PM120955

Future of Making Things in Factory Design: Reality Capture, 3D Printing, and Virtual Reality

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Learning Objectives

- Learn how to set up integrated factory workflows
- Learn how to work with reality capture in a factory-layout workflow
- Learn how to use Virtual Reality Solutions to communicate with stakeholders and customers
- Understand how smart manufacturing is paving the way to agile manufacturing

Description

In this session, we'll cover a complete workflow based solely on Autodesk technology, from process planning to 2D-3D layout and 4D timeline management. Then we'll bring you into the virtual factory experience, meaning that you can experience the factory as if it was built already. Finally, we'll present the advanced manufacturing technologies for the factory of the future—technologies that are available today. At the end of the session, you'll understand how to set up integrated factory workflows, and you'll know the importance of process planning and the integration of an "as build" situation—which is very common and useful for avoiding collisions. Additionally, you'll know how to use virtual reality solutions to communicate the entire plan with stakeholders, and you'll understand how smart manufacturing is paving the way for agile manufacturing.

Speaker(s)

Alessandro Gasso is currently employed as Enterprise Solutions Leads Manager within the Customer Success Services organization at Autodesk, Inc. Over the past 15 years with Autodesk, Ale has worked in various roles including Product Support Specialist for Inventor, the lead for the EMEA Inventor Product Support Team, EMEA Technical Lead of Inventor software, Premium Support Specialist leading the PSS Manufacturing Team, and manufacturing Industry Technical Lead. Ale was the co-author of the Being Inventive Inventor blog, and he has spoken at Autodesk University in 2012, 2013, 2014, and 2015. Before Autodesk, Ale worked for seven years as a mechanical designer for a company in the defense industry. Ale is a native of Italy who speaks English, Italian, French, Spanish, and Portuguese, and he holds a master's degree in electro-mechanical engineering from the University of Naples (Napoli).

Matt Lemay is currently an Enterprise Solutions Lead for Advanced Manufacturing. The Enterprise Solutions Lead team is a new group in Customer Success Services, targeted at offering comprehensive and flexible solutions that help Enterprise customers master the FoMT. Matt is a Mechanical Engineer with experience in composites manufacturing (Laser Projection Technologies), as well as additive manufacturing for patient specific surgical implants (ConforMIS). Since joining Autodesk, Matt's role has been aiding Enterprise Manufacturers in adopting Additive Manufacturing technology, through developing services that address the technical knowledge gap. As an Enterprise Business Agreement (EBA) entitlement, customer's can understand their Additive Manufacturing readiness through the Enterprise 3D Printing Maturity Assessment; as well as evangelize new technical mindsets internally through the Additive Manufacturing Fundamental Concepts (learning management system) and the Introduction to Generative Design (learning management system) Outside of professional engagements, Matt is active through the Autodesk Pro-Bono program and has volunteered on advanced manufacturing projects including: Patient Specific Maxillofacial Implant Design (Mexico), and 3D Printed Prosthetics (Uganda).

Nate Moore is an Enterprise Solutions Lead for Autodesk's Customer Success Services group . He has been working to keep Autodesk's largest customers on track with their projects and deliverables for 8+ years. Currently focused on EMEA customers and their infrastructure projects, he sees massive road, rail, waterway and urban projects daily. His educational background includes a B.A. in Geography and a master's degree in GIS.

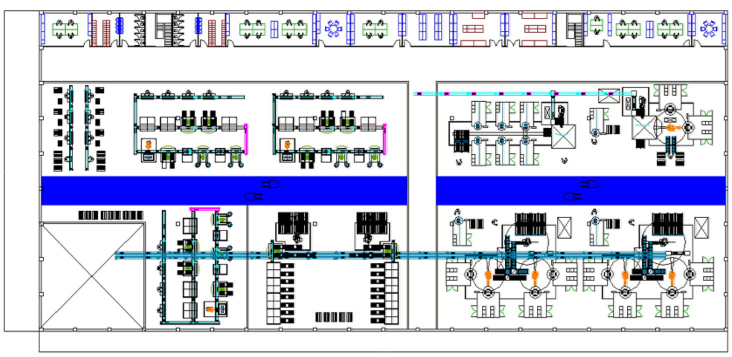
Dave Tyner is an Immersive Technology Lead at Autodesk who's heavily focused on developing interoperable workflows within Autodesk's diverse visualization software portfolio as well as driving awareness/adoption of Autodesk's cross industry VR/AR solutions.

Factory planning

If you want to implement a Manufacturing or Assembly line, whether if you do it in an existing building or in a new building, space is always the biggest issue. So, it's very important to optimize the workflow as much as it's possible and check if it fits in your building.

It's a kind of container where your process needs to fit, but also you need to check if the process you have in mind will allow to reach the production goals. That said, the most efficient way to start with your design is to start with a simulation.

Up until today, AutoCAD is a perfect product to create layouts, used in about 90% of the cases for creating 2D layouts, but there are other aspects to consider when creating Factory layouts.

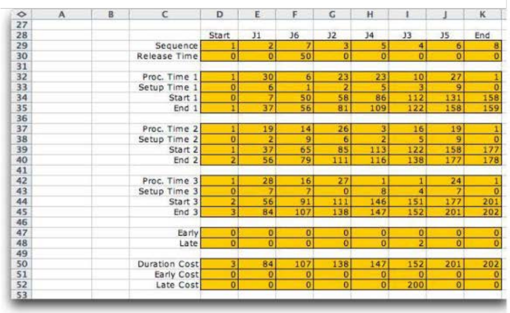


In the Digital Factory approach, we talk about a layout going from 1D to 4D where the 2D layout is only a small part. It is important to clarify you can jump in any "D" you want. So, it's not mandatory to follow the workflow starting from 1 D and ending in 4 D.

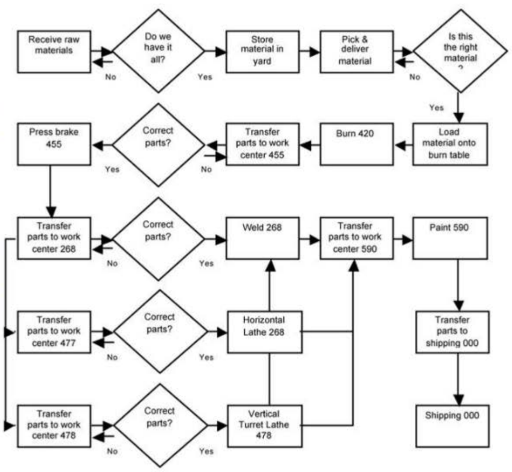
But in this session, we are going to show the complete workflow. The goal is to equip one of the building of an existing Factory with an automated welding cell for welding the frames of little tractors. Of course, we have a target for the frames produced in a work day and we are going to see how to automate this for increasing the production.

