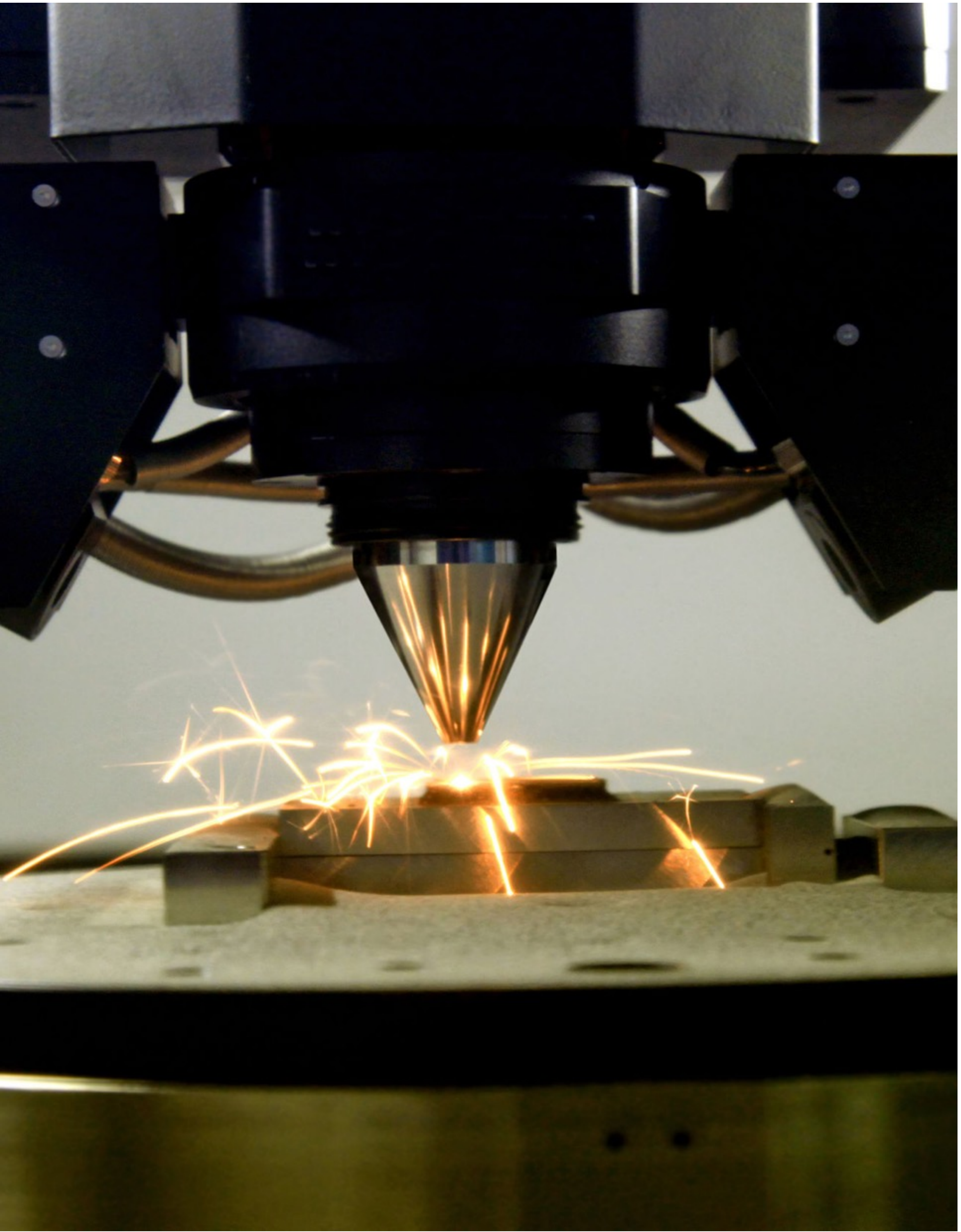
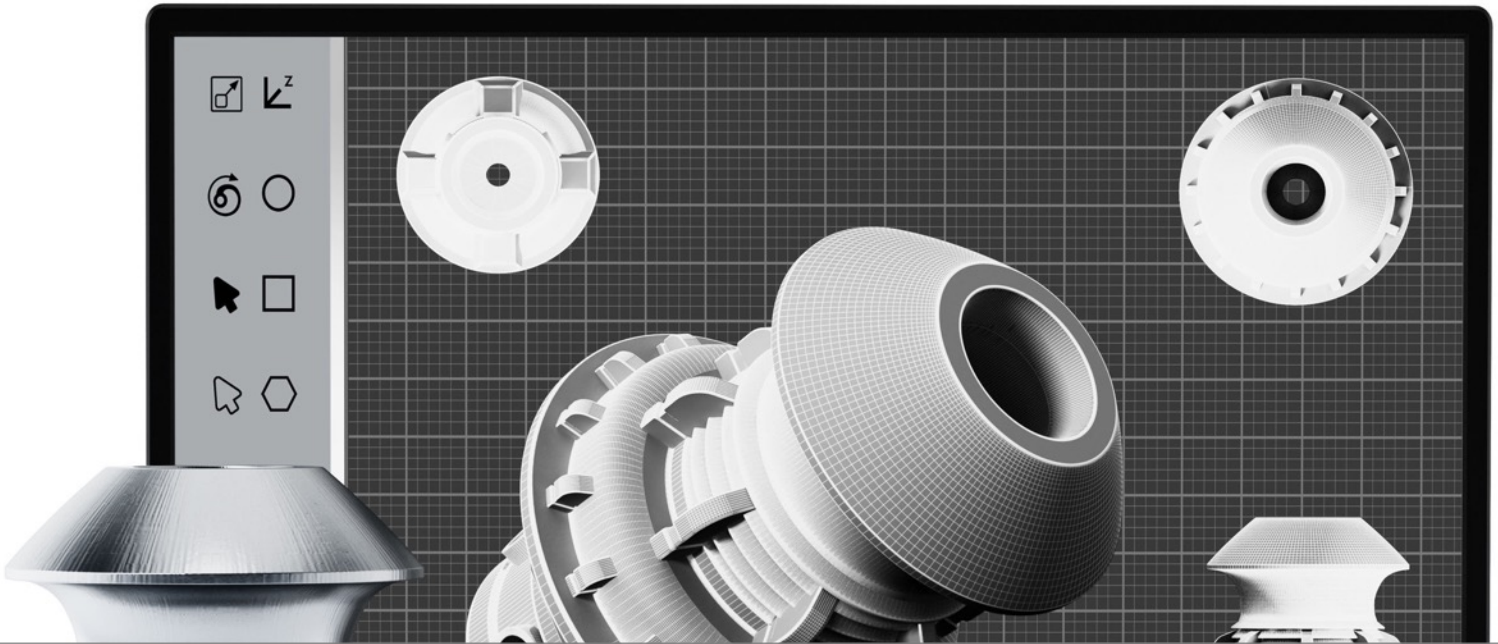


