AUTODESK **UNIVERSITY** 2015

CS10127-L

Scan to BIM to Field

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Learning Objectives

- Learn how to import point cloud scans into Navisworks
- Learn how to place points in the model using Point Layout
- Learn how to upload and share the model and points with the Field Team using BIM 360 Glue
- Learn how to layout and verify points in the field using the BIM 360 Layout iPad application connected to a robotic total station

Description

Why model as-built conditions when you can work directly with a high-resolution point cloud? In this very hands-on class we will stake out the foundations for a new addition to our Autodesk University (AU) classroom using a remarkably easy, cloud-enabled workflow. First, participants will import a point cloud of our AU classroom into Navisworks Manage software. We will then use Point Layout software to place points on a number of modeled objects that we intend to stake out as part of a small classroom renovation. The model will be shared with the field using BIM 360 Glue cloud service. Finally, we will connect the BIM 360 Layout iPad application to a robotic total station to enable field users to stake out and verify the exact position of the points. All of this will happen using a contextual model of our surroundings.

Your AU Experts

Andrew Evans *is Software Application Specialist for Topcon focused on Mass-data and Mapping Software. Mass-data encompasses anything to do with points, pictures and point clouds using products ranging from desktop photogrammetry through to mobile mapping. Survey and mapping trained he has academic and commercial experience in the rapid collection and visualisation of three-dimensional data covering projects from residential boundaries through to full city models.*

He has a PhD in Space Geodesy, is a Fellow of the Chartered Institution of Civil Engineering Surveyors and a member of the Steering Committee for the BIM Task Group partner organisation - Survey4BIM.

Michael Moran *is a consultant at Autodesk, Inc., focusing on construction. He helps customers optimize their construction processes through adoption of cloud-based BIM 360 tools, with a focus on design review, production planning, scheduling, field management, layout, and project handover to owner/operator. His master's thesis in construction management at the Delft University of Technology was a comparative study designed to assess productivity gains from using Building Information Modeling (BIM) tools on Skanska AB U.S. building projects. Together with Skanska and Autodesk, Michael*

presented a webinar on this case study. Michael has taught 3 previous Autodesk University classes and has spoken multiple times about the benefits of cloud-based BIM at the European 5D Conference. Other experiences in the building industry include founding and running a concrete specialty forming firm, working as a consultant on several major infrastructure projects, and obtaining a bachelor's degree in architecture from the University of Bath in the United Kingdom.

Class Rationale

The role of the surveyor in construction - It's applied mathematics - Surveyors today are professional geospatial trained consultants.

A WHAT YOU MAY ASK?

Let's re-phrase that and be a little more specific. It's the application of mathematics to make sure that the stuff we build today, gets built in the right place in the right orientation and to the intended design. Members of the trade also know how to quantify and validate the materials moved around and installed during a construction project.

The current trend in the industry segment revolves around mass data collection, mass data by definition implies millions of points that have coordinate information as a root element but also this data enables us to communicate existing conditions and make this highly accurate information look like a pretty picture.

That's the beauty of mass data, there's more to it than meets the eye.

FIGURE 1 - A POINT CLOUD

As one of the mass data collection tools available to us today and due to the ever improving associated software it is now possible to cost effectively employ laser scanners on a construction site not only for existing conditions, or as-built documentation, but with the right tooling and workflows it can be used to achieve a continuous update of reality also known as continuous representation of reality, continuous as-built.

With LiDAR based instruments we have a rich, informative, base data set that when combined with smart software such as Navisworks gives us the potential to report daily site progress as pretty, compelling pictures as well as numbers and spreadsheets.

Those awe inspiring point clouds offer much more than just an incredibly compelling visual communication of complex 3D structure and infrastructure.

However, there are some key considerations:

1) Repeatable, accurate, and precise control is critical to enable this concept and minimise poor reporting – ensure your applied mathematicians are compensated well for their expertise, always challenge their coordinate deviation reports and what they mean and how they define both the accuracy AND the precision.

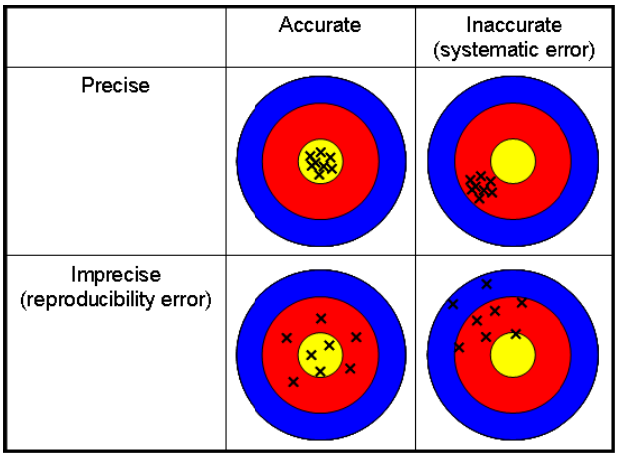


FIGURE 2 - PRECISION V ACCURACY

2) Lidar data can "mislead" point cloud analysts. An easy fix is to collect and utilize the geo-referenced images as a default to ensure correct data interpretation. However , all measurement tools have some known system uncertainty in the resulting measurement. The beauty of scanning is that you have so many points that the best fit of a wall position will typically be much more precise than the system specification leads you to think at first. For example a high quality laser scanner such as the Topcon GLS-2000 reports 3.5mm range error on the specification, but this is representative of measuring a single point many times. Actually we should be more interested in the statistics of a surface fit on the points to indicate the quality of the scan data.

