# FRENCO REANY

## GEAR INSPECTION SOFTWARE MELDS DATA FROM MULTIPLE SOURCES

### What is REANY?

*REANY* is software for the evaluation of gears and splines that have been measured completely on all teeth. It is suited to both quality assessment and analyzing the causes for deviations. *REANY* is short for Reality Analysis.

### What is REANY's Use?

Various measurement methods have become prevalent during the past few decades. As a quick and simple test, double flank gear inspection looms large in the gear production area. One single curve represents the quality of the whole gear. The measurement result is not a special individual form deviation, but a summation of individual form deviations. The same applies to a single flank gear inspection. However, two curves are given out—one for the left and one for the right flanks. Since electronics are stringently required here, it is less popular than the double flank gear inspection.

Single deviation checks provide concrete information about profile, helix and pitch. To save time, profile and helix deviations are measured randomly at only four teeth. Pitch and runout deviations are calculated from a single point per tooth flank.

In some cases, information about the topology of all tooth flanks is desirable, especially when it comes to primary forming methods such as injection molding or sintering. The tooth flanks are refinished individually, which does not necessarily lead to a good result as the corrections are based on a random check. For classical machining methods, information about the whole gearing is interesting as well. Relations between the deviations and its causes in the manufacturing process can be established.

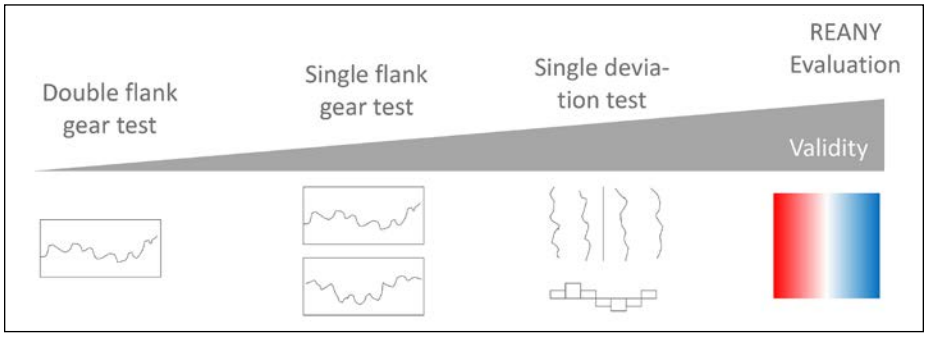



**Figure 1**

**Table 1**

| Method | Data | Duration | Notice |
|---|---|---|---|
| Frenco Gear Flank Analyzing | Profile tracks in approx. 11–15 planes | 7–13 minutes | For large batches only due to required master gear |
| Measurement of all teeth | Profile tracks at any number of planes, lead tracks at any number of diameters, combination of both possible | 30–120 minutes | Almost all kinds of gears and splines measureable, though long duration |
| Focus variation | Point cloud; extraction of profile tracks at any number of planes | 5–10 minutes | Profitable for micro gearings only |

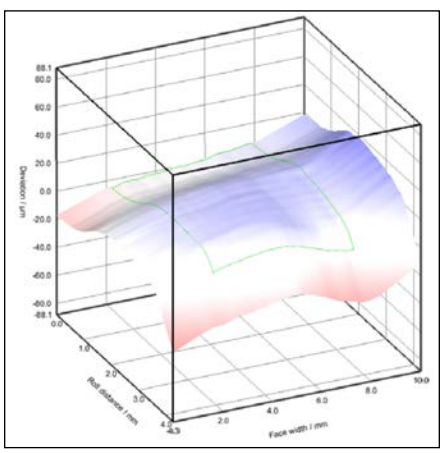
### How Does It Work?

The evaluation is based on profile tracks of all teeth determined on several planes. Thereupon, the topology of every single tooth flank is generated by interpolating the measured data. The position of the flanks can be traced back to one point of origin. All measured values are related to each other, which is the main difference to standard plots. This data is the basis for the *REANY* evaluation.

The deviations from the nominal contour are displayed in colors. Like on a map, "hills" and "valleys" become visible. The view "Total Gear Geometry" shows all tooth flanks sorted and lined up.

