VeraCAD Technology Compendium

Title:	**Isolines with a new look**
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This article explains how to use the Isolines function

- Switching the view to mode isolines
- Types of isolines
- Menu entries and parameter selection
- Practical use cases for using isolines

General

Already in the versions up to VeraCAD 3.84 there was a function that could display certain properties of the reducer roll and product surfaces with the help of coloured markings (small crosses). However, the analysis was limited to kinks at the segment boundaries and small radii in the surfaces. Due to the new display as a colour gradient (similar to a weather map), the module has become much more practical and user-friendly.

The new isoline function is included in all of our software products VeraCAD, VeraMASS and Zeye3D.

Elements of the isoline view

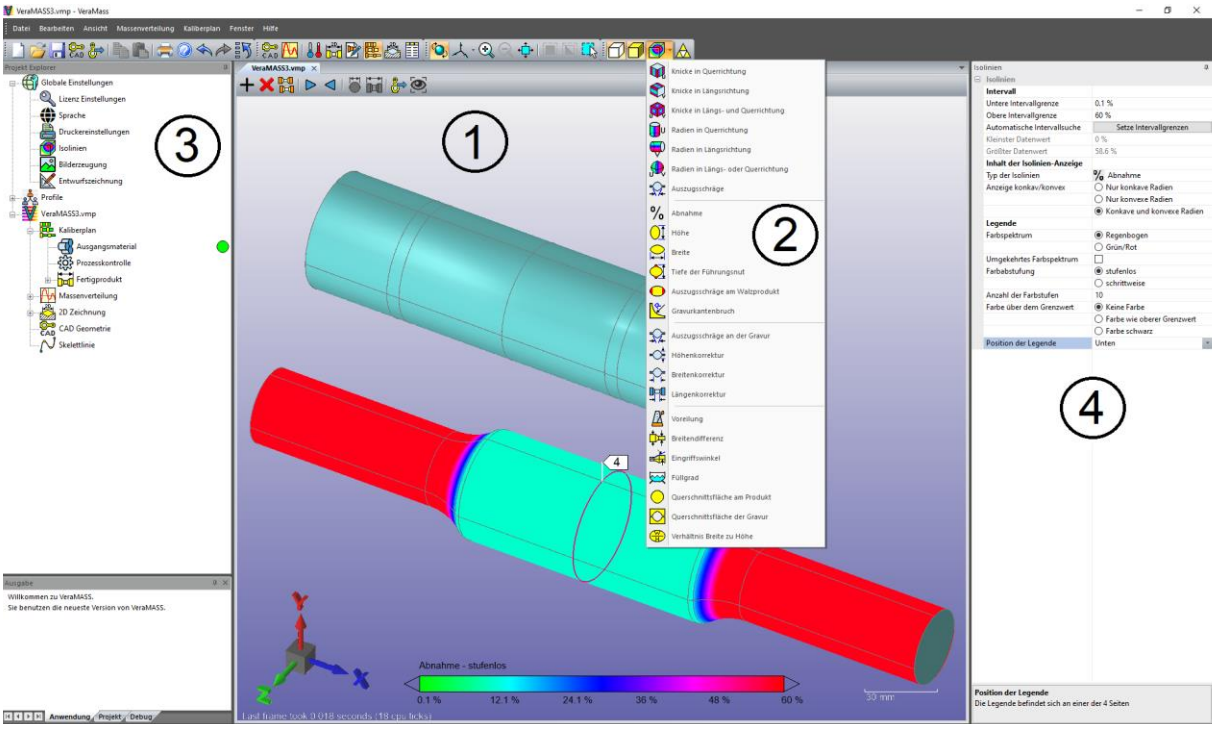


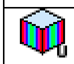
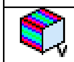
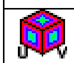
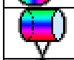
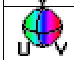
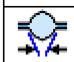
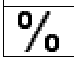
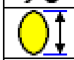
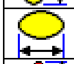
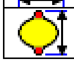
Image 1: Isoline representation and associated user interface.

The isolines function consists of 4 essential elements.

1. In the graphic window, the desired values are displayed as colour gradients on the surface of the geometry. Therefore, a representation with isolines is only possible in 3D views and only for surfaces (not for STL data - triangular meshes). The calculation of the gradient and the isolines are displayed when the coloured icon is clicked in the toolbar “draw mode“ (see No. 2).
   When switching to isolines, the legend also appears in the graphic window and shows which colour belongs to which value.
2. This icon or the associated drop-down menu is used to specify which value the isolines should stand for (see list of isoline modes). For image 1, the selection "Reduction" was clicked.
3. The button for configuring the display and changing the value ranges is located in the project explorer under "Global settings".
4. Here there are numerous parameters by which the isoline functions can be adjusted. These settings are not saved in the project, but in the "settings.dat" file, which is found under "AppData" and therefore are the same for all projects.

Isoline modes

The isolines function has 24 different display values (isoline modes). The first 7 are geometry-based display values, which can be completely calculated from the geometry. These include the radii, kinks at patch borders and the draft angle.
The other values are based on the rolling technology, e.g., cross-section reduction, length correction, relative motion, etc.
The list (Figure 2) shows the options and examples of display modes.