1D

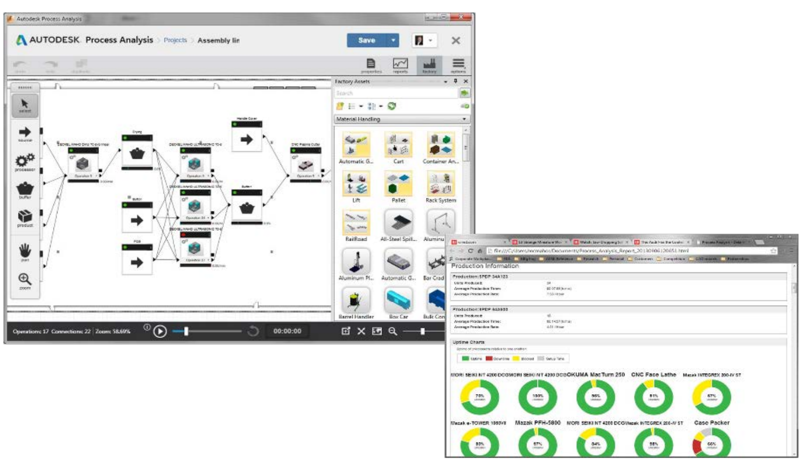
1D is the virtual set up of the process to check and verify if you can obtain the required product at the end of the day.
In this case, in general, the customers use a product flow chart to see the sequence and the path where each product is going. In some cases, besides that, they use excel files that contain all the data related to state of time, machines, machine information, etc. But these are broken processes, separated, not linked to each other.



	Start	J1	J6	J2	J4	J3	J5	End
Sequence	1	2	7	3	5	4	6	8
Release Time	0	0	50	0	0	0	0	0
Proc. Time 1	1	30	6	23	23	10	27	1
Setup Time 1	0	6	1	2	5	3	9	0
Start 1	0	7	50	58	86	112	131	158
End 1	1	37	56	81	109	122	158	159
Proc. Time 2	1	19	14	26	3	16	19	1
Setup Time 2	0	2	9	6	2	5	9	0
Start 2	1	37	65	85	113	122	158	177
End 2	2	56	79	111	116	138	177	178
Proc. Time 3	1	28	16	27	1	1	24	1
Setup Time 3	0	7	7	0	8	4	7	0
Start 3	2	56	91	111	146	151	177	201
End 3	3	84	107	138	147	152	201	202
Early	0	0	0	0	0	0	0	0
Late	0	0	0	0	0	2	0	0
Duration Cost	3	84	107	138	147	152	201	202
Early Cost	0	0	0	0	0	0	0	0
Late Cost	0	0	0	0	0	200	0	0



Instead with Autodesk Process Analysis we have a tool that combines these things. That is, you can create a process layout combined with data and animate it, which means you can quickly verify and detects hiccups in the process, "what if" scenarios, "what if a machine fails for a certain time?", "is there a bypass needed or we need a bigger buffer?", etc. And you can predict all this before even drawing one line.

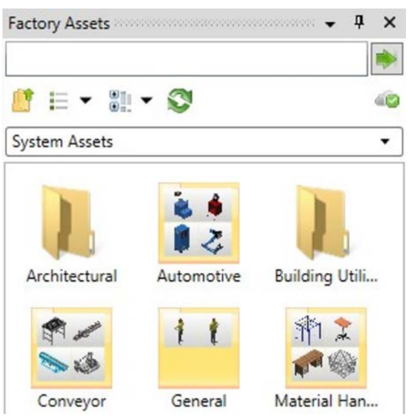


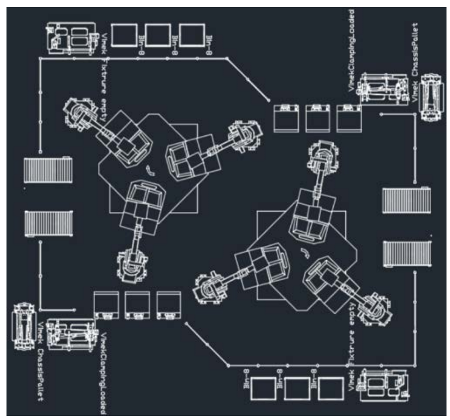
We can start setting up the entire process by dragging in, one by one, the resources and the processors, but, in this case, we will use a faster way loading an excel file.
A kind of template where you can put all the processors, buffers and all intelligence you want and this is a flexible way of working because the content of this file can be populated by

manufacturing people from the machines directly. You don't need to make estimation about the time, for instance, because they can populate the excel sheet with the real numbers, and, this is, of course, more accurate.

	A	B	C	D	E	F	G	H	I	J	K
1	ID	Type	Name								
2	101	0	Part 1	1	1	100	1	60	0.3		
3	102	0	Part 2	1	2	200	1	80	0.2		
4	103	0	Part 3	1	3	200	1	90	0.3		
5	201	1	Vimek Fixture Empty	2	2	80	0.25	60	0.8	0.92	0.2
6	202	1	Vimek Welding Cell	3.5	2	80	0.5	60	0.8	0.92	0.2
7	203	1	Vimek Chasis Pallet	5	2	80	0.5	60	0.8	0.92	0.2
8	401	3	Vimek Chassis Pallet	7	2	300					
9	501	4	Load Parts	201	0.25	0.5	1				
10	502	4	Part 1 - Weld	202	0	1.5	1				
11	503	4	Part 2 - Weld	202	0	1.5	1				
12	504	4	Part 3 - Weld	202	0	2	1				
13	505	4	Unload Chassis	203	0.25	1	1				
14	601	5	Part 1 - Fixture	101	201	0	0	120	0.25	1	1
15	602	5	Part 2 - Fixture	102	201	0	0	120	0.3	1	1
16	603	5	Part 3 - Fixture	103	201	0	0	120	0.5	1	1
17	604	5	Fixture - Welding Cell	201	202	0	0	240	0.5	1	1
18	605	5	Welding Cell - Unload	504	203	0	0	360	0.5	1	1
19	607	5	Send to Shipping	203	401	0	0	240	0.5	1	1

Already in the virtual setup stage, we can start using the Factory Asset Library that is the backbone of the Factory utilities.