To back up the statements on "misleading", the nature of the measurement mechanism of a scanner means that you can see stray points at edge interfaces, reflected points from glass and water, no points from dark surfaces and highly shiny oblique surfaces, refracted points when the laser has measured through glass. All of these points can exist in a data set and quite happily mess up your coordination of the final point cloud, and further more can be accidentally selected during point cloud analysis. I'm not suggesting your point cloud should be clear of all noise points before accepting it, however, as achieving this can add significant cost to a project, you just need to be aware of sources and likely locations of erroneous points as there are many awesome tools that can achieve great analysis on "dirty" data

without introducing a bias to the numbers. As I'm sure you will all appreciate: If you know where the error can creep in, typically it is already dealt with.

It's clear that mass data collection is going to become simpler, quicker and an even richer data source than it is already. For the construction industry there is now a relatively clear path highlighting that it is almost painless to implement scanning technology and reap the benefits in time and money on site.

This class will be run in real time, with classroom specific data collected live – the class handout is for illustrative purposes only, the data will be made available during class.

Learning objective 1: Learn how to import point cloud scans into Navisworks

Autodesk Navisworks is a powerful collaboration tool for managing multiple file types in one software environment. Construction companies use Navisworks to combine Revit models, Civil DWG, all types of 3D data and communicate design to all personnel involved in the project.

In the quest for maximizing efficiencies on the job site, and supporting the concept of "Continuous As-Built" this guide shows you how to maximize your productivity in the field utilizing Point clouds, Navisworks and Autodesk Point layout. Why model when you can work directly with a high resolution point cloud?

Step 1 – Prepare your Point Cloud by generating it as a TXT file. In this example a three scan point cloud is exported from ScanMaster as a TXT file ready for import into Navisworks.