So far, there are only a few methods to perform such measurements.

Focus variation is an optical measuring method providing a point cloud of the specimen's surface. Before reading the data, the desired number of transverse sections are extracted from the point cloud. Those can be loaded by



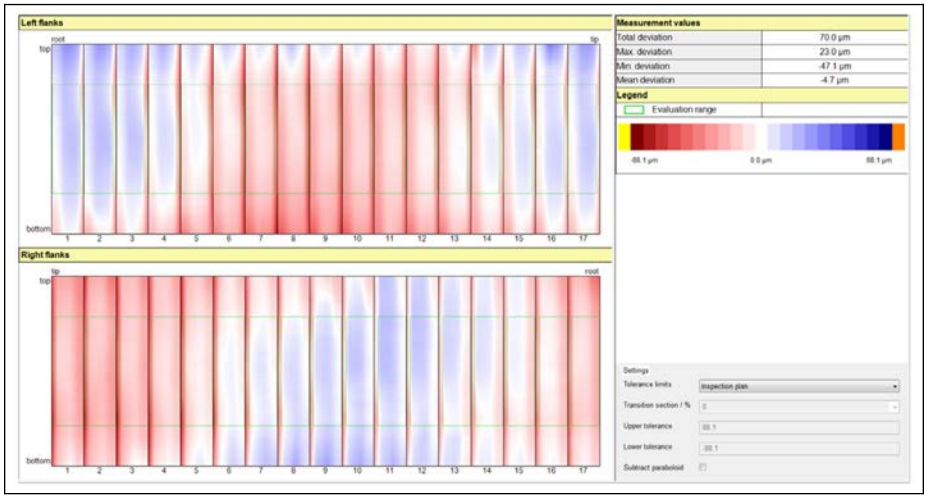
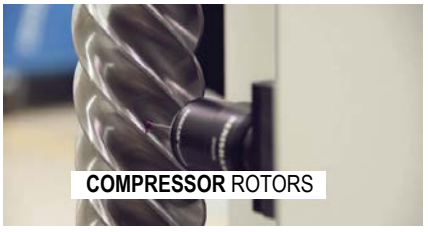



**Figure 2 Left: topology of a single flank; Right: View "Total Gear Geometry" with all flanks being related to each other.**



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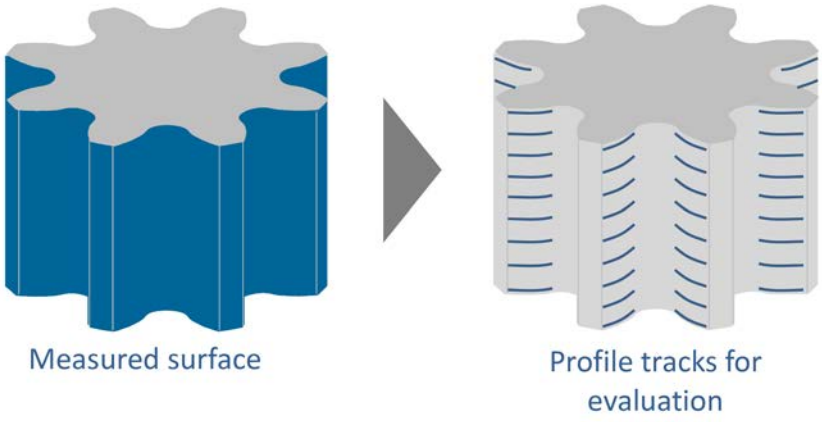


