

[CES473700]

# Working Efficiently with ReCap Pro on Reality Captured Project

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## Learning Objectives

- How to prepare point cloud projects in ReCap
- How to make point cloud editing faster for large project
- How to manage your ReCap project for collaboration
- Discover custom and automation workflow of ReCap

## Description

This session will provide multiple tips on ReCap indexing, editing, collaboration and project management workflow from an experience ReCap developer's point of view. You will learn how to make the best use of ReCap to improve work efficiency on Reality Captured projects. Also, ReCap development team will introduce how to use ReCap OEM tool and Reality Solutions SDK to customize your workflow.

## Speaker(s)

Yan Fu is a Sr. principal research engineer in Autodesk Reality Solutions Group. Yan has over 10 years experience in software research and development of the reality capture industry.

## Introduction

With the advancement of reality capture technology, more and more companies are adopting reality capture technology in their workflow. The target audience of this talk is beginners in reality capture domain. This talk will talk about the most frequently asked questions from ReCap users and we would like to give answers to the question and give some tips on how to work efficiently with ReCap from developer's perspective.

ReCap is architected in pretty distinct (workflow-based) modules:

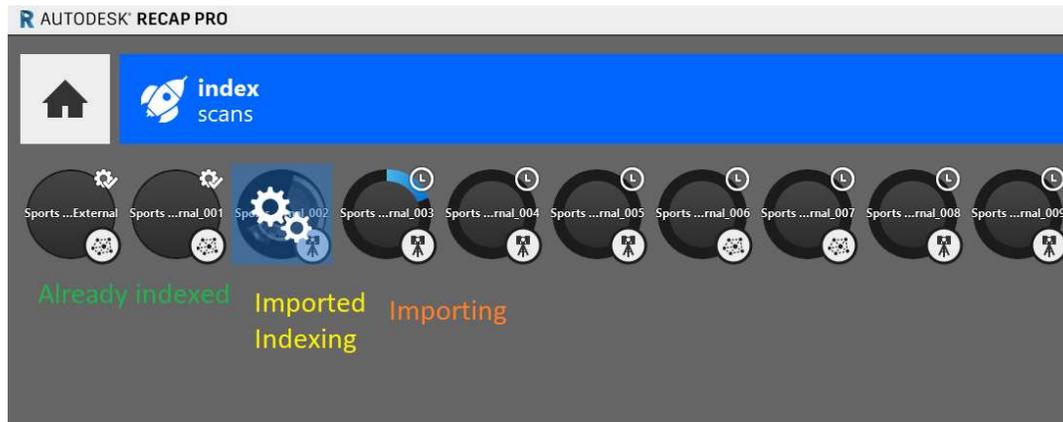
- Import (reading of raw data)
- Registration
- Indexing (creation of 3D point clouds)
- Editing & Analysis (cleanup, regioning, measurement, viewing, etc)
- Export

So it's best to execute these steps (when needed) in a linear fashion. Specifically - most of the Editing & Analysis tools assume the registration and alignment is complete. For example, if you create a note in the 3D point cloud, then go back and change the registration in some meaningful way - you'll notice that your note has moved when you go back to the 3D view. So in the following talk, we will go through the core modules of ReCap in the order of above mentioned order to talk about the tips of working with ReCap.

## How to prepare point cloud project in ReCap

### Parallelize importing and indexing

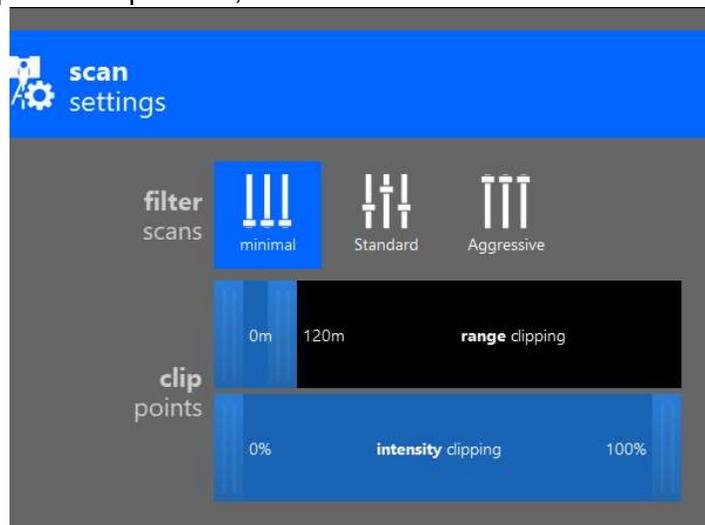
There are two steps involved when bringing the raw scans into ReCap, let's call them importing and indexing. The importing step will parse the raw scans and convert the raw scan into .rcc files if the raw scan is structured scan. The indexing phase will compute the derived information and creating the indexing structure for the point cloud. Since ReCap7.0, these two steps are parallelized. If you click "Index" button right after the raw scans are pulled in, the importing and indexing process will run in parallel as demonstrated in the following image. The difference in the icon shows the current status of the scan. User can check the icon status to see if the scans have finished indexing.



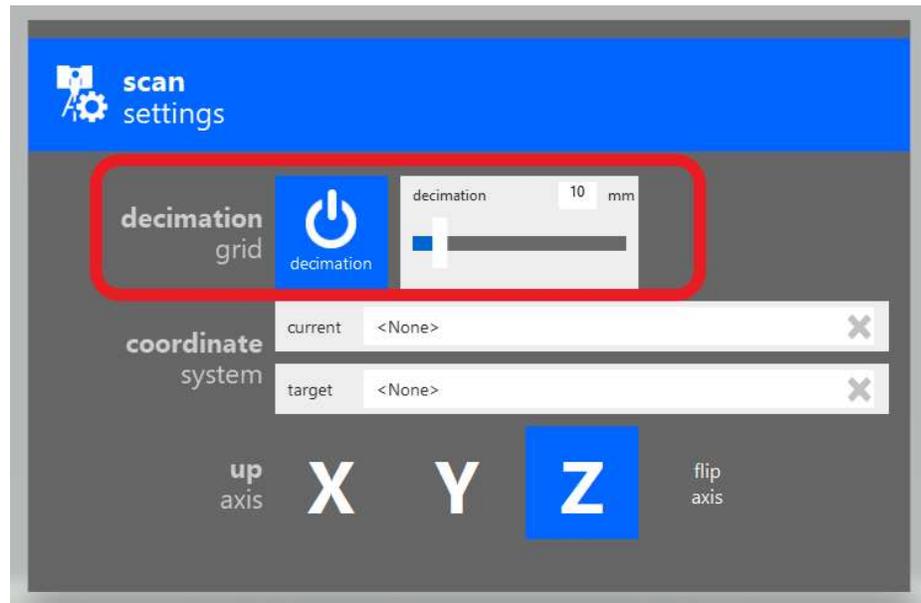
## Decimation setting

A lot of ReCap users concerns about their input data got decimated or want to decimate the point cloud. Below are some explanation of the decimation working in ReCap.

