Computer Tomography has arrived in automated inspection processes, combining material and geometry analyses.
Volume Graphics GmbH …

- is the world leader in iCT data analysis and visualization since 1997
- is a German company with headquarter in Heidelberg
- is also located in Nagoya, Japan and Charlotte NC, USA
- is working together with all major CT manufacturers around the world
- is the home of VGStudio MAX
Material and Geometry Analysis

iCT and **VGStudio MAX** allows to inspect a larger number of quality relevant aspects of a part on a single CT data set!

**Material Information**

**Composite Material Analysis**

**Defect/Inclusion Analysis**

**Geometry Information**

**Coordinate Measurement**

**Nominal/Actual Comparison**

**Wall Thickness Analysis**
Material Analysis

iCT & VGStudio MAX

Material Information

Composite Material Analysis

Defect/Inclusion Analysis
• The defect analysis tool allows an automated detection and analysis of internal defects, porosity or inclusions, e.g. in castings.
Combining the defect distribution with a CAD model ...
Defect Detection and Virtual Machining

• … enables the user to do a pre machining test including a classification of the defects.
Porosity Analysis along P201/VW 50097 allows the comparison of destructive and non-destructive testing methods

- Minimizing human influence due to the use of templates
Porosity Analysis according to P201/VW 50097
Material Analysis

- Fiber Composite Material Analysis
Material Analysis

- Fiber orientation in helicopter rotor blades to identify ripples.
Material Analysis

- Fiber orientation in helicopter rotor blades to identify ripples.
Geometry Analysis

iCT & VGStudio MAX

Geometry Information

Coordinate Measurement  Nominal/Actual Comparison  Wall Thickness Analysis
Metrology and iCT

- Local adaptive surface determination is today’s accepted standard and widely used to define a surface within iCT.
- As a simple rule of thumb: “you can reach about 1/10 of a voxel in measurement uncertainty with reasonable quality CT image data”
• If iCT is used in metrology a precise surface determination is required.

Fuel injector borehole
Thin yellow line = ISO50 surface
Thick yellow line = **VGStudio MAX** local adaptive surface determination.
Surface Determination

• The images below show what difference precise surface determination makes.

Fuel injector borehole with and without local adaptive surface determination.
How to find “The Truth”?

• We have to rely on today’s accepted standards as “the truth” and compare iCT measurements with them.

• We measured the diameter of a borehole in an aluminum cylinder head calibrated by a DKD laboratory.

• If we measure it “CT-style”, probing the complete cylinder surface with e.g. 1000 points.
What Is “The Truth”?

- Nominal by DKD \( D_{\text{nom}} = 6.9966 \pm 0.001 \text{ mm} \)
- Scan 1 (0.140mm resol.) \( D_{140\text{CT}} = 6.9870 \text{ mm} \)
- Scan 2 (0.220mm resol.) \( D_{220\text{CT}} = 6.9850 \text{ mm} \)
What Is “The Truth”?  

• If we measure it in traditional style, we create a cylinder by probing two circles with 24 points in y=18 mm and y=43 mm, following exactly the DKD measurement strategy.
What Is “The Truth”?

- Nominal by DKD: $D_{\text{nom}} = 6.9966 \pm 0.001 \text{ mm}$
- Scan 1 (0.140 mm resol.): $D_{140\text{CMM}} = 6.9931 \text{ mm}$
- Scan 2 (0.220 mm resol.): $D_{220\text{CMM}} = 6.9939 \text{ mm}$
What Is “The Limit & The Truth”?

• This example shows two important things:
  1. The measurement strategy is one of the most important aspects when we continue seeking for even lower measurement uncertainty in iCT-metrology.
  2. A 1/10 of a voxel is not the limit once we get even better image quality and better algorithms.
**VGStudio MAX** makes your CT-scanner a full featured, easy to use, ...
Wall Thickness Analysis

• The Wall Thickness Analysis Module allows to process a data set looking for too thick or too thin walls.

• The results were visualized color-coded in 2D & 3D, and can be probed locally.
Wall Thickness Analysis

- **Wall Thickness statistics:**
  - Thickness histogram
  - Min / Max thickness
  - Average thickness with deviation.

Example: Surface layer thickness on pills. The surface layer includes the active substance. → The thickness defines the dose.
Nominal/Actual Comparison

- The Nominal/Actual Module allows to compare CT with CAD as well as with other CT data.
- The data processing directly based on CT (voxel) data eliminates the need to convert CT data into STL or point cloud data.
The quality description of a part

- Today an unconnected evaluation of all analyses is done:

  - All measurements in tolerance?
  - All pores smaller than limit?
The quality description of a part

- Cross Analysis evaluations are leading to one quality description for a part connecting all information from iCT

Wall-Thickness in tolerance AND No pore > 0.3 AND Wall-Thickness max. 0.1 out of tolerance AND No pore AND CAD comparision < 0.1 AND Measurements in tolerance

Good / Bad - Decision
Atline/Inline iCT

The "gap" between Scanner- and Analysis-Software is closed.

Fully automated
Good / Bad Decision

Scanner Software
VG Project SDK

VGStudio MAX 2.2
Atline/Inline iCT

Computer Tomography has arrived in automated inspection processes, combining material and geometry analyses.
Conclusion and Outlook

- New materials (e.g. composites) and analysis are opening new markets for the whole CT industry.

- Measurements with iCT are highly accurate, the measurement strategy is the crucial factor!

- Material and geometry analyses combined in an evaluation are creating **one** comprehensive quality description of a part.

- Using macros including cross analysis evaluations gives security for supplier/customer relation by minimizing the human influence within quality control.

- Today Inline iCT provides fast good/bad decisions based on material and geometry features of a part, direct in the production process.

CT is already, and will be in future the universal quality control tool in industry.
Thank you for your attention!

For further questions please visit our booth!