AUTODESK UNIVERSITY 2013

Lidar Data & Point Clouds: From Scanning to Planning & Beyond

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CI1870 This class is designed for the surveyor, engineer, or planner who is interested in finding out more about incorporating the use of LiDAR data into their project lifecycle using products from Autodesk® Infrastructure Design Suite Ultimate 2014. The class focuses on the key workflow processes for incorporating LiDAR data from data collection and review to planning and design. With the addition of Autodesk® ReCap™ software to the 2014 design suites, the ability to process and review LiDAR data has been incorporated into our project workflow. In this class, we begin by reviewing and editing a sample LiDAR dataset in Autodesk® ReCap. Next, we see how the data can be incorporated into planning stage visualization using Autodesk® InfraWorks™ software. Following InfraWorks, we see how the LiDAR data can be incorporated into Autodesk® AutoCAD® Civil 3D® software and used for creating existing ground models for the basis of design using Infrastructure Design Suite Ultimate. Finally, we'll see how laser scans can be incorporated into building design and renovations using Autodesk® Revit.

Learning Objectives

At the end of this class, you will be able to:

- Gain a better understanding of the capabilities of Autodesk® ReCap and where it can be used in the project workflow process
- Understand how LiDAR data can be processed & edited prior to importing into primary design software.
- Learn how LiDAR data can be incorporated into high level Planning stage visualizations in Autodesk® InfraWorks
- See how the imported point cloud can be used to generate existing ground models in Autodesk® AutoCAD® Civil 3D®.
- See how processed data can be imported directly into Autodesk® Revit for building design

About the Speaker

Matt is an Application Specialist in Ideate, Inc.'s Seattle office and is an ACI certified instructor. He is a licensed Civil Engineer with a B.S. in Mechanical Engineering. Prior to joining Ideate, Matt worked as a civil design engineer, using Civil 3D on a variety of projects including site development, roadway improvements and infrastructure design. With over 10-years of experience in the civil engineering industry, he uses his real-world knowledge to provide training, consulting, technical support for organizations transitioning to Civil 3D. He is Autodesk® Certified in AutoCAD®, AutoCAD® Civil 3D®, and BIM Workflow for Roads & Highways. Since 2009, Matt has been the instructor for Ideate's online Civil 3D 201: Working with LiDAR Data class, and contributes to Ideate, Inc.'s technical blogs and informational videos.

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Acknowledgements

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Introduction

Lidar data has been around for quite some time, however when trying to incorporate these large datasets into planning and design, end-users have struggled with both hardware and software solutions.

This year, the Autodesk® Design Suites provide a new application to help solve this problem. Autodesk® ReCap Studio and Autodesk® ReCap Pro, along with Autodesk® ReCap Photo introduces a new and enhanced Point Cloud processing engine with high-powered visualization tools and built-in editing capabilities. Because it includes similar capabilities to applications from scanner manufacturers, additional software purchases are no longer required.

Along with this new application, the Point Cloud processing engine has also been enhanced in other Autodesk® software, making navigation and review of Point Cloud data in our primary design environment smoother and more efficient. Incorporating Point Cloud data into the BIM workflow process is significantly easier, as is our method for reviewing and editing Point Clouds prior to using them into our models.

A basic BIM Workflow using Lidar data and products from the 2014 Autodesk Design Suites can be identified as follows:

1. Lidar data analysis and editing using Autodesk® ReCap
2. Planning & Preliminary Design and Analysis using Autodesk® InfraWorks
3. Detailed Survey & Civil Design using Autodesk® AutoCAD® Civil 3D® and/or Building Design using Autodesk® Revit®
4. *Construction Simulation & Visualization with Autodesk® Navisworks® and Autodesk® InfraWorks®

*For the purposes of this presentation, we are covering items 1-3 only.

Lidar Data: Background Information

What is Lidar?

Short for Light Detection And Ranging, Li.D.A.R. is a term used to describe the process for capturing position related data using laser or light sources. Similar to SONAR using sound waves, LiDAR uses light pulses to detect distances and measurements from a known source.

There are two general methods of measurement taken with Lidar scanners.

Time of Flight measurements are a single pulse that measure the time of flight from the scanner to the object and back.

Phase Based scanning uses constant waves of varying length projected from the source. Upon contact with an object, they are reflected back to the scanner. The distance from the scanner to the object is accurately measured by measuring the phase shifts in the waves of infrared light.

Once collected, Lidar datasets can be presented as a three dimensional group of points called a Point Cloud. Point Clouds are a large group of 3D points that spatially represent the environment around the laser scanner and can be made from single or multiple Lidar scans. When multiple files are combined, they can be registered to align common points between scanned files. In many cases, targets are often set up around the object of interest and used as common points for registration. Some scanners also allow known points from survey data to be created and added to the dataset for registration and linking to geographical coordinate systems.

The density of a Point Cloud refers to the distance between collected points. Distance from the source to the scanned point often determines the density. Because Lidar uses light pulses as its measurement tool, a line-of-sight requirement also applies. Any objects that are blocked or outside the line of sight will not be measured by a scan. Scanning of the same object from multiple angles provides a solution for areas that are outside the line-of-sight from a single scan location.

Data Collection Methods

Airborne Laser Scanning refers to a data collection method where a scanner is attached to an airplane or helicopter that flies over an area of interest. The airplane makes multiple passes for the scanner to sweep the area. This method is commonly used for large or inaccessible areas, exteriors, and corridors. Aerial scanning is one of the original methods of data collection, however it is not the most accurate (generally ±10 cm depending on conditions).

Vehicular Mounted Scanning has increased in popularity over the past few years as advancements in technology have made scanners smaller and more portable. In this method, a scanner is attached to a vehicle that is driven through an area of interest. This method is commonly used for roadway corridor and tunnel mapping and can be done at highway speeds with high accuracy depending on conditions and equipment.

Ground Based Scanning provides the highest level of accuracy and control over scanned data. Portable scanners are mounted to tripods that maintain a stationary position while the scanner rotates and scans the area around it. Because the scanner remains at a fixed position, survey grade accuracy can be obtained using ground mounted scanners. This method is highly efficient, safer than traditional surveying methods and provides a high level of detail within its datasets. Due to the high level of detail, building interiors, exteriors, and survey grade ground models are common areas of application for this method.

Pre-2014 Autodesk® Software & Lidar Data

Prior to the 2014 product line, Autodesk® software was able to import Lidar datasets, but users did not have a tool to easily manipulate and edit these large amounts of data. The size of source files as well as the size of the models generated from them often led to lots of crashing and frustration.

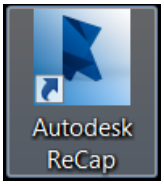
For those who owned a scanner, the scan manufacturer often provided additional applications for reviewing and editing point clouds prior to exporting a finalized dataset. This was a luxury that most did not have, which led to higher costs paid to a vendor to edit the dataset before hand or to purchase software from the scan manufacturer separately.

Avoiding those options required knowledge of database applications like Microsoft® Access® that can apply point filtering queries and the utilization of Autodesk® AutoCAD® Civil 3D® surface editing tools like the Simplify Surface Command and Data Clip Boundaries. Although they did provide a more manageable dataset, these methods are mostly data driven, dealing with raw data and numbers rather than visual areas of interest. This made it very difficult to control exactly what was being preserved or removed from a dataset.

From Scan to Plan using Autodesk® ReCap Products

Autodesk ReCap® Studio & Autodesk ReCap® Pro

The 2014 Autodesk® product line includes new standalone applications for working with Lidar datasets. Autodesk® ReCap Studio was released with the initial product rollout and Autodesk® ReCap Pro is now available for Autodesk® Design Suite Subscription owners.