- Before ReCap 7.0, by default, the noise filtering option is set to Medium. As a result, some sparse points will be filtered. In the latest version, the default filter setting is modified to be minimum so that no sparse points are filtered. If you want to remove the outlier points, you can adjust the noise filtering setting to standard or more aggressive. If you want to keep all the input data, 'minimal' should be used.

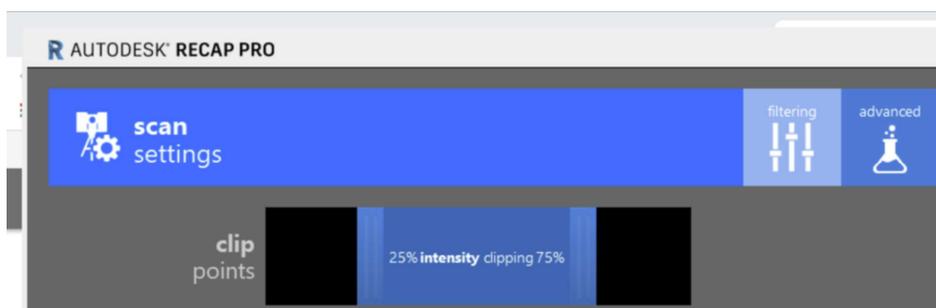


- The densest point density ReCap can support is 1 point per mm<sup>3</sup>. The redundant points will be filtered out. If the raw scan is in different unit, it may cause issue of more points are decimated unexpected.



- Since the point cloud is indexed per scan, there are still redundant points for overlapping area. The redundant points can only be decimated when exporting the point cloud into a single unified RCS file.

## Intensity Clipping

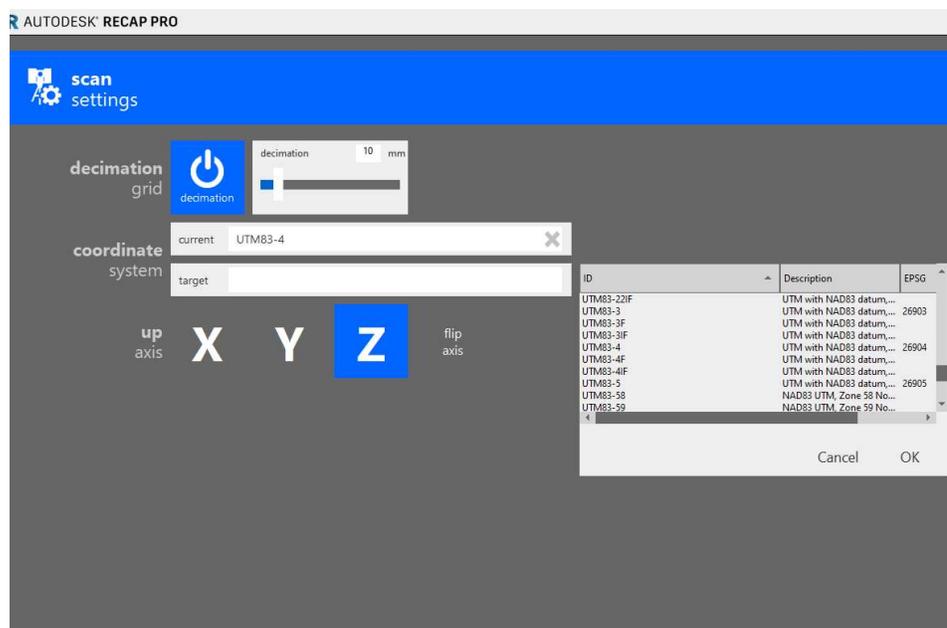


The intensity value is typically sensor dependent energy return of the laser beam, it could be used to indicate some quality measurement. This intensity clipping slider is used to filter out points with either too low or too strong intensity. The blue area is the enabled part. For example, if the blue part ranges from 20% to 80% and intensity range is 0-255, then only the points with intensity in range  $[0.2 \cdot 255, 0.8 \cdot 255]$  will be kept, the rest of the points will be discarded.

## Coordinate System

To correctly prepare your ReCap project for downstream use, coordinate system needs to be set for LiDAR scan.

- As we mentioned earlier, ReCap is designed in a pipeline of importing->registration->editing->exporting. So we expect the coordinate system should be set before the importing process starts. After the coordinate system is set, the coordinates information is persisted into the .rcs file. Even though user can change the coordinate system in project setting, the transformation is performed in run time and the coordinates value is not changed in the .rcs file. So if you only import .rcs file into other products such as AutoCAD, it will still use the raw coordinate system set before importing. The .rcp project file will carry the project setting of coordinate system and perform the coordinate system transformation for the project.
- When importing raw data into ReCap you need to specify which CS the raw data is in (Current) as well as which CS you want the data to be (Target). Look for these settings in the advanced settings tab during import. If your PTX file has data that is already in a specific CS (e.g. Colorado State Plane), you need to tell ReCap that. If you want to work with the data in that CS in ReCap and downstream (Civil 3D, Infravorks, etc.) you need set the target CS to that same CS. If you have some preferred CS that is different than what the raw data is in, ReCap can do the conversion. In that case you might want to convert to UTM, or stateplane in meters instead of feet, etc. so you would set your target CS different than your current CS. current CS = CS where the data is coming from (i.e. raw data) ; target CS = CS where the data needs to be for processing, interrogation, analysis, etc.





## Units in ReCap

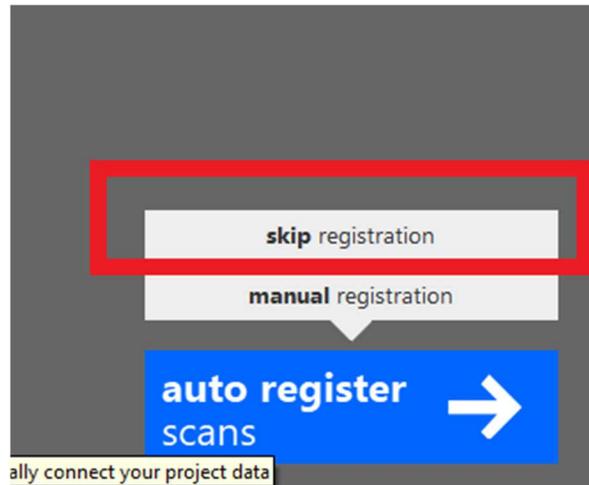
Points in ReCap are represented in metric unit. ReCap takes the input point coordinates as metric unit by default.