	Geometry based Display values	
	Kinks in cross direction	Show surface kinks in cross direction with isolines (unit of measure degree)
	Kinks in longitudinal direction	Show surface kinks in long direction with isolines (unit of measure degree)
	Kinks in Longitudinal and transverse	Show surface kinks in long and cross direction with isolines
	Radius in cross direction	Shows radius in cross-direction
	Radius in long direction	Shows the Radius in long direction
	Radius in long or cross direction	Shows surface radius in long and cross direction with isolines
	Draft angle	Show draft angle in Z-direction (for tool segments radial direction)
	Technology based Display values	
	Reduction	Displays the reduction in this cross-section
	Height	Displays the height of the cross section
	Width	Displays the width of the cross section
	Leading groove depth	Displays the Leading groove depth

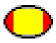
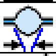
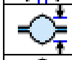
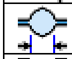
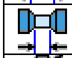
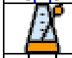
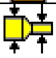
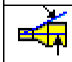
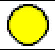
	Product draft angle	Display product draft angle.
	Flash corner radius	Display flash corner radius
	Impression draft angle	Display left and right impression draft angle
	Height correction	Displays the height correction
	Width correction	Displays the width correction
	Length correction	Displays the length correction
	Relative motion	Display relative motion
	Width difference	Display width difference between neighbouring cross-sections
	Attack angle	Display attack angle for this section (in front of cross-section)
	Filling degree	Display filling degree as relation of impression cross-section area to product cross-section area
	Cross-section area on product	Display the Cross-section area on product
	Impression cross-section area	Display the cross-section area of impression
	Spreading	Display spreading as relation of width to height

Figure 2: Table of isoline modes.

Display control

There are numerous parameters to obtain a meaningful and easy-to-interpret representation with isolines. These are located in the "Isolines" parameter window (Figure 3, right).

