Case Study: Vulcan Car Engine Refurbishment: Bringing a piece of British motoring heritage back to life

Technologies used to reverse engineer the 1906 Vulcan Phaeton crankcase:

- FARO Arm portable coordinate measuring machine (PCMM)
- Shining 3D EinScan HX portable 3D scanning system
- GeoMagic post-processing software
- InspireCast simulation software
- Casting tolerances to BS EN ISO 8062 CT12

The Background

In the early 1900's, British car manufacturers were at the forefront of motor vehicle development. The Vulcan Motor company, based in Southport, England, was one such innovator that produced cars from 1902 until the late 1920s and continued to build commercial vehicles until 1953. Today, early examples of Vulcan cars are extremely rare collectors' items.

NovaCast was approached by a specialist engineering company to help with the refurbishment of a 1906 Vulcan Phaeton which had suffered a catastrophic engine failure at some time in its past. Not only had a conrod smashed through the crankcase but the resulting overloading of components had torn the front top half of the casing in the vertical and horizontal plane. To make matters worse, the subsequent welded repair had been done so badly that the casing was severely weakened, the inlet camshaft was out of parallel, the stud holes were compromised, and an engine mounting leg was distorted.

The original crankcase was distorted, cracked, and badly repaired.

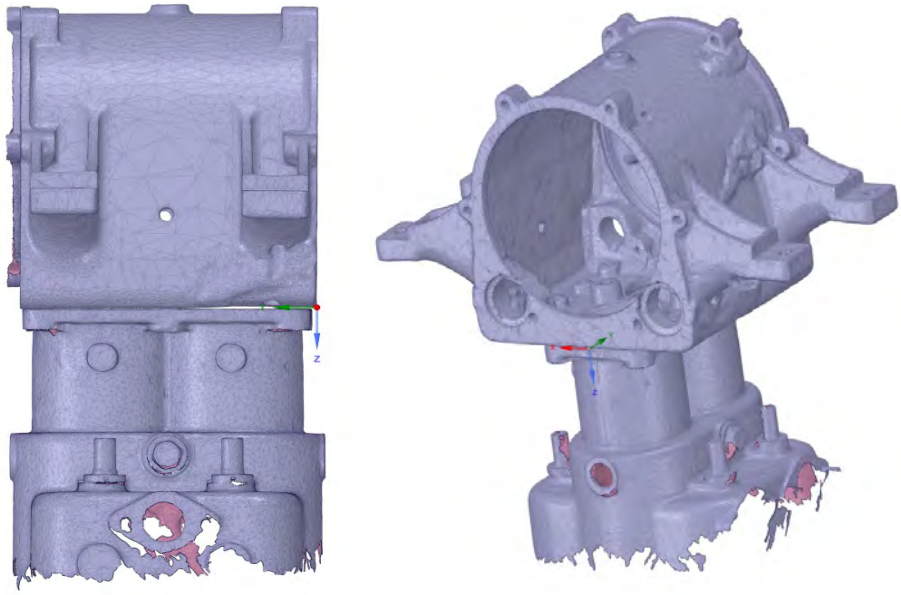
“It was a pleasure to work on such a wonderful piece of historical automotive engineering.”

Richard Phillips
Managing Director
NovaCast

The Requirement

It was obvious that the crankcase was so badly damaged and distorted that it would never function efficiently again, and the engine would need to be re-built using some new cast components. Clearly, with an engine of this age it would not be possible to buy replacement components, so NovaCast was approached to enquire about the possibility of reproducing the main crankcase using the existing one as a guide. As specialists in reverse-engineering, NovaCast was a good choice having extensive expertise in re-creating and improving existing cast components and fabricated assemblies.

To deliver a new casting without any specifications or drawings to work from, it would be necessary to have the main casing scanned and 3D modelled along with the front and rear casing and base of the cylinder block to pick up all centres and stud locations. The main casing scan would need to be adjusted to compensate for the damage and distortion and returned to its original specification. Once cast, the aluminium casing would need to be heat treated and fully machined.