However, for .las file, you can specify the input (source) coordinate system as coordinate system in imperial units, then ReCap will convert the raw coordinates from imperial unit to metric unit. If coordinate system is specified, no transformation will be applied and the original coordinates are kept. For ASCII file,

In ReCap, the system/units set in Settings | General are only for display purposes - it does not affect import or export coordinates.

## Registration

If you scans have already been registered in other software, you can skip registration, which will save you a lot of time and will keep the original transformation of the input scans.

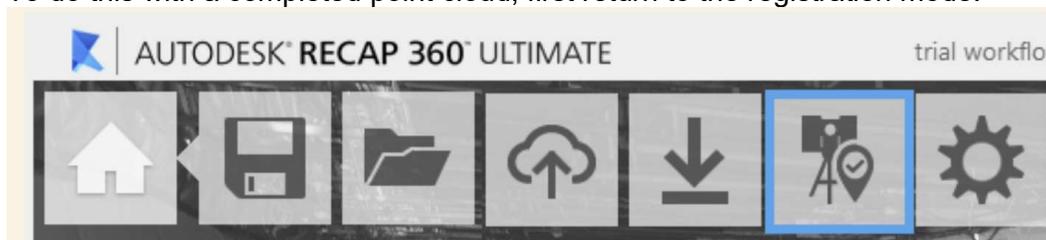


Please note that the registration workflow will use the origin of the first base scan as the origin of the common coordinate system of the registered project. Users may wish to align the consolidated data set onto some other system, e.g. a geographic coordinate system or coordinates from an existing survey of a structure. Users can achieve this goal by importing survey points or updating origin tool.

### Import survey points

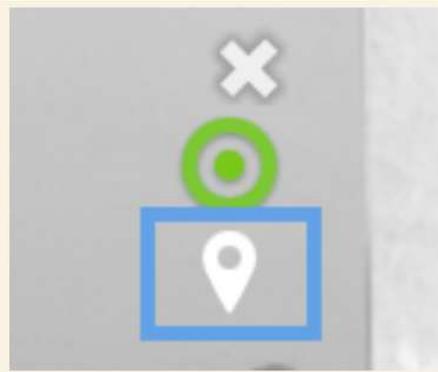
If you want to integrate your GPS data, you can use them as survey point in the registration process.

The entire point cloud can be adjusted based on a combination of any target or targetless survey points. At least three points are needed. To do this with a completed point cloud, first return to the registration mode.

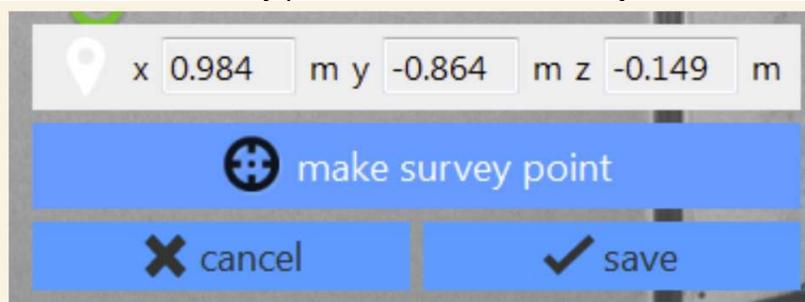


To create a targetless survey point:

1. Click on the desired point
2. Hover on the green/blue/red icon and click the pin below it



3. Click "make survey point" and enter the survey data



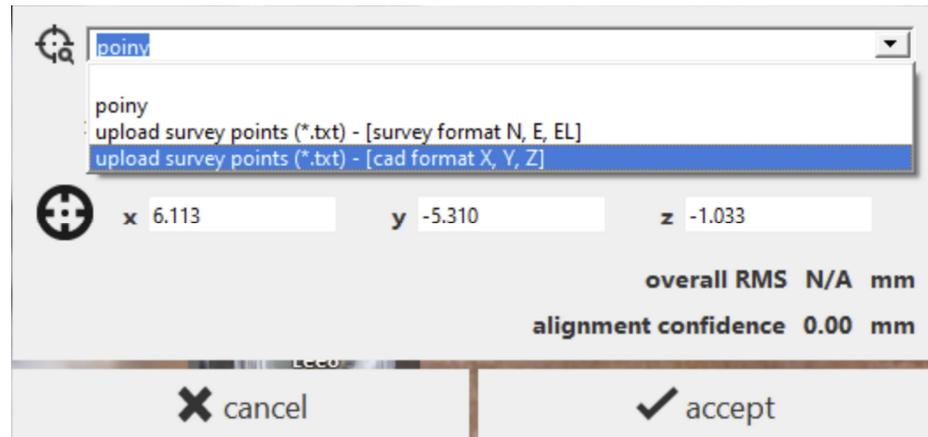
You can also import survey points from a .txt file. The coordinates in the text file represent the coordinate where you want the point to end up. And the coordinates have to be converted to meter.

Please note that you need to use TAB as Delimiter of the coordinates of the survey points.

Sample survey point .txt file format:

**IMPORTANT: Need to use TAB as delimiter**

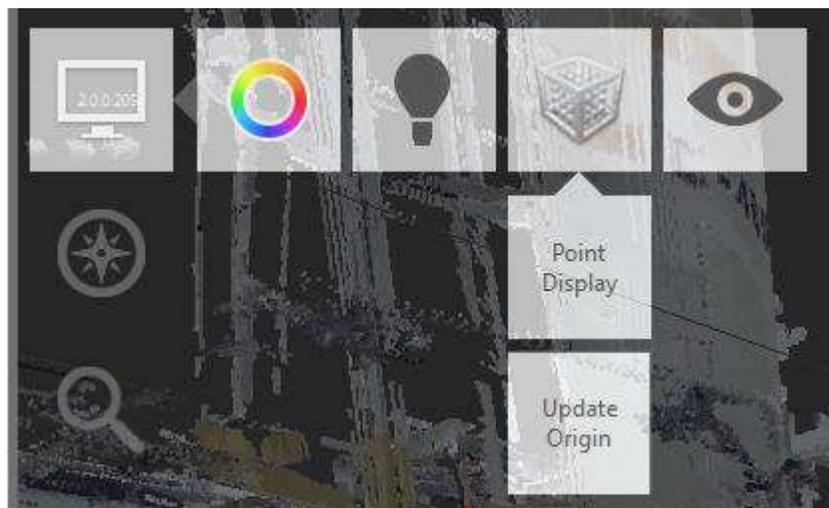
```
8918 -56.598243 -107.318579 62.221082
8921 -52.8204 -110.215829 62.244613
8927 -42.684408 -110.215055 62.297404
8931 -37.009784 -110.211224 62.226203
```