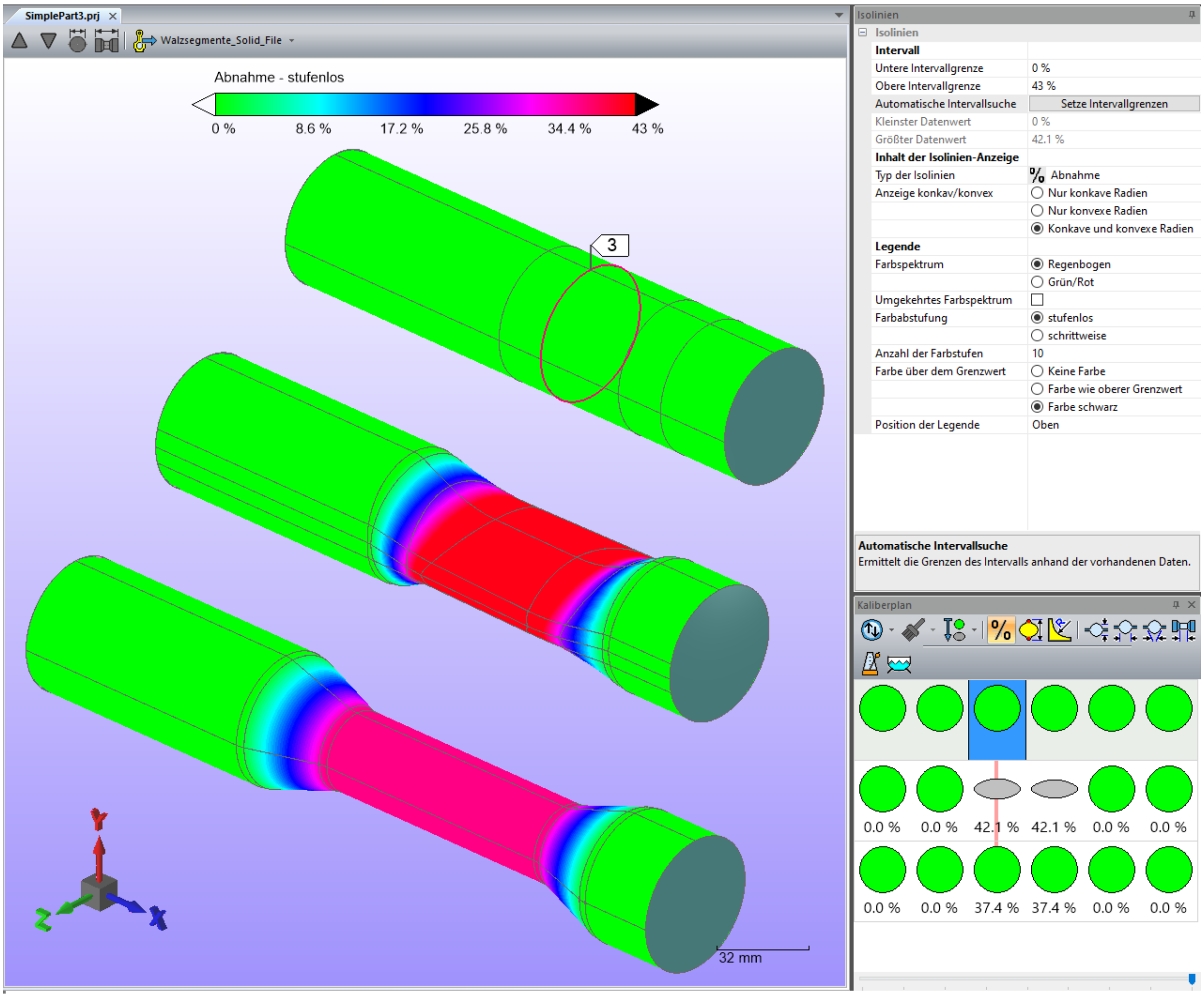


Figure 3: Simple roller part with isolines for the display value: Reduction

An important button is "Set interval limits". A click on the button automatically calculates the value range and adjusts the legend accordingly. At the same time, the entire colour spectrum from green to red is evenly distributed over the range of values. This creates the maximum colour contrast, so that different values can be recognized particularly clearly.
In the example shown, the reduction runs between 0% and 42.1%, as a result large areas are shown in green (0% reduction). The extensive green colour weakens the expressiveness, with a simple trick you can hide it. For this purpose, the value range is manually adjusted to 0.1% - 43%. Areas that are below the limit are now displayed transparently (see image 5).

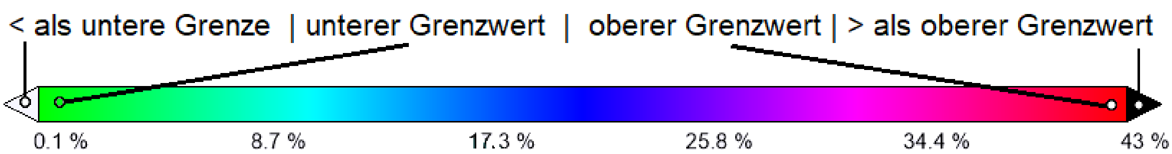


Figure 4: Legend for the colour gradient with labelling of the limit values

In Figure 4, triangles can be seen at both0, end of the legend. They indicate the colour used for values below/above the interval limits.

Isolines are used to see quickly, if process limits are complied. In the example (Fig. 3), the largest reduction is 42.1%. This is absolutely too high, e.g., for reducer rolling, because there is a risk of "wing formation" due to excessive reduction (see Fig. "Golden Rule" 1). In order to see even more clearly that the design does not work, critical areas should not be shown in red but black. This is done by adjusting the upper interval limit to the maximum possible reduction of 36%.
Image 5 shows the result, now the critical areas (too high reduction) are immediately noticeable due to the black colour (compare image 3).
Alternatively, the colour above the maximum can be set from black to the same colour as the maximum, in which case it would be red.

