

CT Analysis Software Product Review: VGSTUDIO by Volume Graphics



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Is VGSTUDIO the right analysis software for me? I’m going to help you answer that question. There are [many analysis software choices](#) for X-ray micro-CT ([computed tomography](#)), and there are good fits and bad fits depending on what you aim to achieve with CT data.

VGSTUDIO was the first CT analysis software I learned to use five years ago, and it still is the main one I use daily. It is a comprehensive tool with various analysis modules, but there are good and not-so-good fits for this product like any other CT analysis and CT processing software. In this article, I will address the following questions customers often ask me when considering VGSTUDIO.

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What is VGSTUDIO MAX software? - An overview



[VGSTUDIO MAX](#) is a modular software suite for [GD&T \(Geometric dimensional and tolerancing\) analysis](#), material analyses, simulation, and CT reconstruction developed and distributed by [Volume Graphics](#). You can use VGSTUDIO MAX to analyze 3D volume data, such as CT images.

Volume Graphics offers various products, including VGSTUDIO MAX, VGSTUDIO, VGMETROLOGY, VGINLINE, and myVGL. Each is optimized for different needs, such as research and development, failure analysis, and process control, including data collection and reporting automation. In this article, I will review VGSTUDIO MAX, the high-end software for analyzing and visualizing industrial CT data.

VGSTUDIO is considered the best tool in the market for metrology (especially geometry and dimensional analysis), and it fully supports GD&T analyses.

The basic edition includes:

1. Data quality evaluation
2. Visualization and animation
3. Image segmentation
4. Reporting
5. Automation

There are more than twenty modules you can add for geometry analysis, materials analysis, simulation, and reconstruction. You can also add multiple modules as a package. Available packages include Geometry, Material, Cast & Mold, Cast & Mold Extended, Composites & Plastic, Additive Manufacturing, and Complete. ([See the full list of modules and packages.](#))

Here is a list of modules included in each package:

- Geometry: For metrology and quality control across a broad range of industries
 - Coordinate Measurement
 - Nominal/Actual Comparison
 - Wall Thickness Analysis
- Material: For lightweight construction and materials research
 - Coordinate Measurement
 - Porosity/Inclusion Analysis
 - Fiber Composite Material Analysis
 - Foam/Powder Analysis
- Cast & Mold: For casting and injection molding; eg., the automotive and aerospace industries
 - Coordinate Measurement
 - Nominal/Actual Comparison
 - Wall Thickness Analysis
 - Porosity/Inclusion Analysis
- Cast & Mold Extended: For aluminum casting, mainly for the automotive industry
 - Coordinate Measurement
 - Nominal/Actual Comparison
 - Wall Thickness Analysis
 - Porosity/Inclusion Analysis
 - Extended Porosity/Inclusion Analysis
- Composites & Plastic: For industries working with plastic injection molding and fiber composite materials
 - Coordinate Measurement
 - Nominal/Actual Comparison
 - Wall Thickness Analysis
 - Porosity/Inclusion Analysis
 - Fiber Composite Material Analysis
- Additive Manufacturing: For the inspection of additively manufactured parts, including powders

- Coordinate Measurement
- Nominal/Actual Comparison
- Wall Thickness Analysis
- Porosity/Inclusion Analysis
- Foam/Powder Analysis
- Complete*: For advanced users in quality assurance labs who face different analysis and measurement tasks as part of their daily work
 - Coordinate Measurement
 - Nominal/Actual Comparison
 - Wall Thickness Analysis
 - Porosity/Inclusion Analysis
 - Extended Porosity/Inclusion Analysis
 - Manufacturing Geometry Correction
 - Fiber Composite Material Analysis
 - Foam/Powder Analysis
 - Volume Meshing
 - Structural Mechanics Simulation
 - Transport Phenomena Simulation
 - Reverse Engineering
 - Digital Volume Correlation Module
(* Does not include the add-on modules CT Reconstruction, CAD Import, CAD Import with PMI, and Structural Mechanics Cluster Extension.)

What are the pros and cons of VGSTUDIO MAX?



Pros

VGSTUDIO works very well for metrology required in the manufacturing and production processes for three reasons.