Short for "Reality Capture," Autodesk® ReCap is a front-end application for processing, reviewing and editing scanned data. It provides similar tools to those typically provided by scanner manufactures like Trimble® and Leica®. Along with review and editing capabilities, the overall processing and rendering engine has been updated in 2014, leading to smoother manipulation, higher quality visualization and navigation capabilities.

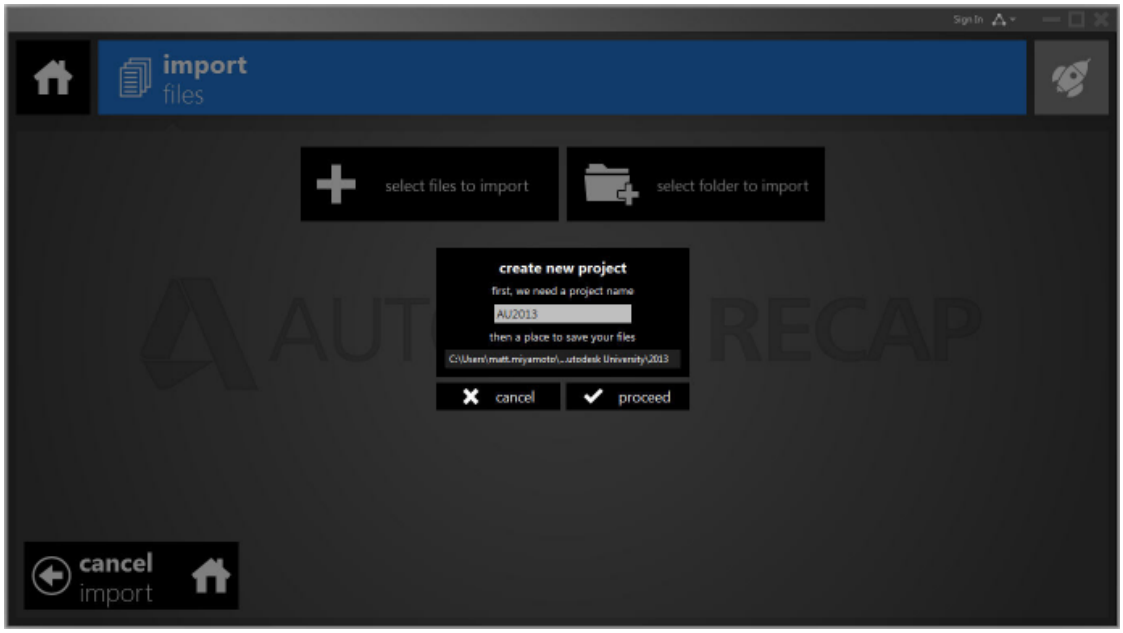
Creating a Project with Autodesk® ReCap

The first step in creating a project is collecting data. Autodesk® ReCap is compatible with a wide range of file types, including those from scanner manufactures and past Autodesk® software. The application itself works with two primary file types. A ReCap project is tagged with a .RCP file extension, and individual scan files are tagged with .RCS file extensions. ReCap projects are created and populated with one or more .RCS files containing scanned data. Original source files imported from native file formats are processed and converted into .RCS files for use within the application. The original files are maintained, and a new copy of the file with a .RCS extension is generated during import.

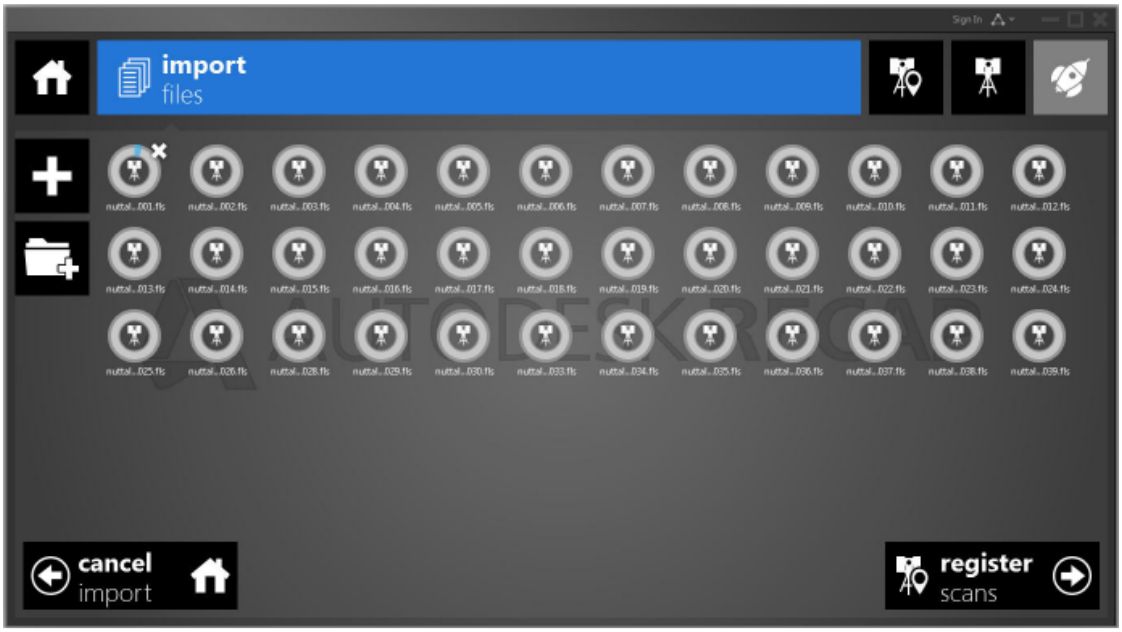
During the import process, multiple source files can be selected, and with Autodesk® ReCap Pro, files that are not pre-registered by the provider can also be registered during creation of the ReCap project. Known common points must be identified in each scan file, and those points are aligned when the project is displayed in the application. Files that are pre-registered do not require any additional steps, and can be imported directly by simply selecting all files of interest.

Typical steps for creating a new project and importing scan files are outlined below.

1. After obtaining scan data, launch the application and create a New Project.

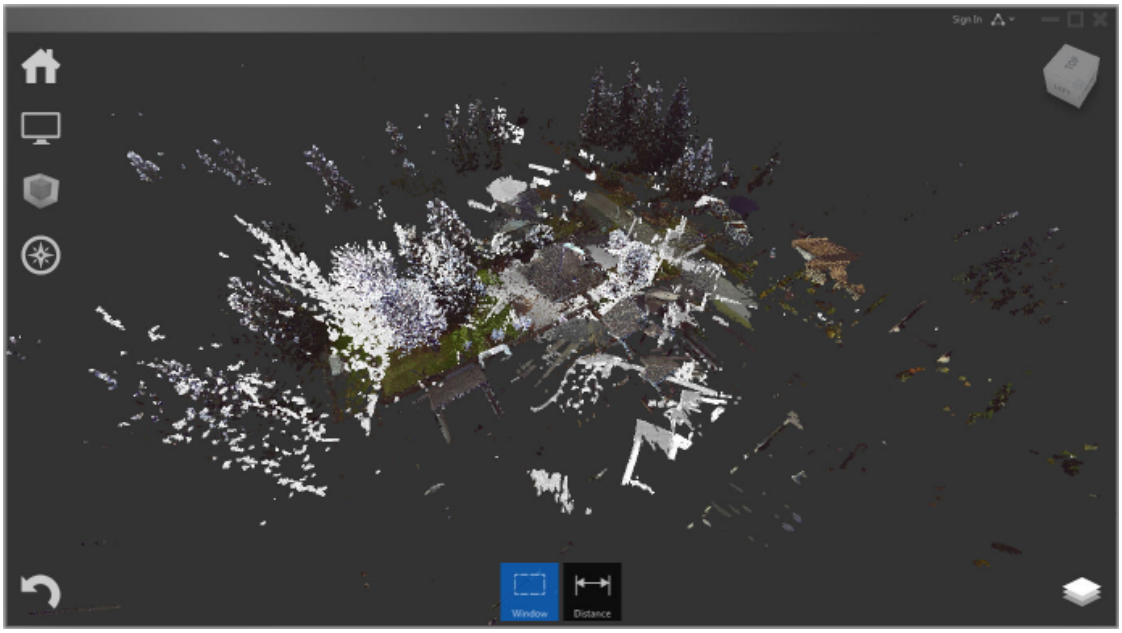


2. Name the new project and specify a location for saving.



3. Select the source files or folder containing compatible files for import. If source files are not pre-registered, the option to register scans is available here.

