MFG 12102

Large Scale Projects with FDS

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Learning Objectives

- Learn how to set up a large-scale project
- Learn how to use laser scan results
- Learn how to use building data sets from Revit
- Learn how to implement data management best practices

Description

Think you have a large-scale project? This class will show how to use Factory Design Suite software to plan, design, and build manufacturing spaces in excess of 1-million square footage. Learn how to set up a project for multiple users to interact with, how to capitalize on laser scan data, how to import/export building information from Revit software, and techniques for achieving required product performance on large data sets.

Your AU Expert

Mike Jolicoeur has over 28 years of experience in manufacturing within large accounts in workflow, software applications, and consulting services. In his 17 1/2 years with Autodesk, Inc., Mike has worked in technical sales and solutions, and in product development for the Factory Design Suite set of tools. Mike has hands-on experience with a myriad of software offerings.

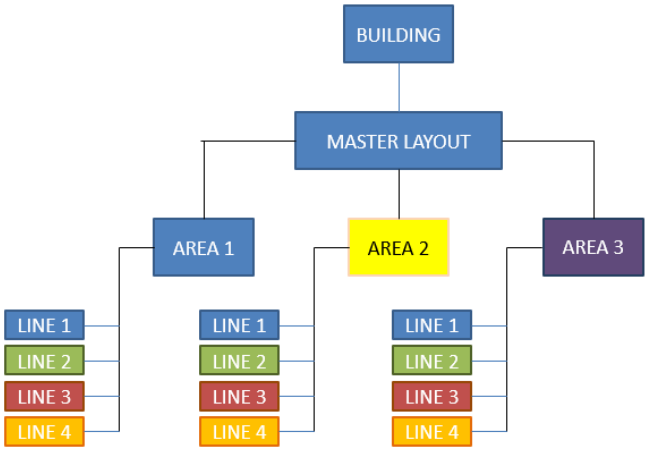
Setting up your large scale project

The basics

A factory project is a bit different than most projects. It is a blend of architecture and manufacturing – the architectural being the building that contains the manufacturing process and manufacturing being the equipment that is producing the products themselves – as well as the process of manufacturing. There are a few basic components that you will need to be successful. These would be a good DWG structure and lightweight assets.

DWG structure – your roadmap to success

A well laid out drawing structure will allow you to build out an efficient layout that can be worked on by several teams at once. The structure consists of a master file, building files, and the equipment layouts. When properly structured, a project can be easily managed by a tool like vault. In addition, building out the layout in this fashion ensures a consistent 0,0 origin – so everything goes where it should, and any update reflects in the layout and is updated as the plan changes and matures.



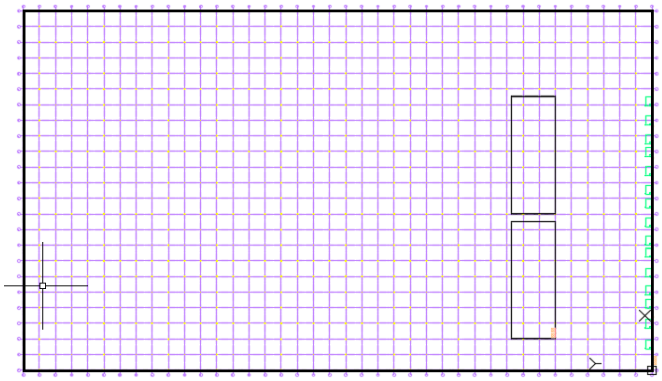
The Master Layout

The master represents the "container" for our entire project. It is a DWG file that contains XREFS of the files listed below.

The Building

The building represents the outside boundaries for our project. In the case of a "green field" project this may include the site and the new design for the building. In the case of a "brown field" this would include a drawing of the existing site that is being retrofitted. The building includes:

- Structural Plan View – shows where the columns are, has the column grid. Shows door openings and monuments inside of the building. This is a 2D DWG file that we will use as our overall map for the project.
- This can either be exported from Revit as a DWG file or can be a native DWG file.

