July 30, 2018

Verity™ Usage Guide

Contents

Overview 4
Key Features 5
Hotkeys: 6
User Interface Guide 7
Autodesk® Navisworks® Plugin 7
Verity Viewer 7
Host and Companion Applications 8
Host File Requirements and File Types 8
Geometry Files 8
Scan Files 8
Host File Types 9
Verity File Types 9
File Types 10
Saving your work 10
Other Settings 10
Display Units 10
Workflow & Functionality 11
Adding Items to Verity 11
Identifying what to Analyze from Autodesk® Navisworks® 11
Selecting elements in Autodesk® Navisworks® 11
Adding to Verity 11
Add to Verity (search tree) 12
Add to Verity (selected node) 12
Refining the Working Set in Verity 13
The Verity Scan and Item Tables 13
Sorting the Item Table 13
Import Selection from Host 14
Export Selection to Host 14

Exploding Items 14
Remove from Verity 14
Analyze your Items 15
Setting the right options 15
The Analyze Progress Bar 16
Canceling the Analysis 16
What impacts Analysis duration 16
Storage Speed and Latency 16
Geometry Correction 16
Number of Points 17
Number of Items 17
Expectations for Analysis Duration 17
QA the Analysis 18
Reviewing the Analysis Results 18
Coverage Percentage 18
Installation Statuses and Conformance to Tolerance 19
Translation and Rotation Metrics 19
Translation Metrics 19
Rotation Metrics 20
View Controls 20
Secret Verity Color Decoder Ring 20
Camera and View Frames 21
Split View / Single View 21
View Frames (Coordinate Systems) 21
Camera style 22
Visibility 22
Opacity 22
Point Color 22
Heatmap 23
Heatmap Gradient 24
Heatmap Gradient Range 25
Heatmap Scale 25
Connection to Host 26

Host View Modes 26
Import and Export Selection to Host 26
Removing Items after running Analyze 26
Export Verity Properties to Host 27
Move Host Item to As-Built 27
QA/QC the results of each Item 28
Measure Distance 28
Measure Scan Point Distance from As-Built Surface 28
Measure As-Designed Geometry Distance from As-Built Surface 28
User Defined Table Fields 28
Tracking what you've reviewed 29
Accepting the Current Status 29
Why our algorithms might guess incorrectly 30
Correcting or Adjusting results 31
Adjusting the Installation Status 31
Manually Adjusting the Fit 31
Recalculate Heatmap 32
Reset Fit 32
Refit 32
Changing the Tolerance 32
Reporting results 33
Reporting with Autodesk® Navisworks® 33
Reports Menu 33
CSV 33
HTML 33
Adding your logo to the HTML Reports 37
Smart Points 37
The Publish Menu 38
Login 38
Project 38
Create Issues 38
Pro Tips: 39
Known Issues 40

Version 1.5 – Release Notes 41
Changes in version 1.5 41
Acknowledgements & Licenses 42

Overview

This document is intended for users of the 1.5 release of Verity™. The goal of our application is to provide a tool that lets you check 100% of a scope of work in the same time as it takes to spot check 10% using traditional methods. Whether you are installing work in the field or creating an as-built model from laser scans, Verity™ should provide you the ability to completely QA/QC your work. Users should be aware that there are several requirements for software versions, scan data, and model data:

- Verity™ is a companion application to Autodesk® Navisworks® Manage and Autodesk® Navisworks® Simulate, and supports the 2016, 2017, 2018, and 2019 versions of the product only. You must have one of these installed on your computer in order to run Verity™
- The advanced algorithms in our software require structured data (single RCS file per scan location) in RCS or RCP format appended to Autodesk® Navisworks® with the "Voxels" conversion mode. For now, this means mobile lidar data and photogrammetry derived point clouds are not supported*. Unified data from terrestrial scanners is also not supported.
- Verity™ assumes the models and scans are on the same coordinate system in Autodesk® Navisworks®. If your laser scans and model are not on the same coordinate system, we recommend you work with your scan provider to establish project coordinates in the scan data. You can use the transform tools in Autodesk® Navisworks® to relatively locate the scans and geometry, but this workflow is not recommended.

** There is currently a technical preview that supports using unstructured mobile or terrestrial data that meets certain requirements. Contact service@clearedge3d.com to learn more and enable this feature.*

Key Features

The key features of the application are noted below. The use of these features and common workflows will be described in the "Workflow and Functionality" section.

1. Identifying Elements in Autodesk® Navisworks® to Add to Verity
    - Use robust selection tools in Navisworks® to identify elements and scans to analyze
    - Add to Verity (search tree) to aggregate your selections into a working set of items to analyze, this option will attempt to find individual elements within a selection
    - Add to Verity (selected node) to add selection to Verity at the level selected (will not search the selection for individual elements)
    - The current number of scans and items added to Verity is displayed for each table
    - Select an added item in Verity to view it individually
    - Sort the added items in Verity by description or surface area to organize the items
    - Sort the added items by their X, Y, or Z location in the project
    - Remove items from Verity if you don't need to analyze them
    - Explode grouped geometry to bring in geometry from a level down in the Autodesk® Navisworks® tree

2. Automatically isolate and compare geometry to scan data
    - Set the installation tolerance used to test whether an item has been installed correctly
    - Set whether the data is from a mobile or unstructured point cloud*
    - Define analysis parameters to get the best results from the automated algorithms
    - Automatically isolate item geometry and surrounding points for visual comparison
    - Automatically classify geometry as installed, not found, or occluded based on point data; or note as having insufficient data, no data, or uncertain
    - Automatically best-fit installed items' geometry to point data and determine if it is in or out of the user-defined tolerance
    - Automatically generate heat map colorizations of point cloud data compared to the as-designed and as-built geometry

3. QA the results of the automated analysis
    - Sortable item table to rapidly organize and review analysis results
    - Selection of items and scans is passed through to Navisworks®
    - Control and synchronize views between Navisworks® and Verity
    - Orient the camera to as-built, as-designed, and project coordinate perspectives
    - Switch the camera between orthographic, perspective, and scanner view
    - Control the visibility of As-Designed, As-Built, Neighboring geometry, and Points
    - Switch the point display between Single Color, Color from Host, and Color by Scan
    - Switch between as-designed, as-built, and as-designed uncorrected heatmaps
    - Switch between smooth and stepped gradients to understand variances
    - Adjust the range over which the heatmap applies (as related to the tolerance)
    - Show or hide the heatmap scale legend
    - Change classifications for uncertain or incorrect results
    - Move the as-built geometry manually if required
    - Adjust the tolerance for individual items

- Re-fit geometry to points the user manually moves the geometry close to
- Re-calculate the heat maps if the user manually moves the geometry into place
- Measure in screen space to understand sizing and variation of objects
- Measure the average deviation of the point cloud from any point on the as-built object
- Measure the variance distance from any point on the as-built geometry
- Workflow to review, sign off on, and note items for further actions

4. Report the final results
    - Push the Verity properties to Autodesk® Navisworks® automatically or manually
    - Push as-built geometry locations to Autodesk® Navisworks® automatically or manually
    - Export the points associated with selected items to PTS with single color, as-designed heatmap, as-built heatmap, or colorized point cloud
    - Export the analysis summary, individual item reports, and the item table of selected items to HTML
    - Export the item table of selected items to CSV
    - Publish items that need resolution to BIM 360 Field or BIMTrack*

** Features with Asterix are in Technical Preview, contact ClearEdge3D Technical Support with questions or suggestions.*

Hotkeys:

We have hotkeys in Verity for most of the major functions in the interface. Be aware that hotkeys won't activate if you've switched context to Navisworks, to moving geometry in an orthographic projection view, or are editing a cell in the table because you might otherwise want to type one of these keys for a non-hotkey related reason.

- "Remove from Verity" – Delete
- "Explode" – E
- "Import Selection from Host" – S
- "Export Selection to Host" – N
- "Export Verity Properties to Host" – P
- "Move Host Item to As-Built" – B
- "Measure" – M
- "Accept Current Status" – A
- "Recalculate Heatmap" – H
- "Reset Fit" – R
- "Refit" – F
- "In Table Multi-edit" - Shift

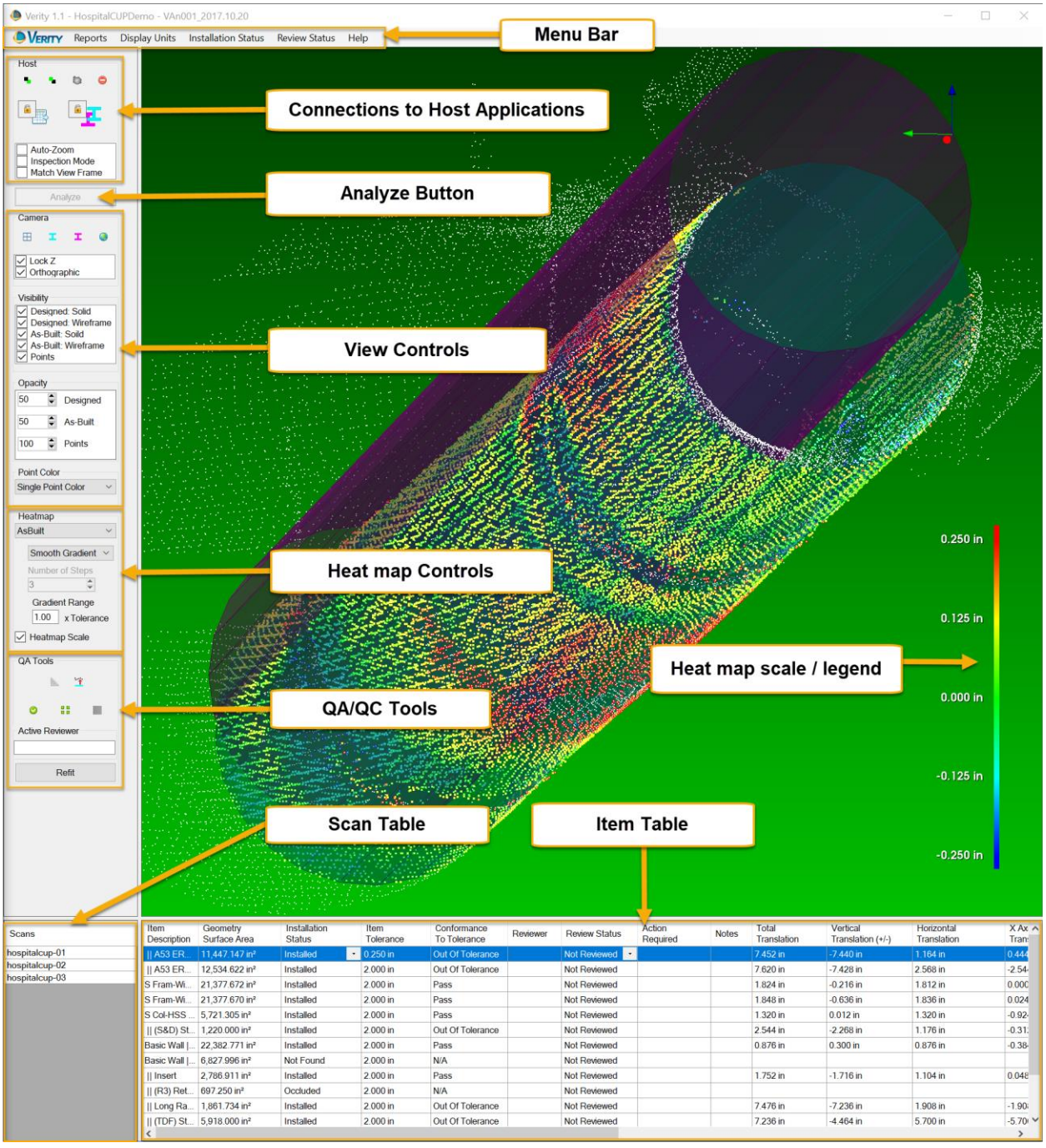
In table editing of multiple items is possible by holding down the Shift key while deleting the current contents or typing the first character of whatever you want to change the values to.

User Interface Guide

Visual Guide to the Verity Viewer and Plugin, and terminology for referring to them.

Autodesk® Navisworks® Plugin

Verity Viewer



Host and Companion Applications

Verity has been designed as a companion application which expands the functionality of a host application. Currently the only applications we support are Autodesk® Navisworks® Manage and Navisworks® Simulate (Versions 2016, 2017, 2018 and 2019)

We plan to integrate with additional host applications in the future, but specific applications are still TBD. We welcome any feedback on additional software we should integrate with to improve your QA workflows.

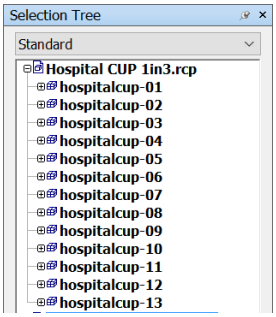
Host File Requirements and File Types

Verity exchanges information with Autodesk® Navisworks® rather than loading data directly, so it is generally compatible with any file format Autodesk® Navisworks® can load.

Geometry Files

Any geometry files that can be loaded into Autodesk® Navisworks® can then be loaded into Verity for analysis. We will load geometry based on user selection from the Autodesk® Navisworks® NWF, including any applied transforms. Autodesk® Navisworks® treats all geometry as a grouping of triangles (like a mesh); however, depending on what file type the geometry came from, there may be triangles missing or otherwise damaged in various ways. Verity cannot fix missing triangles, and if this occurs, we suggest trying an alternate route to import that geometry into Autodesk® Navisworks® (e.g., export from main application to a different format Autodesk® Navisworks® will accept). Verity has a mechanism to repair other issues with Autodesk® Navisworks® geometry which will be covered later.

Scan Files



Any structured scan data that can be loaded into ReCap and then referenced into Autodesk® Navisworks® as RCP/RCS files can be used to compare against the geometry. Verity requires structured scan data loaded into Autodesk® Navisworks® as either a .RCP with nested .RCS scan files or as individual .RCS files. Additionally, you must load these in as Voxels, which can be set in the file reader options for ReCap files. Verity will load scans based on user selection from the Autodesk® Navisworks® NWF, including any applied transforms.

If your scan data has multiple scans within a single .RCS file, it is not structured data. Verity will warn you if it detects only a single scan location for analysis, although you can continue through this warning in case you really have a single scan location to analyze. Verity cannot detect whether you've loaded multiple unified sections of data or loaded unstructured scans in per scan location. This means you can attempt to process a unified scan – however, the results will not be correct in certain cases and we strongly discourage this workflow. It is unsupported, and these types of files may crash Verity or cause other issues.