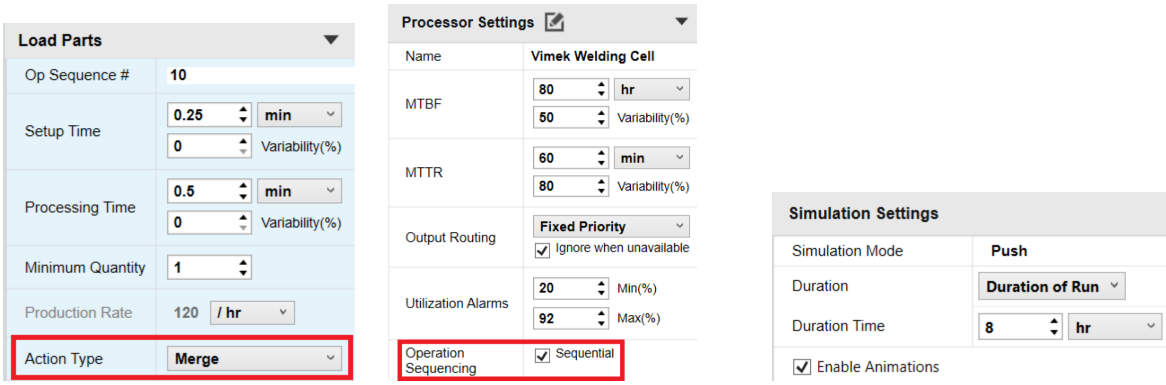




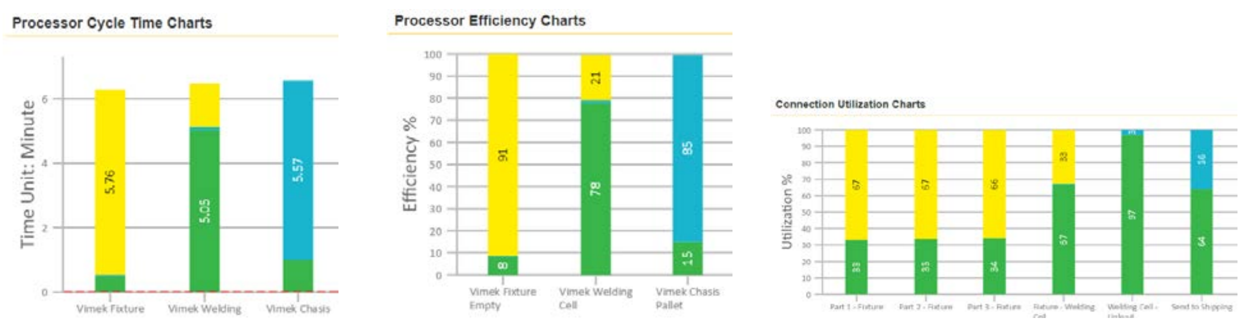
This is a shared asset library that contains 2D/3D information about the machines, about the assets you're going to use in your layout. This library is shared across the 1D – 2D and 3D environments and besides the standard ones, you can publish your custom assets that can be stored locally, or shared in a location defined in the Inventor project and in Vault, or can be also published on the cloud.

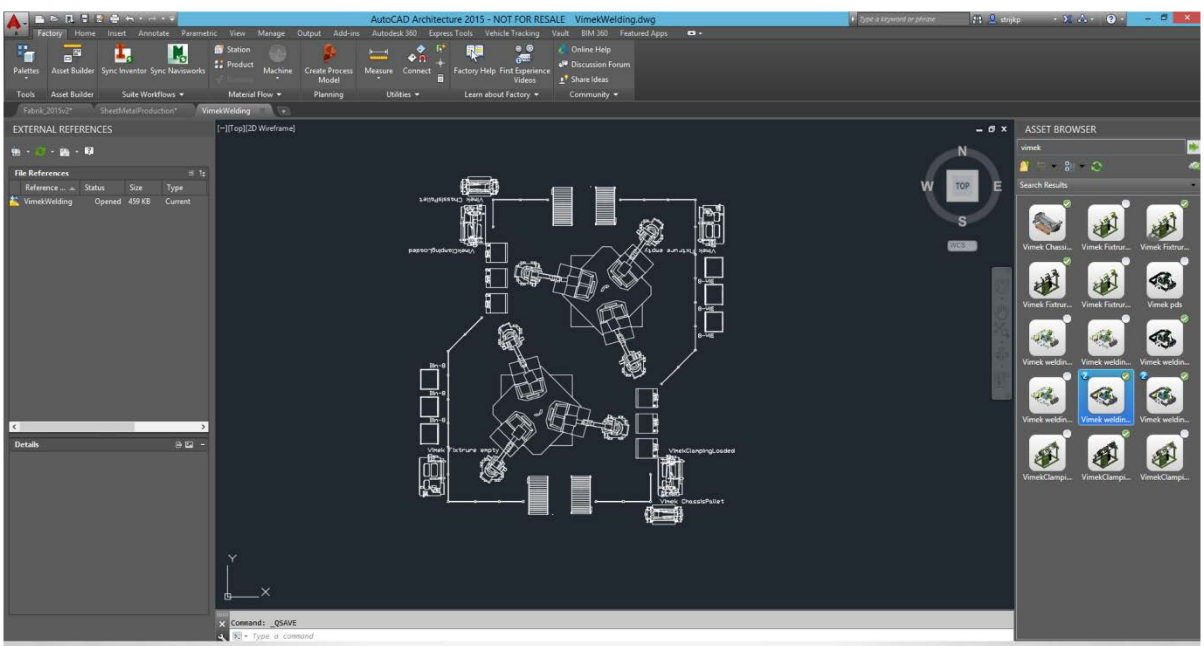
So, if I want to convert the result of the analysis to a 2D layout that contains already the information related to the machines, I need to map the right machines to the right process to get it done.

Then, I need to communicate to Process Analysis, we have three sheet metal parts that need to be assembled on a welding frame, so the property for this processor need to have an assemble option, merge. Then, we move to the Welding cell, that, in this case it's a three-stage welding process, and these is a sequential process, and I can set this in the properties as well.



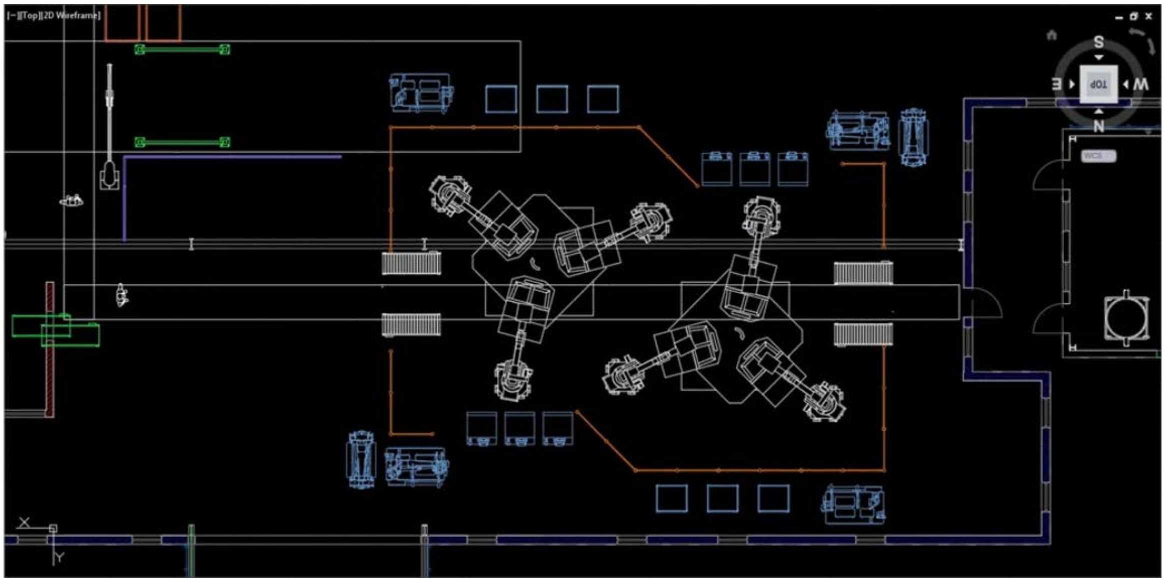
Finally, let's see now how many parts we can produce in 8 hours and how to optimize the process for reaching my daily production target. Once I'm satisfied with the simulation results, I can export the report of my analysis and sharing it with other stakeholders, and, finally export this information to AutoCAD creating a dwg file.





