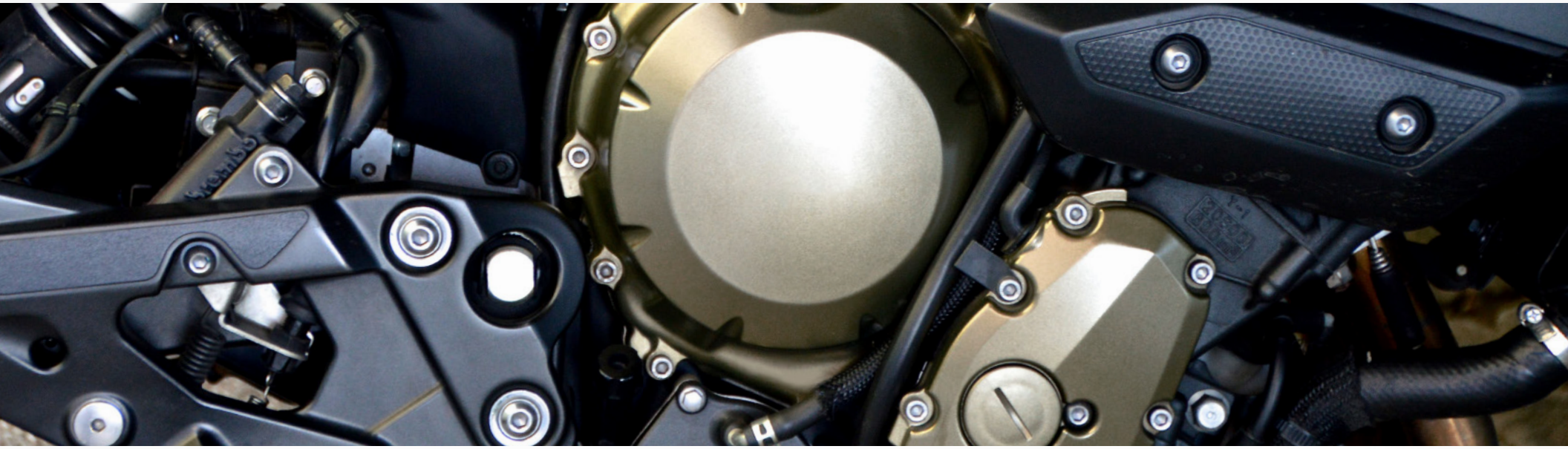
NANOVEA

MACHINED PARTS

INSPECTION FROM CAD MODEL USING 3D PROFILOMETRY



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INTRODUCTION

The demand for precision machining able to create complex geometries has been on the rise across a spectrum of industries. From aerospace, medical and automobile, to tech gears, machinery and musical instruments, the continuous innovation and evolution push expectations and accuracy standards to new heights. Consequently, we see the rise of the demand for rigorous inspection techniques and instruments to ensure the highest quality of the products.

IMPORTANCE OF 3D NON-CONTACT PROFILOMETRY FOR PARTS INSPECTION

Comparing properties of machined parts to their CAD models is essential to verify tolerances and adherence to production standards. Inspection during the service time is also crucial as wear and tear of the parts may call for their replacement. Identification of any deviations from the required specifications in a timely manner will help avoid costly repairs, production halts and tarnished reputation.

Unlike a touch probe technique, the ***NANOVEA*** Optical Profilers perform 3D surface scans with zero contact, allowing for quick, precise and non-destructive measurements of complex shapes with the highest accuracy.

MEASUREMENT OBJECTIVE

*In this application, we showcase **NANOVEA** HS2000, a 3D Non-Contact Profiler with a high-speed sensor, performing a comprehensive surface inspection of dimension, radius, and roughness.*

All in under 40 seconds.