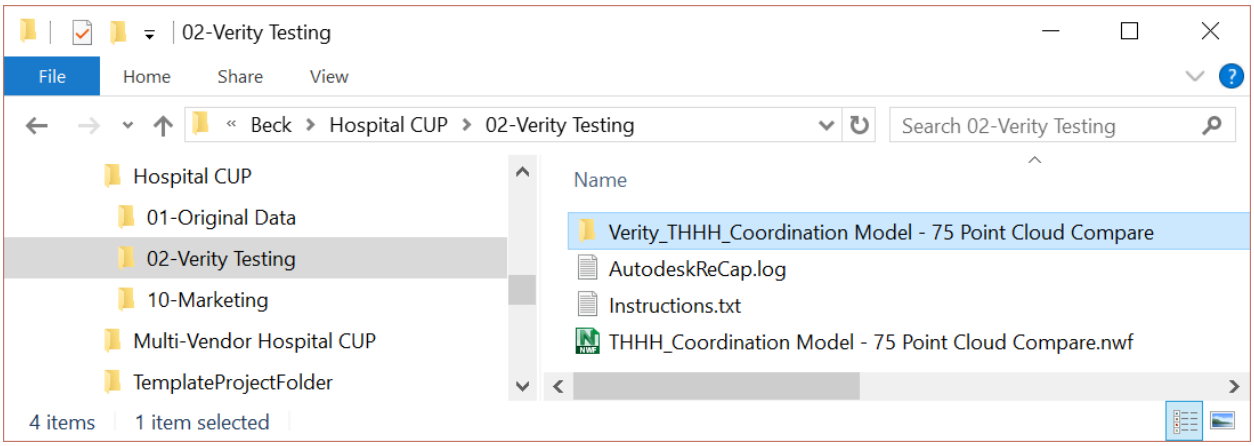
The best way to check is to view your data in ReCap and see if you have bubble views for each scan location. If you do, your data is structured. If you don't see the bubble views in ReCap, please reach out to whomever provided you with your scan data and request that they provide you with structured formats so our software can work properly.

Host File Types

Verity is designed to work side by side with an NWF file. While the software may technically work with an NWD directly, NWDs are not intended to be altered in any way, and as such, this is not a supported workflow. If you have an NWD file, you will need to append it to an NWF along with the Scan Files you want to run Verity. Scan files inside an NWD are not supported as they cannot be independently loaded.

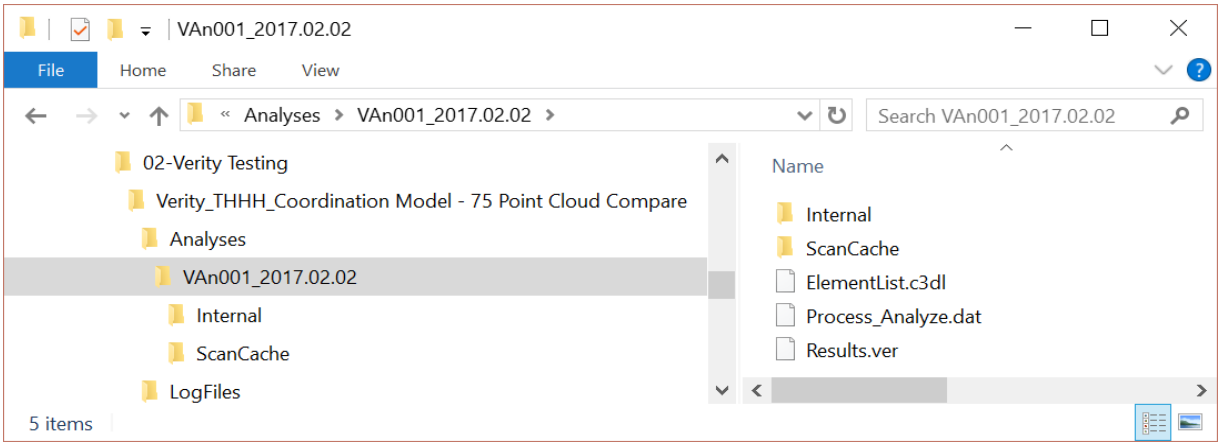
Verity File Types

Verity files are designed to be easily worked with through the File Explorer so that you can rename and relocate files without having to open Verity. Our files are placed in a single directory that is typically located alongside your NWF file:



When opening Verity, if a project directory is not already associated to your NWF, we will create one, automatically name it by appending the prefix “Verity_” to the file name, and place it in the same folder as your NWF file. You have an option to pause that step and provide a user-defined name and location for the Verity directory if you want.

Verity is designed to work with a one-to-one relationship between an NWF file and a Verity Project. While it is possible to have multiple Verity projects per NWF, the user experience will be sub-optimal. We do not support having multiple NWFs per Verity project.



When adding geometry from the Autodesk® Navisworks® Verity Tab, we will create an Analysis directory within the Verity project directory. We will automatically name the analysis based on the number of prior Analyses and the date the Analysis is created. You have an option to pause that step and provide a user-defined name for the Analysis directory.

Verity is designed to have multiple Analyses per Project, and thus per NWF file. Each analysis is a locked snapshot at the point in time the "Analyze" button is pressed. You can analyze the same geometry multiple times in different Analyses, or different geometry in each Analysis.

For the most part, the Verity Project is like an NWF—a container of links and relationships; while a Verity Analysis is like an NWD—a snapshot to document results at a particular point in time.

File Types

We have several file types which will be located in each directory. In order to re-name, move, delete or otherwise modify the Verity files, you interact with the directory and not the files directly. Or, you can use the options in the Verity menu to save as and relocate projects or to rename analyses.

- .VER – These are the container files for the projects and analyses; please don't edit, rename, or delete individually.
- .c3dxxx – Required program files; please don't edit, rename, or delete individually.
- .DAT – These are our log files. These can be opened in Notepad or other text editors, and we may ask you to send these files to us in the event of a crash or error.
- Scan Cache Folder – The scan cache folder is a temporary file that contains the imported voxels from Autodesk® Navisworks®. Once an analysis is complete, these will be automatically deleted to free up file space on your drive.

Saving your work

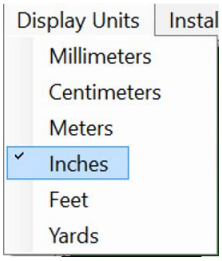
Verity is a database application and saves on every operation. So, there is no save button in Verity. However, Autodesk® Navisworks® projects must be saved after the element in Autodesk® Navisworks® is assigned a GUID for Verity to maintain the link between the item and the element. So, we recommend saving Autodesk® Navisworks® before running Analyze. If you are pushing Verity properties to Autodesk® Navisworks®, you should save Autodesk® Navisworks® after doing so and before closing if you want to keep properties and colorization of elements. If you don't, you can always open the Autodesk® Navisworks® File, open Verity, open the Analysis, and manually push those properties back in as long as you saved the element GUIDs.

Other Settings

Right now we have minimal settings to adjust within Verity. We will be adding customization options like project and analysis defaults and unit defaults in future releases.

Display Units

Display units can be set for the Verity Project. You can choose between a number of unit formats. We apologize in advance to our Metric users as our units still default to imperial units. We promise we will resolve this soon as we all know that Metric is better.



Workflow & Functionality

The workflow in Verity is a simple 4-step process. Since Verity works with Autodesk® Navisworks®, having Autodesk® Navisworks® side-by-side with Verity on two monitors will make things much easier working back and forth between the two applications.

Adding Items to Verity

Verity analyzes only the elements the user selects and adds to Verity rather than the entire model. This dramatically reduces load and analysis times. This also applies to scans, which must be selected and added just like geometry. If you don't add both geometry and scans, the "Analyze" button will be inactive.

Identifying what to Analyze from Autodesk® Navisworks®

These steps are performed in the Host application.

Selecting elements in Autodesk® Navisworks®

There are multiple ways to select elements in Autodesk® Navisworks®, all of which are supported:

- Manual selection – Switch to the Select mode on the home tab (or type Ctrl+1), and manually select an element by clicking on it. The Ctrl modifier will let you aggregate additional elements one by one.
- Manual selection in the Selection Tree – Select objects, layers, or files. Ctrl and Shift modifiers will let you aggregate multiple selections.
- Window selection – Click the drop down under the Select mode on the home tab, and click on "Select Box". This will change your selection mode to an inclusive window selection.
- Selection Sets – Selection sets will let you manually build a list of selected items and then save it for later use. This is helpful if you plan to analyze the same elements multiple times as you add new scans of the installed conditions.
- Search Sets – Search sets let you identify properties of the geometry that you want to select and then save those search criteria for later use. The advantage of search sets over selection sets is that new elements added to Autodesk® Navisworks® will be automatically included in the search set if they meet the search criteria. Open the Find Items window in Autodesk® Navisworks®, and right-click search criteria to identify the elements you want to analyze. Once you have validated the search criteria correctly, select the objects desired; you can save that search in the Sets window.

* If you are new to Autodesk® Navisworks®, we strongly recommend heading over to YouTube or any of the other numerous web-training venues to learn how to efficiently create, manage, and filter selections in Navisworks.

Adding to Verity

There are two different ways to add your selection in Autodesk® Navisworks® to Verity. The primary option will automatically search through your selection and attempt to identify the individual elements within that selection and add those to Verity. However, in some cases the file structure may be non-standard and this search will not yield the desired results. As such, we've added a second method which respects the user selection explicitly.

Add to Verity (search tree)

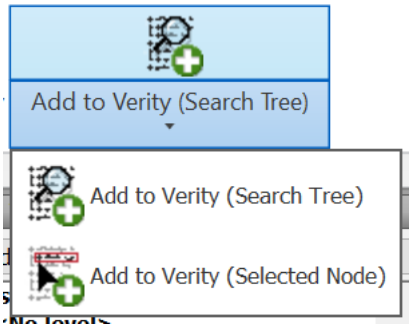
This is the default method for adding elements from Autodesk® Navisworks® into Verity. The software will search based on the user's selection and identify the first geometry node in that selection and add that to Verity. The intent is to allow the user to select within the selection tree at a higher node (an entire category or level) and to let our software find the individual elements to bring into Verity. In most cases, systems or groups do not contain any geometry and will be skipped until a geometry node is found, resulting in the desired elements being added. However, not all file structures follow this standard. In some cases, the first geometry node is at a group or system level (this seems particularly common with electrical files) with duplicate geometry at the element level. In these cases, the "Search tree" option will add the group or system instead of the individual element. This can be checked by reviewing the elements in the working set in Verity to validate that it added the items desired. There are ways to manage this in the next section, or you can remove the grouped geometry from Verity and instead use the "Add to Verity (selected node)" option described below.

Add to Verity (selected node)

This method explicitly trusts the user's selection and does not search the tree for an individual element node. The intent is to allow the user to define a specific node in the selection tree and add that to Verity at that selected tree level as a single item in Verity. So, if you can select a sub-part of a piece of equipment in Autodesk® Navisworks® manually, you can add just that part to Verity. However, this also means that if you pick the entire architectural file in your selection tree and click this button, the entire architectural file will be added to Verity as a single item. This may take hours, or may crash your computer if the file is large enough to cause your computer to run out of memory. As such, we recommend using this option as a secondary mechanism unless you really know what you're doing. Suggested reasons for using the "Add to Verity (selected node)" method:

- "Add to Verity (search tree)" gave unexpected results for a manually-picked selection
- If you are using search sets to select elements by their property values
- If you are wanting to add a system or group of elements as a single item to Verity rather than a bunch of single elements

Once you have selected the elements you want to add to Verity, switch to the Verity tab in Autodesk® Navisworks®, and click the "Add to Verity" button that makes sense for your selection. The "Add to Verity (selected node)" button can be accessed by clicking on the drop-down arrow under the default "Add to Verity (search tree)" button. This will open a project and analysis to add the elements into. Once added to Verity, each object will be set up as a unique Verity item, and a GUID will be assigned to correlate that item back to the element in Autodesk® Navisworks®.



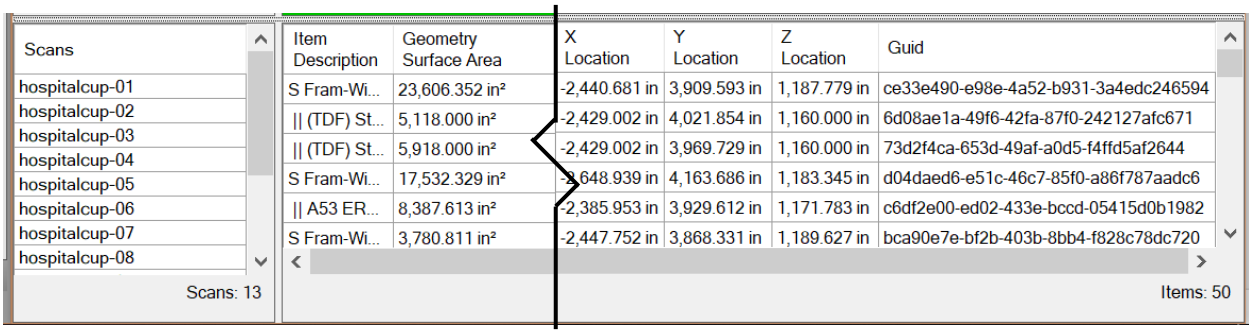
You can "Add to Verity" as many times as you like before an analysis has been analyzed. This allows you to aggregate complex selections without having to know a lot about search and selection sets in Autodesk® Navisworks®. Once an analysis has been analyzed, adding items will require a new analysis be created.

Refining the Working Set in Verity

These steps and functions are within the Verity Viewer and can be found in the "Host" panel that contains all the tools to manage the connection between Verity and the Host Application.

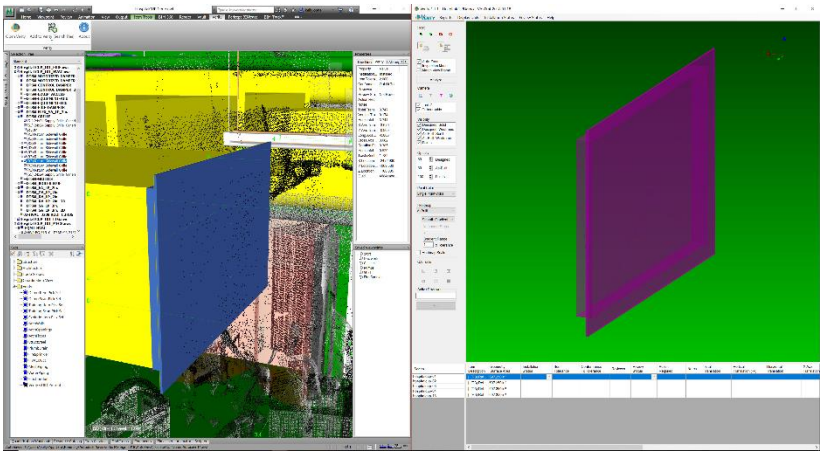
The Verity Scan and Item Tables

Once items or scans are added to Verity they will appear in the Verity Item Table or Scan Table:



Selecting an item in the scan table will clear the item viewer and select the same scan in Navisworks®. The Navisworks view will not be updated when selecting scans even when Auto-Zoom, Inspection Mode, or Match View Frame are checked as no item is currently selected. The total number of added scans is displayed at the bottom-right of the scan table.

Selecting an item in the Item Table will then display the geometry of that item in the Verity viewer and select that same item in Autodesk® Navisworks®. If you have Auto-Zoom, Inspection Mode, or Match View frame enabled the Navisworks® view will be updated accordingly. The total number of added items is displayed at the bottom-right of the item table.



Sorting the Item Table

The Verity Item Table can be sorted in ascending or descending order by clicking on the column header of any column that is populated with values. This can be very useful to help you review geometry you've added before you analyze it. The following columns will have information in them prior to running Analyze:

- The item description is based on the selected element's name in the selection tree in Autodesk® Navisworks®, and you can sort by this description to help identify items to remove. Using the "Selected Node" add to Verity option will give you more control over what names show up in Verity in the Item Description column. If the names you're getting aren't useful (like Insert) you can also try different exports from the source application to load into Autodesk® Navisworks®.