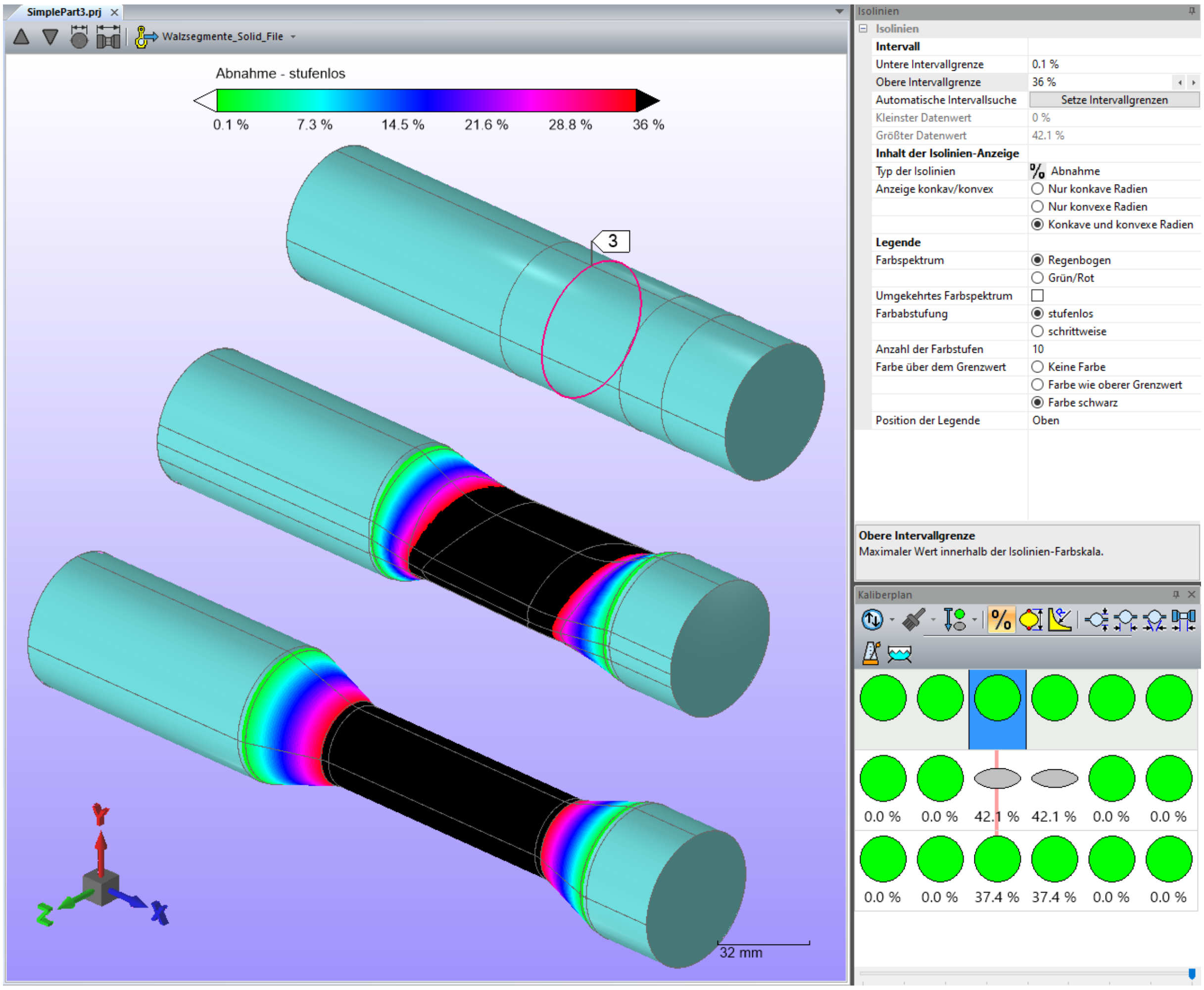


Figure 5: After adjusting the interval limits to 0.1% - 36% and the upper limit set to black.

Isolines as an analysis tool

A common question is the finding of certain values.
Figure 6: The smallest concave radius is sought here. The question behind this is, which milling tool can be used to process the segment cutting. The radius 4.1 mm (red arrow) can be found in the parameter window under "Minimum data value". The legend displays blue as the associated colour. If the user moves the mouse over the blue area, he can quickly read the exact radius at this point in the tooltip window. In this way it is clear that a milling cutter R4 is used and in addition where the area is located.

Concave radii greater than 10mm are irrelevant. To hide them, the upper limit is set to 10 mm and the "Colour above limit" option is set to "No colour".

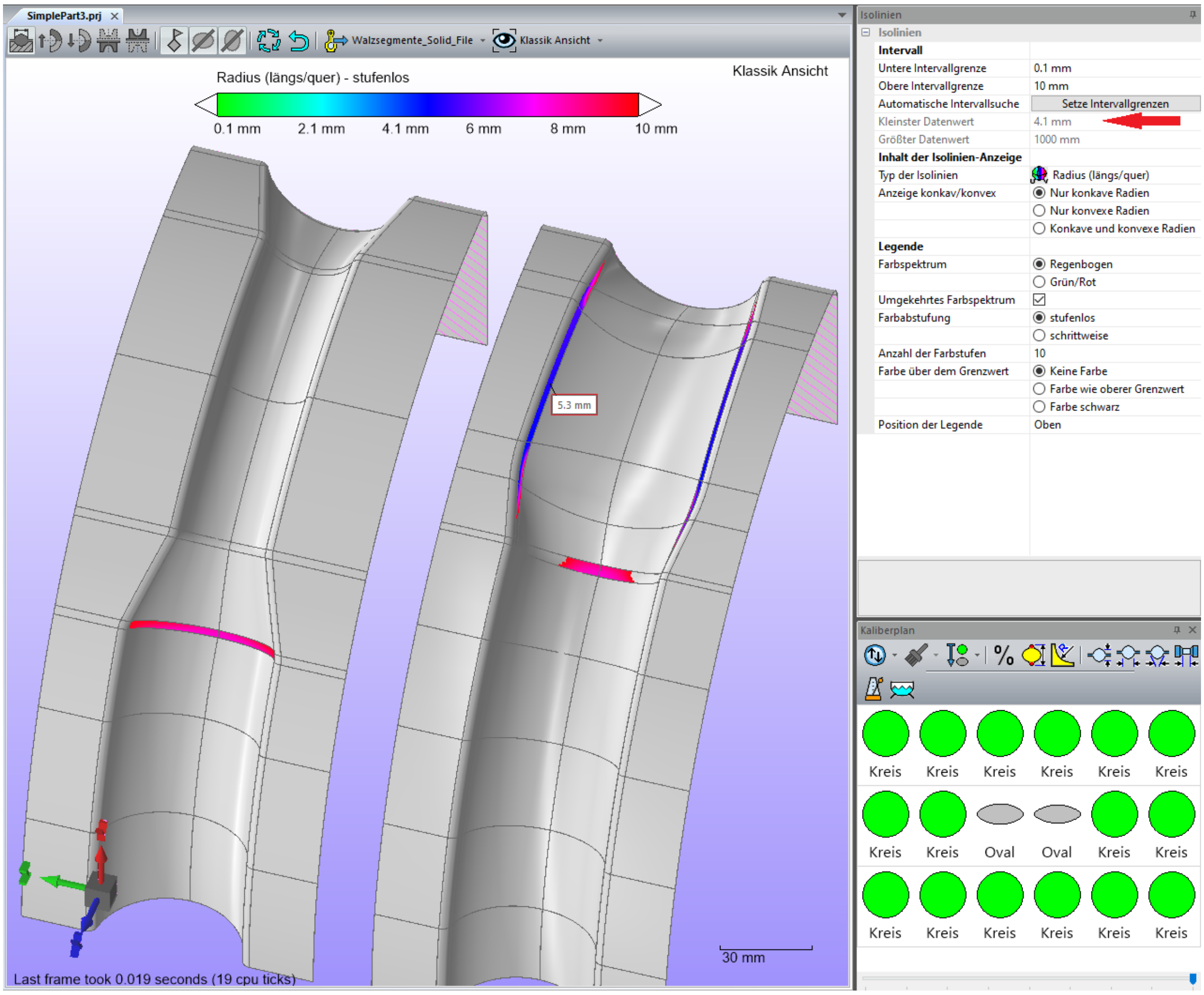


Figure 6: Isolines for the analysis of the smallest concave radius

Figure 7: Here, kinks within the roller segment surface are evaluated. These kinks occur at the patch boundaries when the transition from different cross-sections (e.g., oval to square) creates strong twisting or when radii of different sizes collide. This is often the case with VeraCAD close to the entry edge, if the mouth radius is large.