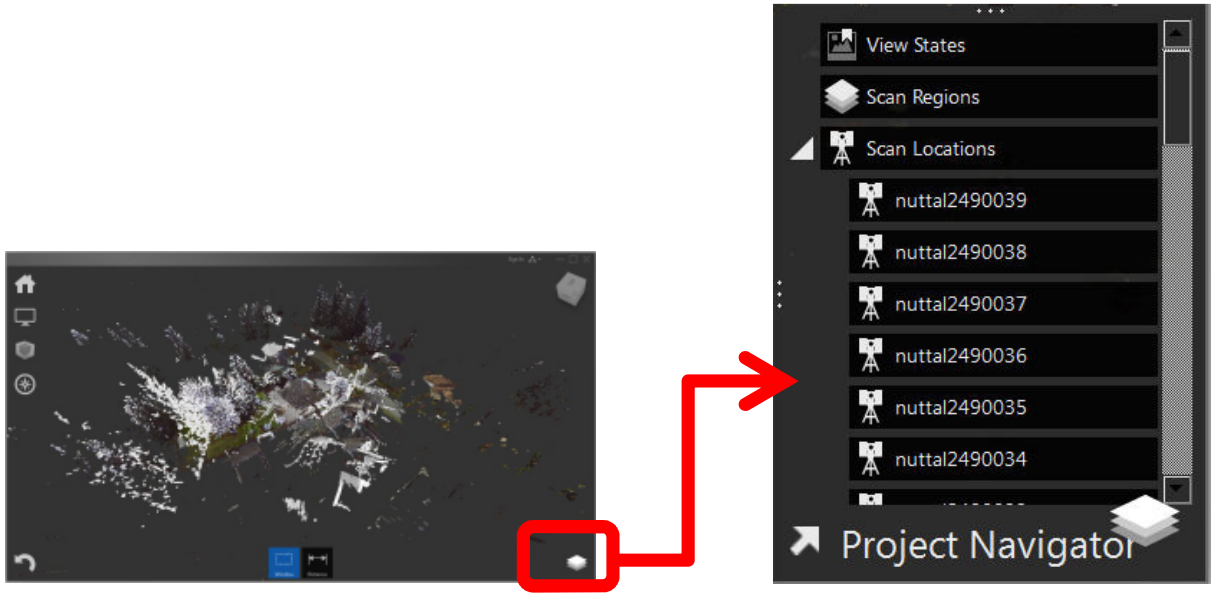
*Sample files provided by Andrew Torgerson of Surface & Edge 3D Laser Scanning



4. Once files are processed, the option to Launch Project appears. Projects can be launched after processing is complete on at least one source file.

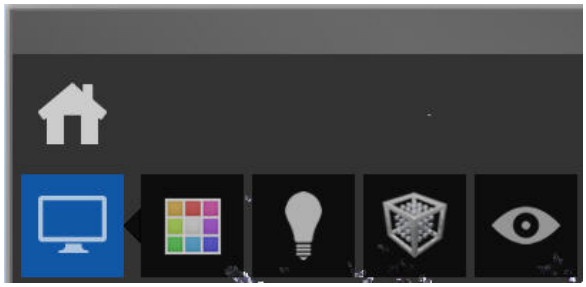
Point Cloud Visualization

After a project is launched, Autodesk® ReCap provides tools for Visualization, Navigation, Annotation, Measurement and Editing.



The **Project Navigator** is located at the bottom right portion of the screen. This tool allows users to control the display point cloud data from each imported scan file. Users can also create saved View States and designate Scan Regions here.

Limit Box



Display Settings

The upper left of the application window includes a **Limit Box** tool for specifying project limits and **Display Settings** for controlling the visual representation of the Point Cloud. Most notably within these tools, the Display Settings has options for adjusting the Point Size (very useful when selecting points for editing) and pre-defined color based settings like RGB, Elevation, Intensity, Normal, and Scan Location.

Point Cloud Review

Besides visualization tools, Autodesk® ReCap also includes useful navigation and review tools for exploring your point cloud. Icons are available on left side of the screen below the Limit Box and can be activated by left-clicking on them with the mouse. These tools can also be activated through keyboard and mouse shortcut combinations.

Navigation Toolbar

Window: **Left-click & drag**
Pan: **Hold down mouse wheel** and move the mouse
Orbit: **Hold down the Right-click** button and move the mouse
Look: **CTRL + Right-click** button and move the mouse
Fly: **SHIFT + Right-click** button and move the mouse (roll the wheel up or down to increase or decrease flying speed)

*Shortcuts can also be accessed by hovering over the navigation tool icon in the toolbar.

Point Cloud Annotation & Editing

The bottom-center of the application window displays editing and annotating tools. The two available icons are **Window** and **Distance**. When these icons are hovered over, they expand to display more measurement and windowing options.

The Distance tool provides Linear dimensions, Angular dimensions, and Note bubbles for adding custom annotations.

The Window icon includes standard Window based selection (click and drag) as well as a Fence option (polygon selection method) and a feature for identifying flat planes within the model.

After a portion of the model has been selected using windowing options, additional editing tools appear.

Editing Toolbar (appears after a selection set is created)

Region: **Creates a new Scan Region from selected points**
Clip Outside: **Removes points outside the selection set**
Delete: **Removes the selected points**
Clear: **Clears the selection set (deselect)**

Maneuvering around the Point Cloud using Navigation Tools and creating selection sets through Window or Fence selections provides users with the added ability to apply visual edits to point cloud data. Unlike past methods that incorporated database queries or background simplification processes, we are now able to see what portions of the point cloud we are modifying.

Exporting Modified Datasets

After edits are complete, a modified ReCap project is visible on screen. Although the project itself has been edited through the removal of points, the background project data remains the same. Saving the ReCap project, and importing the .RCP file into another application will still display the full dataset.

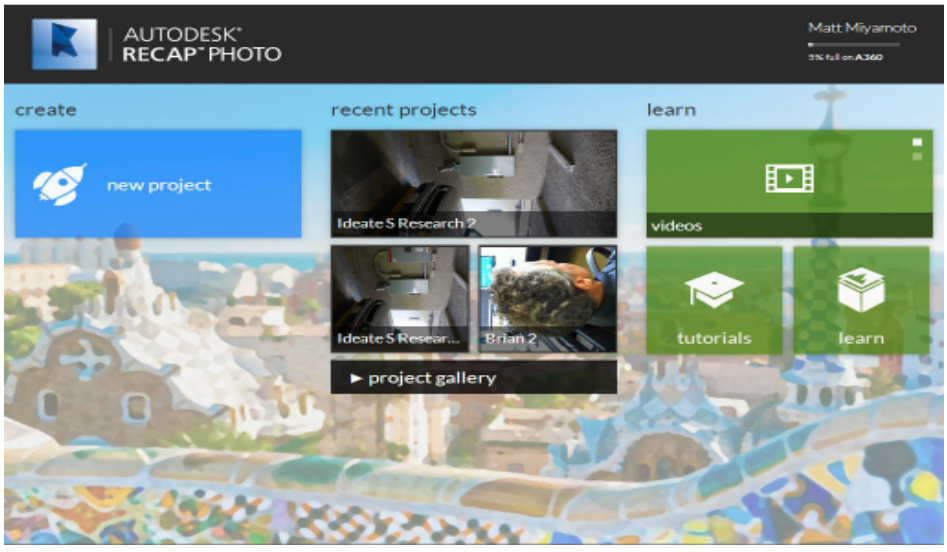
To generate a reduced dataset compatible with our primary design software, the edited project should be exported to a new file. The Home icon in the upper left includes a command to export a single .RCS file of the modified project. The 2014 Autodesk® product line supports .RCS and .RCP file formats, so once the new .RCS file is created, it can be imported directly into products like Autodesk® InfraWorks, Autodesk® AutoCAD® Civil 3D®, and Autodesk® Revit® for incorporation into our BIM Workflow.