2D

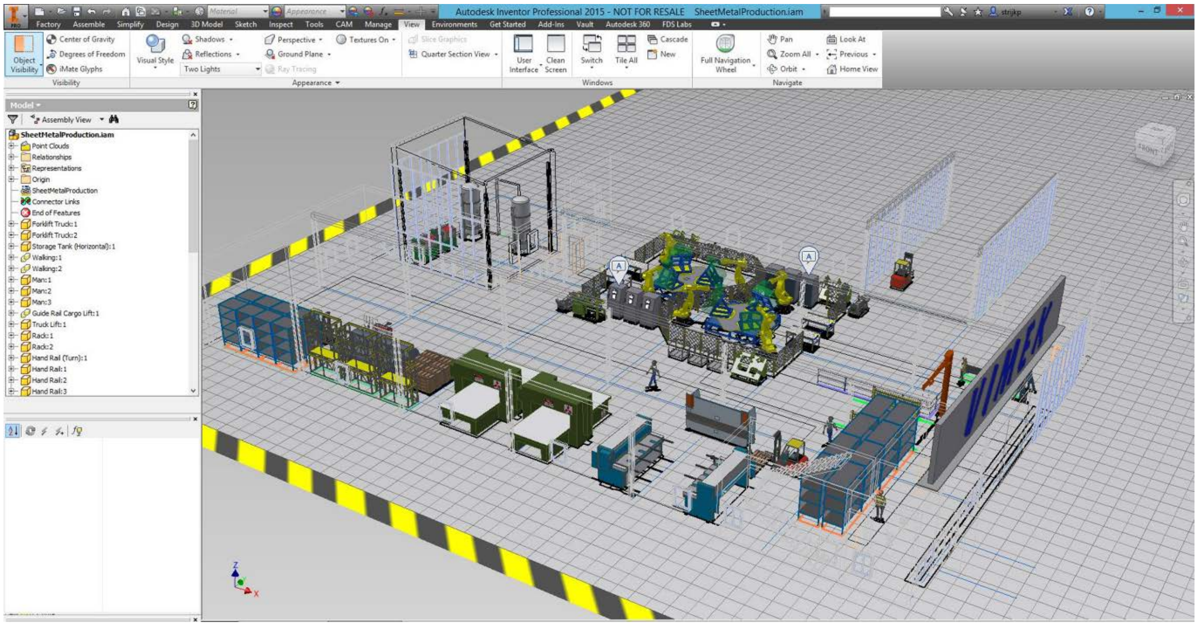
In AutoCAD, I insert the dwg file exported from Process Analysis as xref in the existing layout of the facility and I position it where I want to put the new welding cell, approximately.

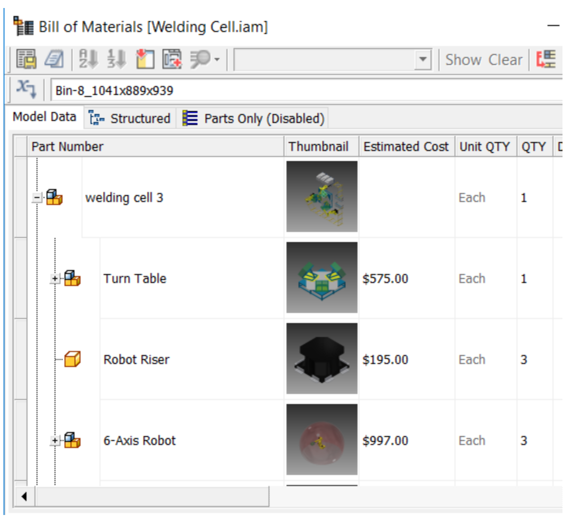


If I need, I can add additional assets from the same Factory Asset Library I have used in Process Analysis for mapping the right machines to the right buffers, processor, etc.

3D

As I wrote at the beginning, nowadays, in most of the cases the Factory design is just done in 2D, but, as you can see, in my story the 2D is just a small part, because, in my opinion, 3D is more powerful to work in.
I can very easily convert 2D layout in 3D layout, bidirectionally, that is, I can make changes or adding equipment in 3D and reflect them back in the 2D layout and vice versa So, my next goal is to have the welding cell in the facility as in the image below.
Converting this 2D layout to 3D is very simple. I just need to click on the Sync Inventor button and the blocks will be converted in 3D models. I can insert additional assets from the same library I've used in the 1D and 2D environment, and now in 3D.
Once I have the 3D model of the Factory in Inventor, I get as well the Bill of Materials that lists the exact numbers of the machines used in the layout directly from the Process Analysis simulation, and I can, of course, generate drawings and relative Parts Lists and balloons.

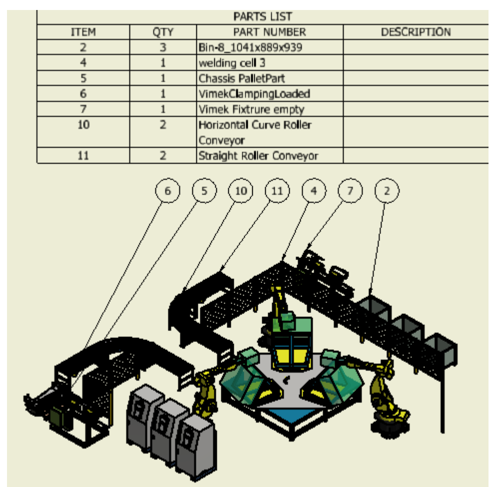



Bill of Materials [Welding Cell.iam]

Bin-8_1041x889x939

Model Data | Structured | Parts Only (Disabled)