First, its design is optimized for process control and failure analysis, and addresses common needs such as dimensional and geometrical tests, nominal versus actual comparison, and defect analyses.

Second, the procedures often used in the production process are straightforward and relatively easy to learn.

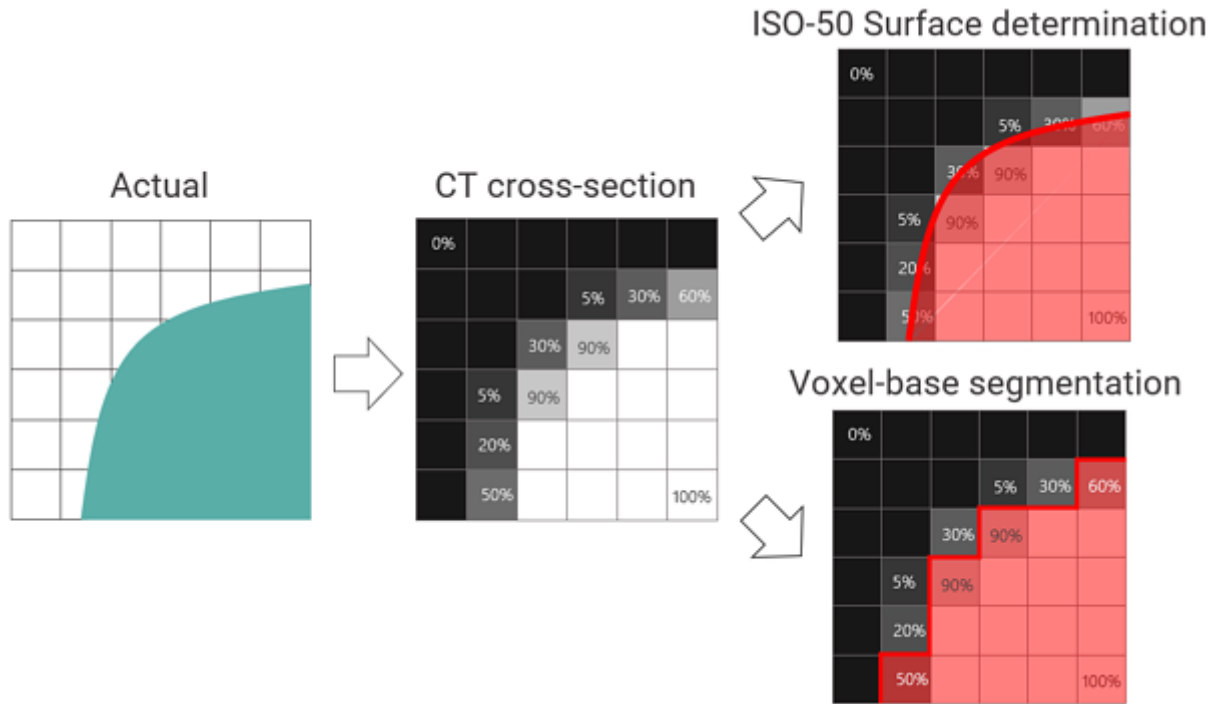
Lastly, once you develop a process control or test plan, you can apply it to other parts or extend it to a fully automated workflow from data collection and analysis through reporting.

1. Best tool for the production process metrology

VGSTUDIO is the de facto standard for metrology, especially geometry analysis, and fully supports [GD&T analysis](#).

For dimensional and geometric analyses, it is crucial to determine the object's surface position precisely and accurately. The first step of CT image analysis is often image segmentation by labeling each voxel as "solid (object)" and "air (background)," for example. However, this technique's resolution is limited to the voxel size, which is insufficient for accurate dimensional analysis.