Autodesk ReCap® Photo

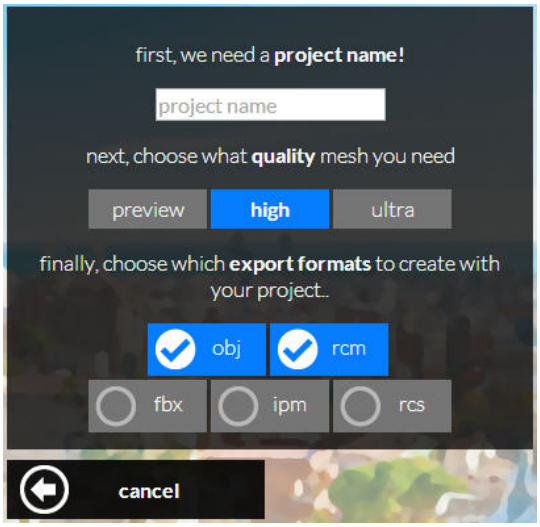
For those of us out there who do not have easy access to Lidar data or scanners, Autodesk® has also provided a cloud-based service called Autodesk® ReCap Photo.

Available online through **recap.autodesk.com**, this service produces point clouds by stitching together multiple digital photographs of an object. The entire process is handled via the cloud, freeing up workstation processing and allowing users to continue working without interruption.

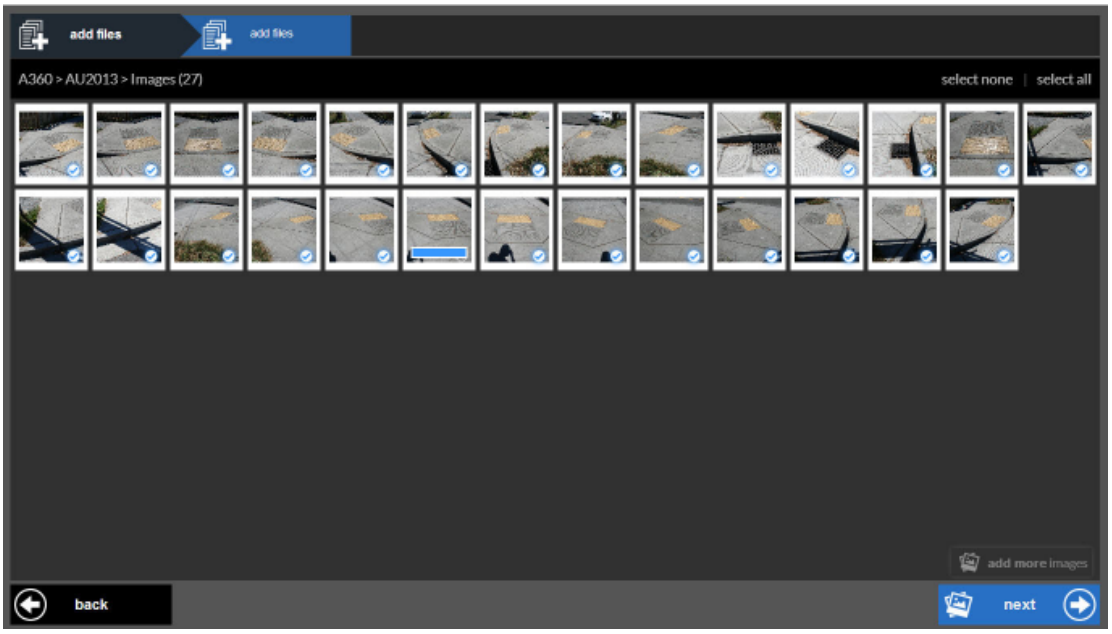
In order to use ReCap Photo, you must have an existing, or create a new Autodesk® 360 account for login to the site.



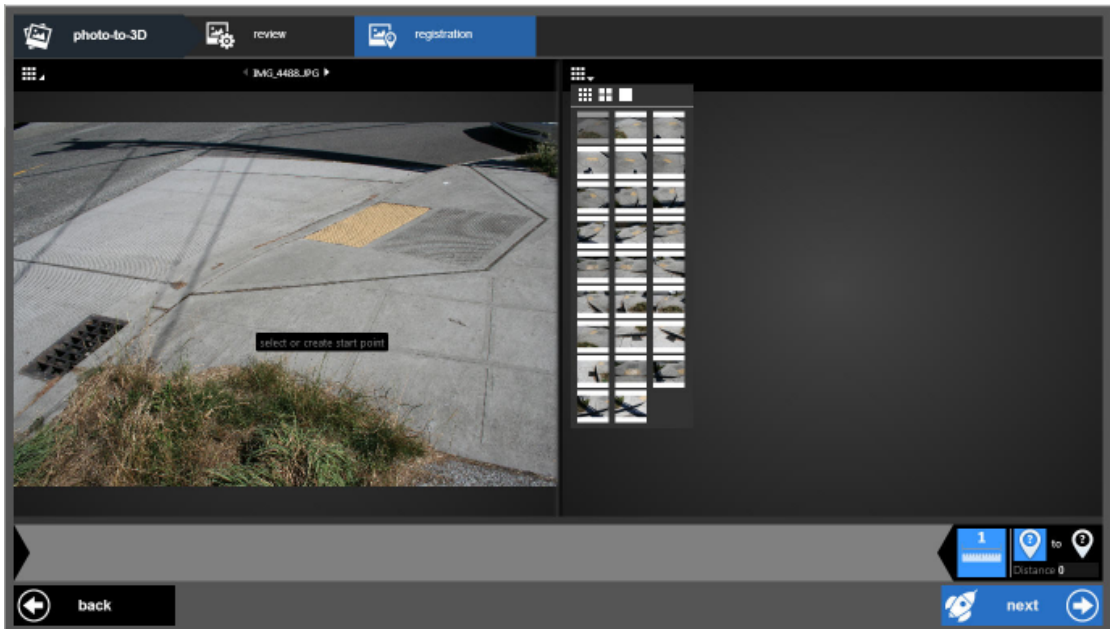
Once logged in, a new project can be created and photos uploaded to the project.



The first step in creating a new project is providing a Name, and specifying the desired output file formats. Only the High or Ultra quality options provide an output file for use with other applications (.RCS, .OBJ, .RCM, .FBX, and .IPM).



After creating the new project and specifying the output file format, digital photos must be provided. They can be dragged & dropped into the dialog or selected individually.



With photos uploaded, users can review the images that will be used for generating the output file, and access Advanced Tools for registration options within the digital photos. Points can be created manually within the photo and distance references can also be included for measurements. Field measurements should always be taken for model verification and/or scaling within the application as needed after the output file is generated.