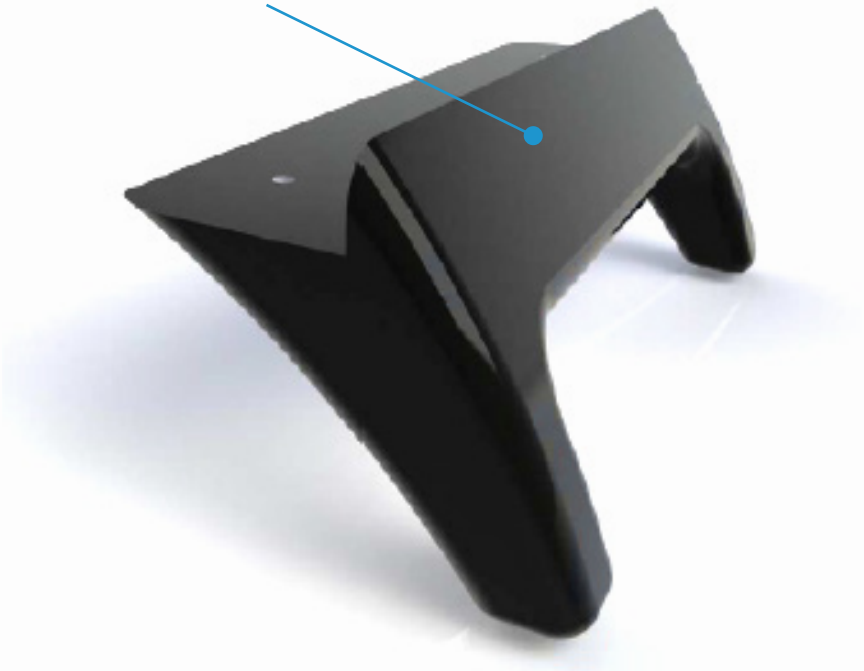
NANOVEA
HS2000

CAD MODEL

A precise measurement of the dimension and surface roughness of the machined part is critical to make sure it meets the desired specifications, tolerances and surface finishes. The 3D model and the engineering drawing of the part to be inspected are presented below.

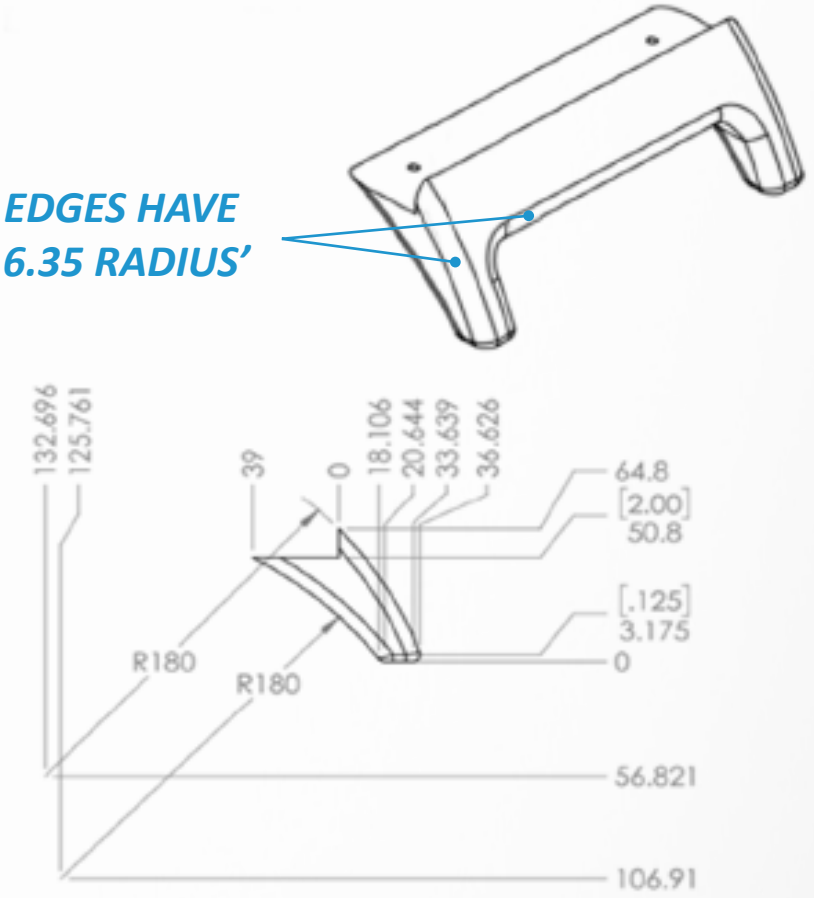
3D CAD MODEL
OF THE MACHINED PART

SCANNED FACE



DIMENSIONAL CAD MODEL
OF THE MACHINED PART

EDGES HAVE 6.35 RADIUS'



FALSE COLOR VIEW

The false color view of the CAD model and the scanned machined part surface are compared in **FIGURE 3**. The height variation on the sample surface can be observed by the change in color.

Three 2D profiles are extracted from the 3D surface scan as indicated in **FIGURE 2** to further verify the dimensional tolerance of the machined part.