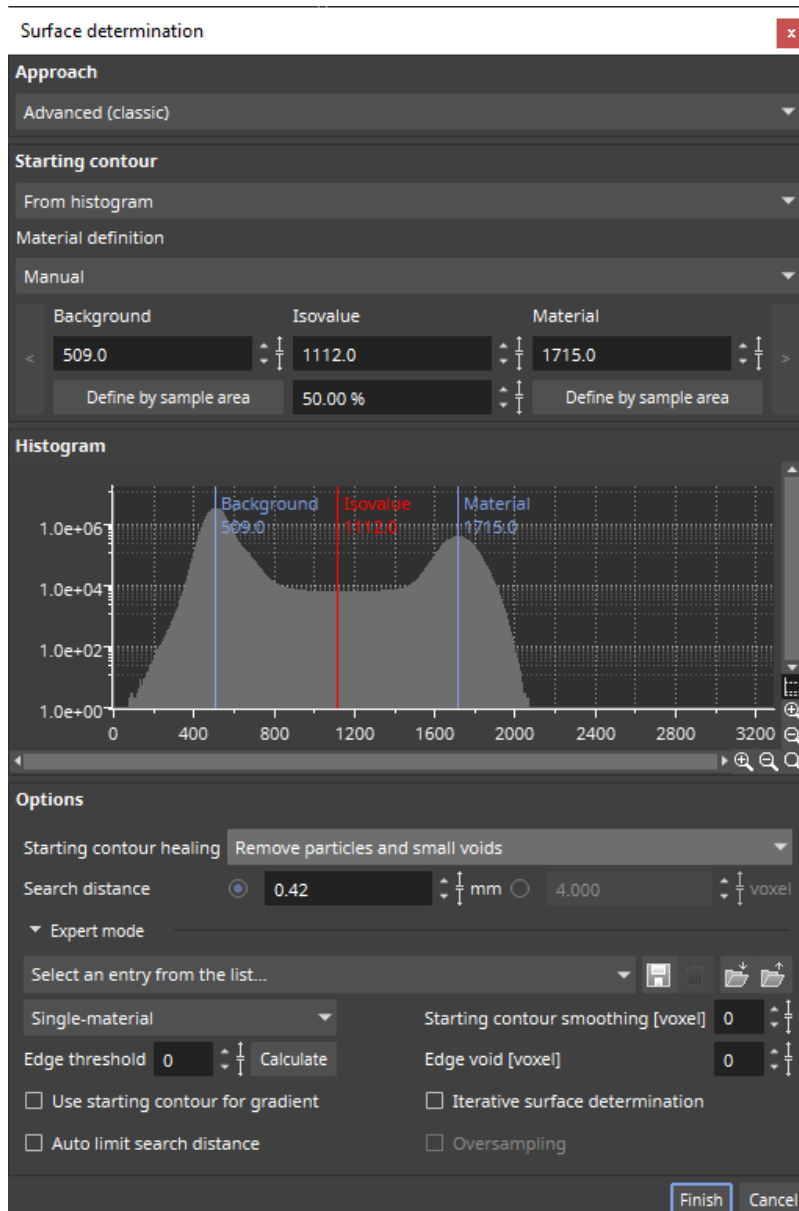
For dimensional analysis, the surface position needs to be determined by a technique called ISO-50. This technique, when properly calibrated, can achieve higher resolution, up to 1/10 of the voxel size, by defining a surface “within” voxels, as shown in the figure below.



To learn more about dimensional analysis using CT images, watch: [X-ray Computed Tomography Webinar Series: Metrology Applications](#)

VGSTUDIO MAX uses the ISO-50 principle and further refines the surface determination by allowing detailed adjustments. For example, a uniform object can exhibit varying gray levels due to artifacts. This is accounted for in the surface determination process.

You can also set more than two materials in one scan, while the simple ISO-50 can handle only one material. You can eliminate false “holes” and “islands” while determining the surface. You can see the level of control you have in the surface determination dialog shown below.



The precision and accuracy of dimensional analysis are not easy to determine. It requires rigorous evaluation involving standard objects with “known” or certified dimensions, repeated measurements under different conditions, and comparison with other dimensional analysis equipment such as [CMMs \(coordinate measuring machines\)](#). (Refer to German industry standard [VDI/VDE 2630 Part 2.1](#) for more details on the evaluation procedure.)

The good news is that two prestigious institutions have already evaluated VGSTUDIO MAX as a metrology tool. [PTB \(Physikalisch-Technische Bundesanstalt\)](#) and [NIST \(National Institute of Standards and Technology\)](#) have verified its algorithms. This is one of the main reasons why VGSTUDIO MAX is considered the best and most trusted analysis software in the industry for

metrology. You should still evaluate the accuracy of your hardware, but you don't need to worry about the analysis software if you use VGSTUDIO MAX.