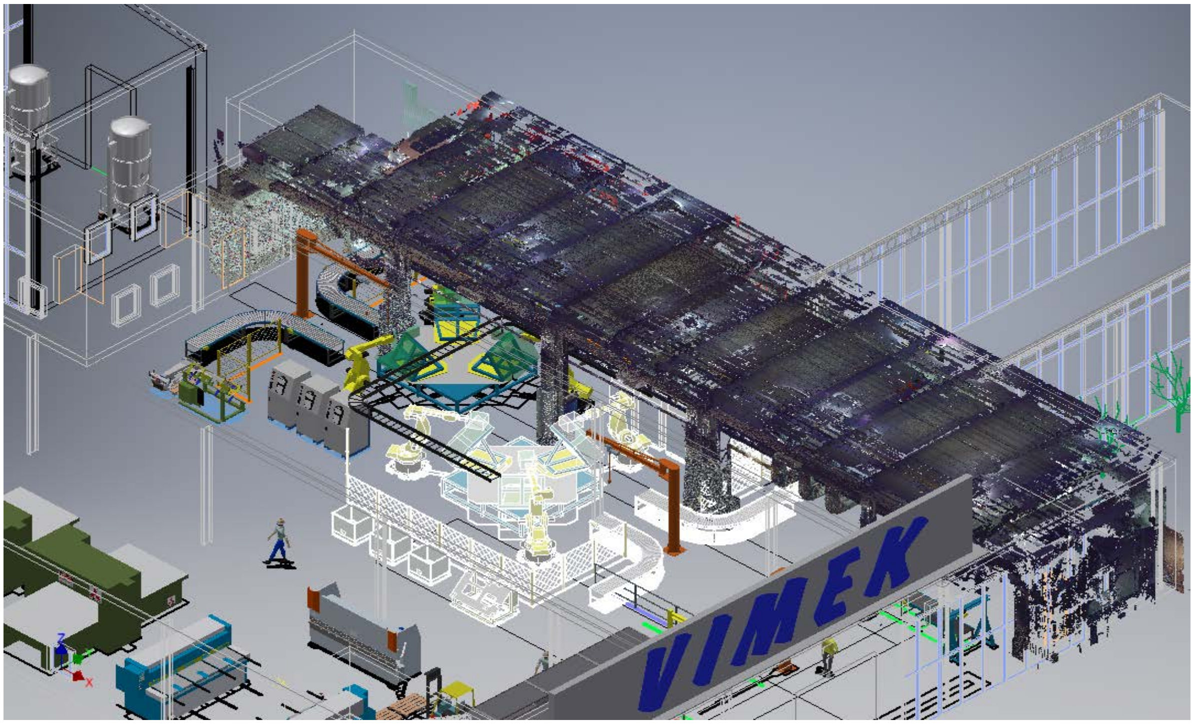
Part Number	Thumbnail	Estimated Cost	Unit QTY	QTY
welding cell 3			Each	1
Turn Table		$575.00	Each	1
Robot Riser		$195.00	Each	3
6-Axis Robot		$997.00	Each	3


PARTS LIST

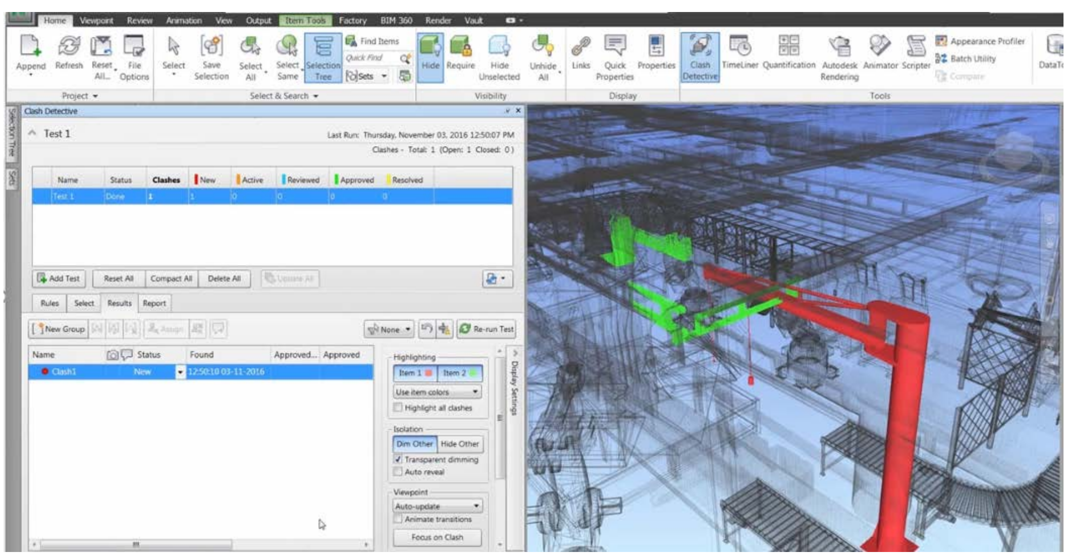
ITEM	QTY	PART NUMBER	DESCRIPTION
2	3	Bin-8_1041x889x939	
4	1	welding cell 3	
5	1	Chassis PalletPart	
6	1	VimekClampingLoaded	
7	1	Vimek Fixtrure empty	
10	2	Horizontal Curve Roller Conveyor	
11	2	Straight Roller Conveyor	

Finally, with a single click, I can sync all I've modified or added in the 3D environment, back to 2D, and I can keep on doing that, if I want to keep the 2D layout and the 3D model in sync.

Another thing I can do in 3D is to check if the new welding cell collides with the existing as-build situation. For doing that, we can make a scan of the interior of the building and insert it in Inventor. Before doing that, we can edit the scan with ReCap, cleaning it and creating regions, so that I can control the visibility of what I need to see.



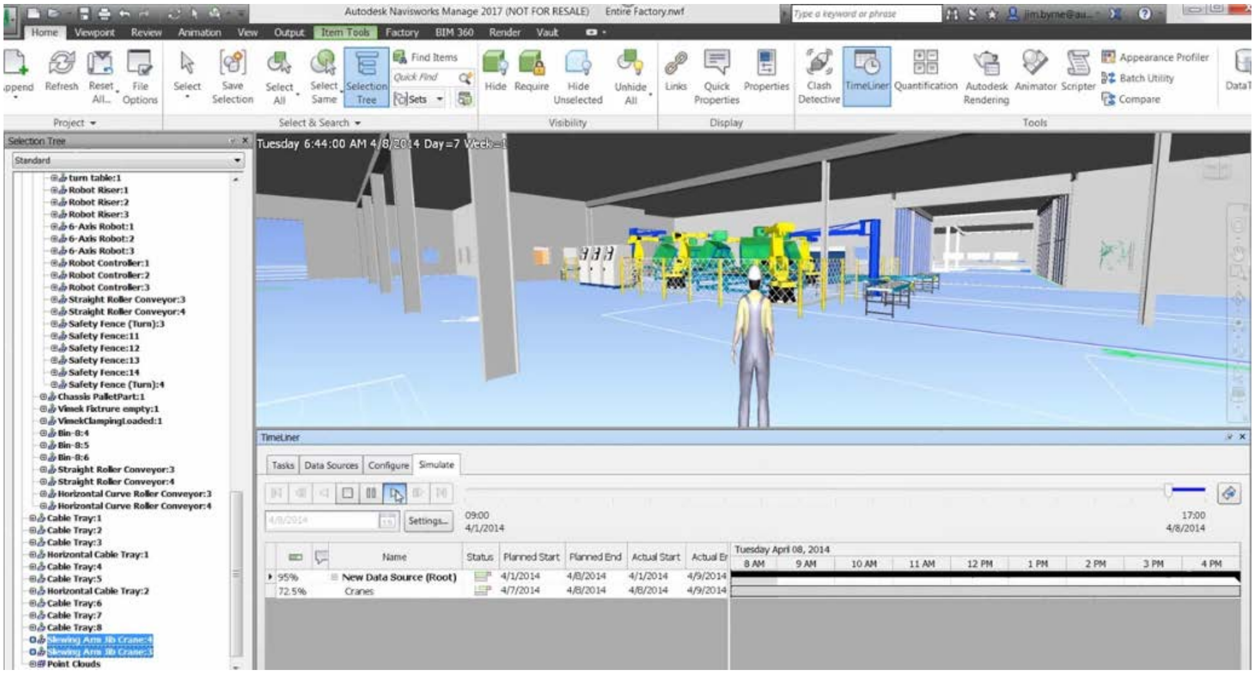
After that, with one click, I can sync my 3D model from Inventor to Navisworks where I can make walkthrough, define viewpoints, and so on, but I can also check the collision between the existing as-build situation, including the point cloud and the equipment we have positioned in the layout.
Something to notice is that the tool doesn't consider the point cloud as one big entities, but highlight zones in the point cloud.