- When adding the geometry to Verity we extract the surface area of all the triangles and calculate the total surface area for the geometry. You can sort by this column to identify small elements that you don't need to analyze and group identical geometries together.

- We also calculate a minimum oriented bounding box for the As-Designed geometry and use the centroid of that box to populate the X, Y, and Z locations of each item in the table. This location can be used to correlate our different reports to the item's location in the project. It is also useful for sorting as you can group items by Z location to order them by level for instance.

- You will also see the GUID field on the far-right side of the Item Table. This is the globally unique identifier that is added into the Autodesk® Navisworks® NWF file as an element property to allow Verity to maintain the link between the element in Navisworks® and the item in Verity.

Import Selection from Host

If there are elements you want to find and review in the Verity Item Table based on what you're looking at in Autodesk® Navisworks®, you can select the elements in Autodesk® Navisworks® and use the "Import Selection from Host" button to find and select any of those elements that have been added to Verity and are in the Item Table. This will clear your current selection in Verity.

Export Selection to Host

Similarly, if there are elements in Verity you wish to see in Autodesk® Navisworks® in context you can use the "Export Selection to Host" button to re-send your Verity selection to Autodesk® Navisworks®. If you have Autozoom, Inspection Mode, or Match View frame enabled the Autodesk® Navisworks® view will be updated accordingly as well.

Exploding Items

We do our best to correctly find the right level in the selection tree in Autodesk® Navisworks® when we bring geometry into Verity. However, many manufacturing or system analysis applications have assembly or system level geometry. If they do we will bring in many individual elements grouped together as a single item, greatly reducing the usefulness of our analysis.

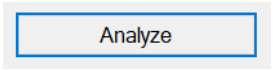
We have added an "Explode" button to allow you to bring in geometry from the next level down in the Autodesk® Navisworks® tree structure. If the next level down does not contain sub-elements, we will continue to search down the tree until we either find sub-elements or run out of tree to search. If you run out of tree and still have one large grouped item, try to find an alternate means of importing the geometry into Autodesk® Navisworks®.

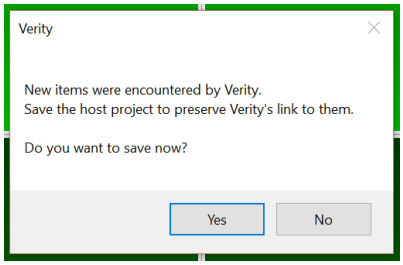
Remove from Verity

The Remove tool provides a way to remove items you added that you don't want to Analyze. Select the items in the Item Table that you want to remove, and click the "Remove Selected Items from Verity" button in the Verity Console. Ctrl and Shift modifiers work in our table view to select multiple items. The table sorting will also be useful to group items you may want to remove. You can also remove selected scans from the Scan Table if you've added a scan you don't need for the current analysis.

Analyze your Items

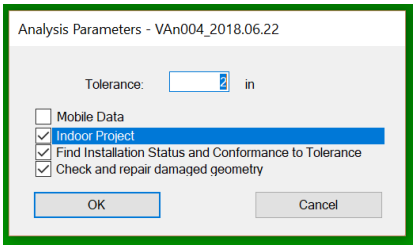
Once you have built up a working set of elements and scans to Analyze, you can click the “Analyze” button in the Verity Viewer.





If you haven’t yet saved your NWF file, you will be prompted to do so. If you click “Yes” your NWF will be saved in its current location. If you click “No”, your file will not be saved. In the event of a crash, loss of power, or anything else that interrupts the analysis and prevents you from saving the NWF in Autodesk® Navisworks®, the connection back to the NWF will be lost. It can be manually recovered later as long as the elements haven’t changed in the host file.

Clicking Analyze will open a dialog showing the Analysis options:



Setting the right options

The various fields in the Analyze dialog let you control what algorithms we run and provide some initial guidance for how to process the points.

- Tolerance – This will set the default dimension you want to compare against to define if items are outside of tolerance, it can be overridden per item in the table after the Analysis. This dimension also informs our algorithm search radius. It is recommended to keep this under 4 inches or 100mm in the current version for both performance and reliability reasons.

- Mobile Data (Technical Preview) – This option is off by default. This will cause Verity to use a beta algorithm optimized to run on unstructured scan data that meets certain requirements. *This requires a technical preview license to run, contact support for more information.*

- Indoor Project – This option is off by default. When scanning outside, a hole in the scan data (i.e., no return) is usually a result of things being too far away from the scanner to register (e.g., the sky, distant buildings, etc.). In these cases, our algorithms assume that items with geometry in those locations are missing since there were no recorded scan points. In indoor projects, holes in the data are usually caused by non-ideal surface quality (e.g., highly reflective, shiny, dark, rough, etc.) that the scanner cannot capture well. By checking the “Indoor Project” option, you are telling our algorithm to treat missing data accordingly.

- Find Installation Status and Conformance to Tolerance – This option is on by default. This controls whether our algorithms attempt to determine the Installation Status and the Conformance to Tolerance of each item in the table. If unchecked, no initial classification will be done and every item will have to be manually reviewed, classified, and fit. When your geometry and scan data are not similar, each item will have to be manually adjusted anyway; so skipping this step may make sense as it will cut down the analyze duration significantly.

- Check and Repair Damaged Geometry – This option is on by default. This forces a routine that will check every piece of geometry brought into Verity for mesh corruption issues. If any are found it will repair those issues so that the analysis will yield the best results.

The Analyze Progress Bar

Depending on your data set, the Analyze process can be very short (less than a minute) or very long (days). As such, it is important to understand what is going on at different stages in the process.

1. 0%-10% - loading geometry from Autodesk® Navisworks®
2. 10%-35% - triangle check and repair
3. 35%-100% - pull points from Autodesk® Navisworks® and analyze with our algorithms

*If triangle repair is unchecked in the Analysis Parameters dialog, the third step will start at 10%.

Armed with this information, if your progress has stalled out between 10% and 35%, you have an item with very complex geometry and our check and repair process is taking a long time. If it has stalled out past 35%, then you likely have unnecessarily dense point cloud data or you're just testing 10,000 items.

As a companion application to Autodesk® Navisworks®, we inherit an issue where Autodesk® products show as "Not Responding" when they are processing information. Verity very rarely crashes (knock on wood) but can take a long time to process. So, please be patient! If you want to confirm if Autodesk® Navisworks® or Verity are still working, open the task manager and look at the Autodesk® Navisworks® process. If either the CPU or Memory % numbers are changing (or both) then the application is working.

Canceling the Analysis

If patience isn't your middle name (join the club), or you know you want to go back and do something different so the analysis will take less time; then please hit the cancel button on the Analyze progress bar. It will take a minute or two to cancel if it is in the middle of a complex step. However, this allows us to exit the analysis gracefully and not risk corrupting anything in Autodesk® Navisworks® or Verity. If you cancel, the analysis data calculated thus far will be discarded and the analysis will be ready to run with different settings and will be open to adding new elements or exploding blocks of elements.

What impacts Analysis duration

Analyze durations are driven by three related factors: the amount of time it takes is linearly related to number of items, the geometric complexity of those items, and the total number of points around those items. These are listed below in order of impact.

Storage Speed and Latency

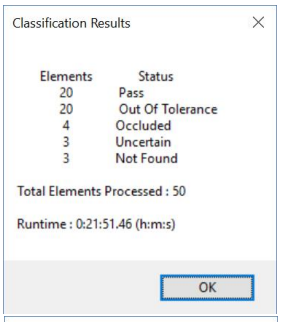
Both Navisworks and Verity make a lot of small read and write requests to your hard drive as data is being exchanged between applications. In applications that do not have massive data sets this is usually handled in your computer's memory rather than on disk. However, applications that work with point cloud data usually are working with data sets that are much larger than available memory. As a result, we have to store and cache information on disk regularly. Because of this, the speed and latency (time to respond) of your data storage infrastructure has the single largest impact on analysis times. We do not support running Verity on data sets stored on any network drive, and do not recommend using external hard drives or mechanical hard drives as internal SSDs will provide dramatically better performance. How dramatically? Running an analysis on network storage takes ~100 times longer.

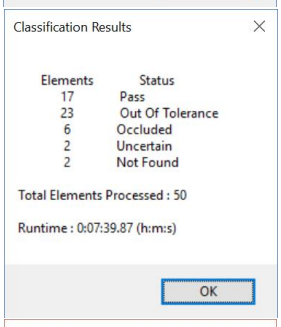
Geometry Correction

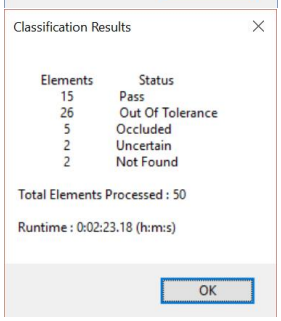
Checking and fixing the geometry usually takes a very small percentage of time. However, on data sets with extremely complex geometry (tens or hundreds of thousands of triangles per object), this step can increase analysis times significantly.

Number of Points

Verity must load the scans through the Autodesk® Navisworks® API, and this process is particularly slow. This will take approximately 75% of the total analysis time on most data sets. To minimize this, you can reduce the number of scans you are using for the analysis and reduce the number of points in each scan through down sampling each scan on export. Verity only needs a few thousand points on each item to work well. For example, the images on the right show the same items analyzed with three different point cloud densities. The full resolution data (8.6 GB) took 21:51 (m:s) to run. Exporting every third row/column (2.25GB) resulted in it completing the processing in 7:40, roughly 35% of the time the full resolution data took to complete. Taking the lower resolution scans and using ReCap's grid decimation set to 25mm on import (860MB) resulted in a processing time of 2:23, or 11% of the full resolution data. It is worth noting that the results are slightly different at each setting. There are less points on some objects to analyze, and this does have an impact. This is most pronounced on small objects. For items close to the edge of the defined tolerance range small changes in the points for analysis will change them from passing to out of tolerance and vice versa.







Number of Items

The time it takes to run our algorithms (after loading points from Autodesk® Navisworks®) scales linearly with the number of items to analyze. Large complex items with a lot of points will take longer than smaller items with fewer points, but the impact is not dramatic. We typically process each item in one to five seconds depending on size, complexity of geometry, and the number of points on that object.

Expectations for Analysis Duration

While it is tough to predict the duration of an analysis in advance given the number of variables involved, we thought some examples might be useful to help understand the range of processing times possible:

- Small project with approximately 150 structural members, 15 scan locations, and optimized scan data (25mmx25mm grid spacing at 10M) took approximately 10 minutes to process. So, that took approximately 4 seconds per object analyzed for the entire process.

- Large project with 5000 structural members, 130 scan locations, and high resolution scan data (6.1mmx6.1mm grid spacing at 10M) took approximately 46 hours to process. So that took approximately 33 seconds per object analyzed for the entire process.

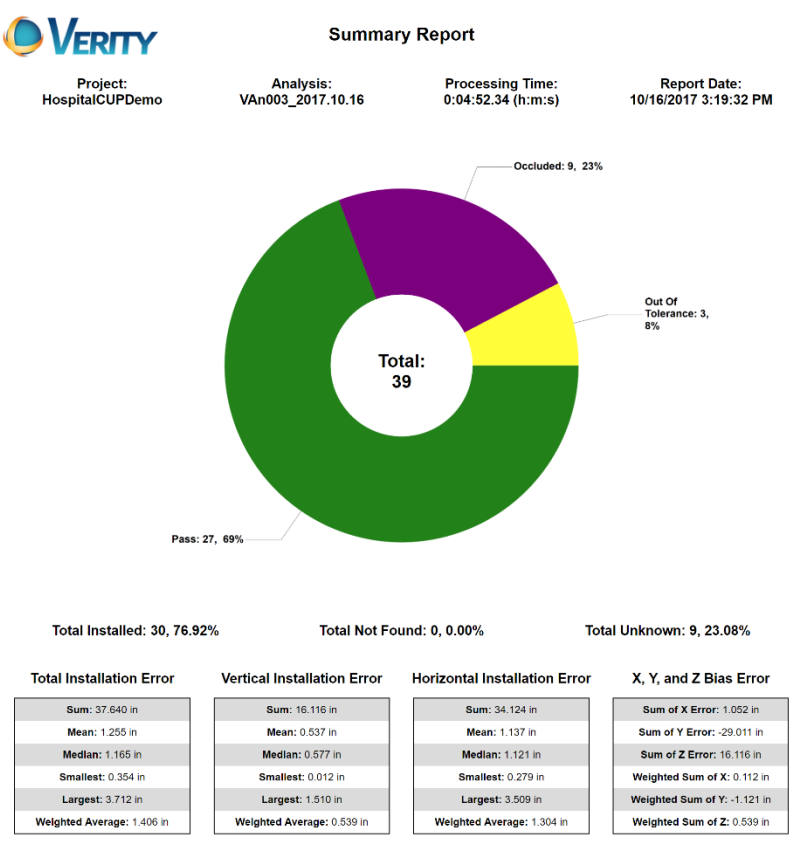
Breaking it down by seconds per object, both of these are relatively fast compared to manual human comparison. However, no one wants to wait 46 hours to review 5000 members. Using the information above to optimize the scans and the items you're testing can have a dramatic impact on overall processing times. So, bear that in mind as you apply Verity to your project.

QA the Analysis

Verity, like any automated analysis, will not be right 100% of the time. The purpose of our tool is to dramatically increase the efficiency of a human by organizing the data and making an initial attempt at the right answer. Our target for our algorithms is 80% correct, plus or minus 10%. Most datasets we have tested fall within that range or exceed it. However, because we cannot be correct 100% of the time, we highly recommend you review each item as part of your QA process. Since Verity cannot tell you the correct resolution to the issue (e.g., move in field or update as-builts), you should be looking at most of the results anyway in order to determine what needs to be done.

Reviewing the Analysis Results

Once the analysis is complete, an HTML summary report will be generated and automatically open in your default internet browser. This report will show you aggregate information about the analysis including processing time, the percentage of items in each classification, as well as some aggregate error information that may be helpful diagnosing global errors in your dataset such as control busts. The report can be manually generated at any time through the "Reports" menu by selecting HTML and then selecting the "Summary" report Manual generation will respect the active selection rather than running on all items, so either select the elements you want in advance or hit Esc to clear the selection and Verity will prompt to confirm you want to run on all items.



Coverage Percentage

During the analysis Verity calculates how much of the surface area of each piece of geometry is covered by scan data, and this percentage is reported in the % Coverage column of the table. Like all columns in the Verity tables, you can sort by this information and use it to help focus your review time. While it isn't a guaranteed metric in all cases, items with lower coverage are more likely to have errors in the fit and classification than items with higher coverage values.

The column is there so you can identify which items are most likely to be erroneously classified or fit by our algorithms, so you can more easily and quickly find them and make the necessary corrections. It is not meant to replace the process of reviewing each item and determining what must be done about any errors.

