to run on a computer to look for failure points and life cycle timescales and give usable results in a much shorter time.
- This allows companies to redesign parts to avoid these issues much quicker than before. This also means that new parts can be put onto markets, having had more tests and analysis quicker than previously possible.
- Companies can also run fluid dynamics simulations to test aerodynamics, which helps to keep costs low. Instead of making a new carbon fibre wing, they can design and add one to the car on the simulation enabling them to test for results closer to what the car will actually put out on track.

References

Figure 1 + figure 2 - Design With Mahek,- Computer aided designing and engineering, (2017) "Static and Thermal analysis of Piston Head", available at: <https://mehakkar.wordpress.com/2017/05/12/static-and-thermal-analysis-of-piston-head/> (Accessed on 25/04/2025)

Further reading done at:

Quadco Engineering BV – (2009 – 2025), Advantages and disadvantages of Computational Fluid Dynamics, available at: <https://www.quadco.engineering/en/know-how/cfd-advantages-and-disadvantages.htm> (Accessed on: 25/04/2025)

Design News – Dan Carney, (12/12/2023), Red Bull Racing Employs Ansys Simulation to Help Win F1 Races, accessed at: <https://www.designnews.com/automotive-engineering/red-bull-racing-employs-ansys-simulation-to-help-win-f1-races> Accessed on: (25/04/2025)

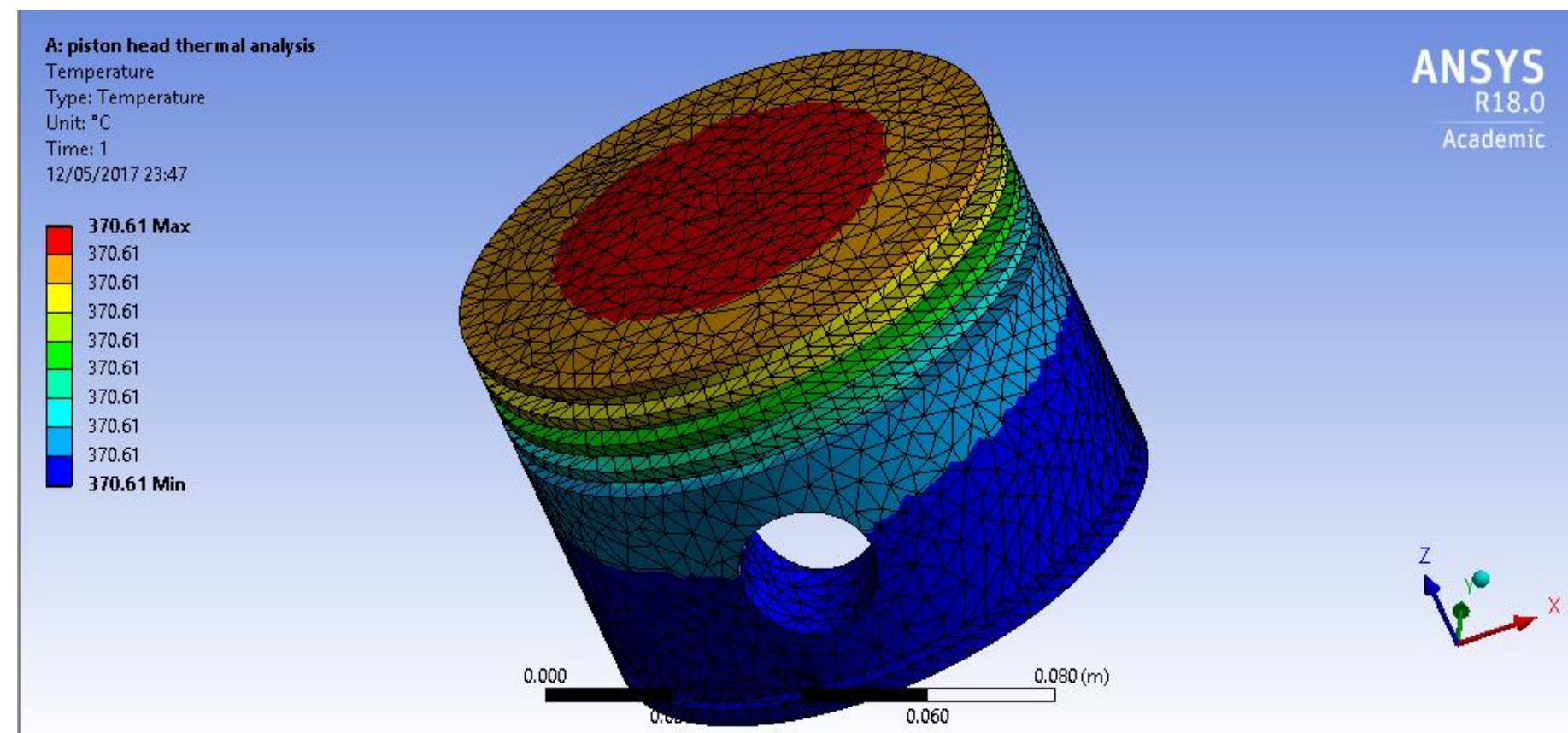


Figure 1- Static and thermal analysis of a Piston head.

