



Computational Simulation as an Engineering Tool

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Introduction

Computational Simulation is a tool that is used a lot when engineering. This tool help to test the products before the manufacturing process. The engineers start the process by making a computers and technology for testing.

These tests can show many different important factors of the product such as the life cycle of the part that's being tests, it can also show the strength and durability of the product and show which areas need to be improved before batch manufacturing the product.

Many companies use this method for testing to help **lower costs**, this method lowers the cost of testing due to the companies not having to manufacture multiple times if it is not up to the selling standers.

Different Tests/analysis:

- Testing product life cycle.
- Thermal analysis.
- Crash analysis.
- Durability.
- Noise and Vibration testing.
- Dynamic analysis.
- Vehicle simulation.

Areas of Aided Design:

- **Computational Engineering** – First phase of designing the product and testing.
- **CAD** – Computer Aided Design - Where the engineers design the product before testing.
- **CAE** – Computer Aided Engineering – Where the product gets tested before manufacturing, testing forces, stress, airflow, temperatures.
- **CAM** – Computer Aided Manufacturing – Where the final product gets manufactured after testing and improving. Manufacturing by using computers and programming information to robots for manufacturing process.

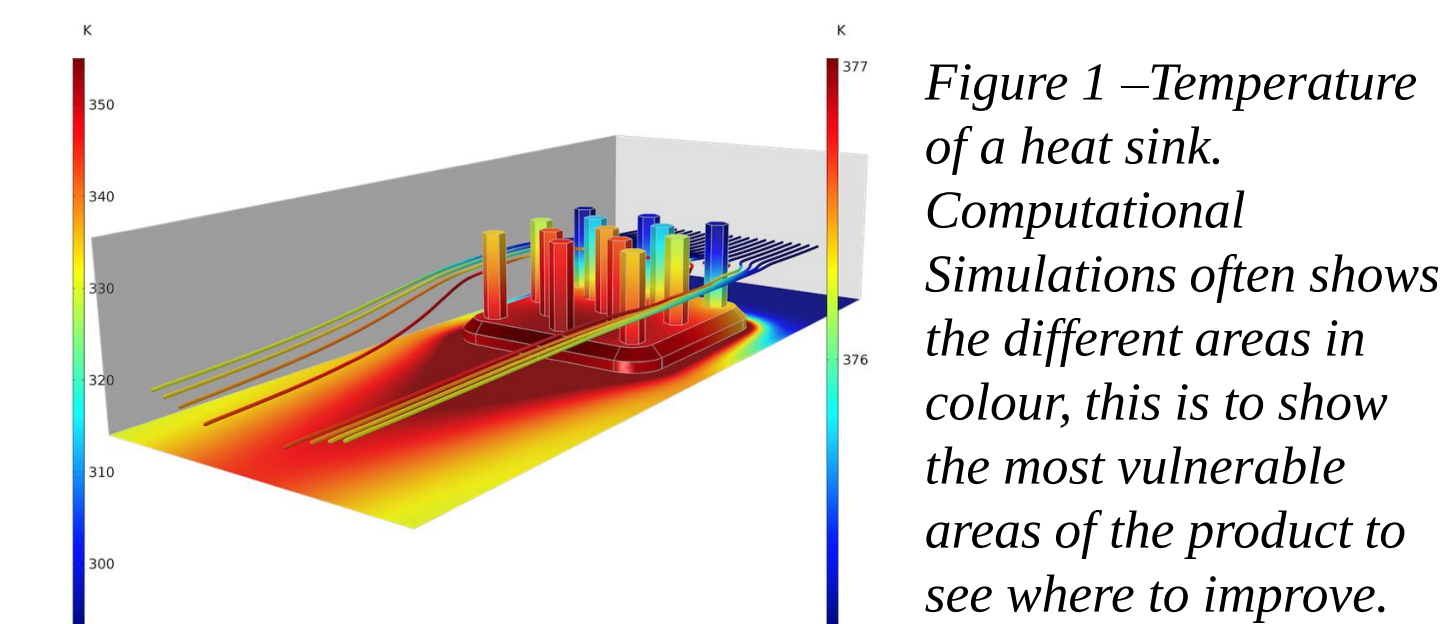


Figure 1 –Temperature of a heat sink. Computational Simulations often shows the different areas in colour, this is to show the most vulnerable areas of the product to see where to improve.