Installation Statuses and Conformance to Tolerance

Assuming all primary analysis steps were run, here are the installation status and conformance to tolerance values you see in the Verity table for each item and what they mean:

- Installed – Algorithm found a signature matching the geometry in the scan data
- Uncertain – Point data was inconclusive or contradictory for this item
- Occluded – Captured points obscured the geometry location, so we can't tell what it is
- Not Found – Points would have been captured if the geometry was there, so it is missing
- Not Enough Data – There are insufficient points to analyze this item
- No Data – There were no points in the space around the item
- N/A – Not applicable because no as-built location was found

For any items found to be Installed, we will then compare the total translation against the tolerance to determine how each item conforms to that user defined tolerance.

- Pass – Item was installed within the specified tolerance (less than or equal to)
- Out Of Tolerance – Item was installed outside the specified tolerance (greater than)
- N/A – Not applicable because the item wasn't found to be installed

Translation and Rotation Metrics

In addition to the statuses above, we also report out ten different measurements comparing the As-Built geometry back to the As-Designed geometry.

Total Translation	Vertical Translation (+/-)	Horizontal Translation	X Axis Translation (+/-)	Y Axis Translation (+/-)	Long Axis Translation	Cross Axis Translation	Rotation From Vertical	Horizontal Rotation	Twist (Secional Rotation)
0.962 in	-0.003 in	0.962 in	-0.962 in	-0.005 in	0.005 in	0.962 in	0.000°	0.017°	0.007°
1.030 in	-0.505 in	0.898 in	-0.898 in	0.018 in	0.505 in	0.898 in	0.000°	0.000°	0.000°
1.045 in	0.437 in	0.951 in	-0.573 in	-0.761 in	0.437 in	0.951 in	0.413°	0.000°	0.200°
1.044 in	-0.071 in	1.043 in	-0.953 in	-0.425 in	0.071 in	1.043 in	0.149°	0.000°	0.123°
1.539 in	0.061 in	1.538 in	-1.537 in	0.154 in	-0.061 in	1.538 in	0.084°	0.000°	0.036°
0.481 in	0.052 in	0.478 in	-0.029 in	-0.478 in	0.052 in	0.478 in	0.145°	0.000°	0.144°
0.215 in	0.000 in	0.215 in	0.000 in	-0.215 in	0.000 in	0.215 in	0.000°	0.000°	0.000°
1.757 in	-0.039 in	1.757 in	1.757 in	0.039 in	-0.039 in	1.757 in	0.003°	0.124°	0.096°

Translation Metrics

Translations are computed by taking each vertex on the As-Designed geometry and measuring the distance to the same vertex on the As-Built geometry. Those measurements are broken into vector components where required to isolate movements along certain planes or axes. For each metric, the worst of those measurements is what is reported in the column. The measurements made in the object's coordinate system are not given a sign (+ or -) as that is highly subjective. Measurements made in the project coordinate system are given a sign where possible.

- Cross Axis Translation – component vector on the plane perpendicular to the item's long axis
- Long Axis Translation – component vector along the item's long axis
- Y Axis Translation – component vector parallel to the project Y axis
- X Axis Translation – component vector parallel to the project X axis
- Horizontal Translation – component vector in the project XY plane
- Vertical Translation – component vector parallel to the project Z axis
- Total Translation – linear distance between both points

The Total Translation is what is used to test against the user defined tolerance value. Anything with a total translation greater than the tolerance will be classified as Out of Tolerance.

Rotation Metrics

Rotations are more complex to calculate as there are multiple methods that will yield different answers. We use two different methodologies for calculating our rotations based on whether the object is "typical" (anything but almost vertical) or like a column (vertical or almost vertical).

a) In most cases, we calculate the rotation from vertical and horizontal as the difference in altitude and azimuth (respectively) between the as-designed geometry and the as-built geometry. Twist is determined first by rotating the geometry along the altitude, then changing azimuth, with twist calculated as whatever additional rotation is needed around the long axis of the geometry to align to the as-built.
b) In the case that the item is almost vertical we calculate the rotation from vertical as the total angular difference between the as-designed and as-built geometry, with twist calculated as whatever additional rotation is needed around the long axis of the geometry to align to the as-built. In this case the horizontal rotation will be calculated as 0 (zero).

This solution yields the most consistent results for building components in most cases. If we have incorrectly identified the long axis, then these calculations will not be relevant. This may happen in the case of beams or pipe with lengths shorter than their depth for instance.

If you find this as confusing as some of us do, we have a bunch of Math and Physics PHDs that will be happy to talk to you about it until your head explodes.

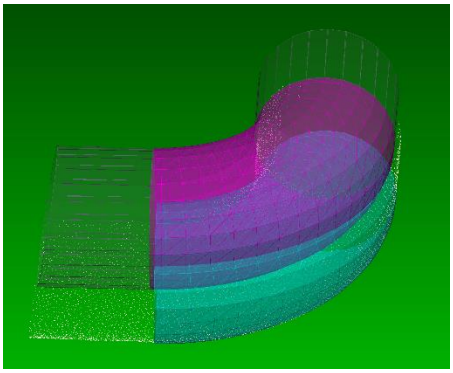
View Controls

Select an analyzed element in our table, and it will be displayed in our Verity Viewer.

Secret Verity Color Decoder Ring

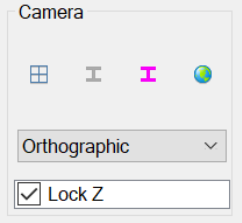
Now that the item has been analyzed, you'll see several types of geometry in the Verity Viewer window along with the points that fell within the object's bounding box. The three types of geometry are colored as noted below to differentiate which is the original as-designed geometry, which is the best-fit as-built geometry, and which is the neighboring geometry that has also been analyzed.

- **As-Designed** – The As-Designed geometry represents where the geometry is positioned in the Navisworks file before Verity analyses it.
  This geometry will be displayed in a Magenta color.
- **As-Built** – The As-Built geometry represents where our algorithms best-fit the geometry to the point cloud data.
  This geometry will be displayed in a Cyan color.
- **Neighbor** – Any neighboring geometry than Verity has analyzed and is visible within the search box around the selected item.
  This geometry will be displayed in a Gray color.



When no As-Built position is found (items with the occluded, not found, not enough data, or no data installation status), only the As-Designed geometry will be shown.

Camera and View Frames



These tools help you control the camera in the Verity Console. These will not affect the view settings in the host application, unless match view frame is active. When active, changing the view frame will update the camera position in the host application as well.

Split View / Single View

We have two viewer modes that can be toggled between using the “Split View” button in the View Controls panel.

- Single View – You have an isometric view of the element that is oriented to looking down the long axis for most elements; you can pan using your middle mouse button (MMB) or use shift+MMB to orbit the view. This is the default view on starting Verity.

- Split View – The isometric view moves to the top left corner, and orients so that the two adjacent sides of the item with the most point coverage are facing the camera; and you can pan and orbit using the same controls above. A projected plan view is placed in the upper right (top view); two corresponding projected elevation views are in the lower two panes (front view is lower right, side view is lower left). The projected views provide access to additional functionality such as manually moving the as-built geometry. You can pan the projected views just like the isometric view, but cannot orbit them.

We do our best to guess the long axis of the geometry based on its dimensional characteristics. The “Top” of the geometry is defined by the face that is closest to vertical. Looking down the long axis is considered the “Front” of the geometry, and looking perpendicular to the long axis is considered the “Side” of the geometry. In cases where the long axis is near vertical (columns) we choose the next longest axis to define the “Front” of the geometry.

In cases such as a beam that is deeper than it is long or geometry that is roughly the same length as width, we may not choose the correct long axis and this will result in less than ideal views being chosen for you to review the geometry. This is a very rare occurrence and we have no real means to resolve these fringe conditions in Autodesk® Navisworks® since it is a geometry centric application.

View Frames (Coordinate Systems)

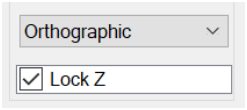
We have three view frames that determine the angle at which the camera is looking at the items to help you evaluate the results and compare them back to the host application:

- As-Built – The “Zoom As-Built” button will align the camera’s frame to the as-built geometry. This is the default setting for views if an As-Built location is found. 

- As-Designed - The “Zoom As-Designed” button will align the camera’s frame to the as-designed geometry. This is the default setting for views if no As-Built location is found. 

- Project Coordinates – The “Align to Project” button will align the camera’s frame to the Autodesk® Navisworks® Project’s coordinate system. 

Camera style



The camera style setting configures how the camera views the items and controls how the navigation works. These settings affect the primary isometric view only. Specific projection or other specialized views will be set according to their purpose.

Camera style drop down:

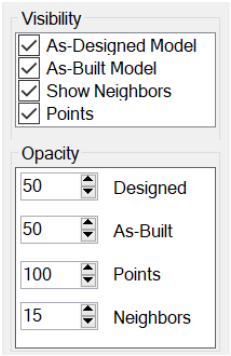
- Orthographic – This is the default option. In Orthographic mode you will be able to pan the geometry by pressing your middle mouse button and dragging, orbit the geometry by holding shift while pressing your middle mouse button and dragging, and change the size of the geometry on the screen by scrolling the mouse wheel.

- Perspective – This mode will change to a perspective projection in the isometric view, and behaves similarly to the Orthographic mode, but with the scroll wheel zooming in and out.

- Scanner – This mode will lock the camera position to the location of the scanner with the most coverage on the selected item, with the camera navigation in a “look” mode. Pressing the middle mouse button and dragging will allow you to change the look direction, but not the camera position. Holding down shift while pressing the middle mouse button and dragging will behave the same. The scroll wheel will allow you to zoom in and out on the item.

Lock Z - allows you to toggle between a locked Z axis and three axes of freedom when orbiting around the object. This is defaulted on.

Visibility

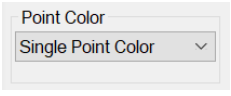


The visibility of all three types of geometry as well as the point cloud can be toggled on and off using the Visibility controls in the View Control Panel.

Opacity

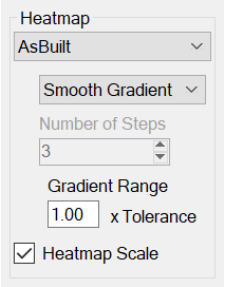
In addition to toggling the visibility of each type of geometry, you can change the opacity of the surface geometry and the points. This is represented as a percentage (0-100) and increases or decreases the opacity (inverse of transparency) for each type of geometry independently. If you want to achieve a wireframe style view for any type of geometry, you can set opacity to 0%.

Point Color



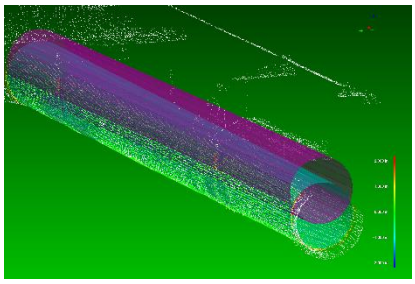
The colorization of the points within the geometry’s bounding box can be controlled using the “Point Color” drop down in the View Control Panel. You can either choose a single color (default) selected to stand out on our background, you can select to use the colors from the host which will be either RGB or Intensity values depending on your point cloud, or you can choose to color the point cloud by scan location. The 10 scans with the most coverage on the item will be mapped to unique color values, and any remaining scans will remain white.

Heatmap

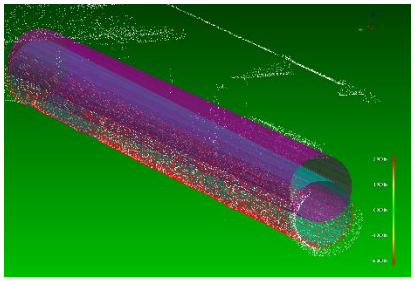


In the heatmap settings you can adjust several heatmap settings that affect which geometry the heatmap is calculated against, the type of gradient, step sizes, range, and the visibility of a legend that displays the values that correspond to each color in the heatmap. The heatmap display is set to “None” by default. However, if you wish to have the colorized heatmap displayed you can choose between the “As-Designed” and “As-Built” heatmaps. If no heatmap is selected, the heatmap legend will auto-hide even when checked.

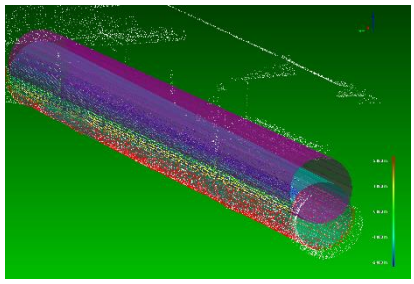
- The As-Built heatmap color for each point is a measurement between the point and the surface, normal to the surface. The As-built heatmap colorizes points below (inside) the surface from blue to green, and points above (outside) the surface from green to red. This provides the best heatmap for evaluating the quality of the fit of the as-built geometry to the point cloud, and for visualizing the deformation and shape variances between the as-built geometry and the point cloud.



- The As-Designed heatmap color for each point starts with the as-built heat map measurement and then adjusts for the distance to the same spot on the as-designed geometry. This allows us to accurately colorize points that happen to be adjacent to one part of the as-designed geometry but are distant from the part of the geometry they are associated with. If the As-built object is incorrectly fit this heatmap will not be accurate since it relies upon the As-built geometry as a basis for its calculation. This heatmap only colorizes points from green to red since the relationship to the as-designed surface is corrected and thus we cannot tell “inside” from “outside”. This heatmap is best to help visualize the rotation and translation of the as-built location relative to the As-Designed geometry. For large displacements this colorization will effectively be all red.

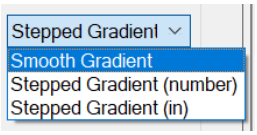


- The As-Designed Uncorrected heatmap color for each point ignores the As-Built geometry and does a raw comparison of the point to the closest point on the As-Built geometry. This results in a more traditional heatmap you might be used to seeing from other software products. This heatmap does use the As-Built geometry to identify the points to heatmap, so it won’t apply colorization to adjacent points that are not associated to the As-Built object. Because there is no correction, this heatmap does support a full blue-to-red spectrum like the As-Built heatmap does. This heatmap is best for floor flatness, wall flatness, or other cases where the overall translation of the object isn’t highly relevant to the quality assurance of that type of item.