- Figure 1 shows a piston head that has been tested for heat distribution over a piston head throughout operation.
- From the data on the photo, you can see that the highest concentration of temperature is on the top middle of the piston, where it reached a maximum temperature of 370.61°C.
- The designs have a mesh put over them to feed information about the components back to the simulation software
- A drawback of these meshes is that they use triangles to map out parts. When using curved parts this is an issue because the part isn't exactly the same as what is being put through the simulation.
- Manually adjusting the faces of the triangles and increasing the number of triangles present on the given mesh can help to curve the mesh.
- This increases the computational requirements to run the simulation as there is more information for the computer to process and can thus make the simulation need more time to render and run for accurate results.

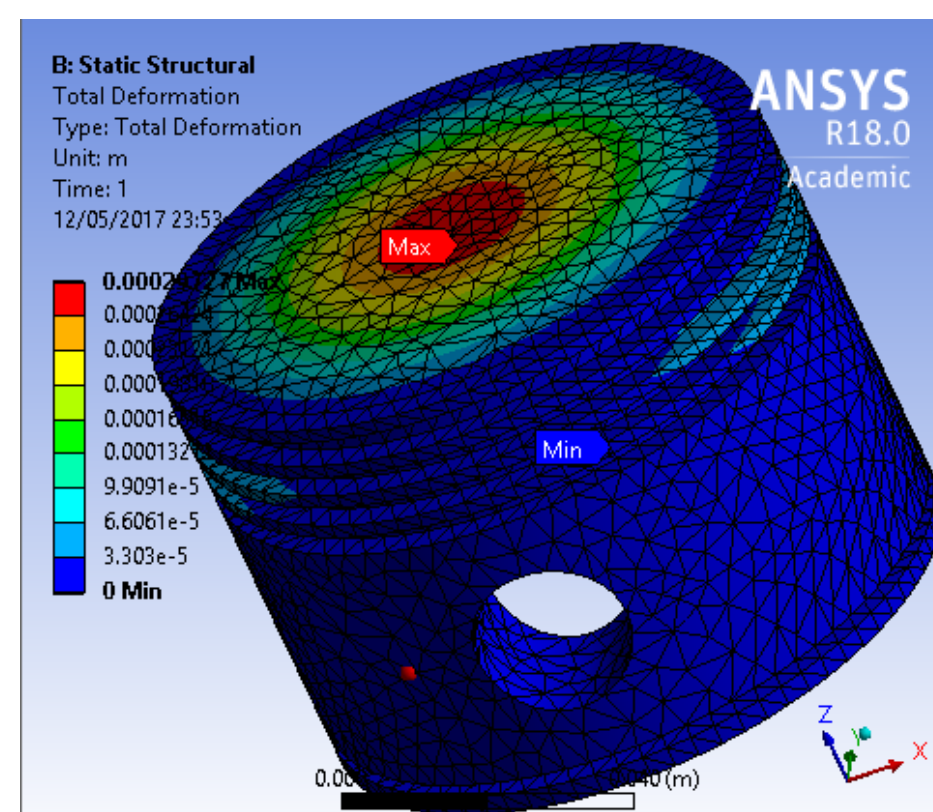


Figure 2- deformation of piston head

In both figure 1 and figure 2, the programme used is a widely known engineering simulation software known as Ansys.

Red bull have “used Ansys simulation technology since 2008 as a part of the team's Innovation Partnership.”(Design News, 2023.)

Acknowledgements

When researching information for the topic, Google AI often tried to answer my search. I was then able to access the links that it took the information from and do my own reading into the papers and documents. This helped me gather information quicker as I didn't have to scroll through many pages of search results, and instead I could follow links for specific areas that I wanted to talk about.

- As seen within the article ‘Static and Thermal Analysis of Piston Head,’ Figure 2 shows the deformation of the piston head after operation due to temperature and pressure generated during combustion (Computer Aided Designing and Engineering, 2017.)
- This analysis would have saved a company the costs of materials and development of an engine block, as well as the cost of running the engine for a desired length of time to enable testing for the same outcome.

Conclusion:

- This process can help with time management, cost effectiveness and overall testing and design processes.
- The lecture that inspired this poster has helped to show me many ways in which I will be able to use simulation in my time in the engineering sector, as well as highlighting to me that many large-scale companies will want their candidates to understand the different elements and applications that this process is likely to be used. It will likely be a major part of my career going forward.