**Figure 3**

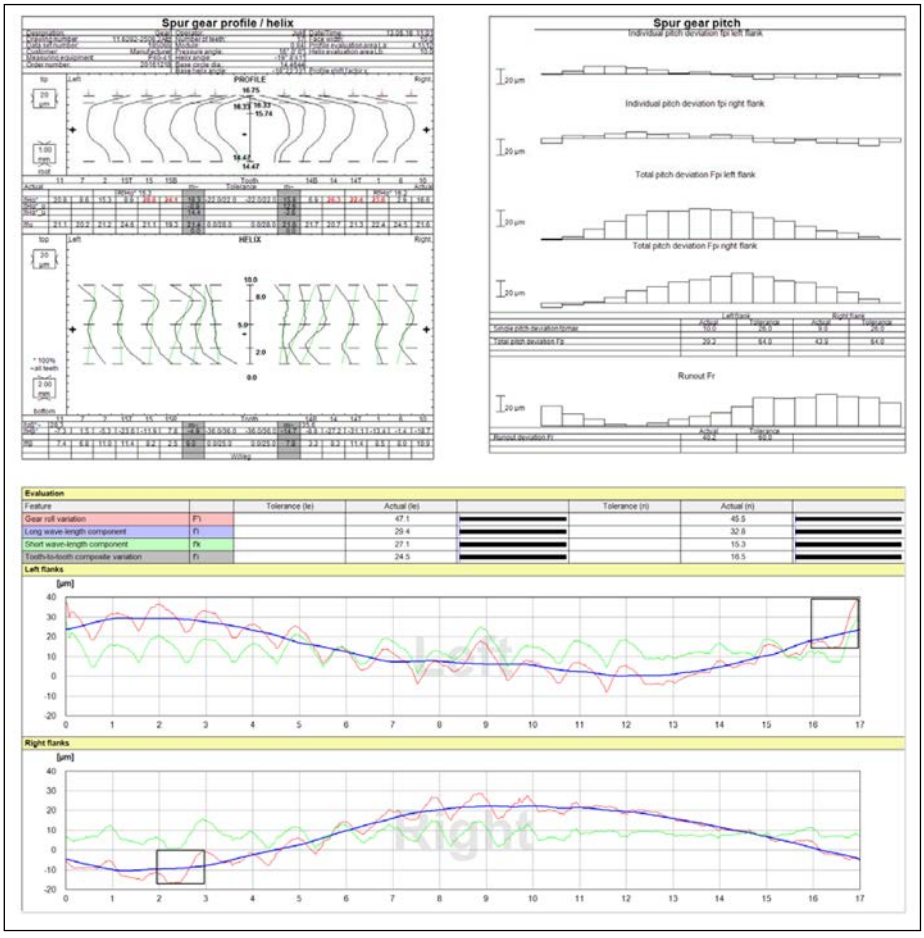


**Figure 4** **Top: Measuring plot including single deviations; Bottom: Curve of simulated single flank inspection.**

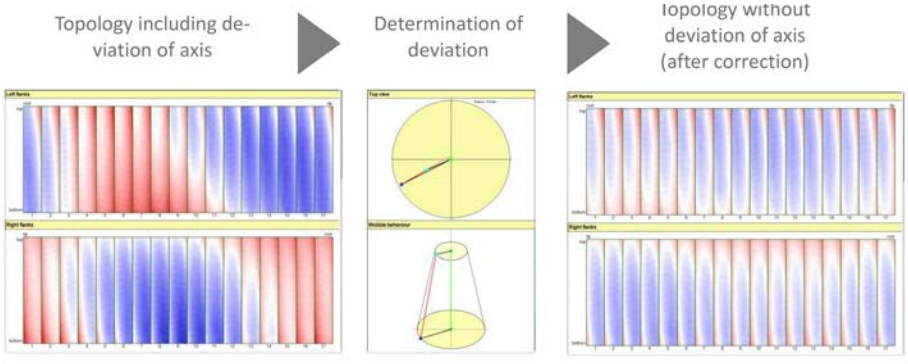


**Figure 5**

*REANY* software. Point clouds of other optical methods can be treated equally. Needless to say, direct processing without cutting the surface into pieces is on the to-do list as well.

## What results Does REANY Provide?

### Quality assessment according to standards

Primarily, the standard evaluation for quality assessment is included. The curves for profile, lead, pitch and run-out are shown in the prevailing way. Furthermore, it is possible to simulate a single flank gear inspection due to the fact that all tooth flanks are available in their entirety. Associated, the FFT-Analysis of the roll curve is calculated to estimate noise emission.