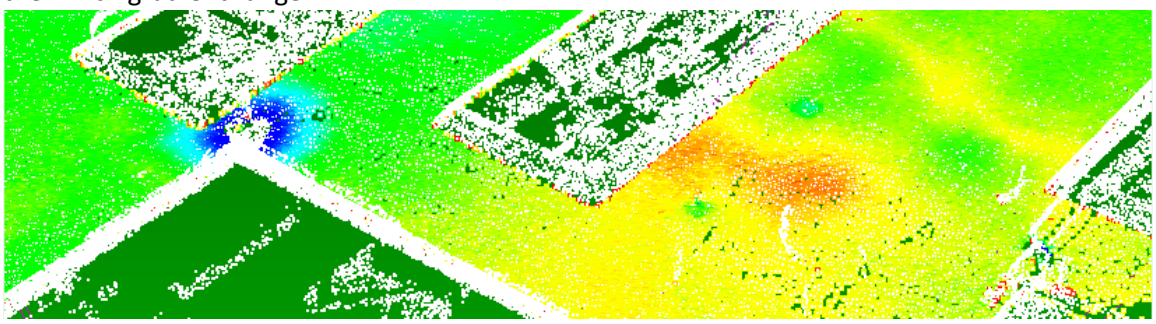


Heatmap Gradient

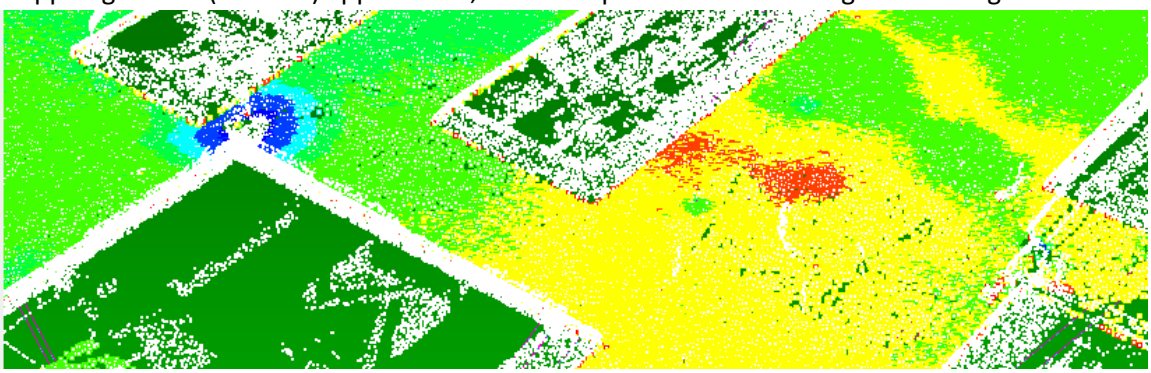
You can also change the gradient that is used for the heatmap. There are three options to choose from, and all of these will be correctly reflected in the heatmap scale legend.



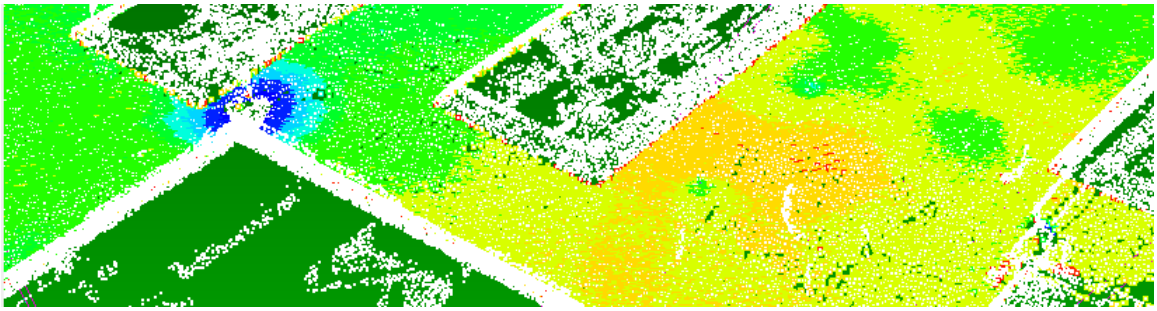
- Smooth Gradient is the default and this maps the color of the points to a 512-step gradient across the range of the heatmap. So, green (0,255,0) is assigned to a point that is on the surface, with red (255,0,0) being assigned to a point that is at the edge (or beyond) the range of the heatmap as set by the gradient range setting. In cases where we are able to differentiate between points that are above (or outside) the surface and points that are below (or inside) the surface, points that are below (or inside) will be mapped between green and blue (0,0,255) instead of red resulting in a 1024 step gradient. The options to control gradient steps will be greyed out if this option is selected. Below you can see a floor with a smooth gradient applied to the 1 inch gradient range.



- Stepped Gradient (number) will allow the user to specify the number of steps to divide the gradient range into. The user is able to set a fixed number of steps to divide the gradient range into. The size of these steps will change per item if the tolerance is set differently per item, but the number of steps will be consistent across items. Below you can see the same floor with the stepped gradient (number) applied to it, with 3 steps across the 1 inch gradient range.



- Stepped Gradient (dimensional) will allow the user to specify the size of the step in the active project units. (It will appear in the drop down as Stepped Gradient (in) if the project units are set to inches, or Stepped Gradient (mm) if the units are set to millimeters) The user is able to set a fixed size for the step to divide the gradient range into. The number of steps will change per item if the tolerance is set differently per item, but the size will remain consistent across items. Below you can see the same floor with a stepped gradient (in) with a step size of .25 inch resulting in 4 steps when applied to the 1 inch gradient range.



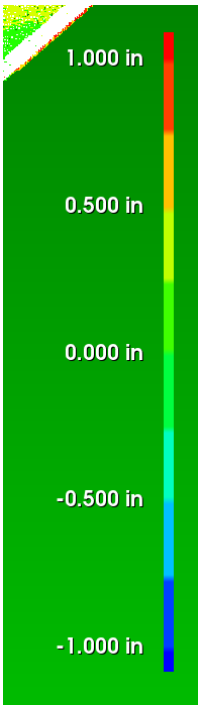
Heatmap Gradient Range

The range over which a heatmap is applied is related to the tolerance of each item. The gradient range is defined as a multiplier of the tolerance. So, an item with a gradient range of 1.0 will have a heatmap that spans from green to red across the item's tolerance. Red (or blue) will be applied to any points that are up to double that distance away from the object. Any points outside that distance will have no color mapped to them and be excluded from the heatmap.

For an item with a tolerance of 25mm or 1 inch:

- Gradient range of 1.0 will result in points within 25 mm or 1 inch being colored with the gradient, points between 25mm and 50mm or 1 to 2 inches being colored red (or blue), and points beyond 50mm or 2 inches being excluded. As such, any out-of-tolerance points will be red (or blue).

- Gradient range of 2.0 will result in points within 50mm or 2 inches being colored with the gradient, points between 50mm and 100mm or 2 to 4 inches will be red (or blue), and points beyond 100mm or 4 inches will be excluded. As such, points that are out of tolerance will be yellow to red.



The gradient can be adjusted to any number between 0.01 and 9.99. Generally the most common settings are 1 and 2. But, we like to give you the freedom to make strange choices and see what you do with it.

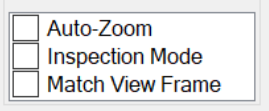
Heatmap Scale

This checkbox toggles on/off the heatmap scale legend that appears in the lower right corner of the Verity Viewer window. This numbers are set based off the end and middle of the gradient range, and the colors will be updated based on the heatmap gradient settings. Below you can see the scale is stepped with .25 inch increments across a 1 inch gradient range.

Connection to Host

One of the reasons we built Verity as a companion to Autodesk® Navisworks® is so that we could use the host application as a contextual viewer. We see Verity as a robust inspection tool to help you understand what has occurred in the installation of that single item. How that relates back to other adjacent elements in Autodesk® Navisworks® is what our connections to the host are for. So, in addition to the view controls that determine how Verity displays the geometry and point clouds, we also have settings that will affect how that geometry is displayed and viewed in Navisworks.

Host View Modes



The Host View Mode toggles create a similar experience to those featured in the Autodesk® Navisworks® clash detection tool.

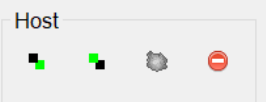
- If checked, Auto-Zoom will attempt to re-orient and fit the view in Autodesk® Navisworks® to the active selection whenever you select items or press the manual “Export Selection to Host” button.
    - Before running Analyze, Auto-Zoom can only pick a view that is focused on and contains the extents of the element, but it is highly likely in dense situations that you will be unable to see the element without the next mode active due to other elements occluding it. (Similar to how the Clash Detective’s Auto-Zoom functionality works)

    - After running Analyze, Auto-Zoom leverages the item’s analysis to pick the best scanner location from which to view the element in Navisworks, and places the camera in that location looking at the element’s centroid. This provides a clear view of the element in a large majority of cases.

- Inspection Mode will automatically make all other non-selected elements transparent so you can clearly see the selected elements in context in Autodesk® Navisworks®

- Match View Frame will actively match the camera location and angle in Autodesk® Navisworks® and Verity bi-directionally. Your best results will occur when both applications are in the same type of view (both in orthographic or both in perspective). Coupled with the new “Scanner View” view style, this effectively provides users with a full 360 scan view in Navisworks®.

Import and Export Selection to Host

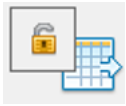


Don’t forget that you have the ability to update the selection in Verity to match the selection in Navisworks, and vice versa if the need arises. This works with individual or multiple items, and is extremely helpful when using both applications side by side.

Removing Items after running Analyze

Also, you can still remove items from Verity after running Analyze if you find an element that you don’t need for reporting purposes. There is no undo and no way to add items in after running analyze, so do this only if you’re sure you don’t need it. You cannot remove scans after running Analyze.

Export Verity Properties to Host



The “Export Verity Properties to Host” button will push selected items’ properties from the Analysis to Autodesk® Navisworks®. If you have no items selected it will confirm if you want to push all items’ properties. This button will also colorize elements in Autodesk® Navisworks® based on the color scheme below:

- Pass – Green, because green is good
- Out Of Tolerance – Yellow, because yellow is worse than good but not as bad as red
- Uncertain – Salmon, because this result is fishy
- Occluded – Purple, just because
- Not Found – Red, because this is usually really bad news
- Not Enough Data – Teal
- No Data – Also Teal

If you make changes in Verity to an item’s status or property, you will need to push this button again to synchronize those changes with Navisworks unless you have it set to automatically update.

If the lock in the upper left corner of the button is locked, we will push the Verity properties of all the items to Autodesk® Navisworks®, and then push each subsequent change in Verity to Autodesk® Navisworks® as it occurs; this includes the colorization of elements in Autodesk® Navisworks®. In this mode, changes you make during the QA/QC process in Verity are effectively synchronized in Autodesk® Navisworks® on the fly.

Move Host Item to As-Built

The “Move Host Item to As-Built” button will push selected items’ as-built locations from Verity to Autodesk® Navisworks®. If you have no items selected it will confirm if you want to push all items’ as-built locations. This feature uses the item transform in Autodesk® Navisworks® to override the location per element. Pushing the as-built locations into Autodesk® Navisworks® allows you to visually inspect the impact of any erroneous or out-of-tolerance elements on the coordinated model, and even run it through clash detection. The transform can be easily re-set in Autodesk® Navisworks® using the re-set transform button. If you make changes in Verity to an item’s As-Built location, you will need to push this button again to synchronize those changes with Navisworks unless you have it set to automatically update.

If the lock in the upper left corner of the button is locked, we will push all items’ as-built locations, and then push each subsequent change to Autodesk® Navisworks® as it occurs. In this mode, changes you make during the QA/QC process in Verity are effectively synchronized in Autodesk® Navisworks® on the fly.

QA/QC the results of each Item

With all the navigation and visual inspection tools covered, it is time to review the results of each Item's analysis. The buttons in the QA Tools panel will let you review, adjust, and approve the results for each item in Verity.

Measure Distance

The "Measure" tool will allow you to measure the distance in screen space from two click-points. This does not snap to points or geometry, and should be used to establish scale (understand the size of elements in Verity, or the distance between elements, points, or geometry in the plane of the view. This is why the tool only works when split pane is activated, and only in the projected views.

Measure Scan Point Distance from As-Built Surface

This tool will take a click point on the As-Built surface and measure the average distance from that point to the points used to fit the As-Built geometry to the point cloud. This provides a spot-measurement tool that is repeatable and doesn't rely on a single point as the basis of measurement. Error ranges and number of points used are provided to show the variance within the point data at that location. When active this mode will highlight the As-Built geometry, and the cursor will change to a cross hair when hovering over the As-Built geometry and taking a measurement is possible.

Measure As-Designed Geometry Distance from As-Built Surface

This tool will take a click point on the As-Built surface and measure the distance from that point to the same point on the As-Designed. This provides a spot-measurement tool between the two identical geometries. The tool reports the linear distance as well as the X, Y, and Z components in project coordinates. When active this mode will highlight the As-Built geometry, and the cursor will change to a cross hair when hovering over the As-Built geometry and taking a measurement is possible.

User Defined Table Fields

We also have several fields in the Item Table that you can fill out with whatever your heart desires.

- Action Required – this field provides a place to note any next steps or actions that need to occur to come to a resolution about the item. Usually we see this populated with things like "Fix in field" or "Update as-built drawings" or the names of people to get involved. But, it's your data so be as creative as you want!

- Notes – as the name suggests, take whatever notes strike your fancy in this field. The best thing we've seen people populate in here is grid intersection information for each item that needs action. Very clever Tim, nicely done!

Both these fields will be present in any of the data reporting options we have and can be very useful in organizing and explaining the results.

Tracking what you've reviewed

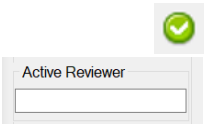
There are also two fields designed to help you keep track of which items you have reviewed and which you haven't.

- Reviewer – This lets you type in a name, initials, or anything else you might desire to indicate who has looked at the results and decided they're sufficient to generate reports from.

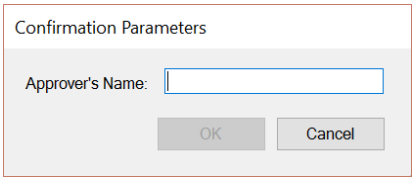
- Review Status – This lets you designate one of three pre-defined statuses for each item.
  - Not Reviewed
  - Under Review
  - Reviewed

While you can fill out or edit each of these fields manually, we also have a review workflow to fill them both out at the same time…

Accepting the Current Status



The "Accept Current Status" button places your name, initials, or whatever you've typed into the "Active Reviewer" field in the QA Tools section of the tool bar into the "Reviewer" field and changes the "Review Status" to "Reviewed".



If you haven't filled out the "Active Reviewer" in the toolbar the first time you press this button in the Verity project, a dialog will appear prompting you to type in the reviewer for that session. This will then populate the "Active Reviewer" field in the menu bar with whatever you type. The information in the "Active Reviewer" field will then be used from them on for that project.

If you wish to change active reviewers mid-session or for the project, just change the text in the "Active Reviewer" field and any newly accepted items will get the new name. You can always manually change the Reviewer field later by editing it in the table directly.

Why our algorithms might guess incorrectly

Or, why you might need to make manual adjustments and overrides. Our job is to teach a computer to see information in point cloud data like a human can. But, computers aren't human and this isn't a process that can achieve perfection. At least not yet. So, our algorithms are designed with certain assumptions in mind that allow them to make decisions in the face of uncertainty and process in a reasonable amount of time on your computer. Here are the main assumptions we make:

1. That the scan data is of high enough quality and has sufficient coverage and density to accurately determine the status and fit of the element to the point cloud. If the scan data is too noisy or too sparse we won't be able to. If noise causes so much uncertainty that we don't find a good match, we'll either flag it as "Not Found" or "Uncertain". If the data is too sparse, we'll flag it as "Not Enough Data". For our algorithms to work optimally you want the range noise to be less than half the size of the elements you're testing and you need good coverage on more than one face of the geometry.

2. That the modeled object is very similar in shape and size to the thing that got scanned. If you scanned a square penetration block out and want us to match it to a pipe penetrating a slab in the model you're going to be disappointed in both our installation status and fit. If someone modeled the ductwork without insulation wrap and the wrap was already installed, we're probably going to guess the installation status right, but the fit will not be correct. In these cases you can either get the model corrected to match reality, or you can manually adjust the status and fit in Verity.