Volvo Trucks. Driving Progress

The Vulcan engine project

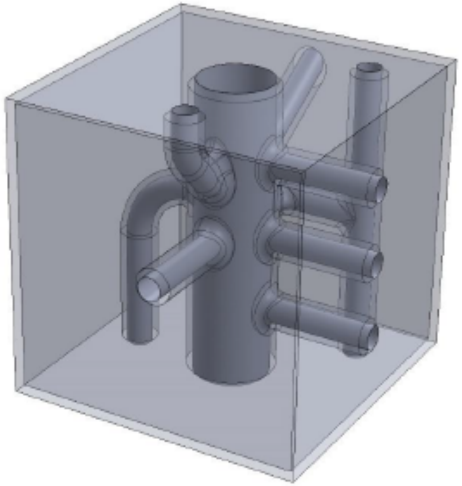
What happens when you 3D print an engine?

The Vulcan engine project is a Volvo Trucks R&D project that looked at how the design of a truck engine can be improved through 3D printing. Is it possible to reduce the number of parts needed to manufacture 3D-printed engine components? And does it affect quality? What about reducing the weight of those components? Is it possible to quantify the effect on the environment?

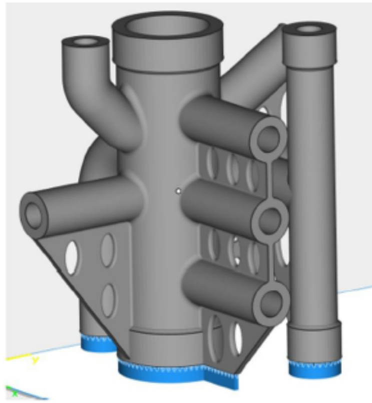


These were the key stages of the project:

Stage 1:
First, the project looked at how to optimize the weight of the engine components using Topological Optimization. Topology is a mathematical method that optimizes the material distribution of a structure within a given package space. By looking at a given set of loads, boundary conditions and constraints, the engineers could find a design that was optimised for weight and met the load requirements. By optimizing the design of a front-face bracket, for example. Engineers in the Vulcan project were able to cut the weight of the component by 40%.