### Searching for deviation causes

The topology of tooth flanks available reflects the superposition of all deviations in the gearing. *REANY's* aspiration is to make systematic deviations visible. Systematic deviations are those that correlate with a cause in the production process and thus can ideally be corrected. The typical example is the deviation of the axis. Whenever the gearing's axis does not align to its reference axis (e.g. the bearing points), the whole topology is sinus-shaped. In case of a pure eccentricity, the sine's amplitude remains the same from top to bottom. In case of a wobble, the amplitude changes linearly along the face width. Both cases have an impact on any values calculated afterwards. The pitch curve will be sine-shaped, even if the pitch deviation as such might be okay. Profile slope and total deviations vary sinusoidally over one full rotation. In short, a deviation of axis casts a cloud over any other deviations, such as one coming from a tool error, for instance. Against this backdrop, *REANY* facilitates an automated correction of the axis. The correction affects the whole tooth flank topology and cached deviations appear.

*REANY* contains figures that display the pitch deviation, referring to the complete gearing. Pitch deviations are color-coded and shown from top to bottom. Before correcting the deviation of axis, the figure outlines the compliance with tolerances along the face width.

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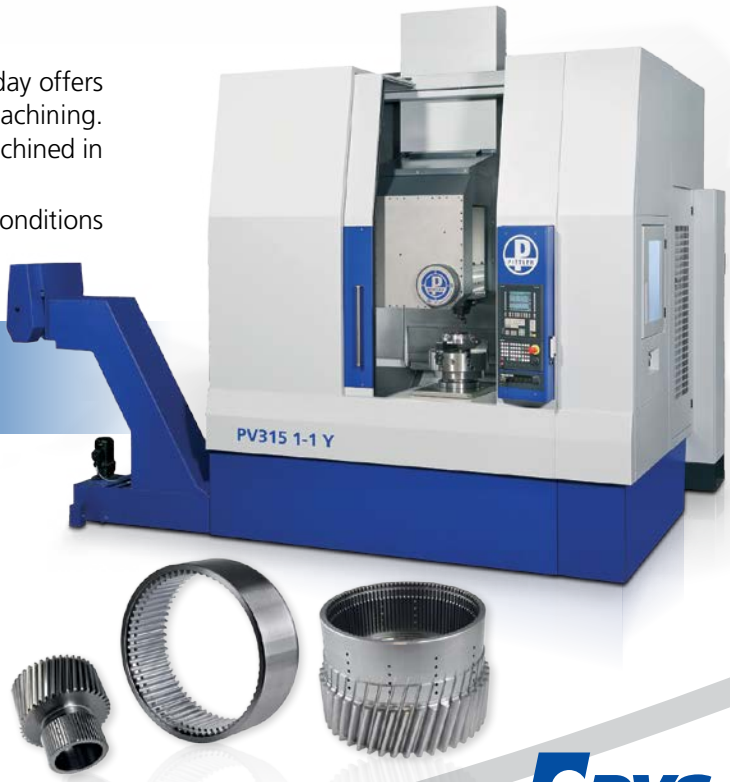


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Correcting the axis's deviation gives the possibility to search for systematic pitch deviations.

Since every pitch consists of a tooth and a gap, the pitch deviation is closely intertwined with tooth and space widths. While there is a tolerance for the tooth thickness, either directly or indirectly (e.g. dimension over pins), and thus it is evaluated, the space widths are usually disregarded. But it is worth a glance, as conventional production methods primarily produce the space widths, which result in tooth width and pitch deviations, depending on the gap's positions and sizes. The sizes of tooth and space widths are displayed in Figure 7.

The angular positions of teeth and gaps are shown by Figure 8. The positions are defined by their middles along the circumference. An output of +10 µm, for example, indicates an offset to the nominal position of the tooth or the gap in counting direction of 10 µm along the circumference. When profile grinding, a deviation of the encoder, for instance, results in a sine-sharped variation of the space middles. Subtracting