The production process might require more than simple dimensional measurements. VGSTUDIO MAX has that covered, too. You can compare a CAD drawing (nominal) and the measurements from CT (actual).

You can also use a gold standard part against which to compare a test part. You can generate a gold standard by averaging good parts. You can also analyze voids and cracks in metal parts or fiber orientations in composite parts.

Furthermore, once you determine the surface, you can simulate von Mises stress distribution, capillary pressure, electrical conductivity, thermal conductivity, etc. For more advanced analyses and simulations, you can export the dataset as a volume mesh and run the [FEA \(finite element analysis\)](#) using other tools such as [ANSYS](#) and [ABAQUS](#).

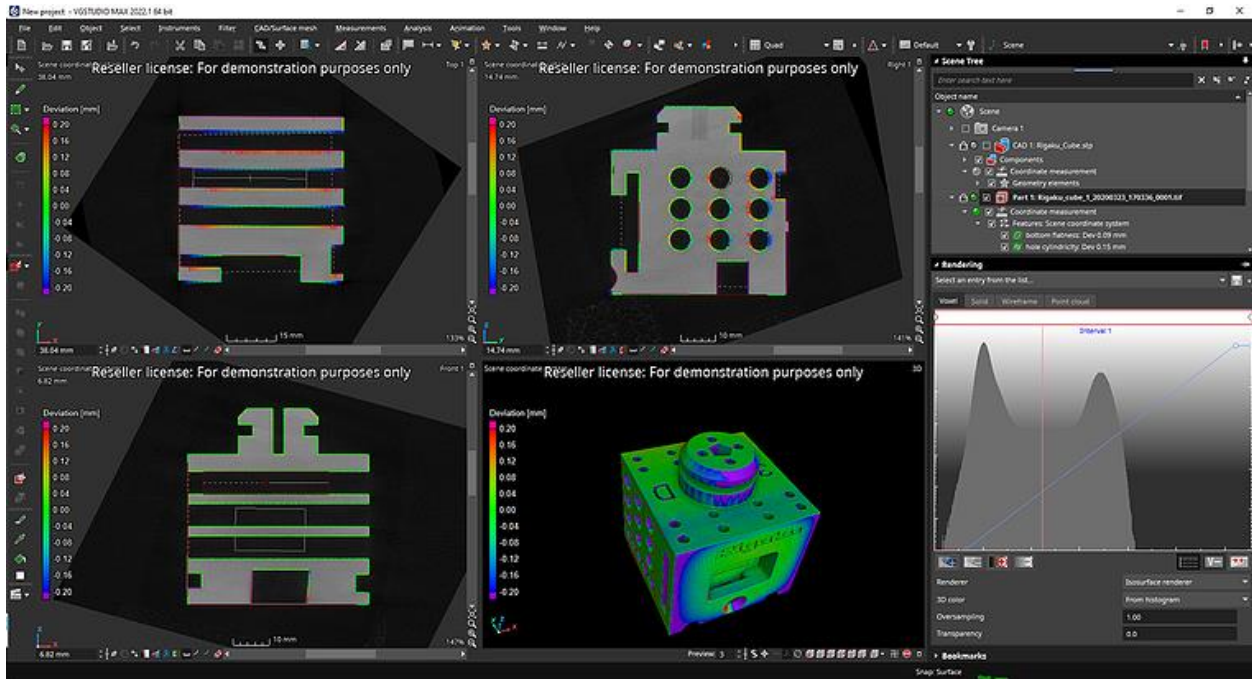
The biggest advantage of VGSTUDIO MAX is that it is designed for the production process, and it supports all of the common analysis needs mentioned above in a cohesive package.

You can see how VGSTUDIO MAX is applied to everyday production process challenges in their [webinars](#) and on the [Applications](#) and [VG Stories](#) pages.

1. Straightforward analysis process

Dimensional analysis starts with surface determination. Then you define the coordinate system. After that, you can select items you want to measure. This is a well-defined and relatively simple process. Because VGSTUDIO MAX is optimized for this process, you can learn how to do this within a day or two.