VeraCAD and VeraMASS adhere to the concept that rolled parts and rolled segments consist of a single surface. At the same time, the spline order is limited to a maximum of 3 (cubic). This makes it very difficult to ensure the tangential transition at all patch boundaries. The function „Kinks in Longitudinal and Transverse“ mark only the kinks at the patch boundaries.

In Figure 7, the flash corner radius was designed with R3 and the mouth radius with R10. Due to the large difference, there are kinks up to 8.2 degrees (red arrow). Above the limit of 5 degrees, they are highlighted in black.
Based on the analysis, the radii can be changed and hereby reducing the kinks.

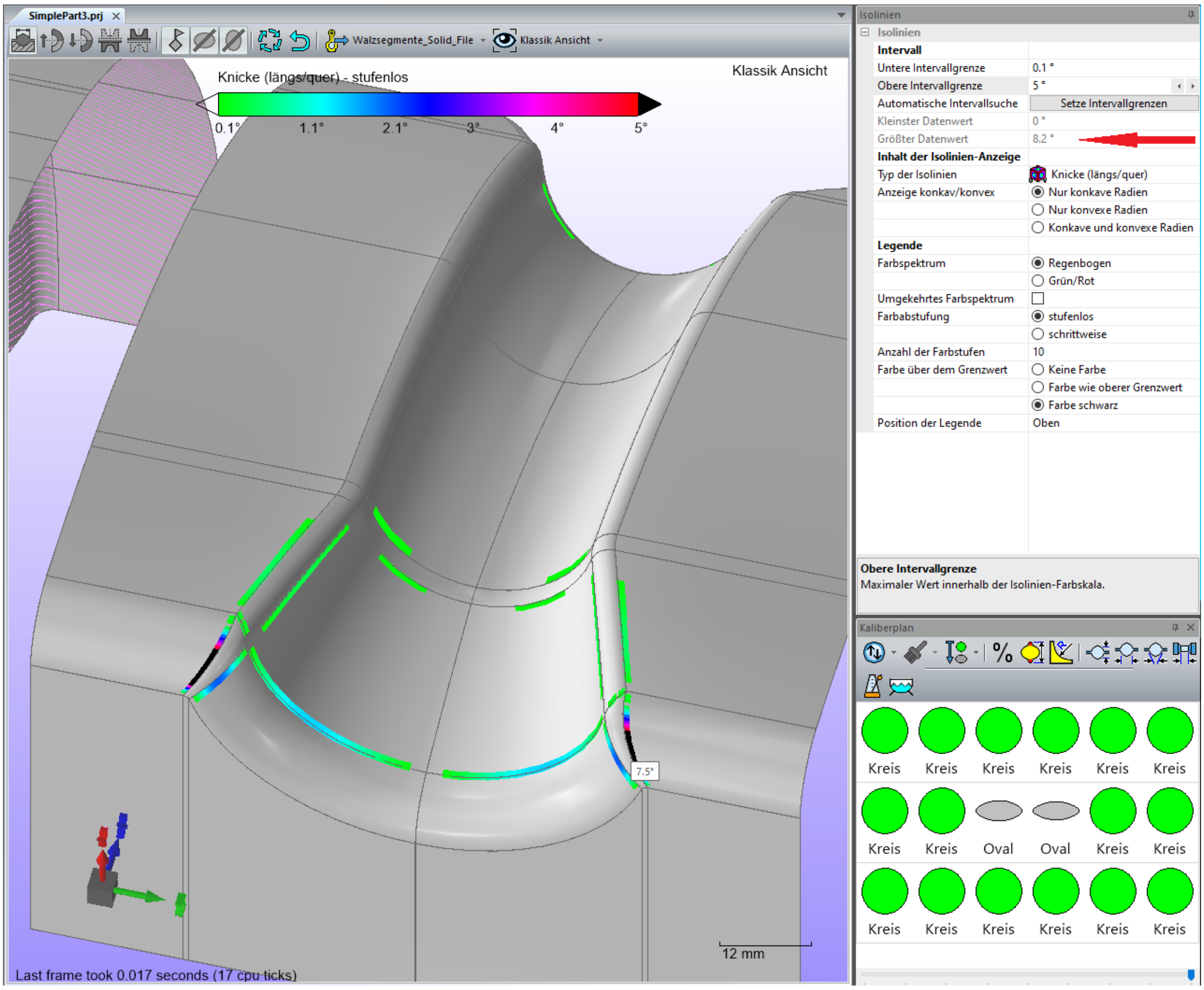


Bild 7: Isolines used to analyse surface defects

Isolines to check the input

The input of parameters in the calibration plan is usually linked to cross-sections. In the calibration plan navigator, you need to navigate to the correct cross-section number and then modify the parameters. Isolines help to check if the values are correct and in the right position (cross-section).

