# Welding measurements by microscopy

Joining metals together by welding goes back several millennia to the Bronze Age in Europe. Of course the means and the techniques have improved greatly over time especially during the 20th century starting with the appearance of stud welding in the 30s to electrogas welding and laser beam welding in the 60s. Welding is used in more and more industries, from the tallest skyscraper to the automotive industry, and in all cases the quality of the weld is paramount.

Typically, welding involves human judgment, more so than in any other machine operation. Consequently, quality control is of primary importance.

The major measure used for judging the quality of a weld is its strength and the strength of the material around it. The most common weld defects include: lack of fusion, lack or excess of penetration, porosity, inclusions, and cracking. Any of these defects are potentially disastrous, and quality control serves to identify the defect, find the cause, and remedy the situation quickly and efficiently.

There are several procedures for rating weld specimens, image analysis being one of them. Metallographic weld evaluation can help determine porosity or lack of fusion. On a micro scale, the examination of weld growth patterns, phase balance assessments or checking for non-metallic precipitates are used to determine the cause of a weakness.

The following report concerns the analysis of a fillet weld, a weld of approximately triangular cross section joining two surfaces at approximately right angles to each other. Important measurements made were the distance from the root of the fillet to the center of its face (or throat), the distance from the root of the joint to the junction between the exposed surface of the weld and the base metal (or leg), the angles and the root penetration. Measurements that could have been done with the same ease on similar samples are, among others: depth of HAZ (heat affected zone), area of HAZ, joint penetration, phase counting, etc.

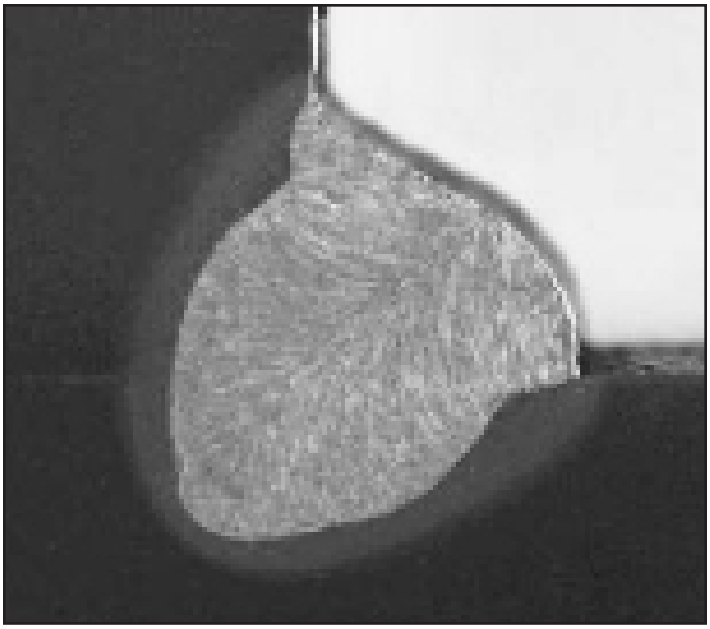
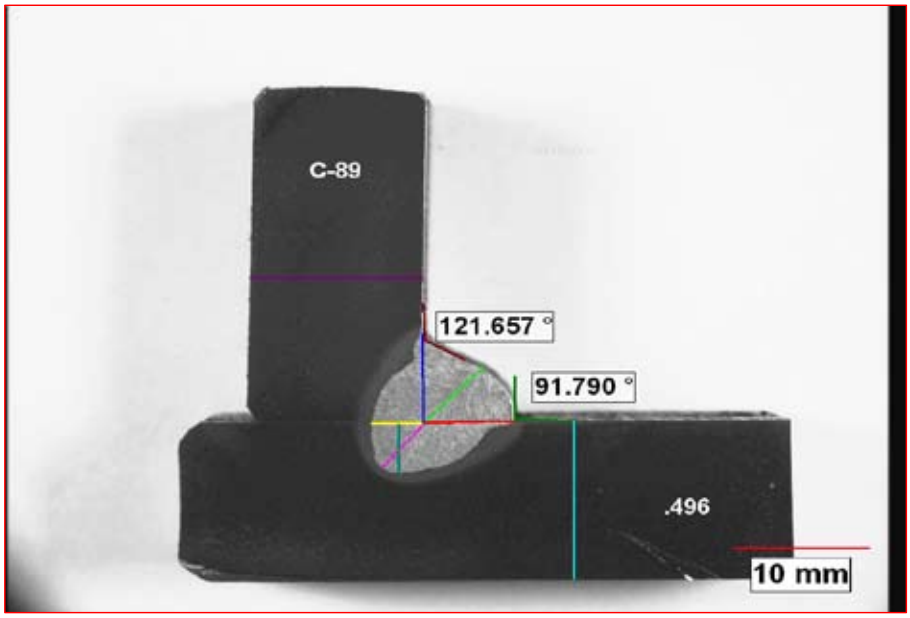


*Figure 1: Part of the original image at 10x (6.43 microns/pixel).*

Clemex Vision PE and Clemex Vision Lite can be used to produce a sequence of specific characteristic measurements. In the present case, the measurements correspond to standard welding measurements performed on a fillet weld. However, the same reasoning could be applied to other types of welding or to any type of parts requiring similar types of direct measurements, including angles, circle, or arc radius, area and others.

The results are expressed based on a specific industry standard using the Report Generator module. This also allows obtaining an automatic passed/failed decision based on predefined acceptance criterion. Once the final report is saved and/or printed, the company has a record of what, and how, characteristics were measured, with the corresponding results. Other important information such as the operator's name, the magnification, the calibration factor, etc., are recorded as well. The final report can be locked if so desired to prevent any possible subsequent modification.




| | Measured | Specification | Passed or Failed |
|---|---|---|---|
| **Leg 1:** | 7.39 | 8.00 | Pass |
| **Leg 2:** | 6.68 | 8.00 | Pass |
| **Throat:** | 6.24 | 6.00 | **Failed** |
| **Root Penetration:** | 4.71 | 5.00 | Pass |
| **Penetration 1:** | 3.86 | 4.00 | Pass |
| **Penetration 2:** | 4.05 | 13.00 | Pass |
| **Material 1:** | 12.66 | 14.00 | Pass |
| **Material 2:** | 12.92 | 15.00 | Pass |
| **Angle 1:** | 121.66 | 115.00 | Pass |
| **Angle 2:** | 91.79 | 115.00 | **Failed** |

*Figure 2: Six typically measured characteristics on welded parts.*
*(Magnigication: 10X / Calibration: 64.2776 micron/pixel / Units: milllimeters)*