3. That someone bothered to install the work reasonably close to where they were supposed to. If the installer put the pipe in several feet or meters away from where they were supposed to, we're not going to find it. We search within a limited area (approximately 2 feet or 600mm) of the as-designed location for a match in the point cloud. If there isn't a good match then we're going to flag that item as "Not Found". If there is a poor match we may flag it as "Uncertain". There's not much to do here other than lament the fact that the field ignored the intent and ask for an updated as-built model. Which, arguably, is exactly the right thing to do in this situation.

Gangs of similarly sized elements can also be challenging for our algorithms as we'll find multiple good matches. In this case we still rely on the hope that someone installed the work as close to the right place as they could. If three 6" pipes are all installed on a pipe rack, and the model shows three pipes, each pipe is going to be individually fit to the matching points based on proximity. So, if the rack is installed so that pipe A was installed closest to where pipe A was supposed to be, all is well. If pipe A was installed closer to where pipe B was supposed to be, we'll match pipe A and pipe B to pipe A's scan data, pipe C to pipe B's scan data, and nothing to pipe C's scan data.

Over time we may find ways to better solve the cases where these assumptions aren't true and make a better automated guess on them. But, that will probably require things like machine learning and connections to more intelligent system-aware hosts to fix. Until then, when these assumptions are violated you will have to get involved and adjust the classification and fit of the items yourself. Hey, at least we isolated the model and scan data into some convenient and easy to review views for you!

Correcting or Adjusting results

If you find we have misclassified or incorrectly fitted an item, there are tools in Verity to manually and algorithmically adjust those to be correct based on good ole' fashioned human input. If the installation status is incorrect, you must change it first.

Adjusting the Installation Status

If you can see that we've misclassified the item's Installation Status, you can change it using the drop down in the "Installation Status" menu bar or in the table cell.

- If you change from "Installed" or "Uncertain" to any other status, the As-Built geometry will vanish as those statuses indicate no As-Built position is there to be found. At this point you don't have anything else to adjust since there is no fit.

- If you change it from any of the "Not There" statuses to "Installed" or "Uncertain", the As-Built geometry will appear at our best fit location for that item. If our best fit is correct, you can accept the current status and move on. If not, you can manually adjust the fit yourself, or get it close to the correct match and use Refit to fit to the adjacent points.

Manually Adjusting the Fit

To correct the fit, switch to the Split Viewport as this will give you three projected views in which you can manually move the As-Built geometry into place. Only these three projected views support manual interaction with the geometry, and the changes you make will be in the plane of the active view frame. So, if you have the "As-Built" view frame active, movements will be aligned to the current as-built's local frame. If you have the "As-Designed" view frame active, movements will be aligned to the original geometry's local frame. And, if you have the "Project Coordinates" view frame active, movements will be aligned to the project's coordinate system (X,Y,Z).

When your mouse hovers over the As-Built geometry it will be highlighted and the mouse cursor will change to a 4-way arrow to indicate you can now move the geometry.

- Move the As-Built geometry by left-clicking on and dragging the geometry into place against the points. If you want the movement to be constrained orthogonally to the view frame, you can hold down the CTRL key at any point before or during the move operation, and release it at any point if you don't want it constrained.

- Rotate the As-Built geometry around the center of the geometry by holding down the Shift key before left-click-holding on the surface of the geometry and dragging. Verity will base the rotation handle and center of rotation based on where your mouse is located when you first start the rotation. The click location will be the rotation handle, and the center will either be at the center of the opposite edge of the item if the handle is closest to the edge of the bounding box, or at the center of the item's bounding box if you click nearest to the center.

As soon as you let go of the mouse the translation and rotation metrics will update based on your input. There is no need to recalculate those. Additionally, if the total translation increases beyond the defined tolerance, the item will automatically be switched to "Out Of Tolerance" and vice versa.

Recalculate Heatmap

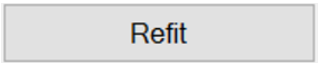
If you have manually moved the item you will need to use the “Recalculate Heatmap” button to update the heatmap based on the new as-built location. This is not updated on-the-fly as it can take several seconds to recalculate.

If you forget to re-calculate the heatmap, don’t worry. Any action that requires the heatmap will automatically trigger a re-calculation if the heatmap is out of date. So, the next time you select that item, or try and export a report, or publish it to another application it will be regenerated for you automatically.

Reset Fit

In cases where our algorithm or your manual moves have resulted in an As-Built position that is hard to manually adjust into place against the points, the “Reset Fit” button will move the As-Built geometry back into alignment with the As-Designed geometry so you can have a fresh pass at manually moving it into place.

Refit



If the points and geometry are similar in shape/size, you can use the “Refit” button to have our algorithms optimize the fit to the points you’ve moved the geometry close to. This is most often used in the case where several similar elements are installed side-by-side and we’ve fit the geometry to the wrong instance. It is also useful if you accidentally dragged the geometry off of a good fit because you got your mouse buttons mixed up.

Changing the Tolerance

The Tolerance value can be changed in the table after the Analysis has been completed in case there are particular items you feel should have a different tolerance metric applied to them. Heatmaps and the Conformance to Tolerance field will be automatically updated if you do so.

Reporting results

Once you have finished the QA process, there are a number of reporting options to get the data Verity has generated documented and into whatever resolution process is next.

Reporting with Autodesk® Navisworks®

While we already covered it earlier, you can manually or automatically push the following information into Autodesk® Navisworks® as a reporting and documentation solution. Use the links below to jump to the sections on how to use these tools and what they do:

-

- Export Verity Properties to Host
- Move Host Item to As-Built

The Autodesk® Navisworks® file can then be saved and sent to other Autodesk® Navisworks® Manage or Simulate users. The file can also be saved to an .NWD for distribution to Autodesk® Navisworks® Freedom users. In both cases, the properties, transforms, and the colorization of objects that were pushed will be there for the recipients to view. When and .NWD with As-Built transforms is loaded back into an NWF with the original source files, you will be able to see the original geometry and the colorized and transformed geometry side-by-side in Autodesk® Navisworks®.

In 2018+ versions of Revit and AutoCAD you can now link in an NWD to see the coordination models in the context of your design or fabrication models. By pushing the As-Built location to Navisworks and saving the NWD you can similarly see the as-built Navisworks models in contect.

Reports Menu

The Reports Menu provides access to reports that can be used outside the Verity and Autodesk® Navisworks® ecosystem. All of our reports are based on the active selection and function on basic WYSIWYG (What you see is what you get) principles. If you want to run a report on all items, you can either use shift+select to select all the items in the table, or you can hit the “ESC” key to deselect your current selection and we’ll ask you if you want to run the report on all elements. All the exports also respect the active sorting of the table, so make sure it is sorted the way you want to see it in the reports.

CSV

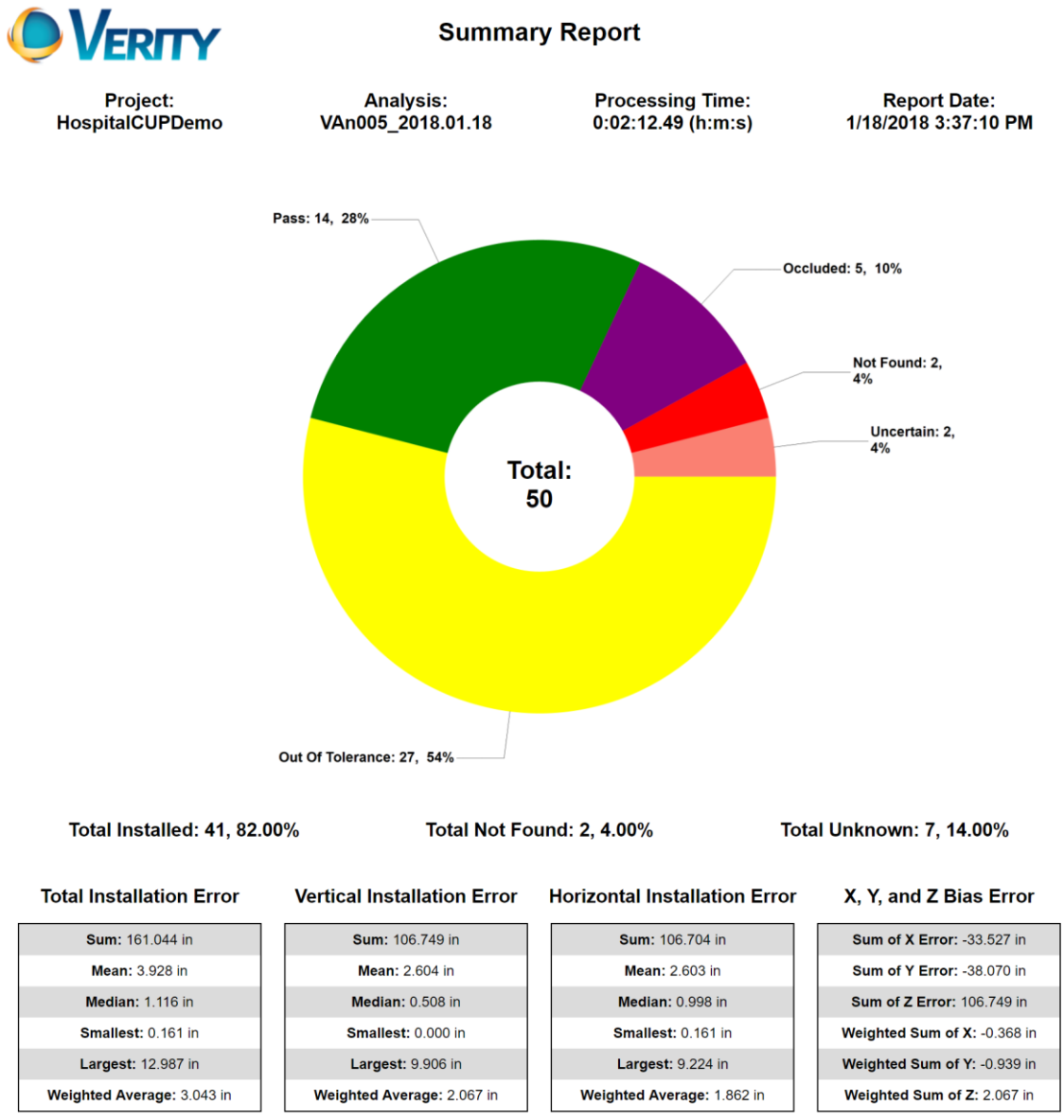
You can export all Verity Table properties of the selected items to CSV format using the current sorting in the Verity Table. This is extremely useful for utilizing the data from Verity for business or process analytics. This can be loaded into Excel or database applications and used to aggregate data across subcontractors, projects, or even your whole company.

HTML

You can export the selected items to several different types of HTML reports that can be opened on any device with an internet browser. None of these reports contain any scripts or other content that would prevent them from running on any particular platform or browser. Android, iOS, Mac, Windows, and Linux are all supported, and they should work on other unlisted systems as long as the browser supports HTML.

Once an HTML report is generated, it will automatically open in your default web browser for you to see the output. This will happen for all three of the HTML report types.

- Summary Report – This will generate a single HTML file that contains aggregate data about the analysis as a whole. This includes graphics and metrics. This is identical in form to the auto-generated summary report, but will respect the current selection (as long as more than one object is selected).



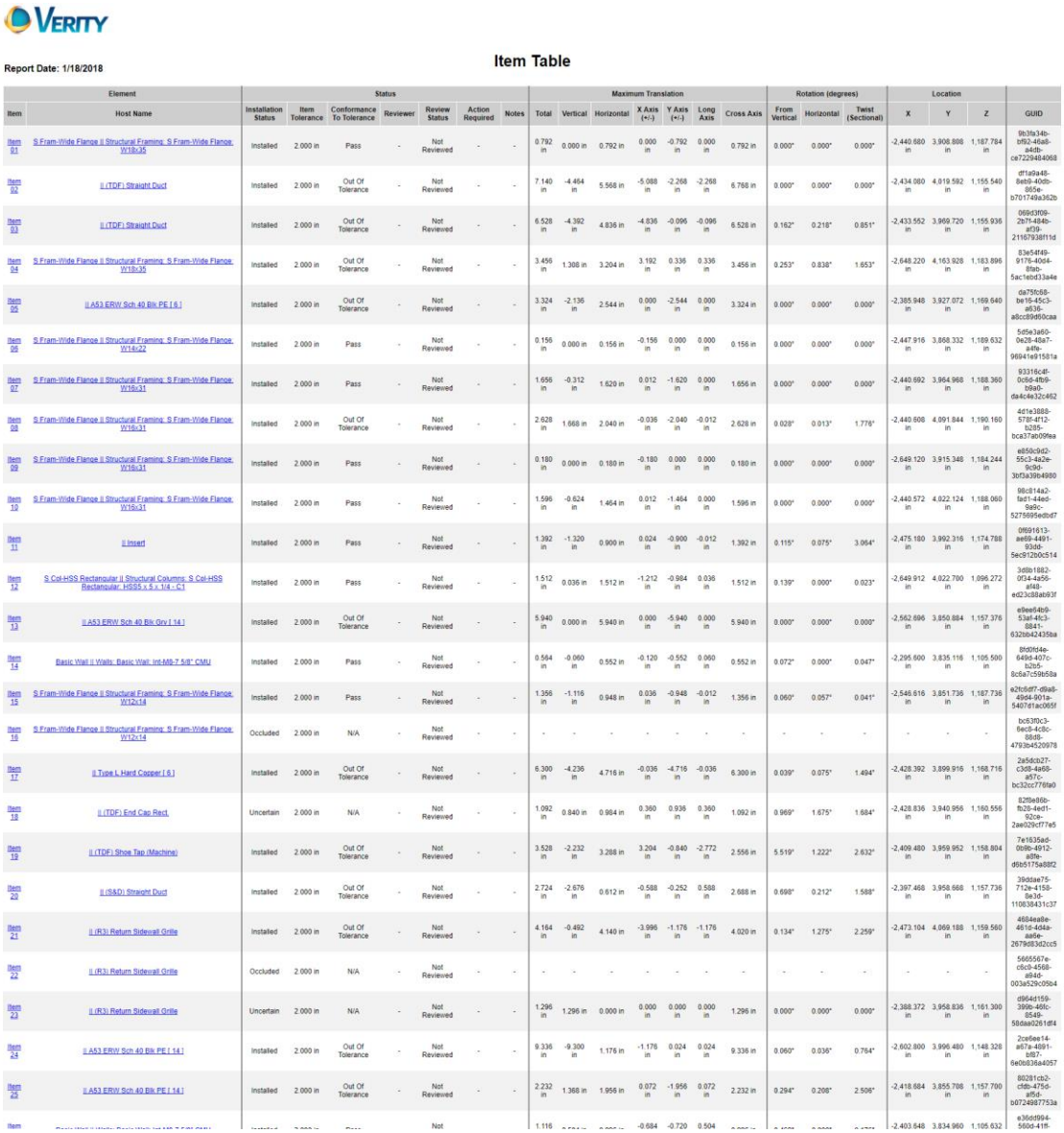
Summary Report

Project:	Analysis:	Processing Time:	Report Date:
HospitalCUPDemo	VAn005_2018.01.18	0:02:12.49 (h:m:s)	1/18/2018 3:37:10 PM

Total Installed: 41, 82.00% **Total Not Found: 2, 4.00%** **Total Unknown: 7, 14.00%**