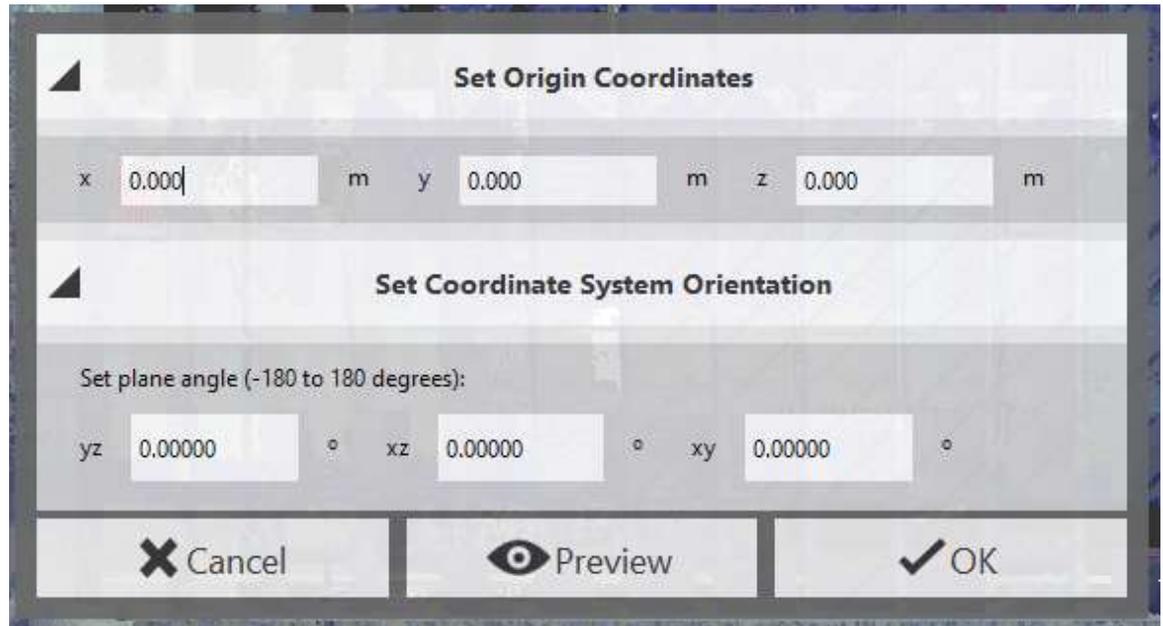
Once you have chosen the control file in the survey point drop down, all points in the text file will show up in a list. You must have a minimum of 3 control points defined before you see any RMS quality values. Once three or more points are added, ReCap will compute a best-fit alignment from the registration group to the final coordinates provided. The quality of this alignment is shown via an RMS value.

## Updating origin

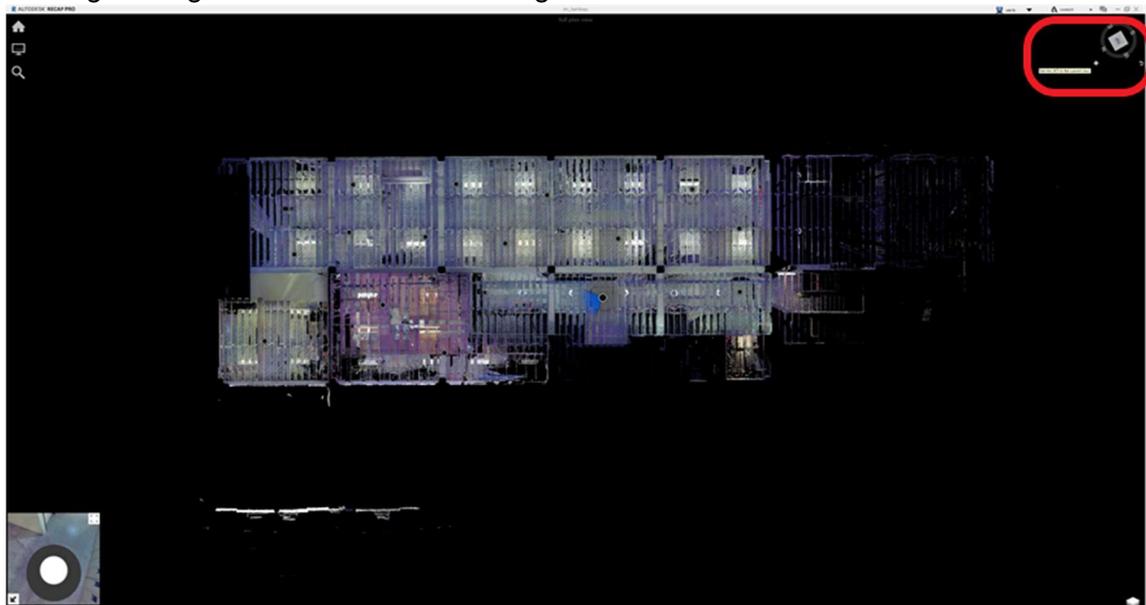
If you want to globally transform the whole project such as translating and rotating the project, Update Origin tool can help to achieve this goal by moving the origin of the project and rotating the project. In older ReCap version, new origin point can only be snapped to some point inside the point cloud and cannot be randomly be chosen.

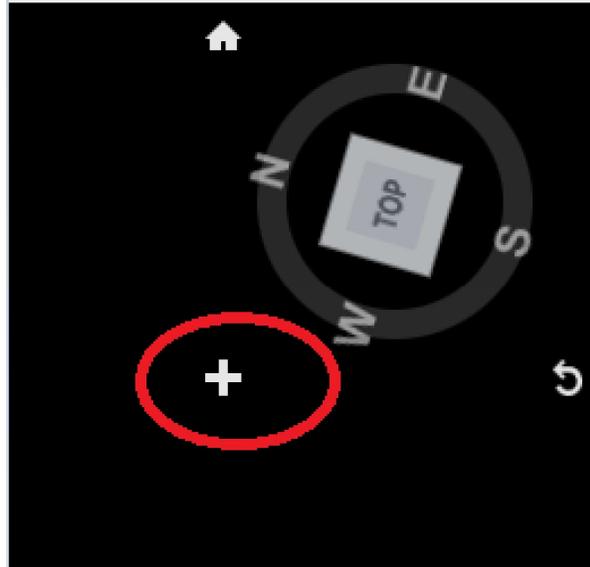


- Since ReCap 6.1, we have provided a new tool to allow user to manually input the new origin coordinates directly instead of limiting to a specific point in the original point cloud.