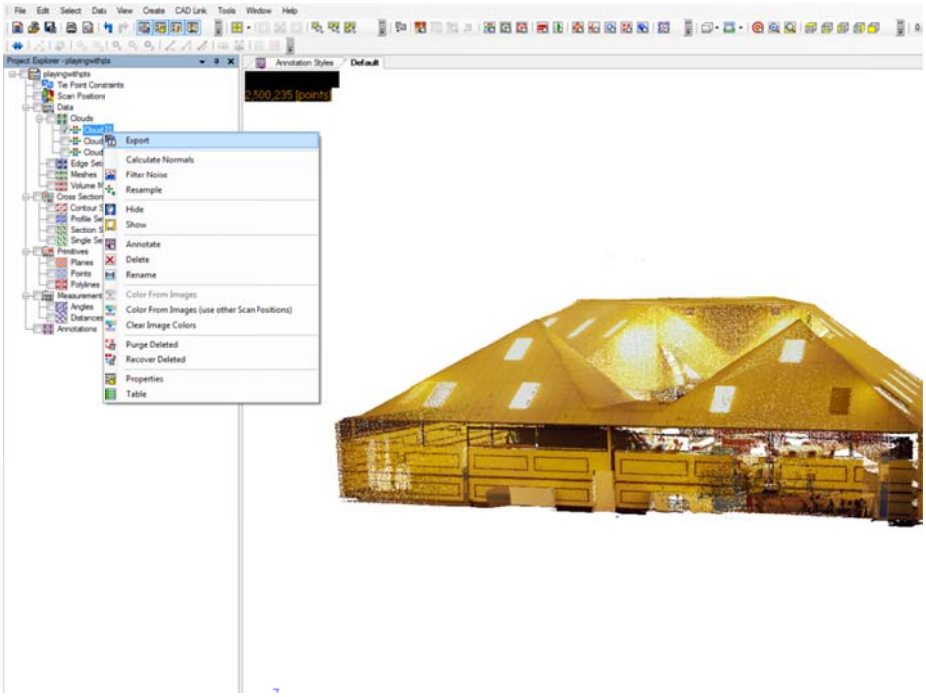


FIGURE 3 - ANOTHER POINT CLOUD

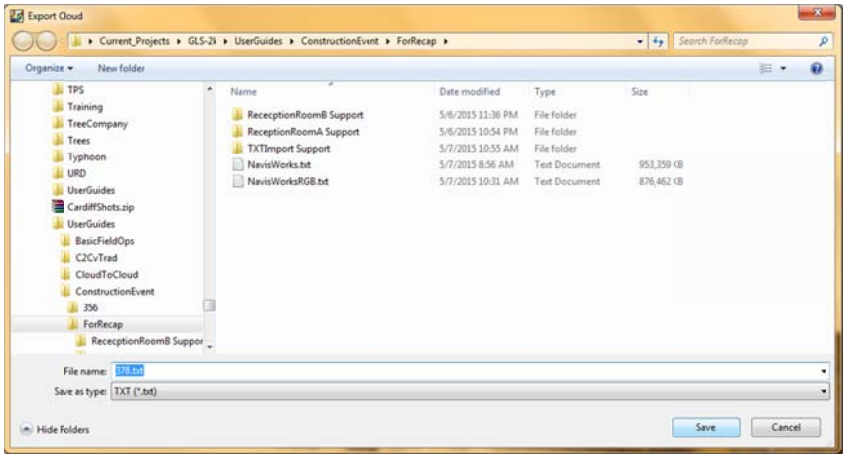


FIGURE 4 - EXPORT ASCII LIDAR DATA

Be sure to export **X,Y,Z,R,G,B** only.

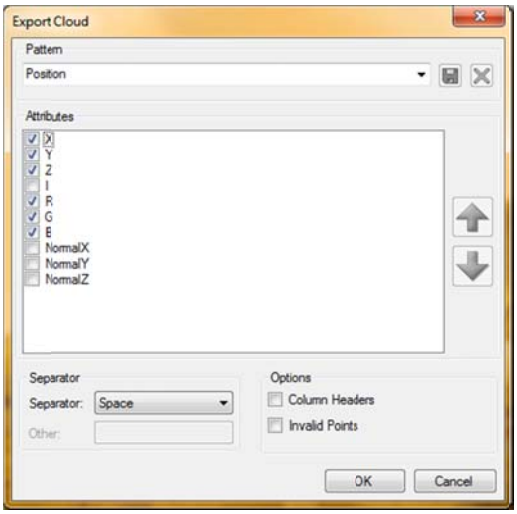


FIGURE 5 - EXPORT CUSTOMIZATION

You can also add in other 3D information for display, different objects can be made visible and project views can be saved to make navigation easier for stakeholders.

Step 2 – Set Navisworks to read the LIDAR TXT file correctly. Edit “Options”.