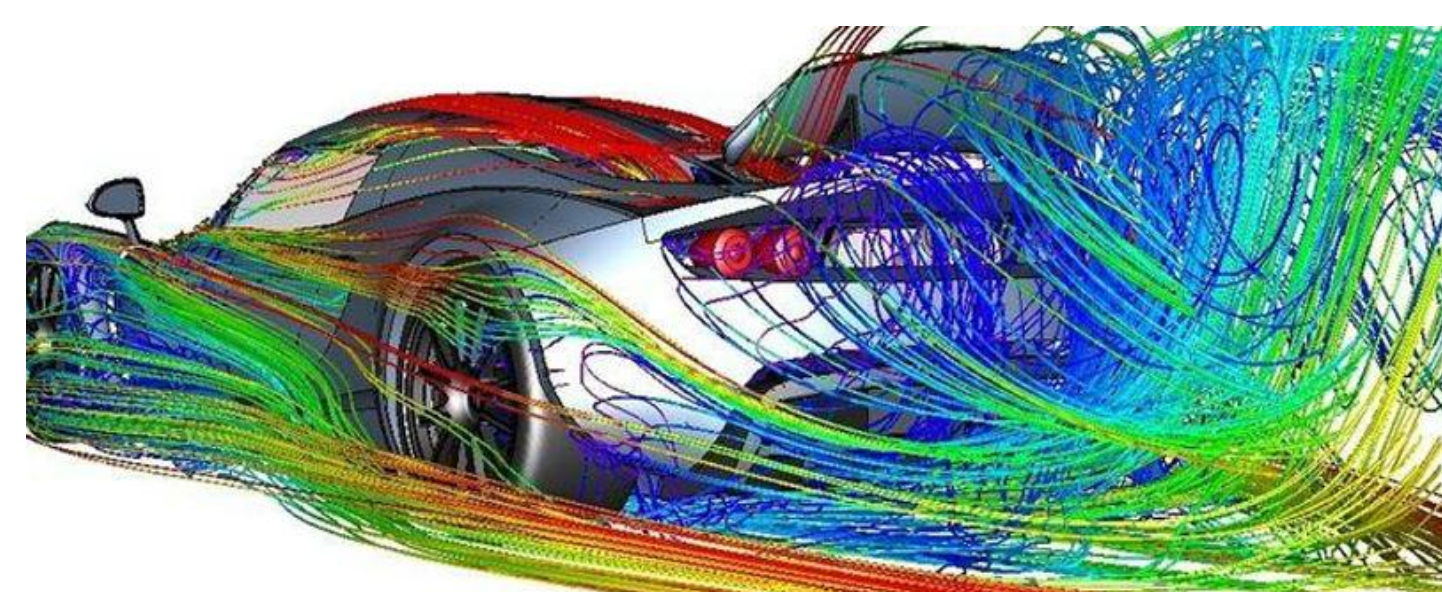


Figure 2 – Showing airflow from a race car. This is a test that shows how the airflow flows over the vehicle. This test is popular in motorsport testing, this is due to the race teams testing aerodynamics of the car to improve the speed.



Figure 3 –Driving Simulator is a form of testing that different manufactures test their vehicle before putting the vehicle out to the real world. This way the manufactures can discover any fault of the vehicles handling prospect.