In **Figure 8**, the radius for the flash corner radius in the area of the greatest reduction (Pass 2, cross section 3 - 4) should be increased to 10 mm in order to minimize the formation of "wings" at highest reduction (see Golden Rule number 6). The other areas retain the normal flash corner radius of 3 mm. At the same time, the Inverted Colour Spectrum option (red arrow) reverses the legend. As a result, large radii appear in Green.

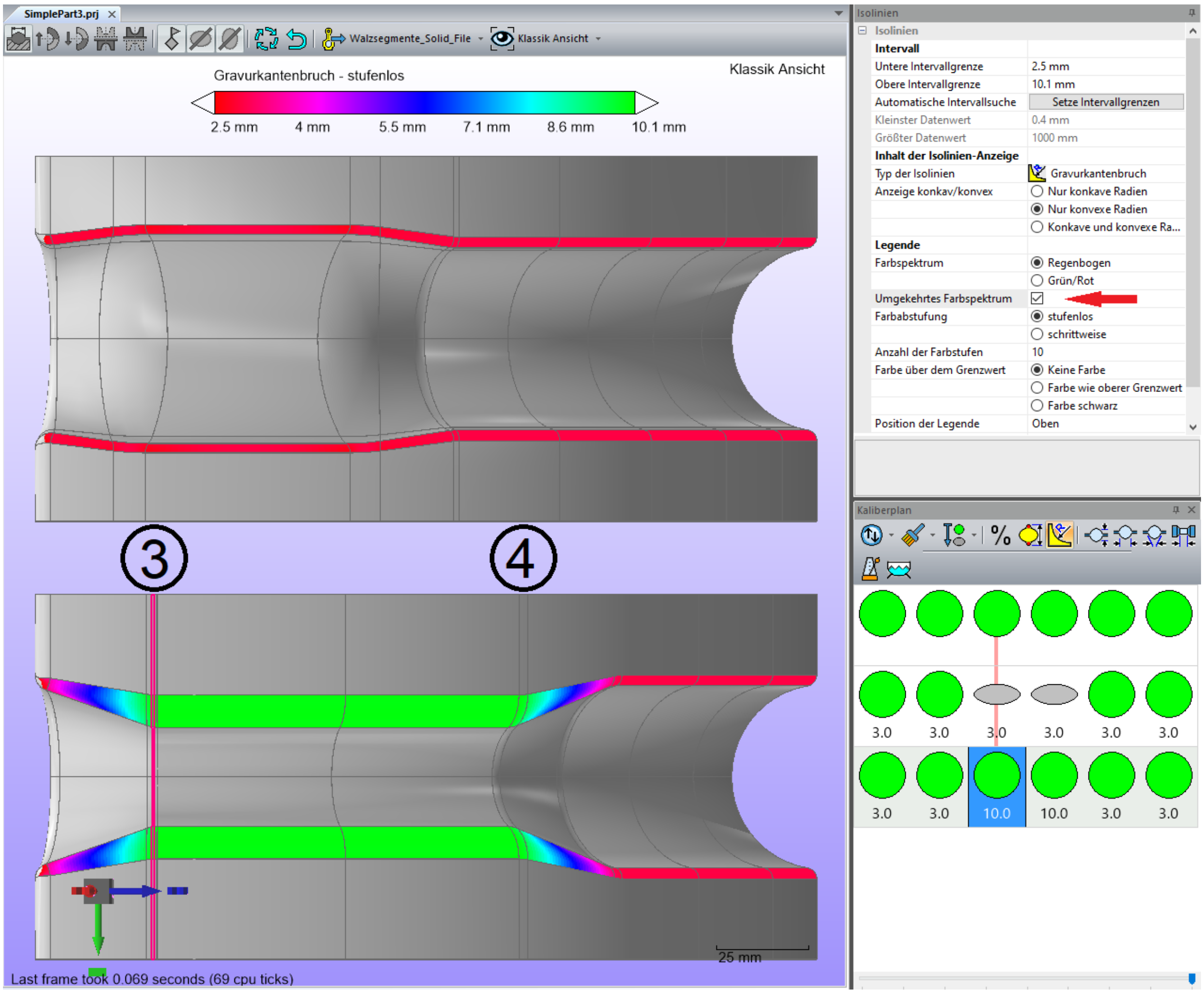


Bild 8: Flash corner radius in pass 2 between cross section 3 and 4

Example: **Draft angle**

According to Golden Rule 5, the draft angle should be at least 25° in all circular cross-sections. Figure 9 on the left shows the draft angle in the impression at a time when no draft angles have been specified. The blue areas have a draft angle of less than 15°.

A draft angle of 25° was set in figure 9 on the right, where upon the entire impression appears in green.