Once complete, the project is submitted and users are notified via email when the output file is ready for download. If a .RCS file was selected as the output format, it can be opened directly through Autodesk® ReCap Studio or Pro. Output files can also be viewed online through a web browser for those who do not own additional software.

The processing is done with pixel recognition to stitch 2D photographs into a 3D point cloud, so quality of photos is very important. It is recommended that photos are taken in well-lit areas with a high quality camera. Although there is no exact number for the amount of photos, pictures should be taken at 5 to 10 degree increments around the subject to provide the best overlap in pixels for use in the stitching process. Environmental variables as well as the object of interest all play a factor in determining the amount of photos required for an accurate model.

For the curb ramp example above, 26 photos from a 10-megapixel DSLR camera were used. Photos were taken mid-day with direct sunlight, resulting in a very nice model.

Planning & Preliminary Design with Autodesk® InfraWorks

Planning and Preliminary Design has been taken to a new level with the release of Autodesk® InfraWorks. Formerly known as Autodesk® Infrastructure Modeler®, this application has been enhanced and re-branded in 2014. Along with the other products identified in our BIM Workflow, Autodesk® InfraWorks also supports ReCap .RCS and .RCP files.

Two main features come to mind when relating Lidar and Point Cloud data with Autodesk® InfraWorks models; existing structures, and terrain models. Once these existing features are created in the model, Autodesk® InfraWorks provides a variety of tools for visualizing, communicating and presenting design information at this stage of the design process.

Existing Structures from Lidar Data in Autodesk® InfraWorks

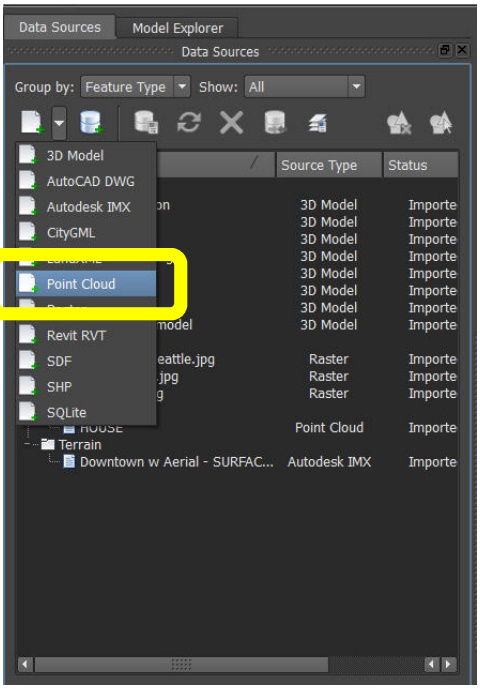
In the case of existing structures, a direct import of Lidar data is an excellent choice. Scanning and importing a feature using Lidar data is an efficient way to show objects within the context of the model without having to redraw or create them from scratch. Scan data can also be pre-processed and edited using Autodesk® ReCap, providing a leaner data source for import.

The imported scan is listed as a Point Cloud object in Autodesk® InfraWorks and displays as a 3D entity that can be placed interactively in the virtual model. Color and detail of the existing structures are based on the information provided by the scan.

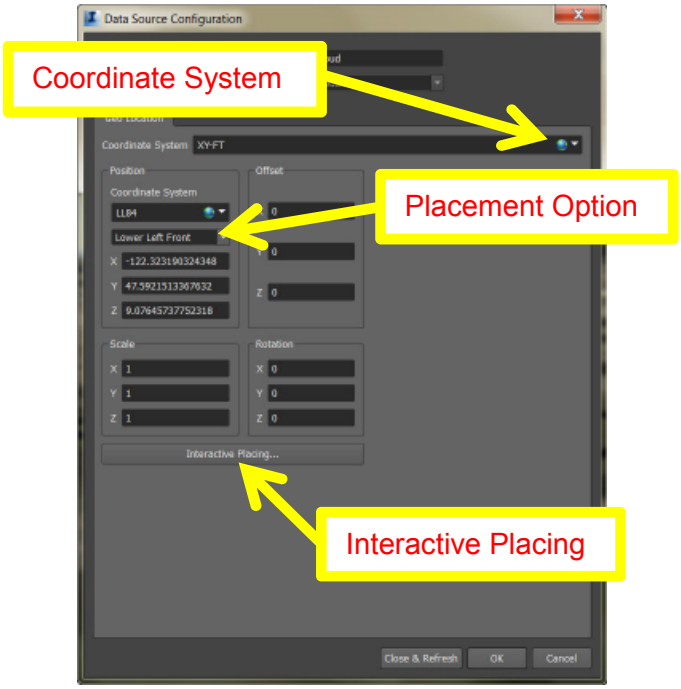
Connecting to Point Clouds as a Data Source in Autodesk® InfraWorks

1. Create a new or launch an existing model in Autodesk® InfraWorks
2. Open the Data Sources panel
3. Use the Data Source drop down list to select Point Cloud
4. Navigate to your .RCS file (exported from ReCap) or other Point Cloud file
5. In the Data Source Configuration window, select the Coordinate System (i.e. XY-FT)
6. In the Position Section, select the placement option (Lower Left Front tends to work well)
7. Click Interactive Placing
8. Double-click the location in the model where you wish to place the Point Cloud
9. Click Close & Refresh to update the model and exit the Data Source Configuration window

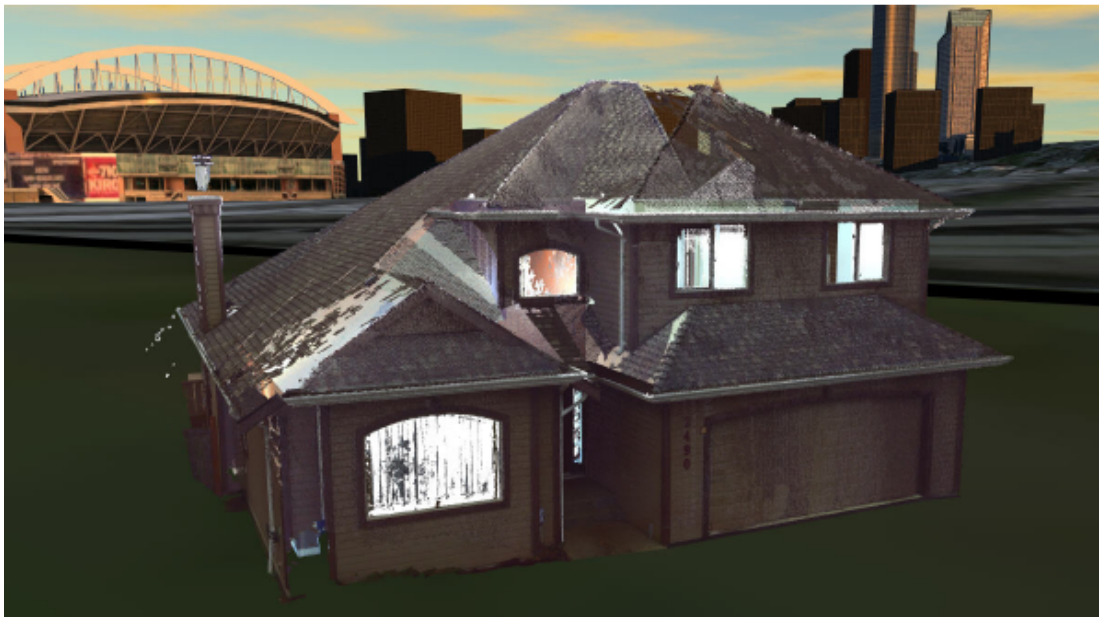
*Manipulating the point cloud once it is placed in the model is limited. Adjustments to scale/rotation/placement are more easily accomplished by going back to the Configuration window.