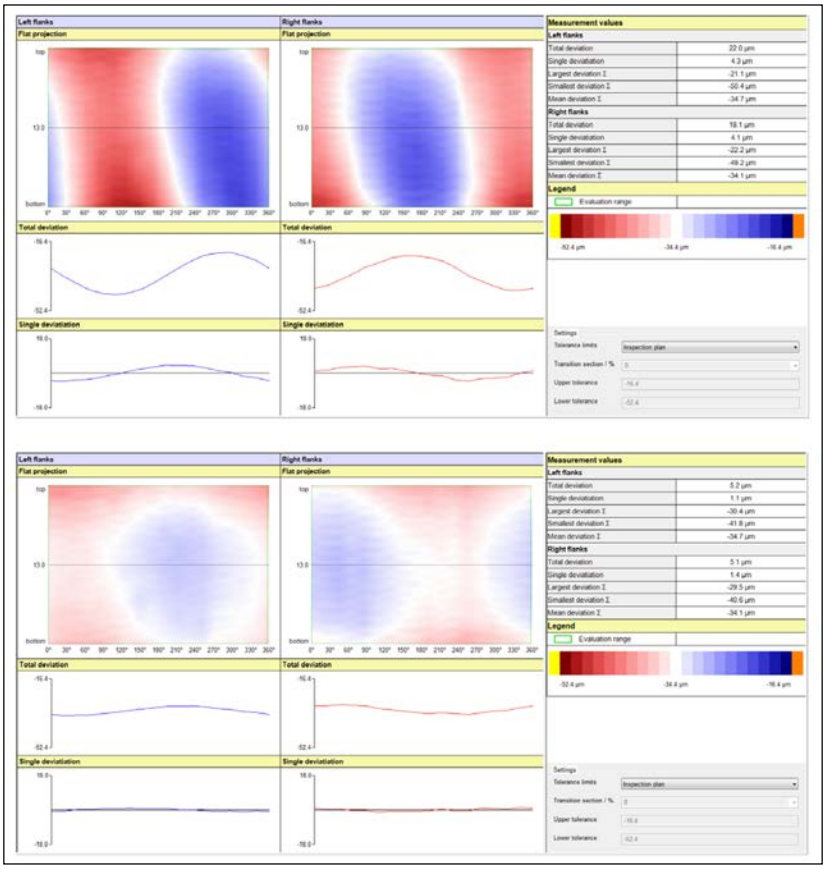


**Figure 6** Pitch deviation of left and right flanks along face width. Above: quality assessment before correction of axis; Below: remaining pitch deviations after correction of axis.

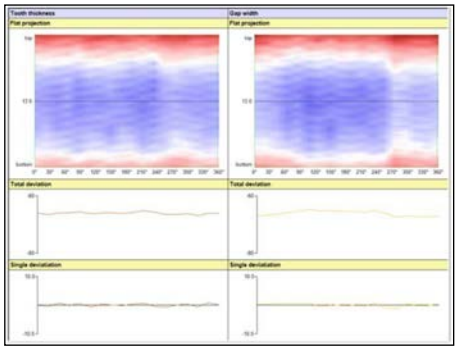

**Figure 7** Tooth widths (left) and space widths (right) equal the size of tooth and space widths

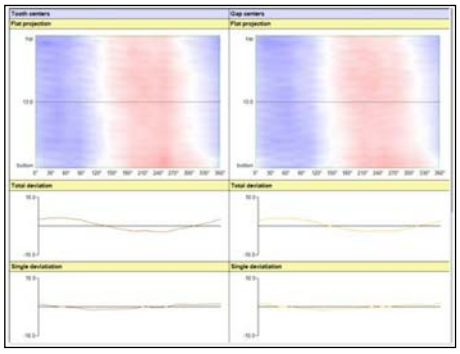

**Figure 8** Tooth middles (left) and gap middles (right) equal the angular position of tooth and space widths

this systematic error from the topology makes pure form deviations visible.

*REANY* offers several figures to assess the form deviations in the whole gear. As with pitch deviations, the profile deviations of all teeth from top to bottom are marked in color. Before the correction of axis, the tolerance limit exceedance can be seen at a glance. After the correction, systematic deviations can be detected easily. For instance, when profile slope deviations show up solely the color red, a systematic tool error is the likely cause.

Correspondingly, the helix slope deviations are shown from root to tip. After the correction of the axis a systematic change of color appears, coming from a twist.

Another method to evaluate the form is to regard the individual tooth flanks as paraboloids. Every paraboloid consists of:

- Profile crowning
- Helix crowning
- Twist
- Profile slope
- Helix slope
- Offset (single pitch deviation)

On one hand this method allows the evaluation of intended modifications.