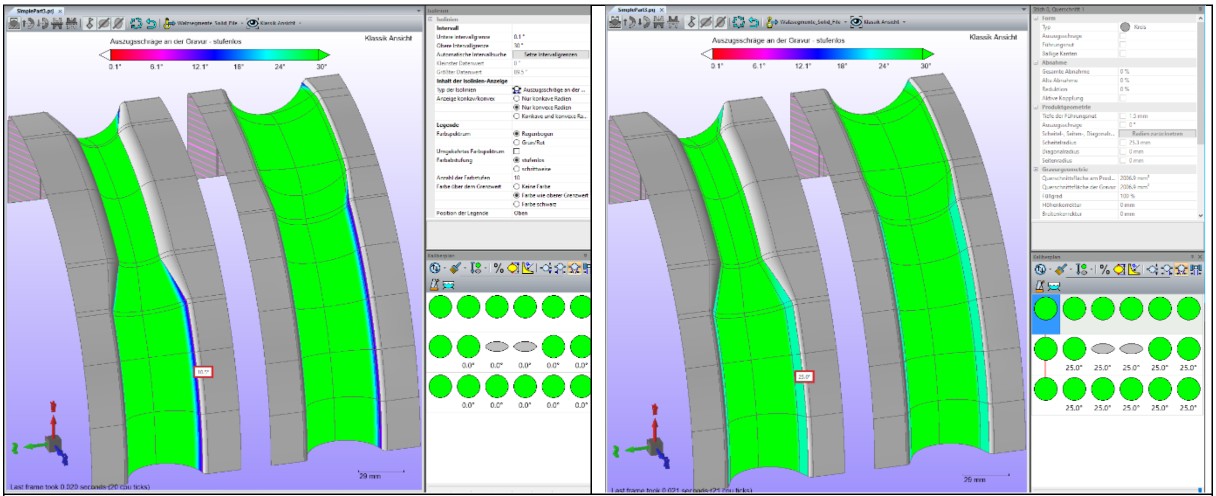


Bild 9: Draft angle in Impression. Blue areas with insufficient draft angles (left).

Example: **Length correction**

Figure 10 shows an application where 3 sections (4, 6 and 8) were provided with a length correction.

After a FEM simulation, it turned out that the two strongly reduced shaft areas (3-4 and 7-8) became 9 mm too long in the last pass. Therefore, the length of these sections in the impression should be reduced by 9 mm. Length errors usually develop continuously across all passes, so the correction in pass 1 should be -3 mm, in pass 2: -6 mm and in pass 3: -9 mm.

At the same time, it turned out that the non-reduced area in the middle (cross-section 5 6) was 15 mm too short. Here the correction for pass 1 should be: +5 mm, pass 2: +10 mm and pass 3: +15 mm.

The display of the length correction with isolines shows whether the length correction was entered for the right cross-sections.

At the same time, the isoline options were set to “discrete” with 10 levels (see red arrow). As a result, there are only a few colours that differ better from each other. This allows the symmetry of the value distribution to be assessed more clearly. The concurrent display also works in this representation, so that the values can be queried.

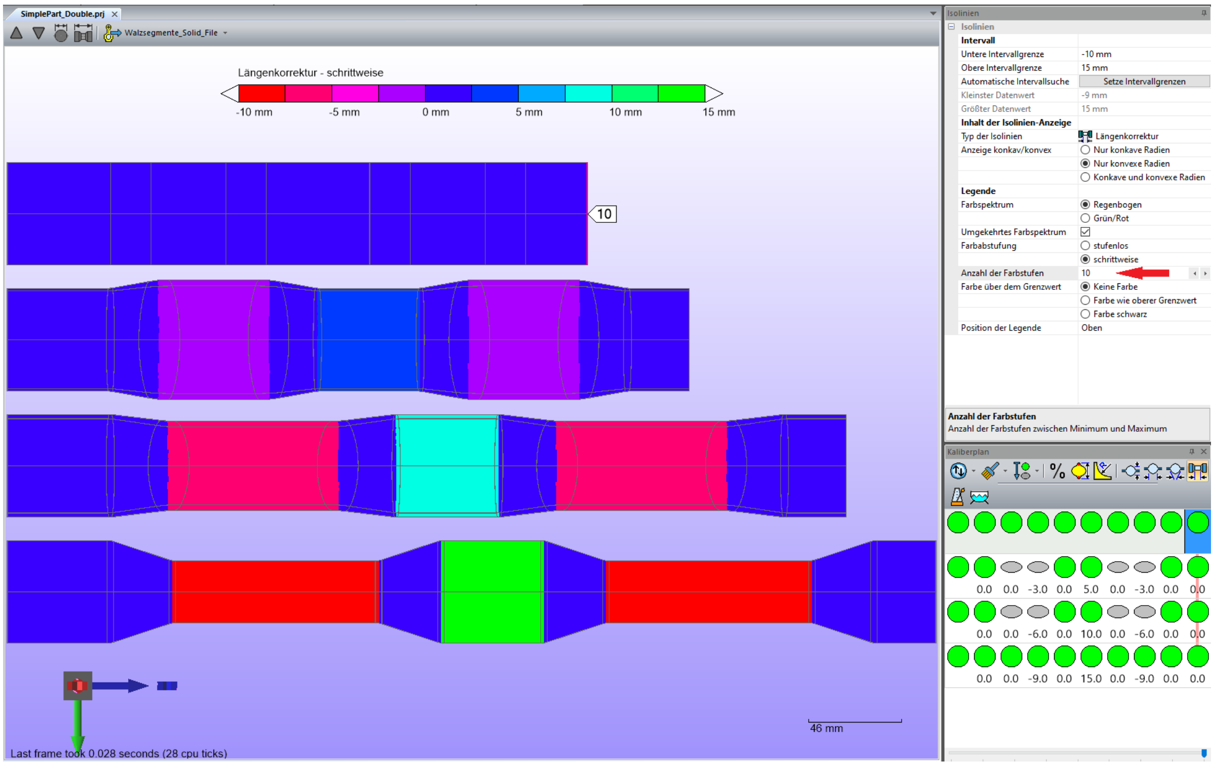


Image 10: Length correction in a double piece rolled with 3 passes.