Data Source Panel



Data Source Configuration



Point Cloud imported from .RCS file displayed in Autodesk® InfraWorks
Scan data provided by Andrew Torgerson of Surface & Edge 3D Laser Scanning

Terrain Models from Lidar Data in Autodesk® InfraWorks

For terrain models, processing lidar data in Autodesk® AutoCAD® Civil 3D® and generating a Surface Object, then exporting to .IMX for import into Autodesk® InfraWorks is recommended. Although there are added steps involved, this recommendation is due to the added features available for Terrain objects in Autodesk® InfraWorks when compared to features of Point Clouds that are imported directly.

After creating the surface object in Autodesk® AutoCAD® Civil 3D®, use the Export IMX option located in the Ribbon → Output tab → Export panel. Everything is done automatically, so no additional options or dialog boxes are involved. The resulting .IMX file appears in the same folder location as the drawing file it was created from. These .IMX files have been created for data transfer between Autodesk® AutoCAD® Civil 3D® and Autodesk® InfraWorks and can be imported directly through the Data Sources panel.

Generating the surface in Autodesk® AutoCAD® Civil 3D® first provides many benefits. Most importantly, it allows users to combine multiple lidar data sources into one surface object prior to exporting and add boundary information to "crop" the area of interest to a more specific portion of the dataset.

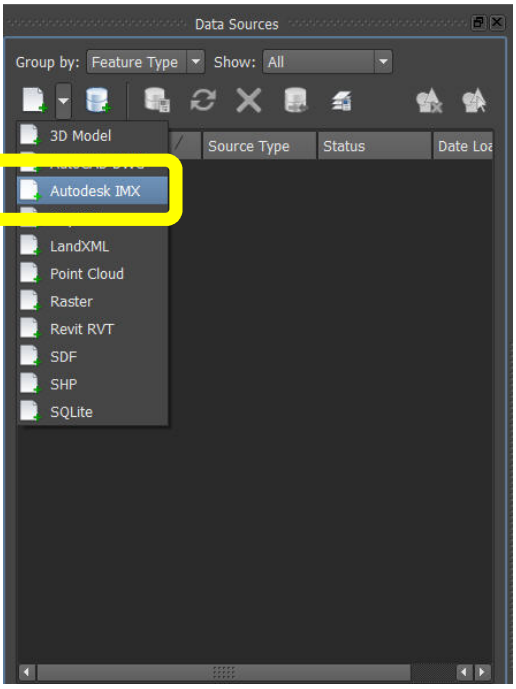
Once imported, the surface created from lidar data in Autodesk® AutoCAD® Civil 3D® appears as a Terrain object in Autodesk® InfraWorks. This allows users to apply Terrain specific features to the data such as Ground Imagery, Visual Effects and Terrain Themes; all of which would not be applicable if imported directly as a Point Cloud. The terrain model can also be used as the existing ground source for placement of buildings, design of proposed roads, landscaping, and other items available through the Autodesk® InfraWorks Create/Edit Features toolbar.

Importing a Autodesk® AutoCAD® Civil 3D® .IMX file in Autodesk® InfraWorks

1. Create a new or launch an existing model in Autodesk® InfraWorks
2. Open the Data Sources panel
3. Use the Data Source drop down list to select Autodesk IMX
4. Navigate to your exported .IMX file from Autodesk® AutoCAD® Civil 3D® and Click Open
5. Double-click or right-click the IMX file in the Data Sources and select Configure
6. In the IMX tab of the Data Source Configuration window, select the objects you wish to display by checking or un-checking the corresponding boxes

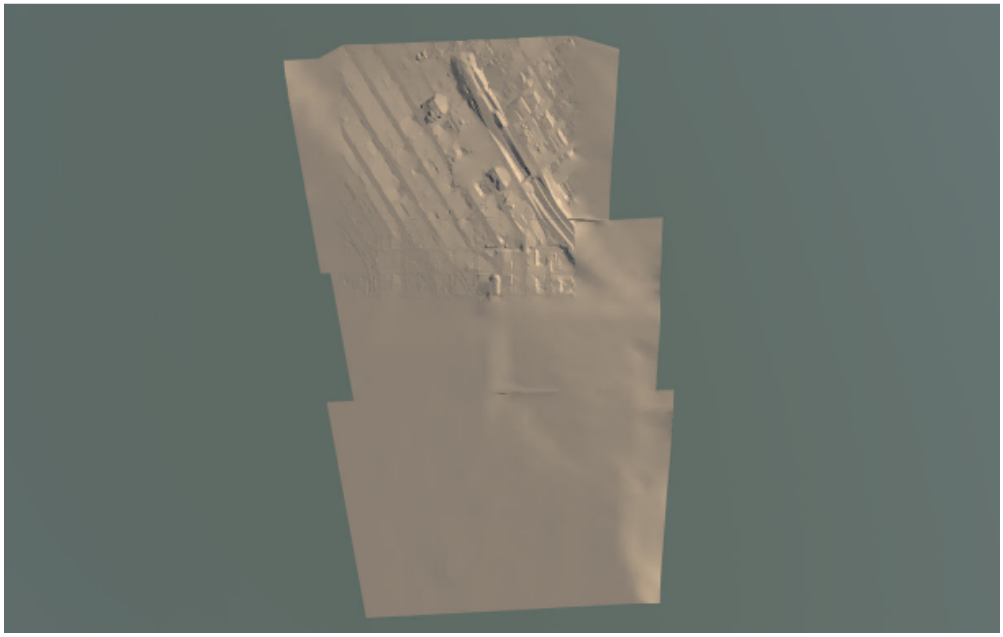
*multiple objects will be listed if the Autodesk® AutoCAD® Civil 3D® drawing contained more than one compatible object when the Export .IMX command was launched

7. Click Close & Refresh to update the model and exit the Data Source Configuration window



Autodesk IMX Data Source

IMX Tab in Data Source Configuration



Terrain Object created from Autodesk .IMX displayed in Autodesk® InfraWorks
Terrain data provided by the Puget Sound Lidar Consortium

Working with Point Clouds in Autodesk® AutoCAD® Civil 3D®

Following the Preliminary Planning & Design stage in Autodesk® InfraWorks, a more detailed design and analysis can be done using Autodesk® AutoCAD® Civil 3D®. This application provides advanced analysis and plan production tools for the next phase in our BIM Workflow.

For any proposed elements created in the model, Autodesk® InfraWorks has an option to Export .IMX files, which can then be imported into Autodesk® AutoCAD® Civil 3D® for continuation of the design. Compatible proposed features created in Autodesk® InfraWorks are included in the exported IMX, and are recreated when imported into the next application.

Importing Autodesk® ReCap Point Clouds in Autodesk® AutoCAD® Civil 3D®

Although Autodesk® AutoCAD® Civil 3D® has supported Point Clouds for the past few releases, the introduction of Autodesk® ReCap .RCS files calls for some additional attention. In this case, point clouds are pre-processed and edited prior to import, therefore the Autodesk® AutoCAD® Civil 3D® _AeccCreatePointCloud command cannot be used with .RCS and .RCP files.

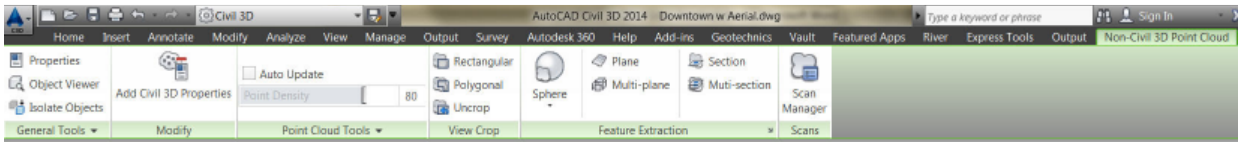
In the 2014 release, the standard AutoCAD® command: **POINTCLOUD** is used to attach the .RCS or .RCP file to the Autodesk® AutoCAD® Civil 3D® drawing. The object appears as a standard AutoCAD® Point Cloud that can be converted into a Autodesk® AutoCAD® Civil 3D® Point Cloud object. After conversion, Autodesk® AutoCAD® Civil 3D® Point Cloud commands can be applied for assigning styles, controlling display, and generating Surface objects.