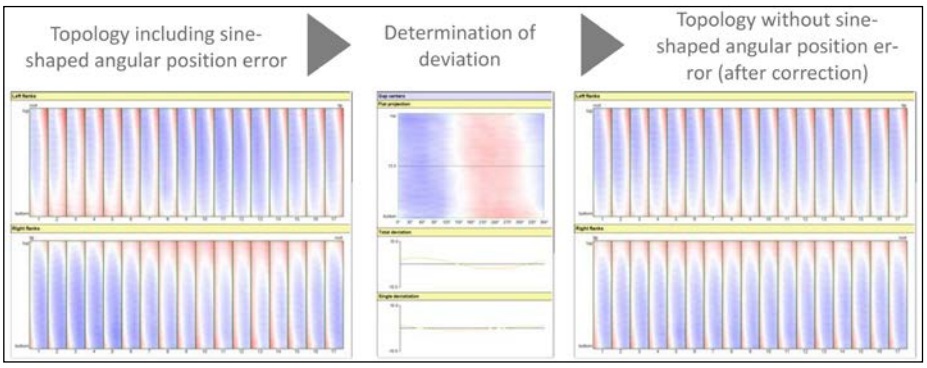


**Figure 9**

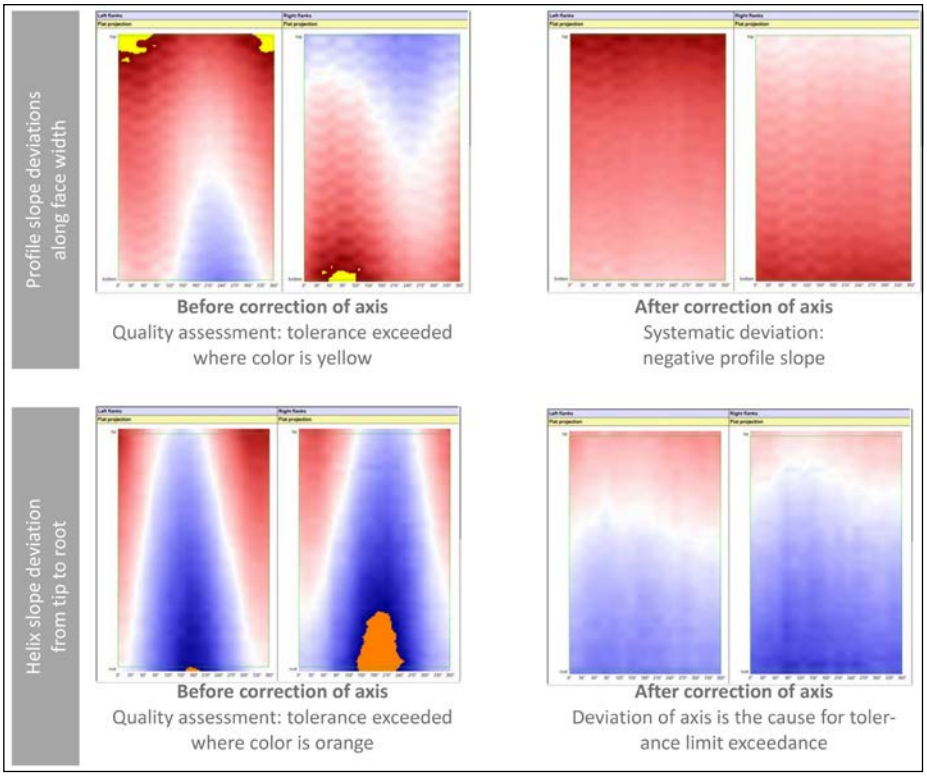


**Figure 10**

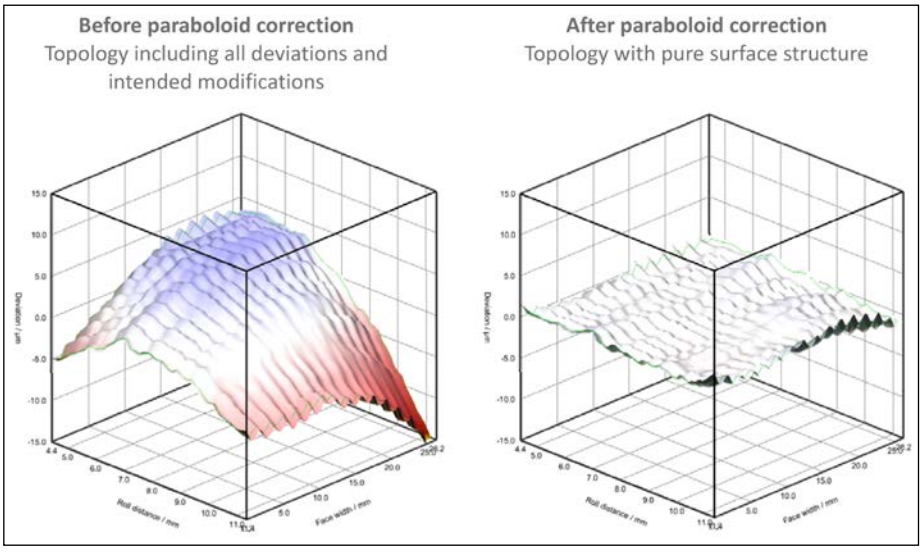


**Figure 11**

On the other, averaged corrections, concerning the whole tooth flank topology, can be defined to improve production. To estimate the influence of these corrections on the measurement results, computational corrections are possible. An output of 4 µm averaged profile slope deviation, for example, can be eliminated from the topology to simulate an associated tool-correction and see the effect on the quality.

Finally, it is interesting to look at the pure form deviations. For that, the paraboloid of each individual tooth flank is subtracted from the topology. This correction of the basic form deviations enables a precise evaluation of the surface structure.