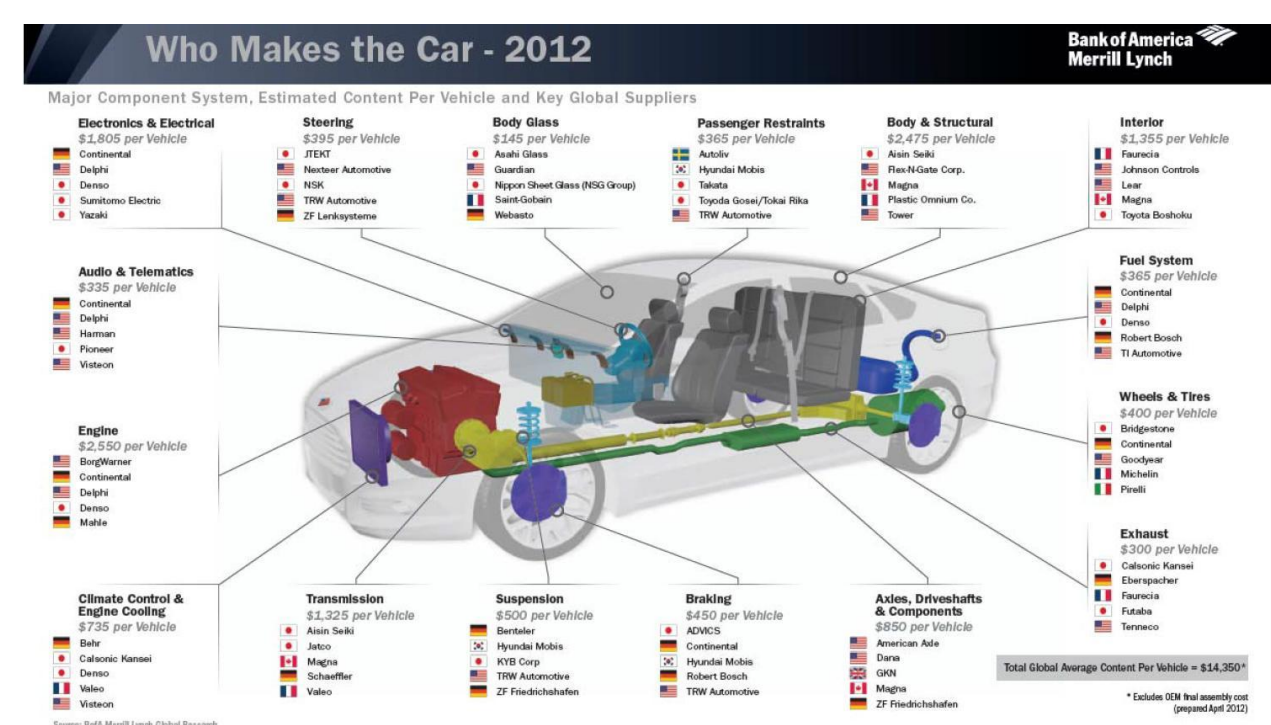


Figure 4 – Where every part of a car is made.

In this figure, it shows that many different manufactures are manufacturing the part for car companies. Reasons behind this is;

- Cheaper for car manufacturers to buy in parts and products.
- Less time testing.
- Focus on core factors of the car (design, performance, safety).

Vehicle Simulation:

Many different vehicle manufactures are using simulations to test their cars. This is also popular in racing such as Formula 1 to make the running costs cheaper.

Categories of Simulation:

- Driver Out of the Loop – Where AI are on the simulator, runs 24/7, less realistic results.
- Driver In the Loop – Where a human is using the simulator, helps to get results of the vehicle in a realistic matter.

Benefits:

- Cheaper to test
- Close to realistic results.
- Discover problems easy.

Future Developments:

AI is a big factor in the future of Computational Simulation with technology developing.

- Design tools.
- Logistics.
- Image processing tool.

Applications within the Automotive Sector

- **Design Optimization** – Lighter, stronger parts without prototypes
- **Structural Analysis** – Crash tests, fatigue, and durability checks,
- **CFD** – Aerodynamics, cooling, HVAC airflow.
- **Powertrain Simulation** – Engine efficiency, emissions, EV range.
- **Battery/Thermal Modelling** – Manage heat in EV systems.
- **Virtual Testing** – Faster R&D with fewer physical tests.
- **Digital Twins** – Real-time vehicle monitoring and tuning.
- **Control System Sim** – Test ECUs and ADAS before physical install.

References

Figure 1 - <https://simutechgroup.com/ansys-software/fluids/fluvent/>

Figure 2 - <https://www.comsol.com/blogs/a-simulation-color-table-for-engineers-with-color-vision-deficiency>

Figure 3 - <https://www.autoexpress.co.uk/91494/inside-the-worlds-best-driving-simulator-pictures>

Figure 4 - <https://www.ft.com/content/ebb13af2-b4f5-390d-bc85-205905850d98>