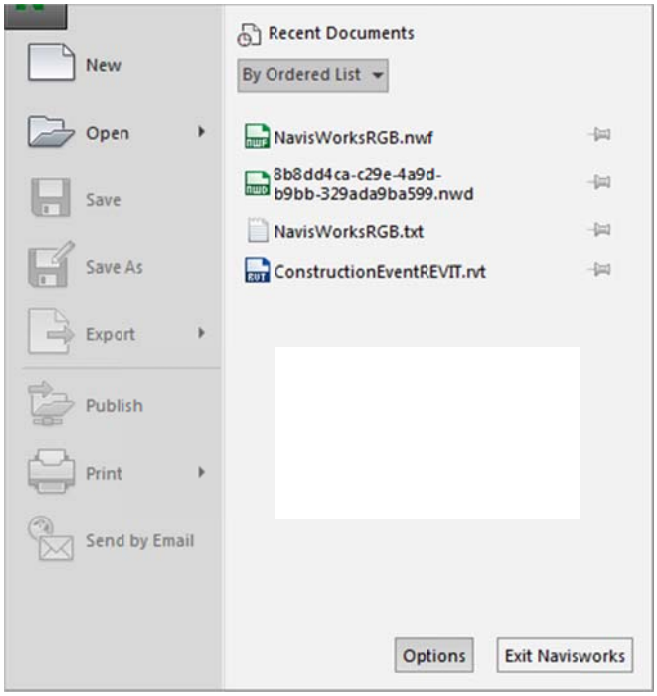


FIGURE 6 - NAVISWORKS OPTIONS

FIGURE 7 - SETTING ASCII LASER DATA FILTER

Step3 – Import the "ASCII Laser" data to your Navisworks project

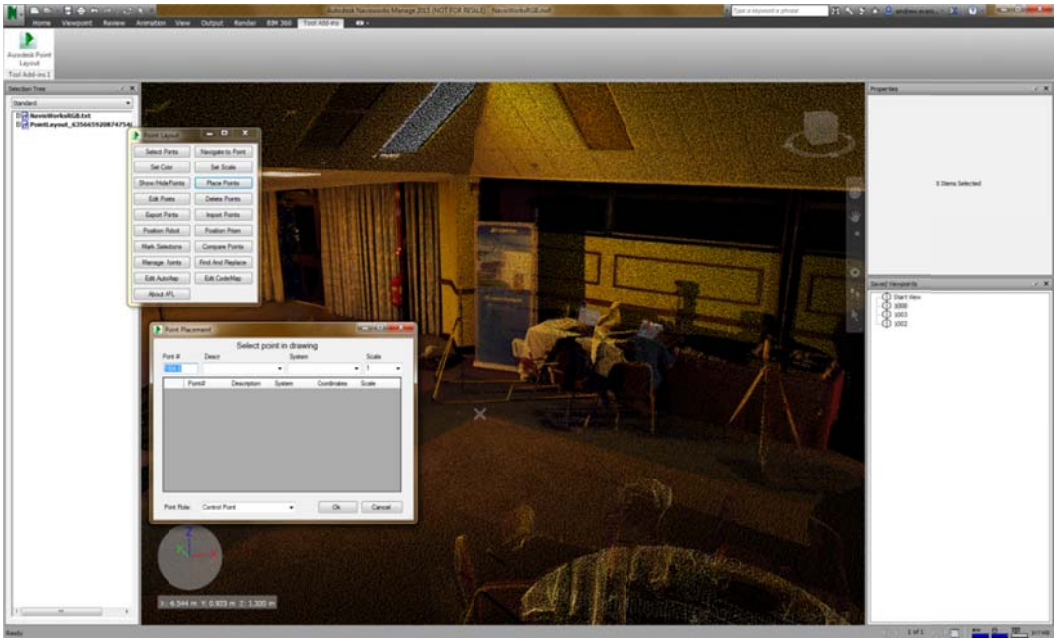


FIGURE 8 - IN NAVISWORKS WITH APL

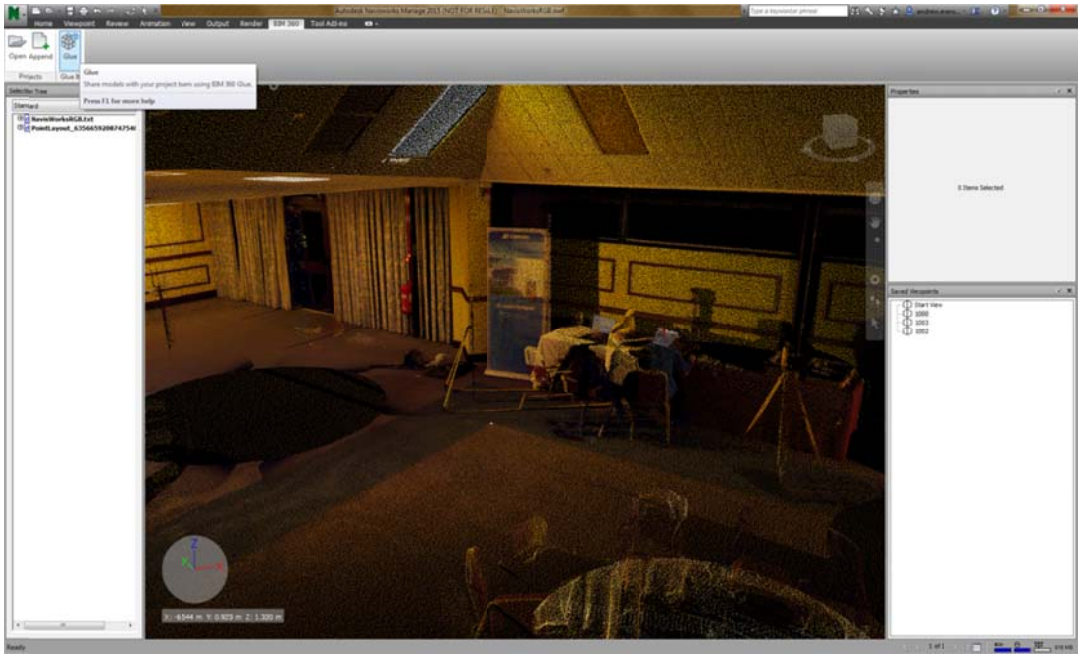


FIGURE 9 - READY TO GLUE

Learning objective 2: Learn how to place points in the model using Point Layout

Autodesk Point Layout (APL) for Autodesk Navisworks enables the addition of point data to Autodesk Navisworks file formats. As Autodesk Navisworks supports a variety of CAD file formats, you can use this add-in a wide range of design and fabrication models, including point cloud scans.

The example in this section explores the imaginary scenario in which we want to stake-out, install and verify a small temporary stage/podium next to Berlin's Brandenburg Gate, of which we have an accurate RGB point scan.

1. Accessing Point Layout in Navisworks

To access the Point Layout Tools:

1. After installing the Point layout add-in, in Navisworks, click the Add-ins tab > Tools Panel> Autodesk Point Layout.

2. In the Point Layout dialog, you can select the various tools.

2. Placing Control Points

a. Importing from file

The general contractor may provide surveyor control points or offsets from the grid through a list of coordinates in a PDF, CAD, or .CSV/.TXT file. Most often, these points are provided in some sort of offset from the structure or the survey monument locations for the site.

To add points to a Navisworks model you can import a CSV file:

1. In the Point Layout dialog, click Import Points.
2. In the Import Location Points from File dialog, click Select File to Import.
3. In the Open dialog, navigate to and select the desired file.