Total Installation Error	Vertical Installation Error	Horizontal Installation Error	X, Y, and Z Bias Error
Sum: 161.044 in	**Sum:** 106.749 in	**Sum:** 106.704 in	**Sum of X Error:** -33.527 in
Mean: 3.928 in	**Mean:** 2.604 in	**Mean:** 2.603 in	**Sum of Y Error:** -38.070 in
Median: 1.116 in	**Median:** 0.508 in	**Median:** 0.998 in	**Sum of Z Error:** 106.749 in
Smallest: 0.161 in	**Smallest:** 0.000 in	**Smallest:** 0.161 in	**Weighted Sum of X:** -0.368 in
Largest: 12.987 in	**Largest:** 9.906 in	**Largest:** 9.224 in	**Weighted Sum of Y:** -0.939 in
Weighted Average: 3.043 in	**Weighted Average:** 2.067 in	**Weighted Average:** 1.862 in	**Weighted Sum of Z:** 2.067 in

- Table Report – This will generate an HTML table of the selected elements, similar in content to the CSV export but in HTML:



VERITY

Report Date: 1/18/2018

Item Table

Element		Status						Maximum Translation						Rotation (degrees)			Location			
Item	Host Name	Installation Status	Item Tolerance	Conformance To Tolerance	Reviewer	Review Status	Action Required	Notes	Total	Vertical	Horizontal	X Axis (+/-)	Y Axis (+/-)	Long Axis	Cross Axis	From Vertical	Horizontal	Twist (Sectional)	X	Y	Z	GUID
Item 91	S Fram-Wide Flange II Structural Framing: S Fram-Wide Flange: W18x35	Installed	2.000 in	Pass	-	Not Reviewed	-	-	0.792 in	0.000 in	0.792 in	0.000 in	-0.792 in	0.000 in	0.792 in	0.000°	0.000°	0.000°	-2,440.680 in	3,906.808 in	1,187.784 in	9b3fa34b-bf92-46a8-a4db-ce722948406
Item 92	II (TDF) Straight Duct	Installed	2.000 in	Out Of Tolerance	-	Not Reviewed	-	-	7.140 in	-4.464 in	5.568 in	-5.088 in	-2.268 in	-2.268 in	6.768 in	0.000°	0.000°	0.000°	-2,434.080 in	4,019.592 in	1,155.540 in	df1a9a48-8eb9-40db-865e-b701749a362b
Item 93	II (TDF) Straight Duct	Installed	2.000 in	Out Of Tolerance	-	Not Reviewed	-	-	6.528 in	-4.392 in	4.836 in	-4.836 in	-0.096 in	-0.096 in	6.528 in	0.162°	0.218°	0.851°	-2,433.552 in	3,969.720 in	1,155.936 in	069d3f09-2b7f-484b-af39-21167938f11d
Item 94	S Fram-Wide Flange II Structural Framing: S Fram-Wide Flange: W18x35	Installed	2.000 in	Out Of Tolerance	-	Not Reviewed	-	-	3.456 in	1.308 in	3.204 in	3.192 in	0.336 in	0.336 in	3.456 in	0.253°	0.838°	1.653°	-2,648.220 in	4,163.928 in	1,183.896 in	83e54f49-9176-40d4-85ab-5ac1ebd33a4e
Item 95	II A53 ERW Sch 40 Blk PE [6]	Installed	2.000 in	Out Of Tolerance	-	Not Reviewed	-	-	3.324 in	-2.136 in	2.544 in	0.000 in	-2.544 in	0.000 in	3.324 in	0.000°	0.000°	0.000°	-2,385.948 in	3,927.072 in	1,169.640 in	da75fc68-be16-45c3-a636-a8cc89d90caa
Item 96	S Fram-Wide Flange II Structural Framing: S Fram-Wide Flange: W14x22	Installed	2.000 in	Pass	-	Not Reviewed	-	-	0.156 in	0.000 in	0.156 in	-0.156 in	0.000 in	0.000 in	0.156 in	0.000°	0.000°	0.000°	-2,447.916 in	3,868.332 in	1,189.632 in	5d5e3a60-0e28-48a7-a4fe-96941e91581a
Item 97	S Fram-Wide Flange II Structural Framing: S Fram-Wide Flange: W16x31	Installed	2.000 in	Pass	-	Not Reviewed	-	-	1.656 in	-0.312 in	1.620 in	0.012 in	-1.620 in	0.000 in	1.656 in	0.000°	0.000°	0.000°	-2,440.692 in	3,964.968 in	1,188.360 in	93316c4f-0c6d-4fb9-b9a0-da4c4e32c462
Item 98	S Fram-Wide Flange II Structural Framing: S Fram-Wide Flange: W16x31	Installed	2.000 in	Out Of Tolerance	-	Not Reviewed	-	-	2.628 in	1.668 in	2.040 in	-0.036 in	-2.040 in	-0.012 in	2.628 in	0.028°	0.013°	1.776°	-2,440.608 in	4,091.844 in	1,190.160 in	4d1e3888-578f-4f12-b285-bca37ab09fea
Item 99	S Fram-Wide Flange II Structural Framing: S Fram-Wide Flange: W16x31	Installed	2.000 in	Pass	-	Not Reviewed	-	-	0.180 in	0.000 in	0.180 in	-0.180 in	0.000 in	0.000 in	0.180 in	0.000°	0.000°	0.000°	-2,649.120 in	3,915.348 in	1,184.244 in	e850c9d2-55c3-4a2e-9c9d-3bf3a39b4980
Item 10	S Fram-Wide Flange II Structural Framing: S Fram-Wide Flange: W16x31	Installed	2.000 in	Pass	-	Not Reviewed	-	-	1.596 in	-0.624 in	1.464 in	0.012 in	-1.464 in	0.000 in	1.596 in	0.000°	0.000°	0.000°	-2,440.572 in	4,022.124 in	1,188.060 in	98c814a2-fad1-44ed-9a9c-5275695edbd7
Item 11	II Insert	Installed	2.000 in	Pass	-	Not Reviewed	-	-	1.392 in	-1.320 in	0.900 in	0.024 in	-0.900 in	-0.012 in	1.392 in	0.115°	0.075°	3.064°	-2,475.180 in	3,992.316 in	1,174.788 in	0f691613-ae69-4491-93d0-5ec912b0c514
Item 12	S Col-HSS Rectangular II Structural Columns: S Col-HSS Rectangular: HSS5.x.5.x.1/4 - C1	Installed	2.000 in	Pass	-	Not Reviewed	-	-	1.512 in	0.036 in	1.512 in	-1.212 in	-0.984 in	0.036 in	1.512 in	0.139°	0.000°	0.023°	-2,649.912 in	4,022.760 in	1,096.272 in	3d8b1882-0f34-4a56-af48-ed23c88ab93f
Item 13	II A53 ERW Sch 40 Blk Grv [14]	Installed	2.000 in	Out Of Tolerance	-	Not Reviewed	-	-	5.940 in	0.000 in	5.940 in	0.000 in	-5.940 in	0.000 in	5.940 in	0.000°	0.000°	0.000°	-2,562.696 in	3,850.884 in	1,157.376 in	e9ee64b9-53af-4fc3-8841-632bd42435ba
Item 14	Basic Wall II Walls: Basic Wall: Int-M8-7 5/8" CMU	Installed	2.000 in	Pass	-	Not Reviewed	-	-	0.564 in	-0.060 in	0.552 in	-0.120 in	-0.552 in	0.060 in	0.552 in	0.072°	0.000°	0.047°	-2,295.600 in	3,835.116 in	1,105.500 in	8fd0fd4e-649d-4407c-b2b5-8c6a7c59b58a
Item 15	S Fram-Wide Flange II Structural Framing: S Fram-Wide Flange: W12x14	Installed	2.000 in	Pass	-	Not Reviewed	-	-	1.356 in	-1.116 in	0.948 in	0.036 in	-0.948 in	-0.012 in	1.356 in	0.060°	0.057°	0.041°	-2,546.616 in	3,851.736 in	1,187.736 in	e2fc6df7-d9a8-49d4-901a-5407d1ac065f
Item 16	S Fram-Wide Flange II Structural Framing: S Fram-Wide Flange: W12x14	Occluded	2.000 in	N/A	-	Not Reviewed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	bc63f0c3-6ec8-4c8c-88d8-4793b4520978
Item 17	II Type L Hard Copper [6]	Installed	2.000 in	Out Of Tolerance	-	Not Reviewed	-	-	6.300 in	-4.236 in	4.716 in	-0.036 in	-4.716 in	-0.036 in	6.300 in	0.039°	0.075°	1.494°	-2,428.392 in	3,899.916 in	1,168.716 in	2a5dcb27-c3d8-4a68-a87c-bc32cc776fa0
Item 18	II (TDF) End Cap Rect	Uncertain	2.000 in	N/A	-	Not Reviewed	-	-	1.092 in	0.840 in	0.984 in	0.360 in	0.936 in	0.360 in	1.092 in	0.969°	1.675°	1.684°	-2,428.836 in	3,940.956 in	1,160.556 in	82f8e86b-fb26-4ed1-92ce-2ae029cf77e5
Item 19	II (TDF) Shoe Tap (Machine)	Installed	2.000 in	Out Of Tolerance	-	Not Reviewed	-	-	3.528 in	-2.232 in	3.288 in	3.204 in	-0.840 in	-2.772 in	2.556 in	5.519°	1.222°	2.632°	-2,409.480 in	3,959.952 in	1,158.804 in	7e1635ad-0b9b-4912-a3fe-d5b5175a88f2
Item 20	II (S&D) Straight Duct	Installed	2.000 in	Out Of Tolerance	-	Not Reviewed	-	-	2.724 in	-2.676 in	0.612 in	-0.588 in	-0.252 in	0.588 in	2.688 in	0.698°	0.212°	1.588°	-2,397.468 in	3,958.668 in	1,157.736 in	39ddae75-712e-4158-9e3d-110838431c37
Item 21	II (R3) Return Sidewall Grille	Installed	2.000 in	Out Of Tolerance	-	Not Reviewed	-	-	4.164 in	-0.492 in	4.140 in	-3.996 in	-1.176 in	-1.176 in	4.020 in	0.134°	1.275°	2.259°	-2,473.104 in	4,069.188 in	1,159.560 in	4684ea8e-461d-4d4a-aa6e-2679d83d2cc5
Item 22	II (R3) Return Sidewall Grille	Occluded	2.000 in	N/A	-	Not Reviewed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5665567e-c6c9-4568-a940-003a529c05b4
Item 23	II (R3) Return Sidewall Grille	Uncertain	2.000 in	N/A	-	Not Reviewed	-	-	1.296 in	1.296 in	0.000 in	0.000 in	0.000 in	0.000 in	1.296 in	0.000°	0.000°	0.000°	-2,388.372 in	3,958.836 in	1,161.300 in	d964d159-399b-466c-8549-58daa0261df4
Item 24	II A53 ERW Sch 40 Blk PE [14]	Installed	2.000 in	Out Of Tolerance	-	Not Reviewed	-	-	9.336 in	-9.300 in	1.176 in	-1.176 in	0.024 in	0.024 in	9.336 in	0.060°	0.036°	0.764°	-2,602.800 in	3,996.480 in	1,148.328 in	2ce6ee14-a67a-4691-bf87-6e0b838a4057
Item 25	II A53 ERW Sch 40 Blk PE [14]	Installed	2.000 in	Out Of Tolerance	-	Not Reviewed	-	-	2.232 in	1.368 in	1.956 in	0.072 in	-1.956 in	0.072 in	2.232 in	0.294°	0.208°	2.506°	-2,418.684 in	3,855.708 in	1,157.700 in	80281cb2-cfdb-475d-af5d-b0724987753a
Item						Not			1.116			-0.684	-0.720	0.504					-2,403.648	3,834.960	1,105.632	e36dd994-560d-41f

- Table + Items – This report will generate both the table above and individual item reports for each selected item in the Verity table. The table acts as a table of contents with items hyperlinked to the item reports and sequentially numbered so you can identify an individual HTML item page in the report elements folder. Each individual item report is a self-contained HTML file, and has the split pane view format as images to accompany the metrics associated with the item. The views will be generated using the current settings in the Verity viewer for visibility of geometry, heatmaps, etc… The navigation buttons at the top to move between items within the full report. These links will work as long as the report and reportelements folder maintain the same relative file path.

Item 01: S Fram-Wide Flange || Structural Framing: S Fram-Wide Flange: W18x35

Installed: Pass - Tolerance: 2.000 in

Action Required:

-

Notes:

-

Review Status:

Not Reviewed

Reviewer:

-

Location:

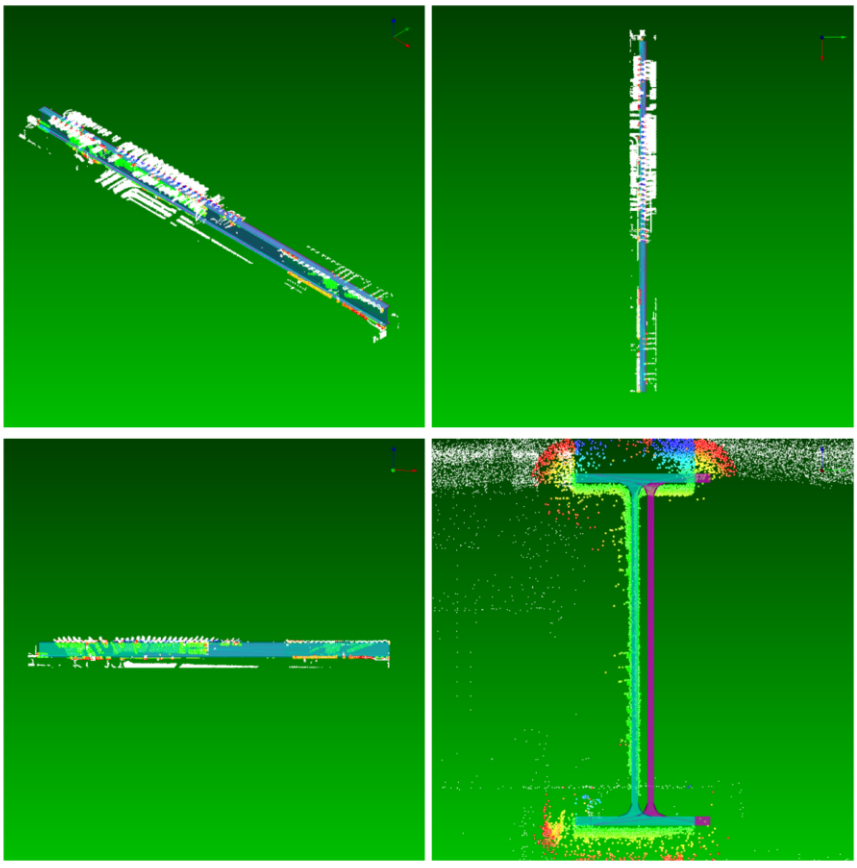
X: -2,440.680 in

Y: 3,908.808 in

Z: 1,187.784 in

GUID:

9b3fa34b-bf92-46a8-a4db-ce7229484068



Maximum Translation							Rotation (degrees)		
Total	Vertical	Horizontal	X Axis (+/-)	Y Axis (+/-)	Long Axis	Cross Axis	From Vertical	Horizontal	Twist (Sectional)
0.792 in	0.000 in	0.792 in	0.000 in	-0.792 in	0.000 in	0.792 in	0.000°	0.000°	0.000°

Adding your logo to the HTML Reports

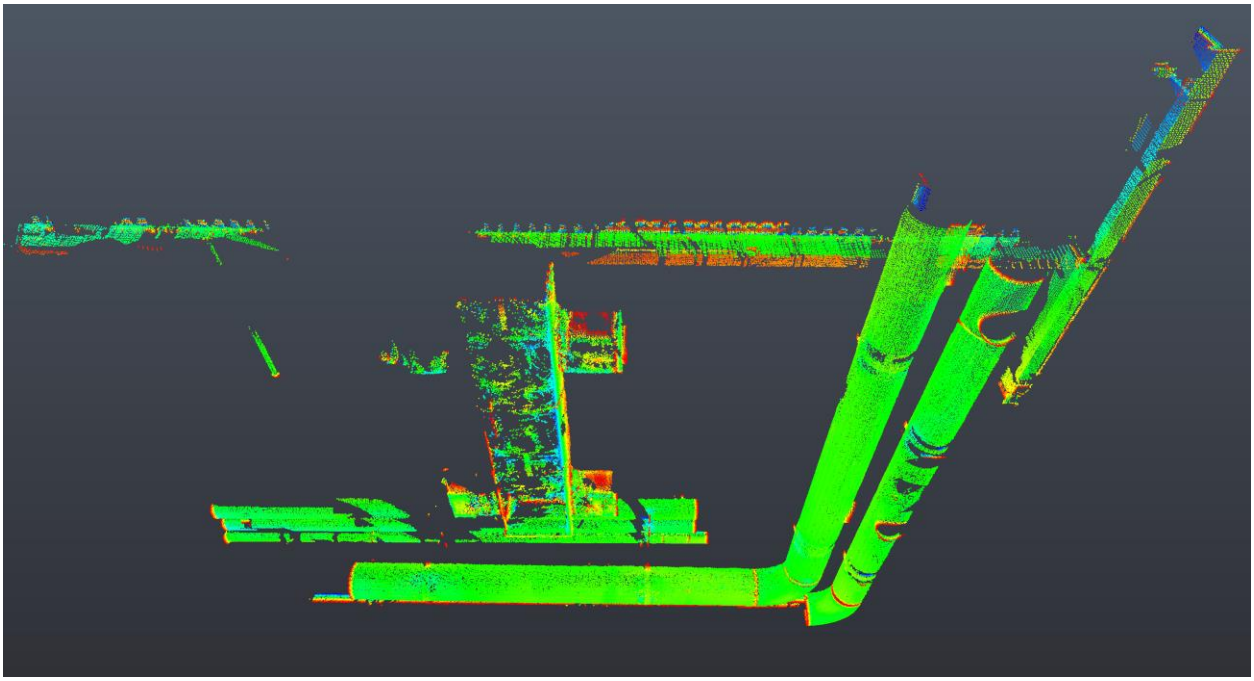
A company logo can be added to HTML reports by saving an image file to the default C:\Users**MyName**\Documents\ClearEdge3D\Verity\CustomerLogo folder. The first image in the folder will be the image that is used in the reports. The image can be left in the folder for future reports.

The report will automatically resize the company logo to fit but the image size in pixels and corresponding file size of the added image directly affects the file size of each HTML file. Generally, a logo with a maximum width and height of 300 pixels will be sufficient but even smaller logo images will work well.

Smart Points

You can export the points associated with the selected items to a unified PTS file on the Autodesk® Navisworks® project coordinate system. These can be brought into Autodesk® Navisworks® or any authoring platform with PTS support. This report also follows WYSIWIG and any points and heatmaps visible on your screen will export to the PTS.

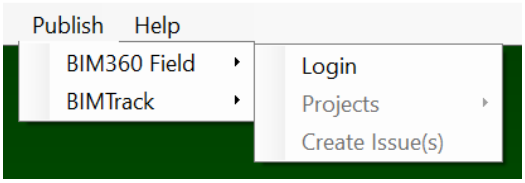
So, if you want to export JUST the As-Built heatmap points for out of tolerance items you'd need to set the heatmap to As-Built, turn off the points in the Visibility section so the surrounding points are turned off, select all the "Out of Tolerance" items in the table, and then export Smart Points.



This is a great tool for resolving issues where the as-built models need updating to reflect the field conditions as you're reducing the point cloud down to just the elements that need updating (this file with 27 items is only 9MB) making it simple for CAD/BIM operators to know what to fix.

The Publish Menu

We have recently added the capability to publish items and all their associated information to multiple web-based workflow management tools for tracking progress on resolving the issues identified in Verity.



Our list of current in-development platforms for this functionality:

- BIMTrack – Technical Preview
- BIM 360 Field (original) – Technical Preview
- Procore – TBD
- BIM 360 Field (Next Gen) – TBD

All these integrations follow similar workflows, though the exact information uploaded varies with each system based on its capabilities. Please contact our technical support team if you have any questions about this functionality or wish to recommend additional platforms to connect to.

Login

The login option will prompt you to enter your user name and password that you use to login to your workflow management system's web site directly. This information is not saved in Verity, and is transmitted and maintained through whatever API/SDK is provided by your workflow management system (WMS) vendor. Please contact your WMS vendor directly about security questions and compliance with security and privacy regulations.

If your WMS requires additional information to associate the Verity project with a project on their system (Ex: Hub Name for BIMTrack), that information will be requested as part of this step.

Project

Once logged in, Verity will query the names of the projects you have access to upload issues to in your WMS. Those projects will be listed in the Projects fly out menu, and you will need to select the one you want to upload issues to. Currently, this information is only retained in Verity for the duration of the active session, or until your WMS forces a time out and logs you out of the system. So, you will have to re-select the project every time you run Verity or after logging back in to your WMS.

Create Issues

This will create issues in your WMS based on the current selection in Verity. The output is similar to what gets exported in our detailed item HTML reports, though the exact location and format in the WMS is dependent upon what each platform supports. Integrations still in Technical Preview will be documented in separate user guides that can be requested from our support team.

Pro Tips:

Below are some good tips from our beta testing we'd like to share. This might help you if you're trying to figure out where to start. We'll have Verity trainings posted soon!

1. Verity uses computer vision algorithms to classify and fit data to point clouds, and those are not correct 100% of the time. Verity should be used as a tool to substantially accelerate a human operator's ability to QA installation of work, not as a replacement for that human. We are constantly trying to improve our algorithms, but will never reach the point of replacement. Users should look at each item – both to review our attempt at automatically identifying and fitting the items, and to determine if any items require subsequent action to correct. We're here to make you more efficient and effective so you can check 100% of your work in the time it used to take you to spot check the same work.

2. Since you should look at each element, be judicious about what you add to Verity and analyze. The QA process is mostly linear, so validating 1000 items takes 10 times as long as validating 100. Examples we've learned from our users include the following:
    - Only add pipes into Verity and exclude (or remove) fittings. If the pipes are correct, the elbows and fittings are correct as well. If a pipe is wrong, so is the fitting.
    - Window selecting in Autodesk® Navisworks® risks bringing in a lot of small items you don't need to analyze. Sort by geometry surface area and remove all the bolts/plates/fittings/etc.
    - Selection sets and search sets can really help streamline bringing in just the items you care about analyzing and none of the ones you don't.

3. Verity does not need a high density of points in order to accurately find and fit the geometry to the scan data. When exporting structured data for use in Verity, we usually find decimation of the data has no negative impacts on the results for most items. If you are trying to analyze very small items (an inch or less across) or items a long distance from the scanner (100s of feet), then leave the data at full resolution. If you are capturing data specifically for use in Verity, run at faster, lower resolution settings, scan from more locations, and export at full resolution.

4. If the modeled geometry and the installed work are not a close geometric match, our algorithms are going to be much less effective. Manual review can still yield great results in these cases since we still break the scan's data and objects out for visual inspection, and will calculate translation variances based on manually adjusting the as-build geometry. Or, if you have access to modeling tools, think about modeling things differently for analysis in Verity. Moving monolithic floor slabs into place will not give you good information on slab edges. However, quickly modeling small slab edge elements in an authoring application can give you geometry to fit to the points that will give you the results you want.

5. Like with any reality capture workflows, surface quality of the elements you're scanning has a big impact on the analysis results. Highly reflective and highly non-reflective surfaces are much harder to work with—although if you have these kinds of elements, be sure to check the "Indoor Project" option in the Analysis settings to get much better results.

Known Issues

These are the known limitations or issues in the application that we are aware of in this release.

1. To maintain the link between Verity items and elements in Autodesk® Navisworks®, you must save the Autodesk® Navisworks® project after adding the items to Verity and before closing Autodesk® Navisworks®. Verity is a database and saves on every operation, but Autodesk® Navisworks® is not and must be saved to retain the data we push into it.

2. Verity does not support working on files on network storage. Working with files on a network storage device can cause extremely slow performance. Please store all working files locally. Note: This is not a Verity issue and may or may not be resolved in the future.

3. We do not support using unified scan data in Verity, but we have no way to prevent you from doing so. If you add unstructured scan data, Verity will attempt to process it and will load the entire scan into memory. With a large unified scan this may cause your computer to run out of memory, crashing Verity and Autodesk® Navisworks®. If it completes, the fitting results will be highly compromised. A high percentage of bad fits in your data indicate unstructured scan data.

4. When using the new “Add to Verity (Selected Node)” option, we bring in your selection at the exact level you have picked it in the selection tree. So, if you select the entire architectural model in the selection tree, we will attempt to load it in as a single item in Verity. This will at the least take a very long time, and may cause your computer to crash if it runs out of memory.

5. Verity’s process is running inside Autodesk® Navisworks®, so occasionally Navisworks® will take operating system focus from Verity and you’ll have to manually re-focus on Verity to see the Verity console or our progress bars. What can we say, sometimes Navisworks® is needy.

6. Calculating three dimensional rotations is a complex procedure as there are multiple ways to calculate it. Additionally, if we have incorrectly identified the long axis, then these calculations will not likely be relevant. This may happen in the case of beams with lengths shorter than their depth for instance. Please refer to the “Rotation Metrics” section in the user guide for specifics.

7. Scan selections will not currently import from host using the “Import Selection from Host” button. This will be addressed in the next service pack or release.

8. When using Verity and BIMTrack, if you have “Match View Frame” checked in Verity and try and then hit the “View Model” button in the BIMTrack plugin, Navisworks crashes.

9. Occasionally, locking the “Push Properties to Host” or “Push As-Built position to Host” buttons will cause Verity to Auto-Zoom to the currently selected items even when “Auto-Zoom” isn’t checked.

10. When using the Navisworks BIMTrack plugin and Verity at the same time, if “Match View Frame” is checked in Verity and “View Model” is pressed in the Navisworks BIMTrack plugin Navisworks will crash.

July 30, 2018

Version 1.5 – Release Notes

Changes in version 1.5

- Fixed a critical bug where items with a long axis within 5 degrees of vertical were reporting an incorrect twist value. Reported values now match the documentation.
- Fixed a bug that pushed incorrect as-built transforms to Navisworks for items that required mesh repair during analyze.
- BIM Track Technical Preview (Beta): Added the ability to create issues in BIM Track for selected items. Issues contain table data, camera information, images, and HTML files.
  Contact ClearEdge3D Technical Support for more information
- BIM 360 Field Technical Preview (Beta): Additional improvements to the information uploaded to draft issues, and new messages in case of failures to upload certain data or entire issues to BIM 360 Field.
  Contact ClearEdge3D Technical Support for more information
- Added support for Navisworks Manage 2019 and Navisworks Simulate 2019.
- Added a column in the table called “% Coverage” as a reliability metric for our algorithm’s result that calculates the percentage of the item covered with scan data.
- Changed rotation of items to be around the center of the opposite side of the geometry to assist in manual adjustments to rotation.
- Users can now control the visibility and opacity of neighboring analyzed geometry within the crop region of the selected item. Neighbor geometry is colored gray in Verity.
- Selecting a scan in Verity’s scan table now selects the same scan in Navisworks.
- To make it obvious that the As-Built object’s position can be adjusted, the As-Built object will be highlighted, and the cursor will change to a 4-way arrow when the mouse is hovering over it in any of the projected views (Quad Pane Mode Only).
- When a measurement mode is activated, the target geometry for that measurement type is highlighted to make it obvious which geometry should be clicked on to take the measurement. The highlighting effect is further increased and the cursor changes to a crosshair when hovering over the target geometry.
- Introduced new unified data detection capabilities – Duplicate scanner locations will now be detected when adding scans to Verity.
- Measurement tool between As-Built and As-Designed geometry now includes individual values for X, Y, and Z measurements.
- All geometry now has a single check-box to control its visibility as a wireframe view style can be achieved by setting the opacity to 0.
- When selecting an item with an out of date heatmap, Verity will automatically recalculate that item’s heatmap before displaying it, generating reports, or publishing it.
- Added option to color scans by scanner location, the 10 scans with the most coverage on the item will be mapped to unique color values, any remaining scans will remain white.

- Added a new camera mode called Scanner View which allows the user to see an element from the scanner with the most coverage of the element.
- After analysis, the Auto Zoom camera location in the Host uses the scanner location with the most coverage to increase the likelihood that the item is visible in the host viewer.
- The scan and item tables now have status bars which show the number of items in the table.
- The scan cache folder is now automatically removed once the Analyze process is complete, and users can now use all functionality (such as Refit) with the scan cache removed.
- Added algorithm to auto-detect the best view angle for each item so Verity would no longer pick a default view looking at a side with no point data.
- Fixed a bug where closing out of Navisworks with Verity Open and Inspection Mode on would result in the element transparency being saved to the NWF.
- Fixed a bug where pressing Open Verity in the Navisworks plugin would crash Verity if it was already open, instead it now brings Verity back to the foreground.
- Fixed a bug where views that open with no visible geometry would not refresh properly when visibility settings change.
- Fixed a bug where search box for cylindrical objects were not aligned with z axis.
- The tooltip for Export Selection now accurately describes that it will only Auto-Zoom if the Auto-Zoom functionality is turned on, otherwise only the selection will be pushed.
- The active reviewer and display units are now saved in the project.
- Release notes are now available from the Verity help menu.
- Added Build ID in Verity “About”.

Acknowledgements & Licenses

Full Copyright information for each of these contributors can be found in the Verity_ClickthroughLicenseAgreement.pdf.

- Inno Setup by Jordan Russell
- VTK (Visualization Toolkit) by Ken Martin, Will Schroeder, and Bill Lorensen
- Boost C++ Libraries by Boost.org
- PCL (Point Cloud Library) by pointclouds.org/.
- FLANN (Fast Library for Approximate Nearest Neighbors) by http://www.cs.ubc.ca/research/flann/.
- Eigen by http://eigen.tuxfamily.org/.
- SafeNet by http://www.safenet-inc.com/.
- RestSharp by http://restsharp.org/.

Icon Sets

- FatCow “Farm-Fresh” Web Icons
  License: Creative Commons Attribution 3.0 United States (CC By 3.0)
  http://creativecommons.org/licenses/by/3.0/us/