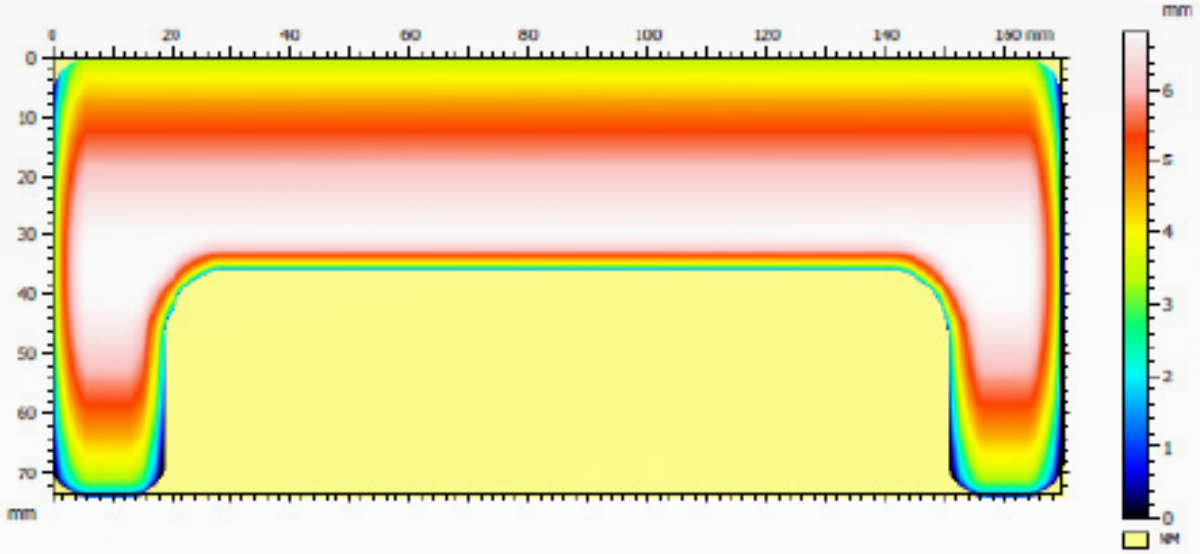


FIGURE 1. 3D surface of the CAD model

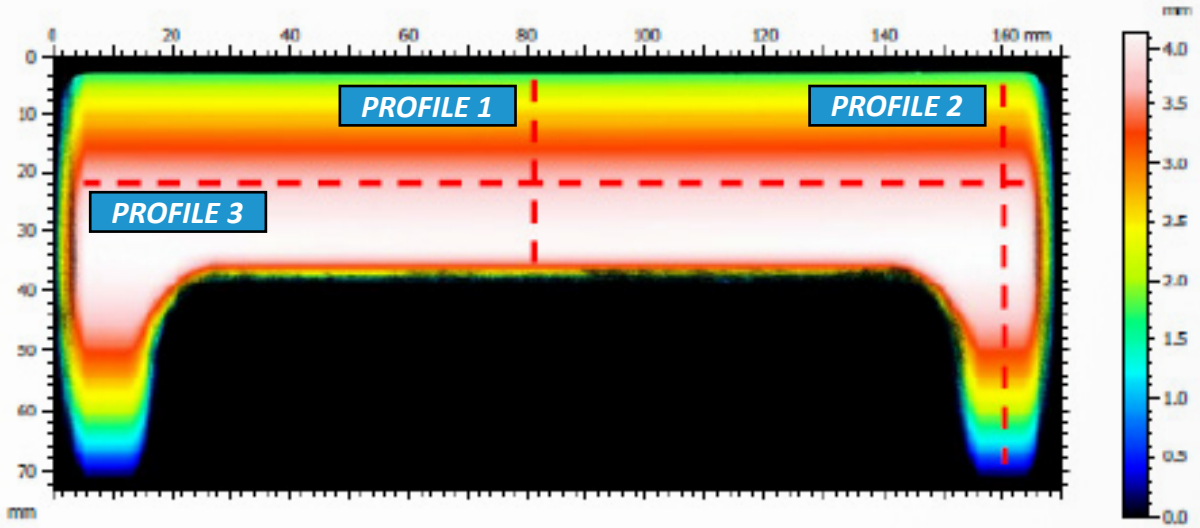


FIGURE 2. 3D surface morphology of the machined part

PROFILES COMPARISON & RESULTS

PROFILE 1 through **3** are shown in **FIGURE 3** through **5**. Quantitative tolerance inspection is carried out by comparing the measured profile with the CAD model to uphold rigorous manufacturing standards. **PROFILE 1** and **PROFILE 2** measure the radius of different areas on the curved machined part. The height variation of **PROFILE 2** is 30 µm over a length of 156 mm which meets the desired ±125 µm tolerance requirement.