The main interface is self-explanatory. You have the three cross-sections in X, Y, and Z directions and a 3D-rendered view. At the right bottom (Rendering), you have tools to change the image display settings. At the right top (Scene tree), you see a tree structure showing components such as the original CT image, defined surface, coordinate system, defined shapes, geometries, and analysis results.



You might be overwhelmed by the number of buttons. However, all tools are accessible from the main menu. These buttons are just convenient shortcuts you can use once you get the hang of them. Plus, once you define the analysis process, you can automate it and might not need to go through it step by step by navigating the menu items.

The Scene tree is a great interface that will help you throughout the analysis process.

The screenshot shows the 'Scene Tree' panel with several annotations:

- Red frame and +** indicates the volume has a defined surface and coordinate. (Points to 'CAD 1: Rigaku_Cube.stp')
- Green** indicates these elements are within the tolerance. (Points to 'bottom flatness: Dev 0.09 mm' and 'hole cylindricity: Dev 0.15 mm')
- Undefined volume** (Points to 'Part 2: Rigaku_cube_1_20200323_170336_01.tif')
- These geometry elements belong to the CAD file.** (Points to 'bottom plane reference: n=0.00/0.00/-1.00', 'front plane reference: n=0.00/-1.00/0.00', and 'side(R) plane reference: n=-1.00/0.00/0.00')
- Apply the same analysis to another volume by copying & pasting** (Points to 'Nominal/actual comparison' and 'Analysis 1' under Part 2)

The Scene tree has various benefits:

- Shows the dataset's status; i.e., if the surface has been determined, the coordinate has been registered, etc.
- Shows the hierarchy of the analyzed items; i.e., which results came from which data set, surface determination conditions, coordinates, etc.
- Synchronized with the image view and shows you where you are and what you are looking at.
- Helps you navigate even through a complex process by customizing the label of each item and "bookmarking" key steps.
- Lets you access analysis conditions and revise them for each step by double-clicking the analysis element you want to revisit.
- Makes it easy to apply the same process to a different dataset by copying and pasting an analysis element.

When you are comparing multiple datasets with tens of geometry elements, things can be complicated and difficult to navigate. The scene tree keeps you oriented.

2. Expandability and automation

When evaluating parts in the production process, you often need to apply the same analysis to many parts and determine if they pass or fail the criteria or analyze the trend of failure. To do this, you would apply the exact same process to all datasets. VGSTUDIO MAX has an extensive macro function and can make even the most complex analysis process automated. You can also add reporting to the automated process.

VGINLine in the Volume Graphics's product family can be set up to control a CT scanner. Once you have a solid analysis workflow, you can apply it to the production line and run everything from the CT scan, data analysis, and pass/failure test, through reporting. This is a unique advantage of the Volume Graphics products compared to other CT manufacturer-independent tools.

Cons

Although you can use VGSTUDIO MAX to perform various material analyses such as void distribution and fiber orientation calculation, these analyses involve many parameters to optimize, and the learning curve is rather steep.

Also, these material analyses sometimes require more flexible phase segmentation; that is, machine learning and deep learning segmentation. Suppose your focus is more on the research phase than the production phase. You might want to analyze the properties of the materials in detail using high-resolution CT images with the ability to interrogate individual fibers, for example. In that case, analysis software optimized for high-resolution materials analysis and equipped with the machine and deep learning segmentation would work better.

How much is VGSTUDIO MAX?

The cost of VGSTUDIO MAX depends on the license type and module configuration. The exact pricing is not published, but it is on the more expensive side compared to other commercial software.

You can contact the distributor in your area and request a quotation ([list of distributors](#)).

One thing to note here is that many modules and license types are available. You can review all products in their [extensive collection of brochures](#). Configuring VGSTUDIO MAX can be an overwhelming process. I recommend you talk to a local distributor (Rigaku is a distributor) or a [sales representative from Volume Graphics](#) and ask them to help you.

What types of licenses are available?