The development of *REANY* is far from over. Cause studies require a deep knowledge of the production process and experts to brood about a solution. For now, *REANY* just supports the brood development. However, Frenco envisions a program, fed with the principal parameters, that tells the operator exactly what to do when a problem occurs. What about the long duration of the measurement? Well, Frenco believes that optical measurements, providing point clouds, will sooner or later take on in-line checks. That will be quick and certainly requires new evaluation methods, beyond those we know today. That's for sure.

**For more information:**
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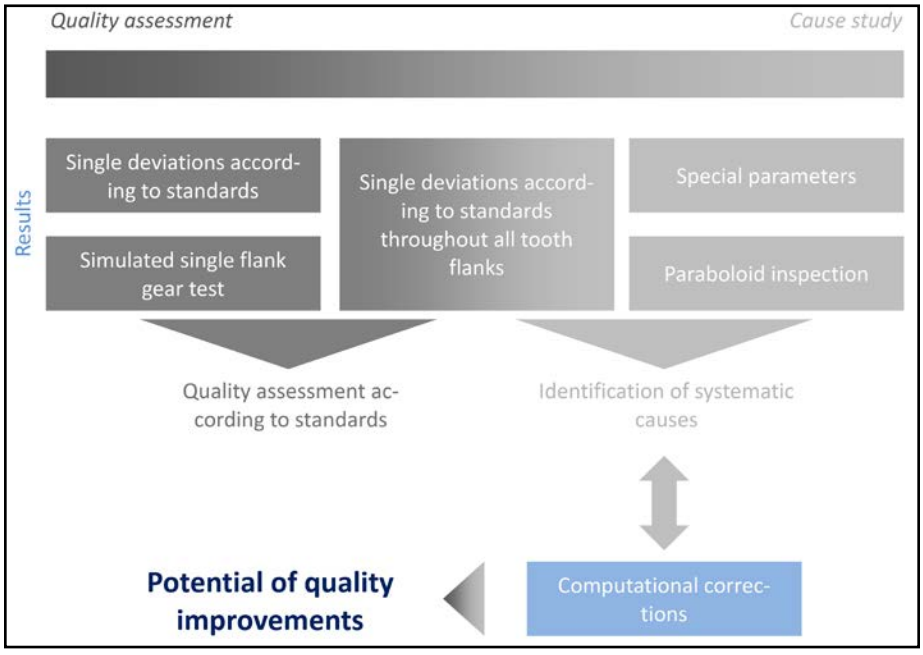


**Figure 12**