3D scans of the original damaged crankcase

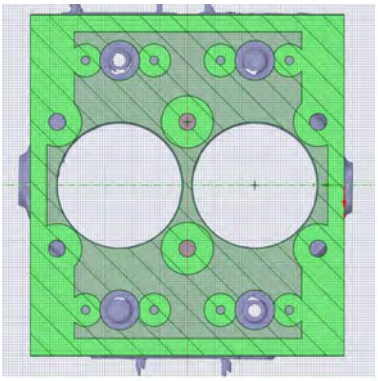
“The project demonstrated how the latest technology and engineering expertise can be used to preserve the work of some of the early pioneers in this field”

Richard Phillips
Managing Director
NovaCast

The Solution

On receiving the original crankcase, NovaCast’s engineers set about creating a digital version of the component that could then be manipulated to recreate the original cast component geometry. The first stage was to take detailed measurements using the FARO Arm portable coordinate measuring machine (PCMM) and other measuring equipment, such as vernier callipers and depth gauges. The crank case was then scanned using the Shining 3D EinScan HX portable 3D scanning system.

Other components, including the original endcaps, which would be re-used, were also scanned for 3D CAD assembly purposes. Once scanned, post-processing of the scan data using GeoMagic software, produced a solid model which would allow the team to alter dimensions when needed. It was critical to continuously take measurements from the original component to ensure accurate reproduction, and to inform discussions with the customer about changes needed, surface finishes and tolerances, allowing for subsequent machining and finishing.



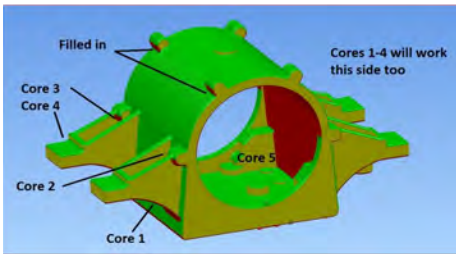
Accurate measurements were taken from the original component.

This crank case was to be sand cast in LM25 aluminium alloy that would then be heat treated to its TF state, then machined to the final tolerances.
Step one was to run a simulation of the casting using InspireCast simulation software without any running method to determine areas where casting defects were likely to occur. Once these had been identified, multiple running method designs were tested using the simulation software until all potential casting defects identified on the original simulation had been eliminated.
The optimum running method design was then used to specify the sand-casting pattern design.

New sand casting patterns were created for the crankcase

The Solution

When the Patternmaker's shrinkage allowance and draft angles had been added to the design, along with the required machining allowances, the design was passed to the patternmaker. To mould the part, it was necessary to find ways to create the undercut feature in the crank case which the customer wanted to keep, so both the pattern and core box had to have a loose core to achieve this.



The Result

It was extremely challenging to achieve the perfect dimensions required by the customer as the original casing had been damaged, badly repaired, and distorted several times. As the part was made over 100 years ago and no specifications existed, NovaCast's engineers worked to general engineering tolerance i.e. ±0.25mm and ±0.5mm machining tolerance. Casting tolerance was based on BS EN ISO 8062 CT12 and the crank case was manufactured in LM25TF, the heat treated form of LM25 aluminium alloy.

Despite the challenges, Richard Phillips, NovaCast's Managing Director, was delighted with the way the project progressed. He commented, "It was a pleasure to work on such a wonderful piece of historical automotive engineering. It really demonstrated how the latest technology and engineering expertise that we have can be used to preserve the work of some of the early pioneers in this field. I can't wait to see this amazing car fully restored and running as it did originally."

The new crankcase was cast in aluminium, heat treated and machined to the original specifications.

About NovaCast Limited

NovaCast has over 45 years of ferrous and non-ferrous metal casting experience extending into markets as diverse as transport, utilities, offshore and general engineering. The company's non-ferrous foundry, based in Melksham, England, is supported by a fully risk-managed supply chain that extends out to the Far East, allowing NovaCast to provide a single source solution for precision cast and machined components. NovaCast has particular expertise in the production of pressure-tight valve and industrial pump components, and converting complex fabrications and assemblies to precision castings across many engineering applications. Metals cast include alloys of Carbon and Stainless Steel, Copper, Aluminium and many others with a full range of testing, machining, surface treatment and finishing options.

To discuss your requirements, call a member of NovaCast's team on +44 (0) 1225 707466 or email sales@novacast.co.uk

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