Create a Point Cloud from .RCS Using the POINTCLOUD Command

1. Create a new or open an existing drawing
2. At the Command Line, type POINTCLOUD and press ENTER
3. Select the ATTACH option
4. Navigate to your Point Cloud .RCS or .RCP file exported from Autodesk® ReCap
5. Specify Scale, Insertion Point and Rotation Information in the Attach Point Cloud dialog and click OK

The Point Cloud object appears in the drawing and includes a frame. Selecting the frame in the drawing file selects the entire object and displays the contextual Ribbon tab for an object classified as a **Non-Civil 3D Point Cloud.**

Non-Civil 3D Point Cloud from Imported .RCS File
Data Source provided by SFC Palma, A Troop 1/82 Cavalry, Oregon Army National Guard



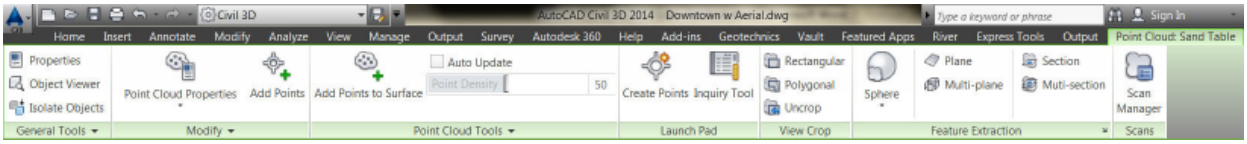
Non-Civil 3D Point Cloud Contextual Ribbon

Prior to adding Autodesk® AutoCAD® Civil 3D® properties to the Point Cloud, standard tools for density control, cropping, 3D object feature extraction, and managing scan files are available. The **Add Civil 3D Properties** command from the contextual tab shown above is used to convert the standard Point Cloud to an intelligent Autodesk® AutoCAD® Civil 3D® Point Cloud object.

Convert a Non-Civil 3D Point Cloud to a Point Cloud Object in the Drawing

1. Select the Non-Civil 3D Point Cloud to access the Contextual Ribbon
2. In the Modify panel, Click Add Civil 3D Properties
3. Click Yes to confirm

Converted Point Cloud using the Add Civil 3D Properties Command



Updated Point Cloud Contextual Ribbon with Modified Commands and Additional Point Cloud Tools Panel

After conversion, the updated Point Cloud has the same properties as an Autodesk® AutoCAD® Civil 3D® Point Cloud object created using the **_AeccCreatePointCloud** command, and points can be used to generate a Surface object in the drawing.

*Autodesk® ReCap .RCS and .RCP files are pre-processed, and not available as source file formats for the _AeccCreatePointCloud command, similar to AutoCAD® .PCG and .ISD files.

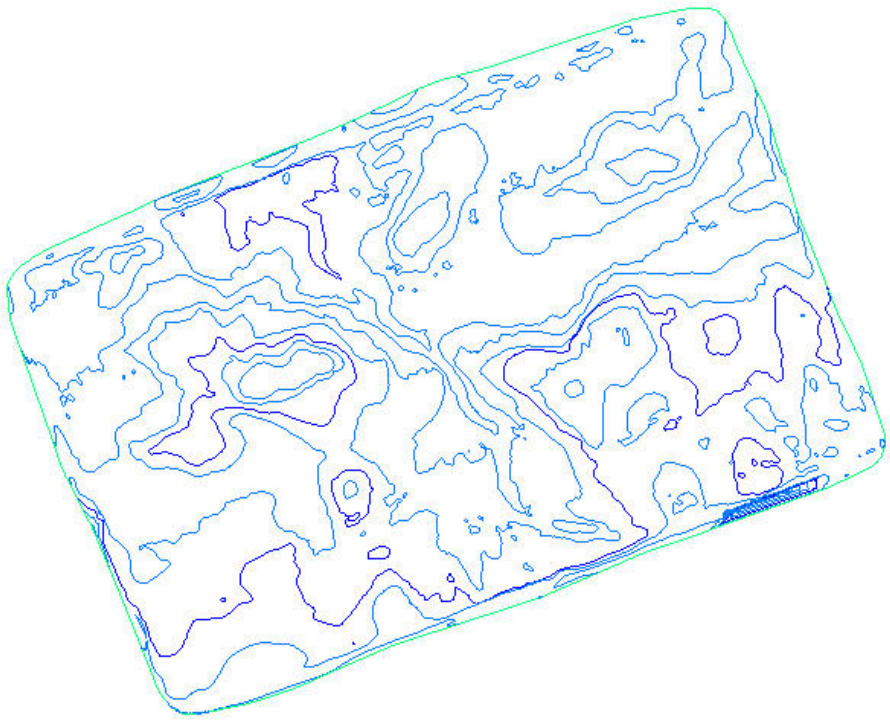
Creating AutoCAD® Civil 3D® Surfaces from Point Clouds

1. Select the Civil 3D Point Cloud to access the Contextual Ribbon
2. In the Point Cloud Tools panel, set the desired Density value (typing in the value works best)
3. In the Point Cloud Tools panel, click Add Points to Surface
4. In the Surface Options page of the Add Points to Surface dialog, specify the Name & Style for the new Surface, or the Existing Surface to add points to.
5. In the Region Options of the Add Points to Surface dialog, specify the region for points added by Point Cloud Extents, Window selection, Window Polygon selection, or Object (existing object in the drawing)
6. Click Finish

After creating the Surface, set the Point Cloud to a "No Display" Style to hide it in the drawing.

Setting the Point Cloud to a No Display Style

1. Select the Civil 3D Point Cloud to access the Contextual Ribbon
2. In the Modify panel, click Point Cloud Properties
3. On the Information tab, select a "No Display" style (a default style named _NoDisplay is included in the application)
4. Click OK to exit



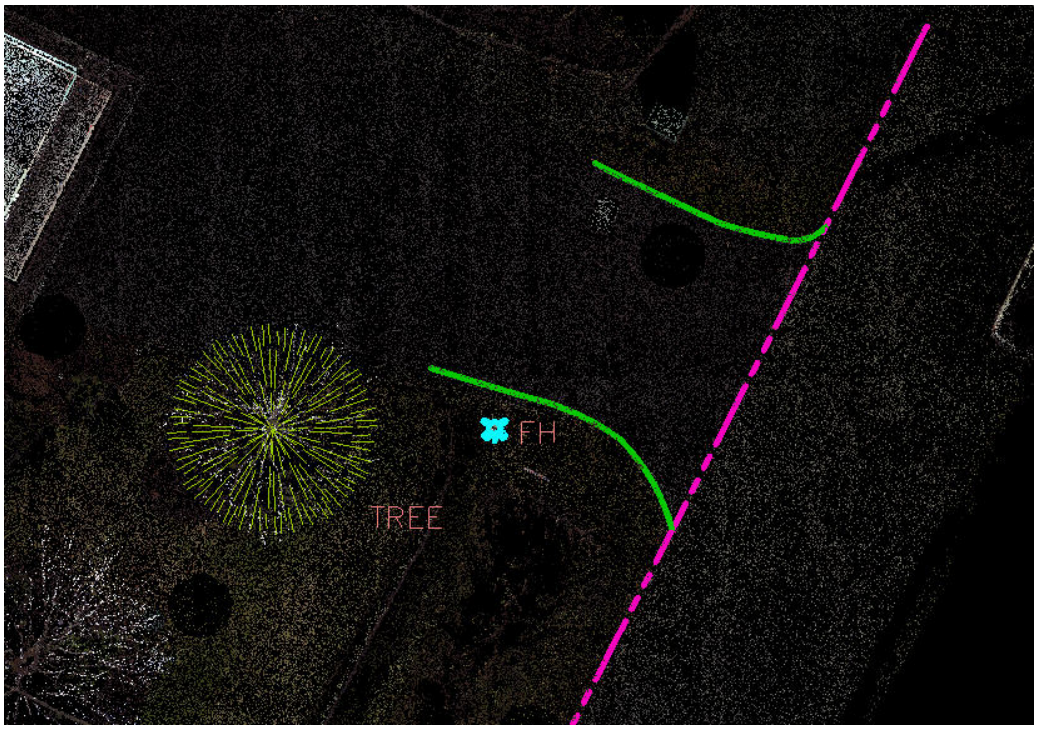
Autodesk® AutoCAD® Civil 3D® Surface Object generated from Point Cloud