A message appears when the points have been imported.

4. In the model, you can see the imported points.

b. If the site has no control established

Measuring offsets from structure

If the site has no control, you can make your own by laying out offset points from the structure and matching them to the BIM/CAD model. For example, a 4 x 4-foot offset from Column A1, H1, A10, and H10 can be laid out in the field using string and tape. Use the same offsets in the CAD model.

Placing points on known monuments in point cloud

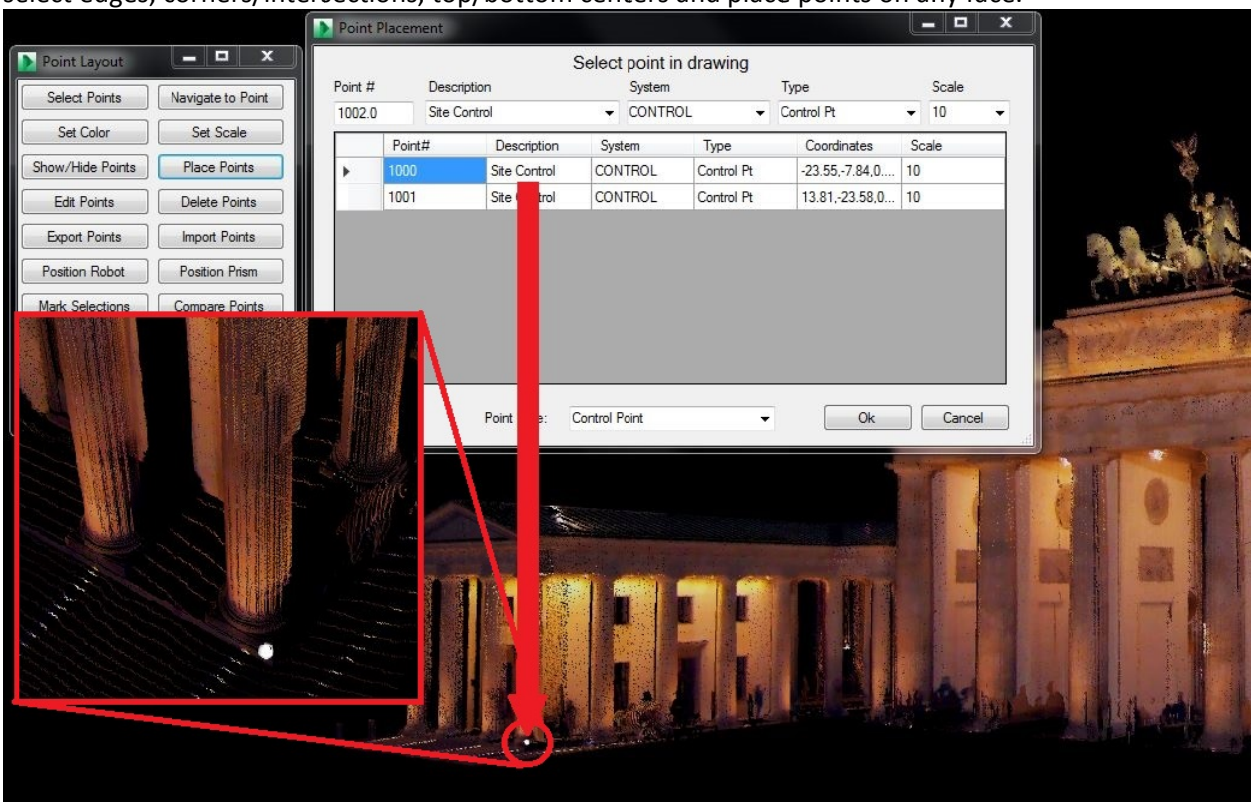
If a point cloud scan contains clearly visible and well defined physical monuments, these can be used as reference points in the field.

With the place points tool, you can place points manually into the model on geometry and objects.

1. In the Point Layout dialog, click Place Points.

2. Enter desired Point #, Description, System, Point Size Scale and Point Role. For control points, make sure system and type are set to Control.

3. With the place points tool still open, manually place points within the model. Note: You can select edges, corners/intersections, top/bottom centers and place points on any face.



In this example, a control point has been placed on the clearly defined edge of a column base, this can be used for setup in the field (see section 4)

3. To Automatically Place Points on Selected Model Objects

With the mark selections tool, you can automatically mark any locations desired in the model.