- In ReCap 7.0, another way is provided so that you can rotate your point cloud project using the widget in the mini-map. And then click the '+' icon to update origin using the current rotation setting of the view cube.





## Export point cloud project

Now you have a prepared ReCap project ready to use and may need to export the project to be used in your downstreaming workflow. Point cloud data can be exported in the following formats.

- Unified RCS / RCP: when you choose unified RCS, the whole point cloud will be unified using a hierarchical grid. Deleted points and redundant points will be removed from the point cloud, thus creating a lightweight RCS file for the following workflow.

If you want to bringing the prepared point cloud to some other application, you may choose exporting to .pts file or .e57 file.

- Structured e57: all the structured information will be kept but it will ignore all the editing information.
- 3D e57: it will respect the editing information and only the visible points will be exported.

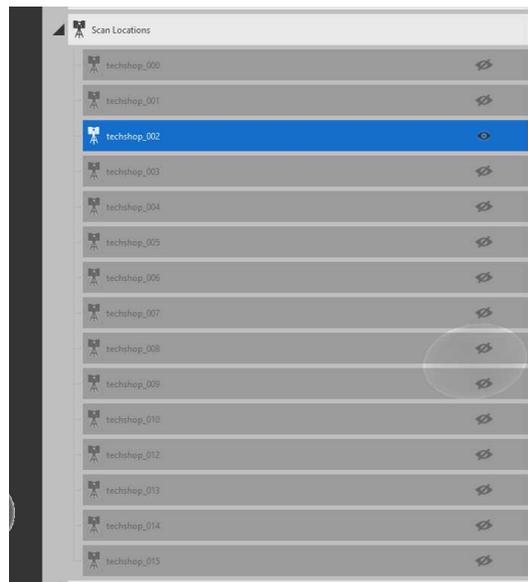
## Make point cloud editing faster for large project

The performance of large project with a lot of editing is a pain point. ReCap keeps the editing history so that the editing also takes effects for points streamed in later. So the performance depends on how many edits (selections) have been made during the editing instead of just how many regions are created for editing. Some efforts have been made in ReCap to improve the performance.

## Control Scan Visibility

For a large project with many scans, it is very helpful to isolate or hide some scans for better editing, analysis and inspection. Two tools have been provided in ReCap to facilitate this process.

- Multi-section for scans: Since ReCap 7.1 , user will be able to use SHIFT and CTRL key to select multiple scans in project navigator so that user can hide / show the scans without clicking the eyeball icon of the scans one by one
- The already available tool to make selection easy is the isolate tool. Using Alt+Click the eyeball icon in project navigator can isolate the selected scan and hide all the rest of the scans

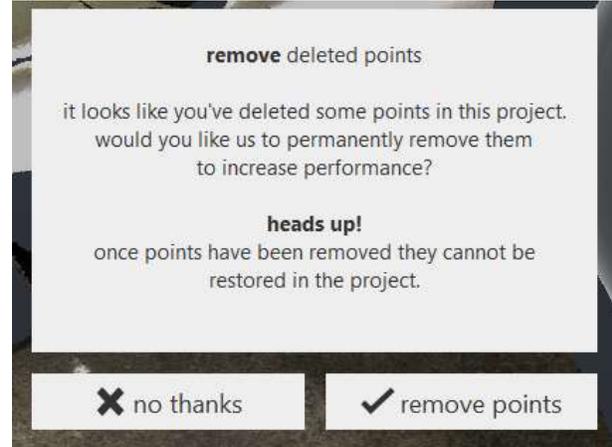
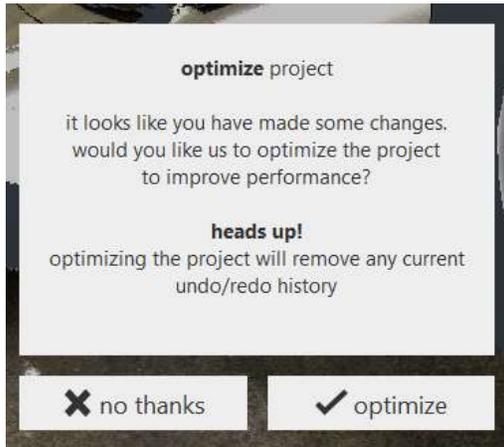


## Optimize your project

As mentioned earlier, the performance is affected by the number of selections made during the editing. Project optimization tries to reduce the number of selections by saving the information into RCS file instead of computing the flags on the fly. Currently, the optimization only takes effect on deletion operations, and does not work for regions yet.

- 3D point cloud is indexed to accelerate the rendering process. When points are deleted, the points will not immediately be removed from the index point cloud structure. A flag is marked for the points to be deleted.
- When saving the project and choosing to optimize the project, the deletion flag is persistent into the files but not removed from the files, so you can still undo all the deletion operation if something went wrong. Since the point cloud deleting information is already persistent, the deletion editing history is removed and not necessary to process the operation history.

- When you choose saveAs the project and then optimize the project, the deleted points are removed from the point cloud and file size is reduced. Deleted points cannot be recovered any more.



## Point Cloud Editing Result Caching

To improve the performance of point cloud editing, ReCap 7.1 has made some changes enabling the editing result to be cached in temporary cached files folder to cache the previous computation result and save time. So you will see multiple .VCH files generated in the temporary cached files folder. User can save frequently to make sure the .vch files cache the latest changes. This caching feature requires user to save frequently to maintain full performance.

1fac76cd-0430-45eb-83df-9e85221785fd.vch	5/25/2020 3:34 PM	VCH File
6ce710ea-b2f0-4687-b532-289622e5d5d8.vch	5/25/2020 3:34 PM	VCH File
7b418706-124b-49bd-a4b7-274507d37d90.vch	5/25/2020 3:34 PM	VCH File
8fc8d9cd-bf32-41bd-8bb2-3e731f1cab54.vch	5/25/2020 3:34 PM	VCH File
9a6bf7df-e745-4c73-b73a-ba65e3053cf2.vch	5/25/2020 3:34 PM	VCH File
9bab2c62-b601-419d-a501-c1b6ebe7794a.vch	5/25/2020 3:34 PM	VCH File
011b08aa-a170-4c19-9410-52525834c99a.vch	5/25/2020 3:34 PM	VCH File
13f03ad8-3e55-4b83-b296-8b26fb5b9f69.vch	5/25/2020 3:34 PM	VCH File
022bf401-548d-4496-9f81-914f83642eb4.vch	5/25/2020 3:34 PM	VCH File
38e2c45b-b0d6-4d0d-ae8c-625c3023f7ef.vch	5/25/2020 3:34 PM	VCH File
78d7e4fc-641a-42b9-ba6d-dedbf42a1841.vch	5/25/2020 3:34 PM	VCH File
428a4b71-5fe7-4afe-b72f-43816b466f2b.vch	5/25/2020 3:34 PM	VCH File
709e3061-78f2-43bc-89d3-1a3bfcf2900f.vch	5/25/2020 3:34 PM	VCH File