By setting up a tolerance limit value, the analysis software can automatically determine pass or fail of the machined part.

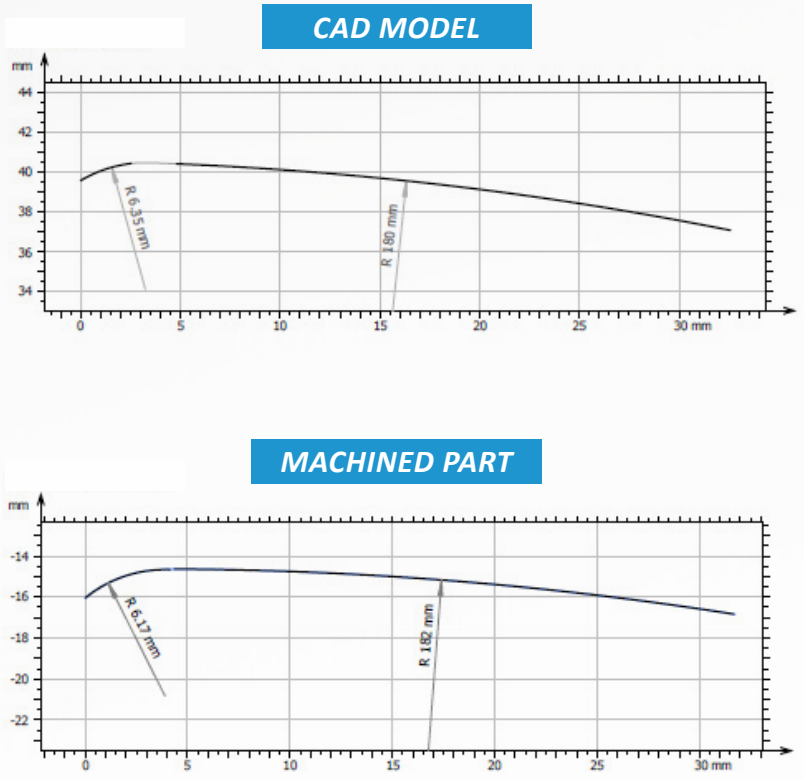


FIGURE 3. Extracted profiles (**PROFILE 1**) on the imported CAD model and machined part scan for dimensional comparative analysis

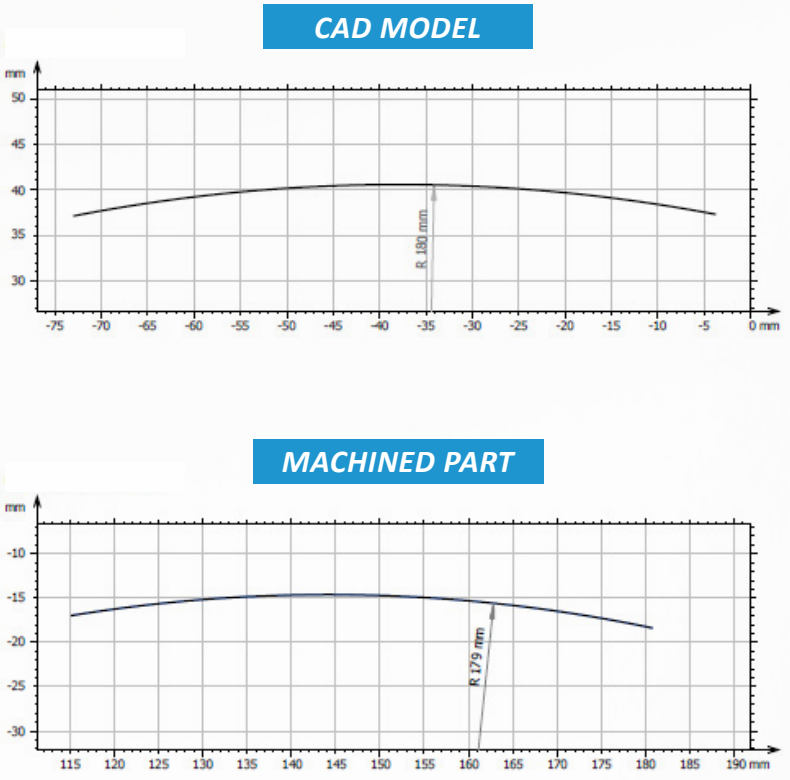


FIGURE 4. Extracted profiles (**PROFILE 2**) on the imported CAD model and machined part scan for dimensional comparative analysis