1. Select objects, geometry, create a search set, etc.

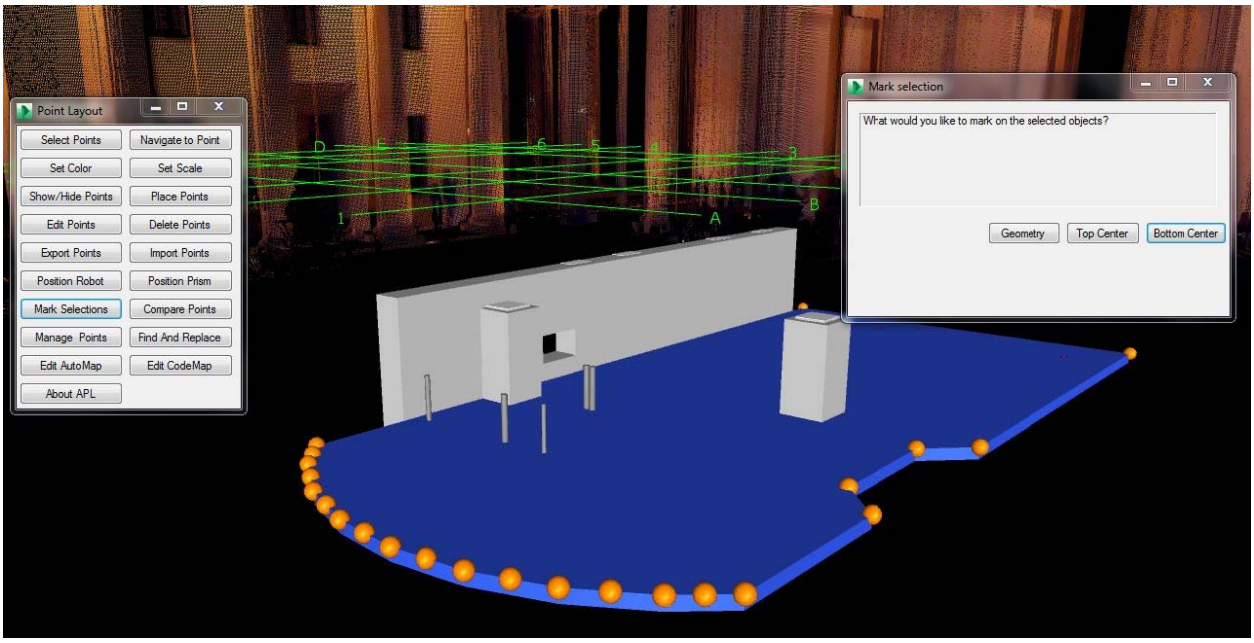
2. In the Point Layout dialog, click Mark Selections.

3. Click Top Geometry, Top Center or Bottom Center as required.

4. With the geometry mark selections, you can mark rods (hangers), Top, Bottom or both Top and Bottom of all geometry (used for walls, slabs, floors etc.).

5. Enter Point Description based on Item Name, Standard or Custom Description.

6. Enter Point System if desired.



In this example, the corners and curved edge of the top of slab geometry have been marked with points for stake-out onsite.

4. To change the appearance of points

Use the Set Color and Set Scale tool to modify point appearance. This can be useful to make points more easily visible, and to visually differentiate different points from each other, eg. control points from points to be staked out or verified.

1. In the Point Layout dialog, click Set Scale or Set Color

2. In the Scale Form dialog, click Filter.

3. Select the points that you want to modify the appearance of by Description or by Point Number and click Apply and OK.

4. In the Scale Form dialog, use the Scale drop down/color picker to apply a new appearance value and click OK.

Learning objective 3: Learn how to upload and share the model and points with the Field Team using BIM 360 Glue

Models with layout points created in Point Layout can be uploaded to BIM 360 Glue directly from AutoCAD, Revit, and Navisworks, and then synched with the BIM 360 Layout iPad app for stake-out and verification tasks in the Field.

1. Upload/save a model from Navisworks 2016 into BIM 360 Glue

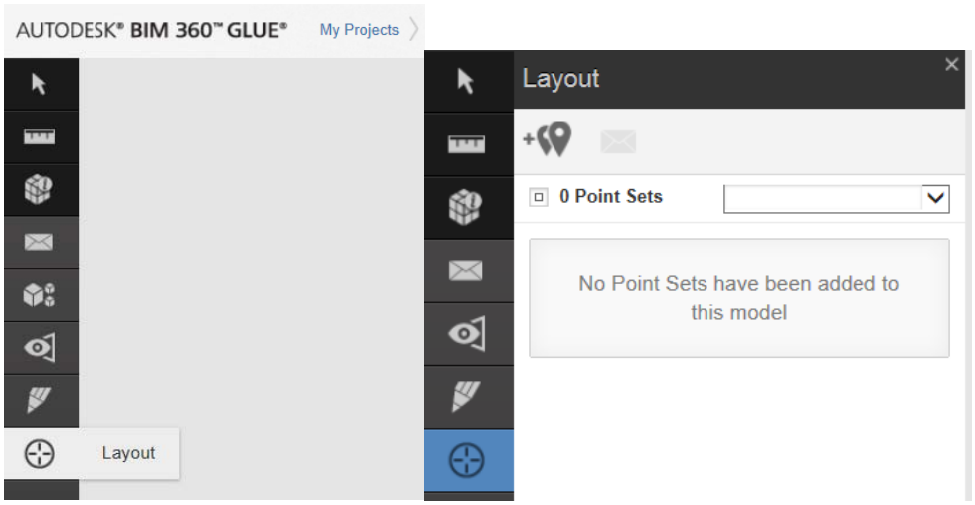
1. Make sure you're signed into Navisworks with a user profile linked to a BIM 360 Glue account
2. In the Navisworks start menu, click Save as
3. Name the model and save it into the correct project folder
4. The model and the points for stake-out and verification are now available to the extended team with access to the project in BIM 360 Glue.