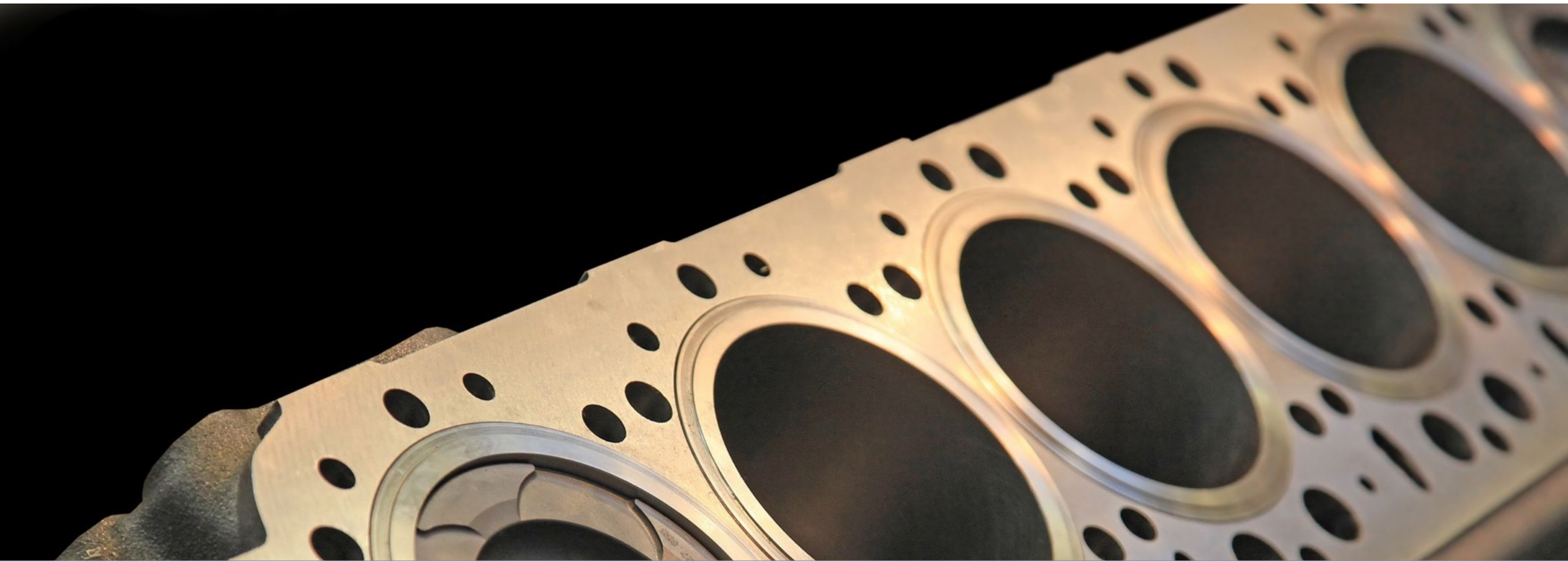


A:
3D printed manifold not designed for 3D printing



B:
3D printed manifold designed for 3D printing

An exhaust manifold which was designed for 3D printing also saw significant reductions in terms of weight and cost. The version designed for 3D printing (B) weighed 14 times less and only took one tenth of the time to print compared to a manifold that was printed using 3D technology but not designed for this purpose.



Stage 2:
System integration; the team behind the Vulcan team looked at the possibility to integrate various engine systems, by simplifying and streamlining different systems in the engine. One major advantage of 3D printing is the possibility to streamline designs and integrate complex components.

For example, by looking at how fluid flowed in an engine, the Vulcan design team was able to design a simpler system, with fewer parts. They also integrated a coolant pipe into the engine’s cylinderblock, which was previously attached to it from the outside. All of this helped reduce weight and improve the durability of the engine.

Stage 3: Prototype design, printing and testing

There are several different types of 3D printing. The most common variant printer variant that is a little like an advanced glue gun. A filament is pushed through to a heated printer nozzle, while the printer moves the nozzle along specified coordinates. But in the Vulcan project, a Powder Bed Fusion printing process was used instead. Here, a granular printing medium is spread across a build platform, creating a bed of powder. It then applies heat created by a laser beam to specific coordinates on the powder bed, binding the granules into a solid layer. This process is then repeated for each layer until the design is fully printed. When the Vulcan engine project was being carried out, there was no printer large enough to print an entire engine. Instead, specific components were printed and tested. After being produced the components were then rig-tested over several weeks to see how measured up. The result? All the prototypes performed as well as regular Volvo Trucks components.

Stage 4: Evaluation.

In the final project evaluation, the project showed that it was possible to:

→ Reduce the weight of components by an average of **31%**
→ Reduce number of parts per component by reduced **25%**
→ Reduce the total number of parts in an engine by **33%**

Another major gain was from a resource perspective; much less material was needed to print a component using 3D printing.

The high costs of 3D printing and the slow printing speed mean that it is no substitute for more traditional manufacturing methods when producing large quantities. Nevertheless, the project showed three key advantages of 3D-printing – making components that are lighter, more streamlined, include fewer parts, and use less resources.

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