Floating, node-locked, and dongle licenses are available. The floating license allows you to use a single license worldwide, continent-wide, country-wide, or within one location. The node-locked license is exclusively for a specific computer. The dongle license allows you to move the license from one computer to another without the need for a network connection.

You can check their [license descriptions on their website](#).

What are the system requirements?

VGSTUDIO MAX requires decent computational power. Let's take a look at the system requirements.

Here is a summary of the official recommended system requirements listed by the manufacturer. To learn more details visit their [system requirements page](#) or [contact Volume Graphics support](#).

- Windows 10 Enterprise 64-bit, 64-bit Windows 10 Professional 64-bit.
- Linux operating system - Ubuntu 20.04 LTS 64-bit
- MacOS Big Sur 11.3.1

- Latest Intel or AMD multi-core processors, e.g., Intel Core i7 or Xeon E5 Processors with 2.4 GHz or higher
- For 2 GB of data - 4 GB of RAM for visualization only or 8-16 GB of RAM for data analysis
- For 16 GB of data - 32 GB of RAM for visualization only or 64-96 GB of RAM for data analysis
- For performing advanced analyses, such as transport phenomena or structural
- Dedicated NVIDIA or AMD graphics cards with at least 4 GB VRAM and OpenGL 4.1 support. Onboard graphics chips are generally not recommended and should be thoroughly evaluated if no dedicated graphics card is available. (For drivers tested by Volume Graphics, see their [full system requirement document available on this page](#).)
- Display resolution 1920 x 1080 at 100% scale.
- VGSTUDIO MAX supports 4K monitors.
- Enough local hard disk storage for data storage and temporary file storage.
Note: CT reconstruction has additional requirements.

■ Read: [7 Things to Consider When Buying a Computer for CT Image Processing](#)

■ Read: [How Should I Manage Tomography Data?](#)

Some laptops satisfy these requirements. However, note the requirements, especially the RAM size, depend on the data size. To comfortably analyze a few to ten GB size images, I would recommend a workstation with 128 GB of RAM and an 8-12 TB hard drive.

I should also mention that when analyzing a volume larger than 10 GB, even with my high-spec computer with the dual CPU (Intel Xeon Gold) and 512 GB of RAM, analysis can take roughly an hour. This is the case not just for VGSTUDIO MAX but for any analysis software with today's computer power.

How can I learn to use VGSTUDIO MAX?



Volume Graphics offers extensive online and in-person training courses called [VG Academy](#) worldwide. The course length is usually about a few days to a few weeks. I would highly recommend you take a course that covers your area of interest. All courses are very well designed and involve practical examples and plenty of hands-on exercises. They also have excellent instructors.

I have attended multiple courses, which is how I learned how to use VGSTUDIO MAX.

How can I try VGSTUDIO MAX?

Volume Graphics offers a [4-week free trial](#) for VGSTUDIO MAX. I recommend you get the trial license and take a look. You will need a computer meeting their [system requirements](#) to use the trial license. You will also need to invest some time in learning how to use it. Alternatively, you can ask a distributor or a [Volume Graphics representative](#) to give you a demonstration.

Is VGSTUDIO MAX for me?

If your main goal is to do dimension, geometry, and defect analyses of parts in the production or pre-production stage, VGSTUDIO MAX is the right tool for you.

If your focus is more on materials research using high-resolution CT images, VGSTUDIO MAX might not be the best choice. If your CT images are difficult to segment because of low contrast, complex texture, etc., you will need a machine or deep learning segmentation tool, which VGSTUDIO MAX does not have—at least not today.

If you decide that VGSTUDIO MAX isn't a good fit for you, you can look for other software that might fit your needs better in [this blog article](#).

Selecting the best CT analysis software for your needs can be complicated because there are so many choices. If you are not sure which one is the best fit for you, our team of application scientists can help you choose the right tool for your research needs. You can talk to one of our CT experts by clicking the “Talk to an expert” button at the right top of the page or send us a message at imaging@rigaku.com.



Junichi Satoh 

My name is Junichi Satoh, I am a Computed Tomography Application Scientist. I hold a PhD from Tokyo University of Agriculture in Bioscience and have been with Rigaku for 6 years. I have a Chihuahua, Rin, and I enjoy hiking and camping.