2. Create point sets for easy filtering in the Field

When hundered of APL points are created inside the model, it can be hard for site engineers to find the points that they need to stake out or verify in a specific task. To facilitate the surveying Layout points can be grouped in point sets per task.

Note: Point sets can only be created using the Glue Web application, not the desktop application.

1. Sign into the web application at b2.autodesk.com and open your specific project
2. Click on the Layout button.



3. Click on the create point set button 
4. The point set can be created using (a combination of)different filters. You can filter by
   - Point number

- Description
- Role
- Type
- Status

5. Click on Search button. The number of points found will be listed. If you click on the Points found indication You get an overview of the resulting points.

6. If you're satisfied with the selection fill out name and description and click 'Add set'. If not you can adjust the filter criteria.

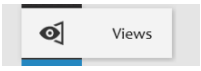
7. Point sets can be edited or deleted by selecting the pont set and selecting the edit or delete option from the drop down menu

3. Save views for easy navigation in the Field

Specific views can be created that allows the user to 'jump' to a specific position in the model. In the iPad app you can select a specific point set using the filter functionality. This way only the points needed for the task are visible in the point list. The saved views are also handy to jump back to a starting point when you navigating the model.

Note: Views can be only created using the desktop application not the web app.

1. Zoom, pan, orbit the model to get the required view of the model

2. Click the Views icon 

3. Click the 'Add view' icon in the views window

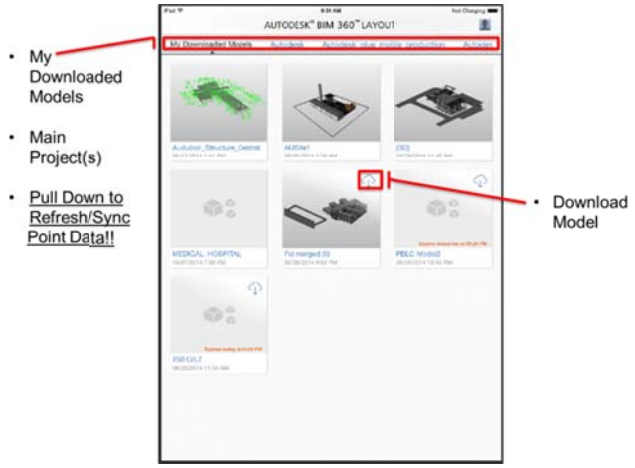
4. Fill out the name for your view. You have the possibility to create a shared view or a personal view.

Learning objective 4: Learn how to layout and verify points in the field using the BIM 360 Layout iPad application connected to a robotic total station

In this example either a LN-100 or DS-200i

1. **Getting started**
    1. Open BIM 360 Layout iPad app to access models and download locally for offline work in the field
    2. Establish data connection with robot by connecting iPad to total station Wi-Fi network
    3. Click layout mode to setup robot and access list of saved points.
    4. Click resection to setup robot using 2 or more control points, if our robot is in an unknown position. See “Autodesk Layout Guide” in the additional class materials for a more detailed discussion of setup routines and best practices.

1.