## Manage your ReCap project for collaboration

### Project file management

To share your project with your team worker or customers, it is better to know more about what's included in a project. The major file types are explained here:

- RCS: indexed 3D point cloud file
- RCC: Support structured scan related workflow
- Thumbnail: Mirror ball in indexing page
- Llt: texture mapping for the mirror balls in 3D preview during registration
- Temporary cached files
  - This folder contains the files that need to support minimap, realview, registration view etc. All the files can be regenerated, and they are used to accelerate the workflows in ReCap.
  - If you want to reduce the project folder size, you can delete the file for project transfer and archive. Next time the project is opened in ReCap, the temporary cached files will be regenerated on demand, which also means, it will slow down the project loading process if the temporary files are not present.
  - If a project is saveAs a new project, since the project content may be changed, the temporary cached files need to be regenerated.

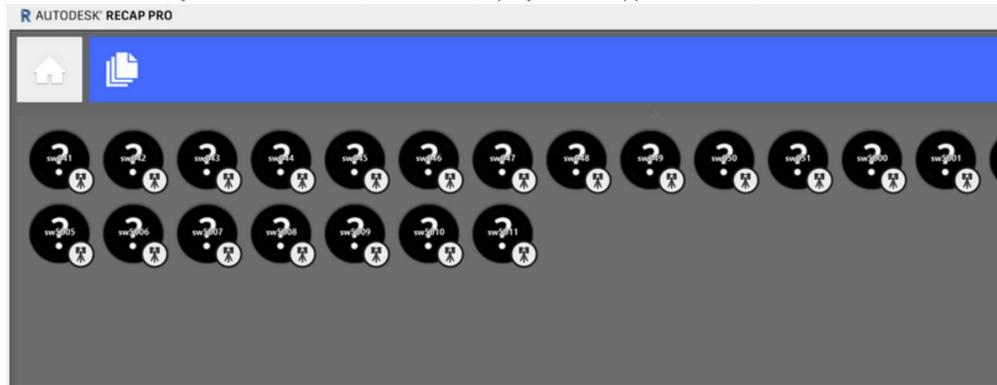
### Creating child projects

For a large project, it might be more efficient to work on a child project if the work can be done in a smaller area. Or when a portion of the project needs to be shared with collaborators, you don't need or want to share the whole project, a child project can be created for these purposes.

- If registration is done inside ReCap before indexing the project, the scan transformation information will be saved into .rcs file. When you create child a project, you can still use the .rcs files without re-registering the scans. However, as mentioned earlier, the temporary cached files will be regenerated. If the registration is done after .rcs files are generated, creating the child a child project doesn't automatically carry the previous registration information and registration might need to be re-done.
- When creating child project, you only need to import the .rcs files into the child project, however, the .rcs files will remain at the original location. This is desired in some cases. In some other cases, if you want to share the project with others, you may find the project support folder is empty without real scans. In this case, you need to do a SaveAs so that all the required files will be copied to the project support folder and will be ready to share as a complete project.

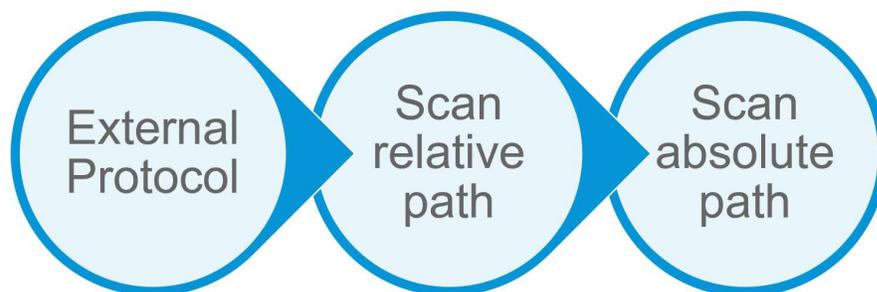
### Moving your project around

When you share a project with your team workers, you may encounter the cases of files missing error message or very slow to open the project.



This might be caused by the following reasons:

- The project folder structure is changed: ReCap relies on the relative path to find the .rcs / .rcc files. If the folder structure is changed and the original file has been moved, .rcs files cannot be found. Similar for .rcc files, if .rcc files cannot be found, the scan will be treated as unstructured scan and realview will not be available.
- If all the support files are already on local drive, the project (without editing) is still very slow to load, this might be caused by the project is actually linking to the support files in a network drive. If the project file path is not set correctly, a project saveAs will solve the issue by copying all the depending files to local project support folder.
- If some protocol is setup by the application where ReCap project is opened, it will change the support file search order and cause file missing issue.