Once I detect the collision in Navisworks, I use the Switch Back tool that allows me to go back to the software that contains the information where you can fix the problem editing few parameters, because Navisworks is not a CAD system, but a mockup tool and it doesn't contain parameters. After that, I can easily switch back to Navisworks and verify the collision is fixed. And you can repeat the process for the fixing the other collisions or accept the ones that are not collisions.

4D

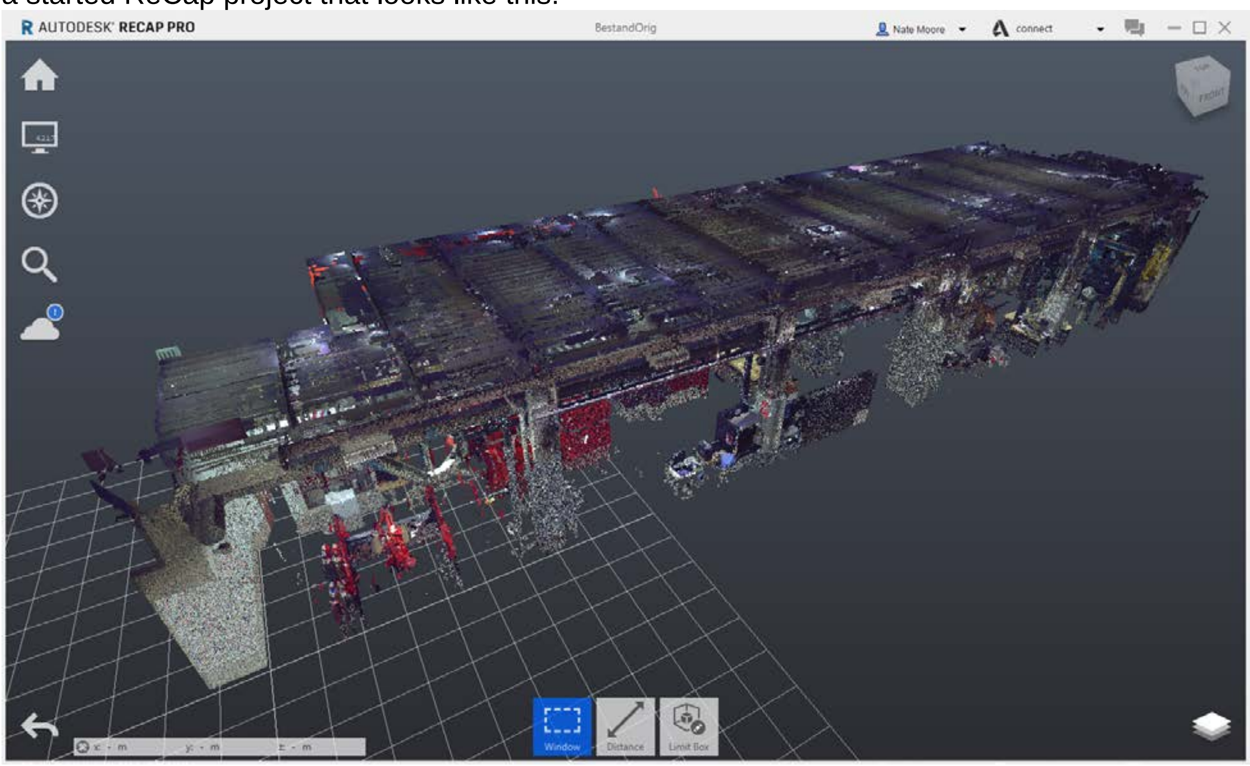
So finally, we reached the end of the story. Let's talk briefly about the 4D, where the fourth D is the time.
That means you can create a timeline and define which component will be implemented on a certain time and date.
You can do it manually, but, for big project we reuse data that come from Microsoft Project or Primavera that are managed by project managers. You can import this information and link it to the facility. You can make then manual adjustments or working with routines.
Finally, you can run the timeline simulation with these settings, record this information and share it with other stakeholders of the project.