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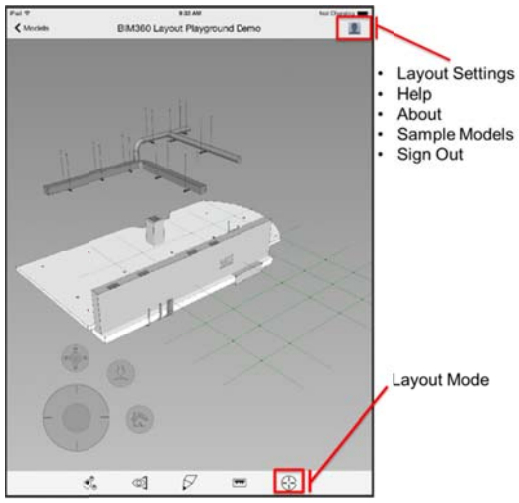
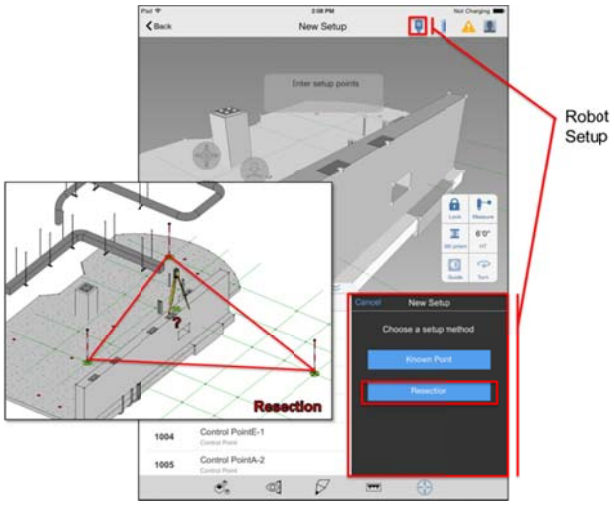
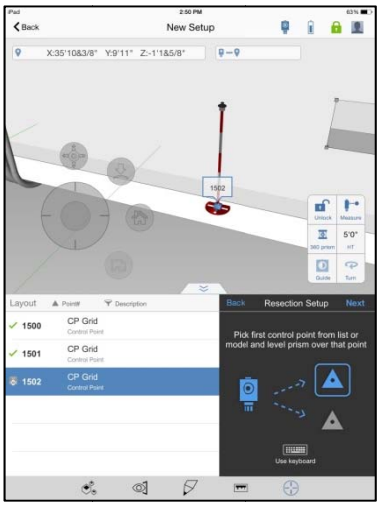
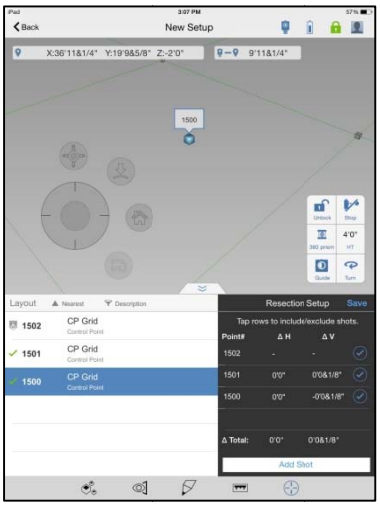
3. 

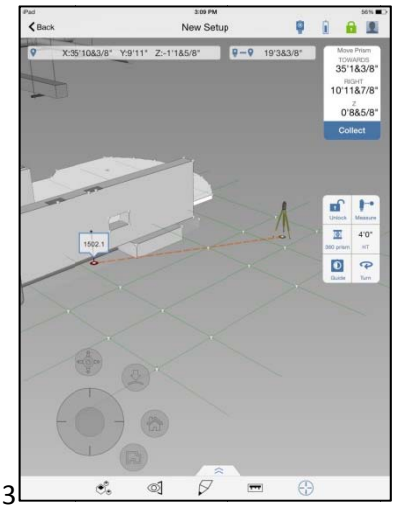
4. 

2. Resection setup:

1. Lock robot laser to prism, level prism over 1st control point, click next to measure position
2. Level prism over 2nd point and click add shot to measure position, take multiple shots until the error is within the margin of tolerance, click save to complete setup.
3. As soon as we save the setup, the robot position is established in the model, and the application enters stakeout mode.

1 

2 

3 

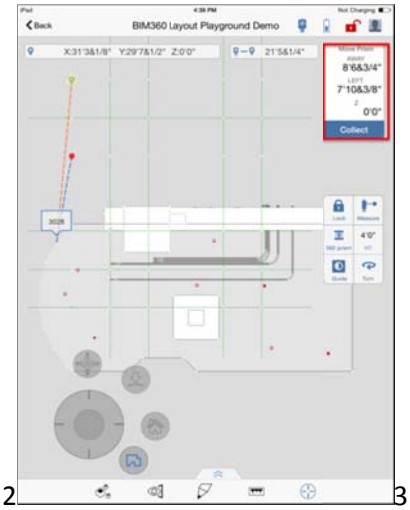
Note: This resection setup routine can be done with more than two control points. Two points is the minimum the total station requires to function but having three or more control points gives more control because you can check angles and distance.

3. Stake-out of new points.

1. Now that we're set up, we can choose points from our list. Our XYZ dialogue box in the top right of the screen always shows us the distance to move our prism to reach the selected point

2. Clicking the floorplan icon in bottom left takes us to a 2D top-down view, for easy navigation
3. We can filter by a number of attributes, and also find point sets if defined in BIM 360 Glue.

1



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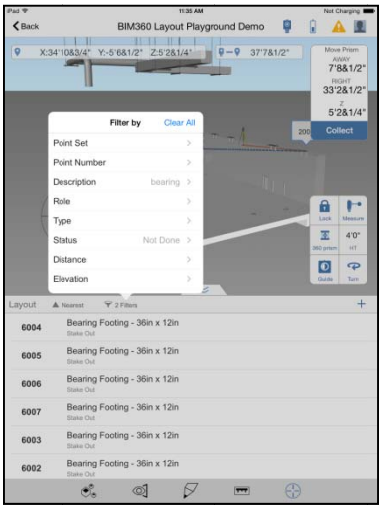

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