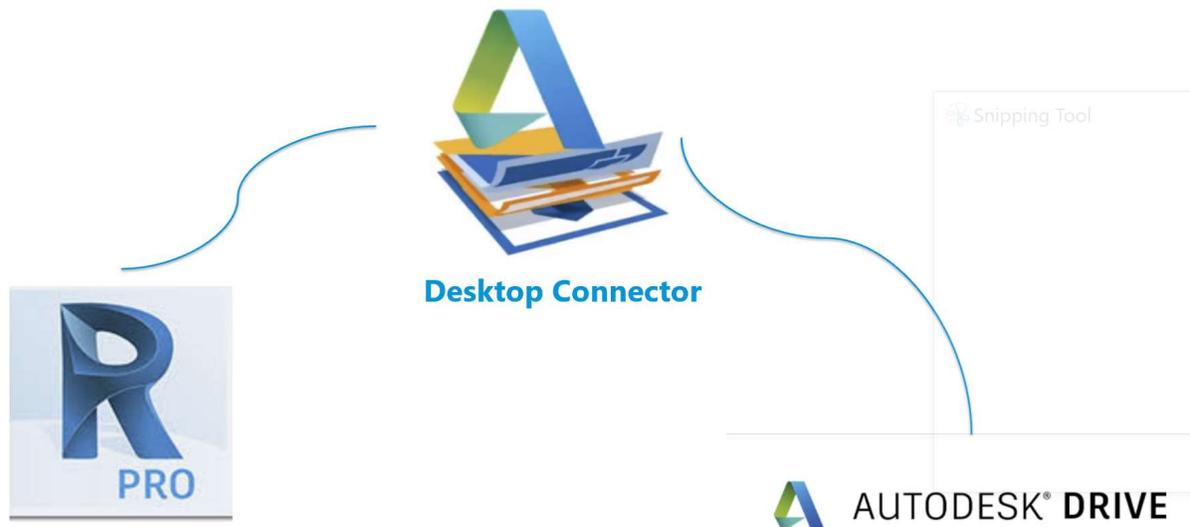


## Collaboration through Autodesk Drive

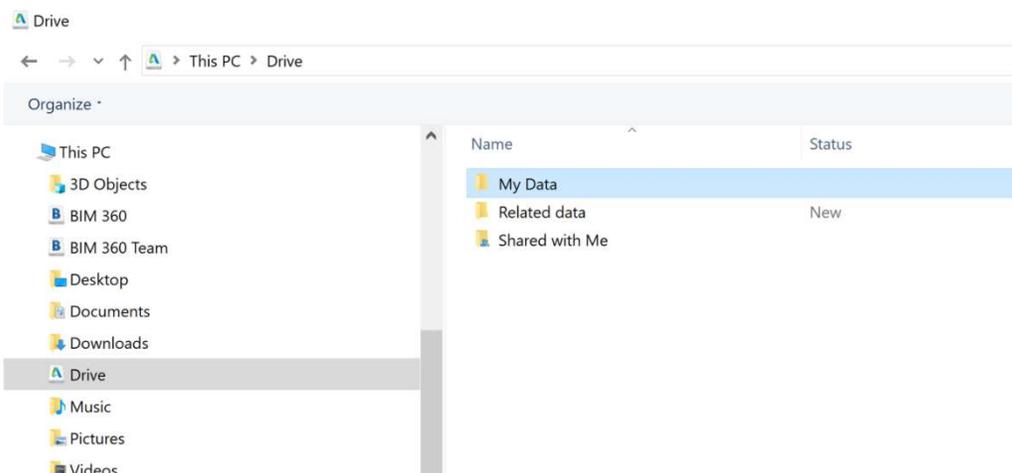
With the retirement of A360, ReCap projects collaboration has been moved to Autodesk Drive since ReCap 7.1. User needs to follow the instruction from the following link to setup Autodesk Desktop Connector and Autodesk Drive. The workflow is new and slightly different from the previous workflow using A360.

<https://knowledge.autodesk.com/support/desktop-connector/learn-explore/caas/CloudHelp/cloudhelp/ENU/CONNECT/files/Get-Started-with-Desktop/GUID-78B8E361-3960-490A-8B1F-8DB28DD039E2-html.html>

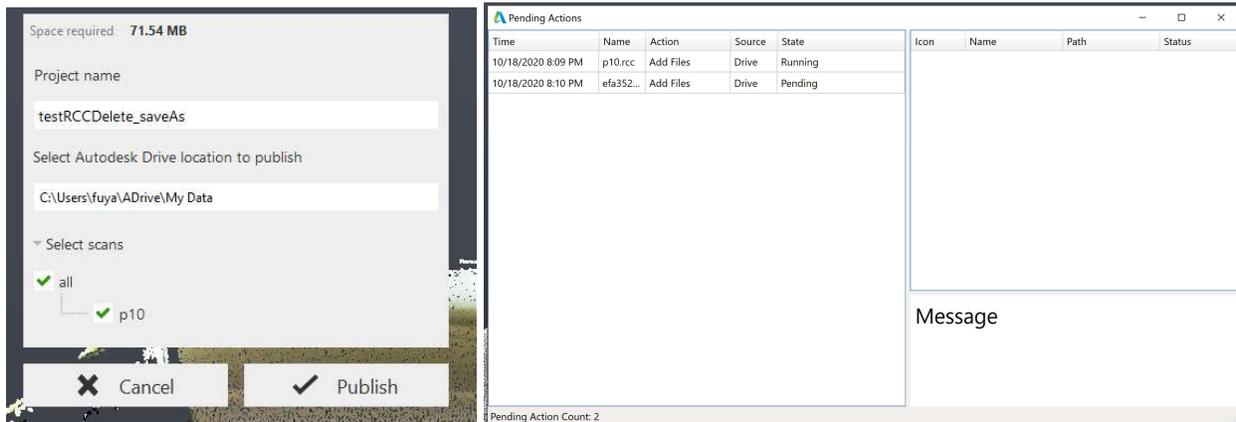
Desktop Connector is a desktop service that integrates an Autodesk data management source (or data source) with your desktop folder and file structure for easy file management.



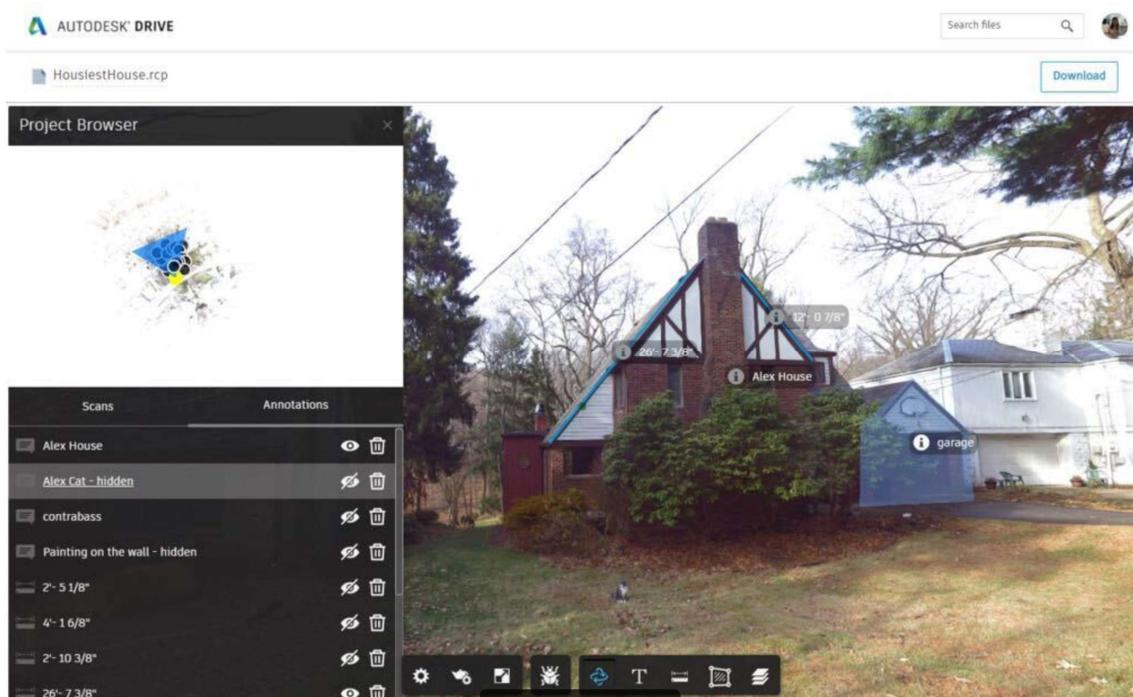
After Autodesk Drive is setup, it can be found under “This PC”.