Reality Capture

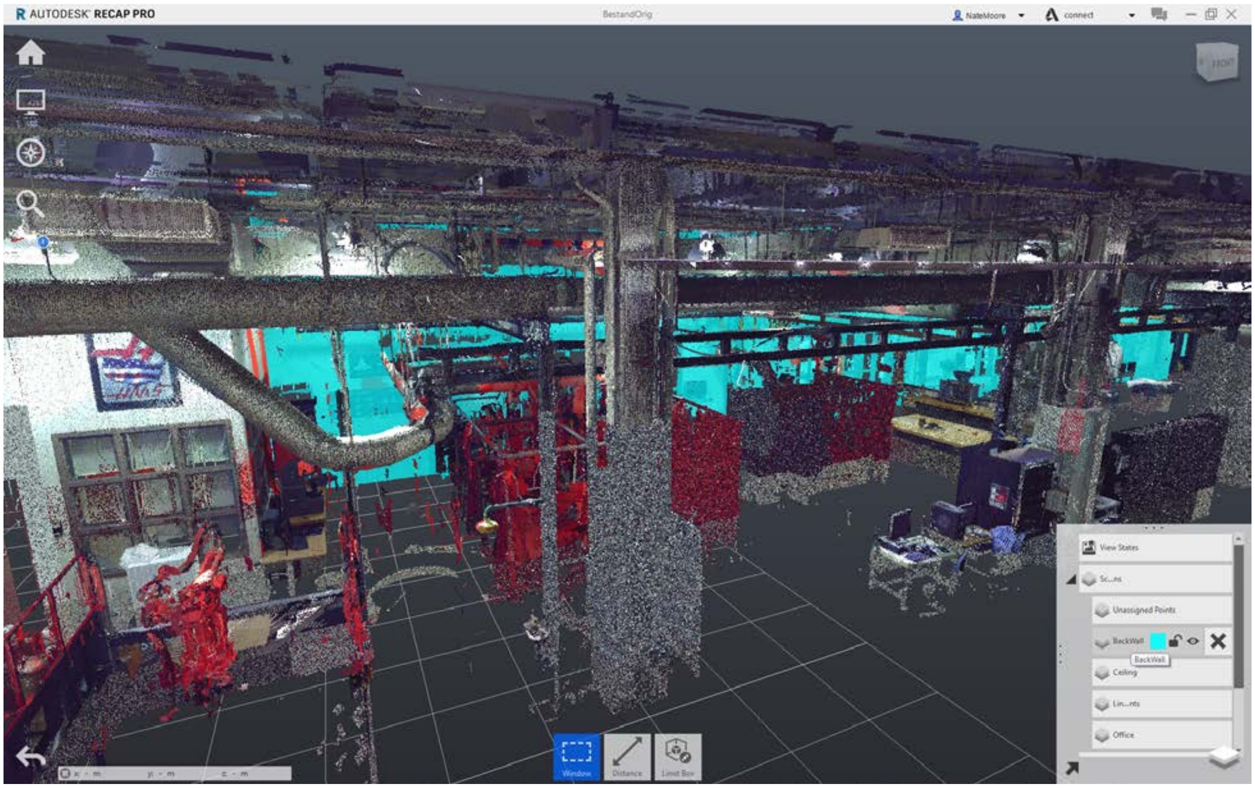
To this point, you've seen the point cloud in action already, but likely want to know more about what it is and how to work with it. ReCap will be the main tool that we work with, once the data is collected. The actual collection of the point cloud requires a laser scanner, sometimes called LIDAR, that does that actual measurement using a laser beam. This hardware has traditionally been quite expensive, but is getting to be more affordable. As a result, in the past, this work has mostly been done by specialty sub-contractors, but more and more is being easier, faster, and cheaper, to the point that you should consider whether it would make sense to do it in-house.

While ReCap does a great job of combining multiple sets of raw scan data into a single project, we're not going to go into that today. Instead, we'll assume that some other team has given you a started ReCap project that looks like this:



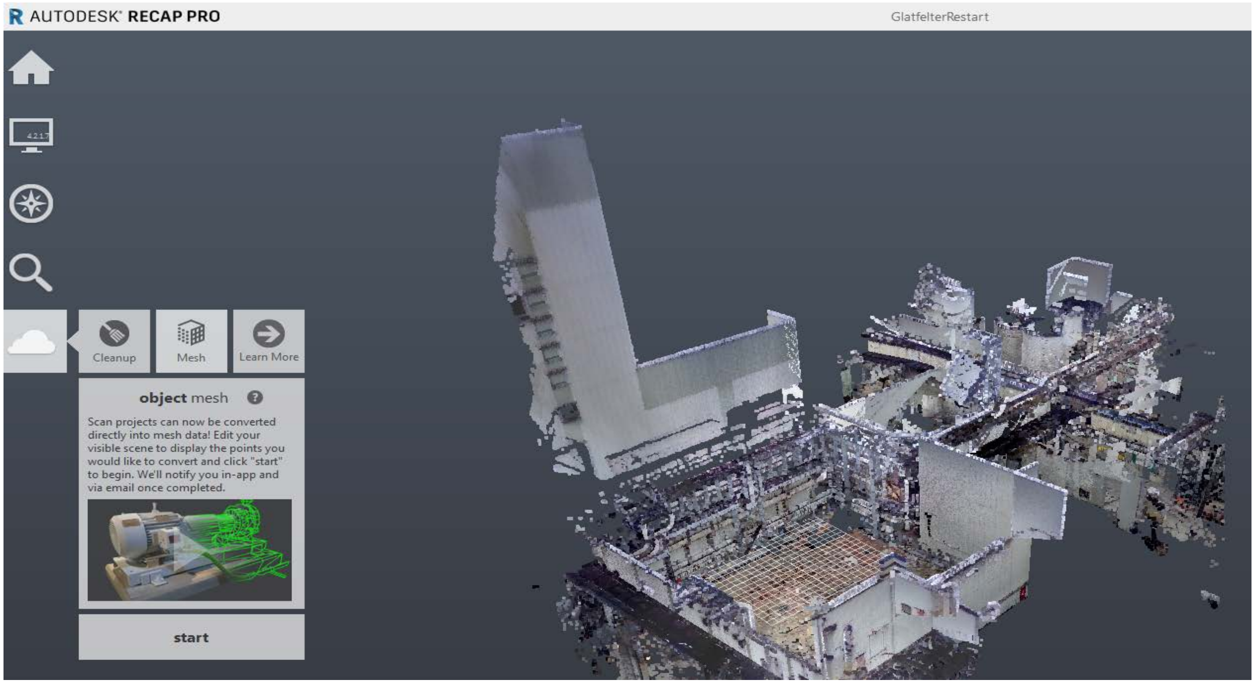
A lot of the hard work of cleaning this up has already been done. The first draft would have included people, objects outside the windows, etc. However, to best see all the relevant parts of the project, it will be much easier to work with regions. Regions allow you to create separate sets of points that can be individually turned on and off. Regions are created using selection windows in ReCap, or can also be created in Navisworks and exported via csv.

With regions, as below, you can then really keep the separate components of the scan separated and controllable, such as this view with only the back wall of the factory separated in a region (blue):