Virtual Surveying Using Point Cloud Data

After importing the Point Cloud into Autodesk® AutoCAD® Civil 3D®, the point nodes can be used as references for drafting and design. One application of this capability is virtual surveying through creation of Autodesk® AutoCAD® Civil 3D® Point Objects and/or Feature Line Objects based on visual inspection of the features shown in the point cloud.

In this case, the method of data collection and prior review and processing of the dataset is extremely important. Scaling and point density must be managed appropriately in order to provide detail and accuracy when drafting Feature Lines and creating Points. The NODE object snap should also be applied to ensure that the drafted features reference actual points collected by the scan for their location and elevations. Descriptions must be applied manually during the drafting process.

Although this is still a manual process, it involves less time out in the field, and also decreases the safety risks involved in collecting survey data. Rather than setting up traffic control or dodging vehicles, surveyors can set up a stationary ground mounted scanner to survey the area for them. When the scan is complete, Points and Features can be added manually back in the office. For ideal results, a combination of conventional field survey and lidar scanning is recommended. Conventional survey methods still need to be applied for note taking and field descriptions of observed objects, while lidar scans can be used to supplement the detailed observations where applicable.



Edge of Travel way and Driveway Feature Lines with Existing FH and Tree Points Created by using Point Cloud Point Nodes as drafting reference

Working with Point Clouds in Autodesk® Revit®

Along with Planners, Surveyors, Site Designers and Road Designers, Architects can also take advantage of Lidar data and Point Clouds for their stage in the design process. The ability to import scans of existing buildings provides a detailed dataset for as-built conditions of a structure or area of interest. In the past, laser scanners were found mounted to airplanes, but we now have smaller, more portable laser scanners have helped introduce this technology to the building and construction industry. These new scanners provide high levels of detail for both interior and exterior spaces.

Importing Autodesk® ReCap Point Clouds in Autodesk® Revit®

Point Cloud support has been enhanced in the 2014 version of Autodesk® Revit® to include Autodesk ReCap .RCS and .RCP files. We can use this to import scans of an existing building, then reference the Point Cloud to set Elevations, and use points within the scan for modeling. This method is very effective for showing existing features in context with proposed design elements from Autodesk® Revit®.

Importing a .RCS File into the Autodesk® Revit® Model

1. Launch an Existing or Create a New Revit Project
2. On the Insert tab of the Ribbon, Click Point Cloud
3. Select the .RCS or .RCP file exported from Autodesk® ReCap
4. Click OPEN

Once loaded, the Point Cloud appears in the Revit model as a single entity. For best results when navigating and drafting, un-check the Select Links option from the Select panel in the Ribbon.

*This should be done after verification of Point Cloud placement within the model.

Recommended: Un-Check Select Links Option in the Revit Model

1. In the Select panel of the Ribbon (available on multiple tabs)
2. Click the Select panel title to expand
3. Un-check Select Links

If this option is left checked, hovering over the Point Cloud will automatically highlight the entire object purple, making it very difficult to use as a reference in the model. Un-checking Select Links also helps to prevent the Point Cloud from being moved inadvertently while drafting.

Point Cloud of a House Imported into Autodesk Revit via .RCS File
Dataset provided by Andrew Torgerson of Surface & Edge 3D Laser Scanning

To finish establishing existing conditions, set Elevations using the Point Cloud as a reference.

Setting Elevations Using the Point Cloud as Reference

1. Switch to an Elevation View
2. Use the Point Cloud components to determine the proper elevations for each Level

*For best accuracy, actual level heights should be field verified. In this example, Level 1 was set at 0'-0" elevation, and the wall height was measured at 9'-0" and set as the height of Level 2.

Elevations set in Autodesk® Revit® Using Point Cloud as Reference

Creating Existing Components with Point Clouds as Reference

Once the Point Cloud has been imported and Elevations set, designers can move on to recreating the necessary model components. In this case, we are considering an extension to the model, so only a floor, and a wall in the location of the extension are required, however additional features can be created as needed. Any features left unaddressed will still be visible since they are already represented by the Point Cloud, but will not be fully interactive with other model entities.

Import the proper Autodesk® Revit® Families, and select model components based on the existing structure, or planned improvements. Standard modeling tools can be applied here to recreate existing features based on their locations in the Point Cloud.

Point Cloud Overlaid with Revit Model Components

Adding Proposed Features to the Autodesk® Revit Model

With existing conditions and features set in the model, designers can move on to adding the proposed improvements. Again, standard Autodesk® Revit modeling tools apply, however we now have model entities constructed off of existing features that we can add them to.

An extension to the existing structure will be added, including a larger floor, added walls, windows, doors and a roof with skylight. A new sliding door will also be added for outdoor access from the extension.

Proposed Extension to Existing Structure from Autodesk® Revit® Model

Lidar and Point Clouds: From Scanning to Planning & Beyond

In the ever-evolving world of BIM, Autodesk continues to lead the way, providing new applications and enhancing the existing capabilities of their products. In the 2014 Design Suites, we saw the addition of Autodesk® ReCap, and an enhanced and re-branded Autodesk® InfraWorks application. In addition, point cloud processing and support has been revamped in all products for a smoother and easier incorporation of scanned data.

Back in 2009, when I did my first presentation on Lidar data here at Autodesk® University, it was a “new” process that not many people considered using because there wasn’t an efficient way to handle the large datasets.

In a short four years, we have new mobile scanners and ground based scanners that provide data at high accuracy and high speed. We also have the ability to not only review even larger point clouds, but process, edit and incorporate them into our designs.

Autodesk’s release of the ReCap Photo online service may be a hint at things to come. If we’re already at the point where we can take still photos and stitch them together to create a 3D model, why wouldn’t we be able to create a model from a recorded video? Aren’t they after all just a series of still shots strung together?

For now we’ll just have to wait and see what’s in store for the next evolution in BIM.

Acknowledgements

Thanks to all of you who attended this presentation and to those of you who may have watched the recording or read through all 28-pages of this handout.

Thank you to Autodesk® for hosting another excellent Autodesk® University and for inviting me here to present again.

Thanks to Ideate, Inc. for providing the necessary tools and opportunities for learning about these new products.

Thanks to Andrew Torgerson of Surface & Edge 3D Laser Scanning, SFC Palma, A Troop 1/82 Cavalry, Oregon Army National Guard, and the Puget Sound Lidar Consortium for providing the datasets used in this handout and in the presentation.

Thanks to my family for all the support throughout my career.

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