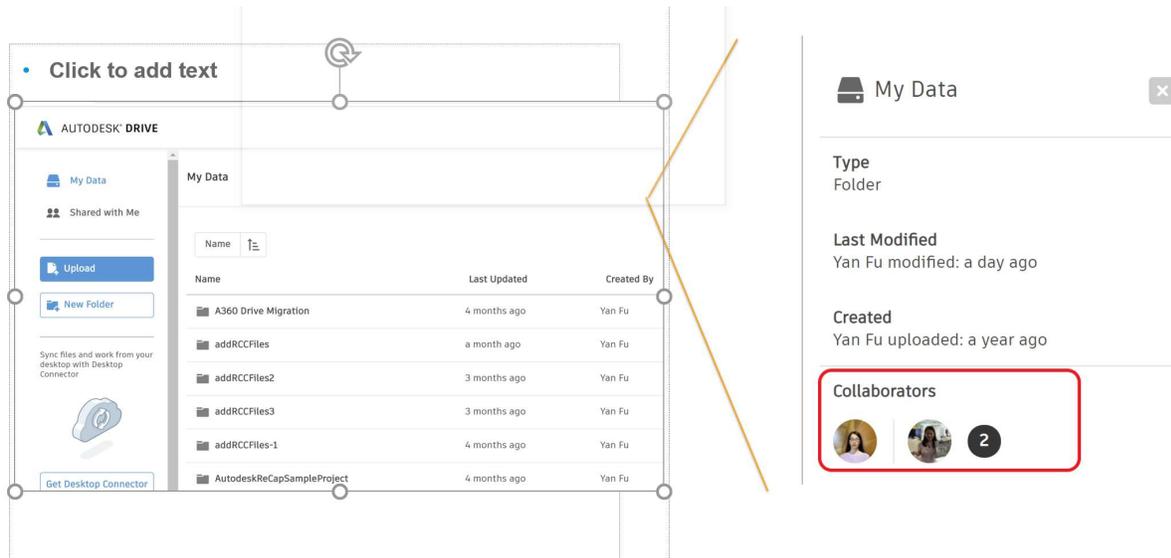
When user publishes a project through ReCap desktop, the project files are transferred to local Autodesk Drive workspace and Desktop Connector will schedule the uploading of project files to cloud storage of Autodesk Drive.



After the project is published, the project can be opened in Autodesk Drive and viewed in Autodesk Viewer, similar to ReCap web.



The published project can also be shared with your collaborators by adding collaborator to the folder so that your collaborators can see the folder in "Shared With Me" folder in their Autodesk Drive workspace.



**NOTE:** Currently ReCap required the project to be published through ReCap desktop for user to view the project in Autodesk Drive. Projects copied directly to Autodesk Drive cannot be viewed in Autodesk viewer yet.

## Discover custom and automation workflow of ReCap

### DeCap.exe

Since ReCap 3.0.1, ReCap includes the ability to create ReCap projects from raw source files in an automated, background fashion. These features are accessible through a command-line executable import tool called DeCap.exe, located in the ReCap 360 install folder. The source files can be specified directly on the command line or provided in a control file. DeCap is authorized using the same license as ReCap Pro.

```
Decap.exe --importWithLicense <output
folder> <project name> [options] <input scan 1>
[input scan 2] ... [input scan N]
```

### Reality Solutions SDK

In the past two years, ReCap team have put more efforts on the Reality Solutions SDK to make the reality solutions technology available to our partners to accelerate the ability to bring more solutions to our customers. More information can be found from:

<https://blogs.autodesk.com/recap/announcing-the-reality-solutions-sdk/>

The Reality Solutions SDK (aka ReCap SDK ) gives your solution the ability to read in the spatial data, spherical range images, and other metadata in the RCP/RCS format. When your customer is ready to save their project from your solution, the SDK provides the ability to write

out the RCP/RCS project. Avoid having to convert formats, eliminating hours of time from your customers' workflows.

Reality Solutions SDK can be obtained from:

<https://www.autodesk.com/developer-network/platform-technologies/reality-solutions-sdk>

Here we will introduce three sample workflows that can be achieved through ReCap SDK to customize your own solution of integrating with ReCap.

- Creating .rcp project from your reality captured data  
 ReCap SDK can be used to load ReCap project and export your own scan file format to ReCap projects. It has been used by many companies such as Leica, Faro ..... User should be able directly export ReCap project from software from Leica, Faro, Trimble, etc.

ReCap SDK provides two types of methods to export your reality captured data to .rcs / .rcp file:

- Add your file format support through Capture Coded Kit (CCK)  
 You need to implement the interface defined by CCK to define the way to parse your raw scans.
- Export your point cloud directly from a buffer  
 Point cloud data can be added into .rcs by keeping adding points from buffer. This method can directly read data from your device or application and save the time of writing to an intermediate file.
- Export panorama images from structured scans  
 With ReCap SDK, you can export Panorama Image, Normal Image, intensity image etc. RCPReaderSample included in the ReCap SDK has provided the sample code and application to export panorama images and ready to be used for your solution integration.



- Deleted points in structured scan

There is one known limitation of editing point cloud in ReCap: points are deleted in 3D view but the deleted points still exist in Realview. In the ReCap SDK version 21.1.0, we include a new feature to support removing points that are deleted from 3D view from the

structured scan, thus the deleted points will also disappear from realview. The green pixels in the following images show the deleted points from realview images.



More features of ReCap SDK can be found from user manual included in the ReCap SDK release. And one more thing worthy mentioning is that ReCap SDK has been integrated in RealDWG which means you can get the entry point of ReCap SDK through RealDWG API so that you can work on the same point cloud object as loaded in AutoCAD.

## Additional Resources

Most of the topics in this talk are inspired by the most frequently asked question in [ReCap community forum](#). So we suggest ReCap users seek for more and latest announcement information from ReCap community forum. ReCap development team and technical support team are actively monitoring the posts in the forum and will try our best to answer the questions. There are also a lot of Reality Capture experts on the forum that could help you get started with ReCap and solve the issues you might encounter in ReCap.