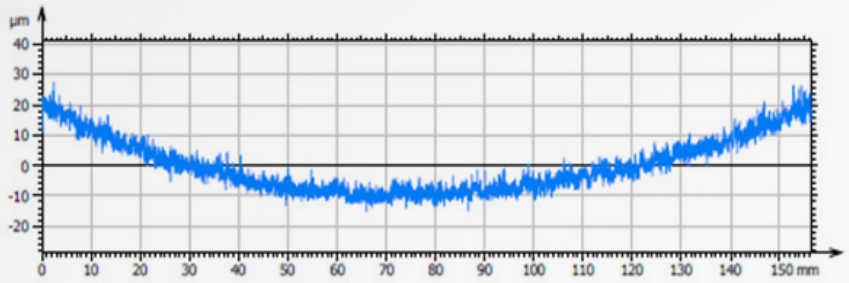


FIGURE 5. Profile (**PROFILE 3**) from the machined part scan for roughness analysis

ISO 4287

Amplitude parameters - Roughness profile		
Rp	2.92 µm	Maximum peak height of the roughness profile
Rv	2.61 µm	Maximum valley depth of the roughness profile
Rz	5.53 µm	Maximum height of roughness profile
Rc	3.76 µm	Mean height of the roughness profile elements
Rc	13.1 µm	Total height of roughness profile
Ra	1.04 µm	Arithmetic mean deviation of the roughness profile
Rq	1.30 µm	Root-mean-square (RMS) deviation of the roughness profile
Rsk	0.149	Skewness of the roughness profile
Rku	3.00	Kurtosis of the roughness profile

Profile roughness values of **PROFILE 3**

The roughness and uniformity of the machined part's surface play an important role in ensuring its quality and functionality. **FIGURE 6** is an extracted surface area from the parent scan of the machined part which was used to quantify the surface finish. The average surface roughness (Sa) was calculated to be 2.31 µm.

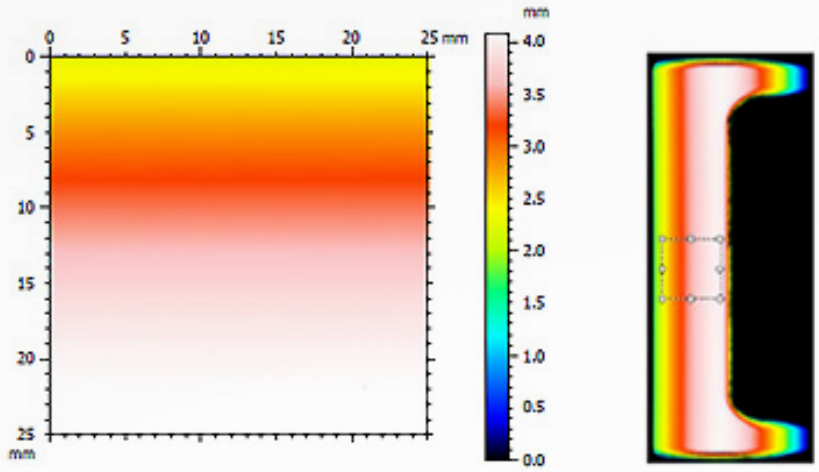


FIGURE 6. Extracted area from the machined part scan for surface roughness analysis

ISO 25178

Height Parameters		
Sq	3.04 µm	Root-mean-square height
Ssk	-0.445	Skewness
Sku	30.1	Kurtosis
Sp	23.3 µm	Maximum peak height
Sv	146 µm	Maximum pit height
Sz	169 µm	Maximum height
Sa	2.31 µm	Arithmetic mean height

Surface roughness values for extracted area from the machined part scan

CONCLUSION

In this study, we have showcased how the ***NANOVEA*** HS2000 Non-Contact Profiler equipped with a high speed sensor performs comprehensive surface inspection of dimensions and roughness.

High-resolution scans enable users to measure detailed morphology and surface features of machined parts and to quantitatively compare them with their CAD models. The instrument is also capable of detecting any defects including scratches and cracks. The advanced contour analysis serves as an unparalleled tool not only to determine whether the machined parts satisfy the set specifications, but also to evaluate the failure mechanisms of the worn components.

The data shown here represents only a portion of the calculations possible with the advanced analysis software that comes equipped with every ***NANOVEA*** Optical Profiler.