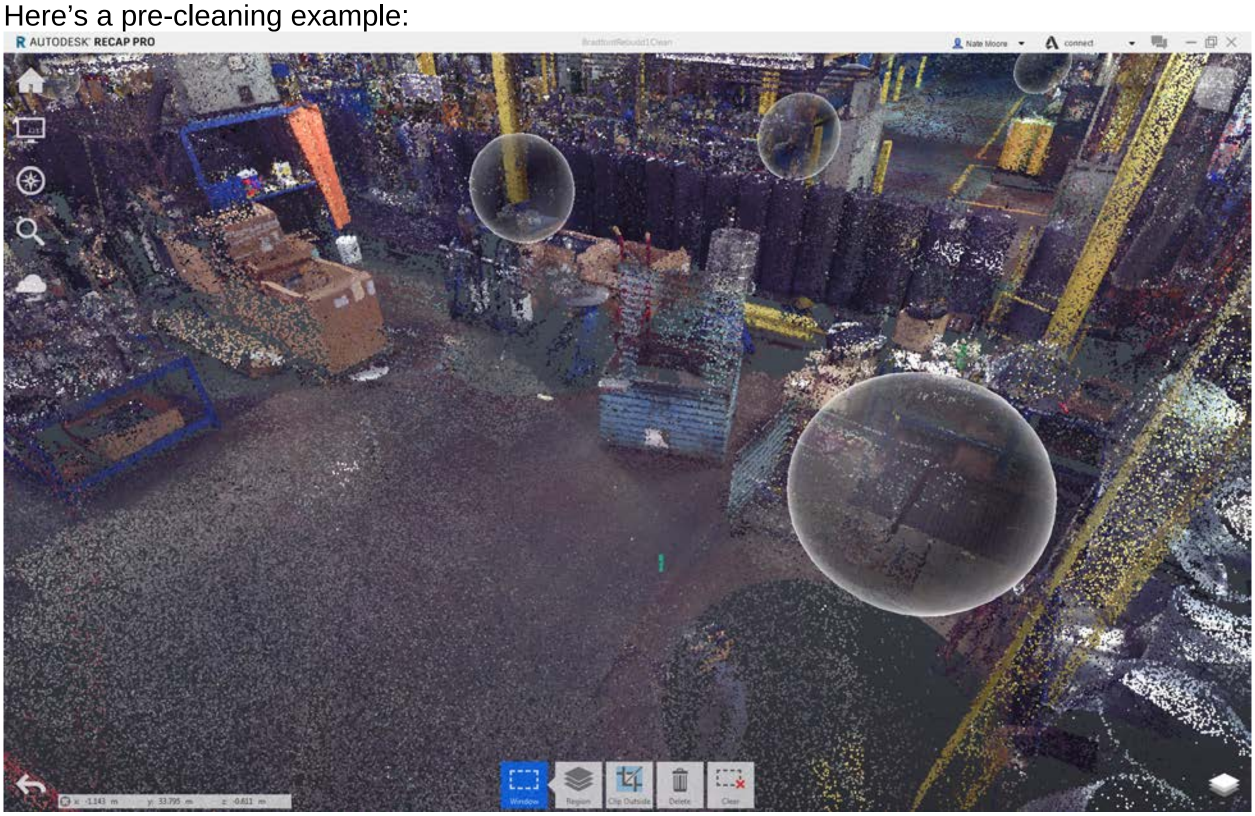


Note that you do have to be a bit careful when creating windows for region selection – the boundaries extend infinitely far, so its important to be aware of what's in the background, even the distant background. For this reason, I recommend creating a few very large regions initially if you are working with large facilties.

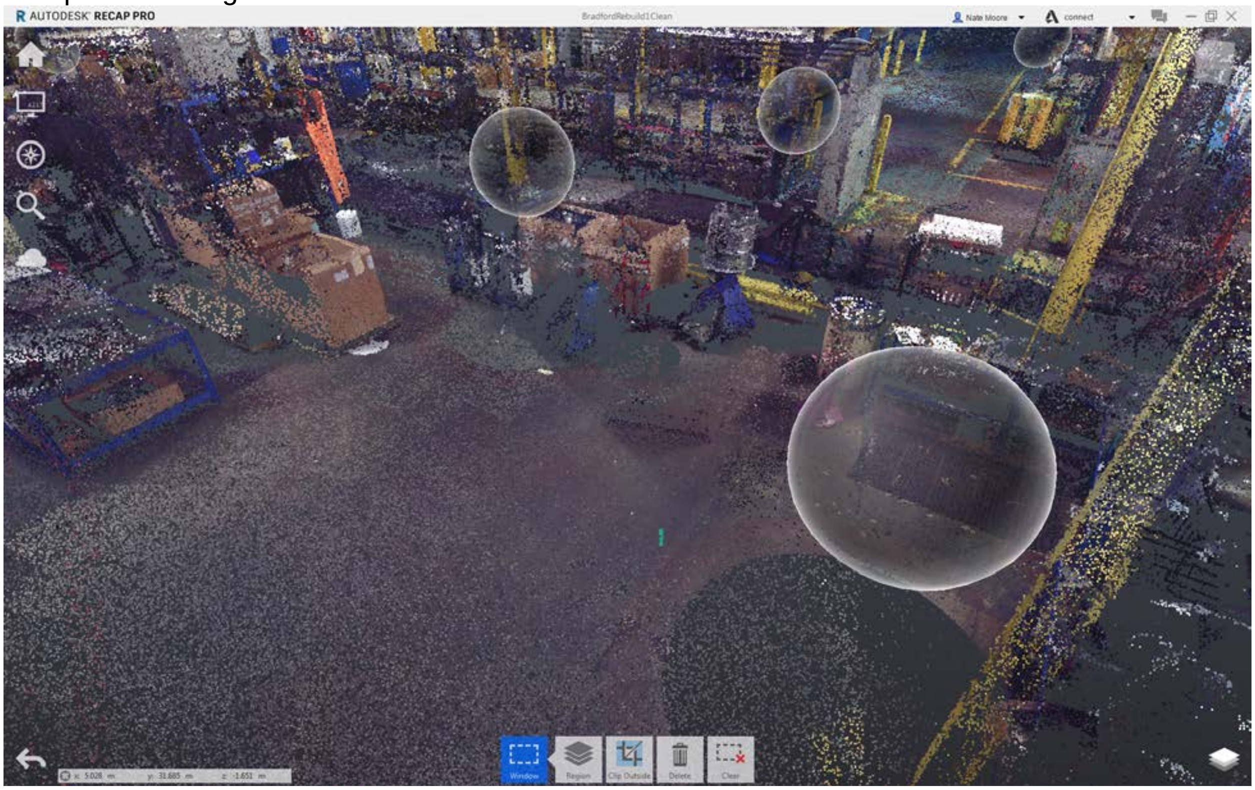
When you are working with a scan, it can be either an unstructured or a structured scan. A structured scan is one that has the registration (the details of how each scan relates to its neighbors), and gives you some additional options in ReCap. An unstructured scan is generally one that has already been cleaned up and unified in another software. With a structured scan you get two primary benefits: the option to clean up, and the option to mesh a scan.



Here's a pre-cleaning example:



And post-cleaning:



This function leverages the relative positions of the scans, and checks for differences in the content between scans, and does a great job of removing people, vehicles, and moved objects, which generally won't be necessary for your final result. The cleaned points are stored in their own regions, so are easily accessible.

Meshing is a little more challenging to use, but can give great results. Here's an example scan from a nightclub and the resulting mesh. You can see the geometry isn't perfect for every feature, but the overall result for the major faces works very nicely. You are limited to a cube that is 30 m on a side (100 ft). Prior releases could only handle 20 scans in the project, but now you just need to turn off scans until the total number is 20 or fewer.

Scan:

Mesh:

Not mentioned yet is that ReCap excels at scan registration – its well worth testing it out to see if that could be a way to simplify your workflow. Otherwise, it's a great cleanup and data prep tool, and thanks to the indexing that it performs, you'll find that the rcp is recognized by all other Autodesk software and performs well with scans of all sizes.