Summary

Isolines are a comprehensive tool in all stages of the layout of calibration plans. It is much easier to assess a colour gradient than to evaluate an extensive table with abstract numbers (e.g., table in the Information view).
In particular, when checking the input parameters, errors are obviously if you work through the technology values one after the other with isolines.
In many cases we expect equal values for equal cross-sections, which means that these cross-sections must also have the same isoline colour (symmetry cases). The workpiece often has symmetrical properties, if symmetrical values are expected (e.g., height, width, draft angle, etc.), this must also be reflected in the isolines.
Figure 11 shows the filling degree with isolines. There is an anomaly in pass 3 at cross-section 8, although the transition is expected to be symmetrical here. With isolines, the input error is quickly localized and can be corrected.

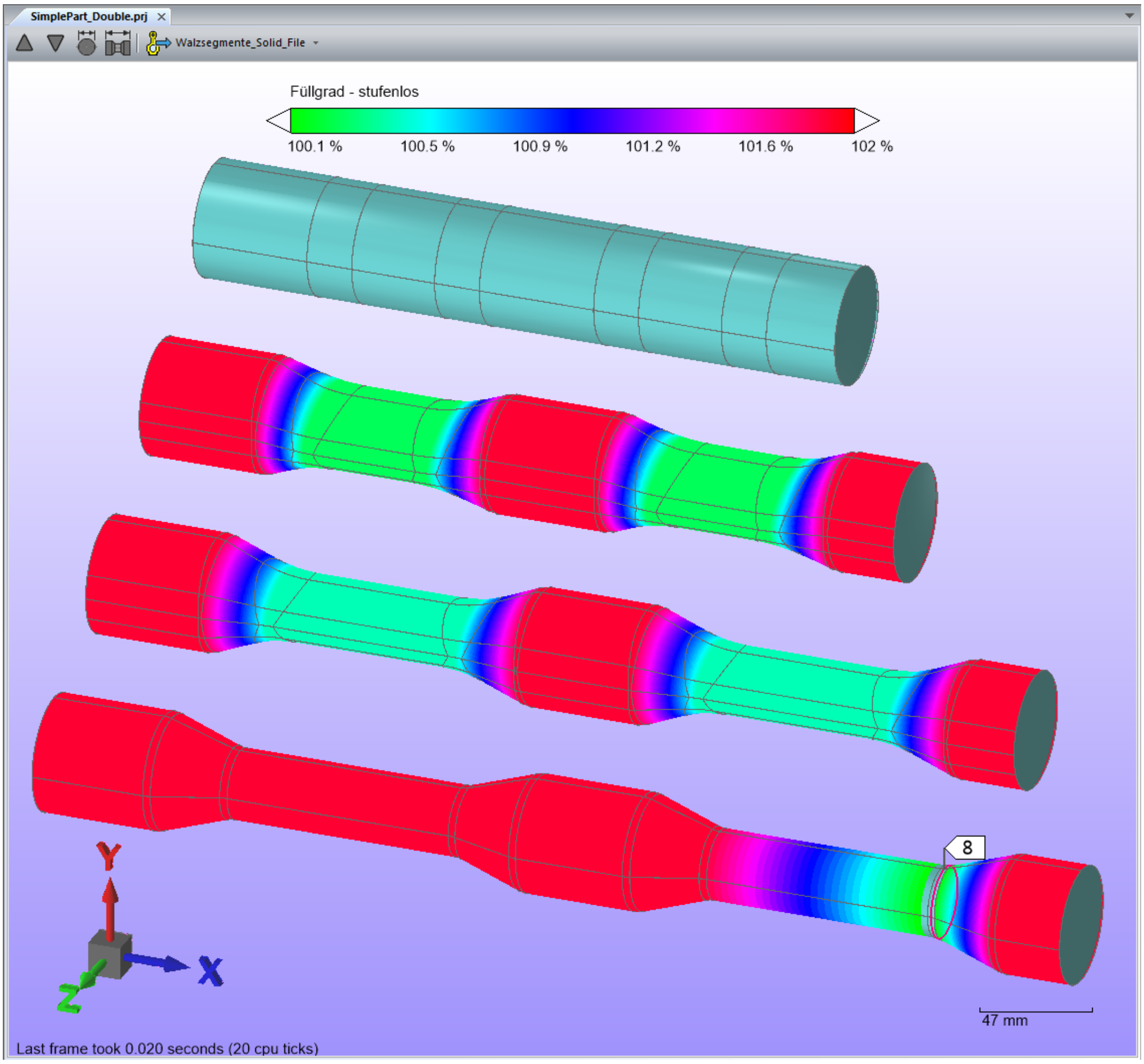


Figure 11: Display of the filling degree with anomaly in pass 3 at cross-section 8

Improvements to the isoline function

We would be pleased to hear your suggestions for improving the function.
The improvements are focussed to the areas:

- Operation of isolines, setting parameters and new options.
- Presentation of the graphic and the legend
- Display of further technology or geometry values