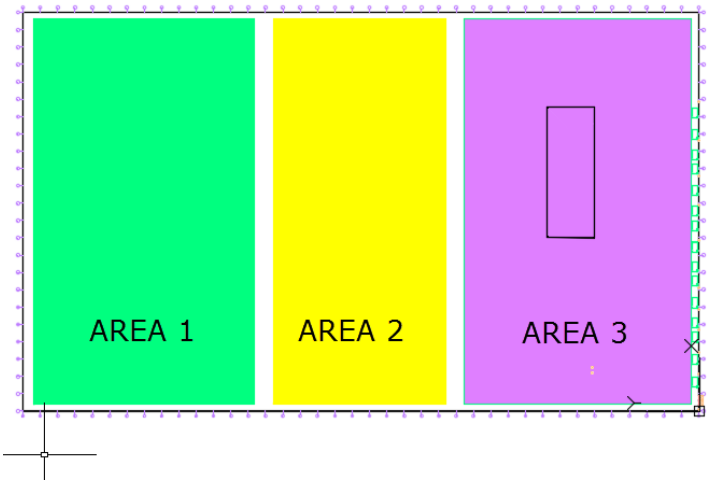


I highly recommend putting the main aisle layout in the building view, but I would recommend putting this on a DWG layer of its own to allow it to be turned on and off. You will be using this building file in several parts of the workflow as a reference.

Any other object that would be seen at floor level (roof drain floor penetrations, fire system risers, pits, stairways, etc.) should be shown as well. If required you can put in above floor level detail such as HVAC, piping, etc. but again I recommend you put these on their own layer. For most general layout purposes, we would not show them as they would clutter the layout drawing.

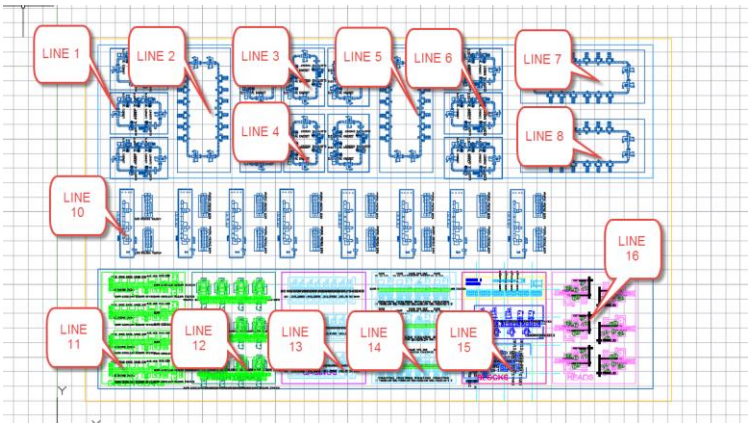
General Area Layouts

With larger plants it may be desirable to break the plant into areas of interest. Area 1, 2 and 3 represent these. In the case of an automotive account, this might be rough machining, finish machining, assembly. Note that this could be several areas.



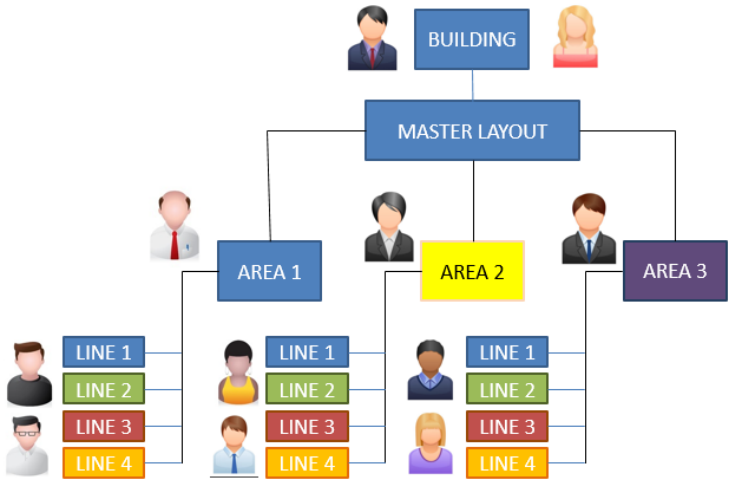
The Equipment Layouts

The equipment, or line layouts, are representations of production lines within the plant – or areas of equipment within the plant. It is a good practice also to break groups of the equipment up as well. This way you have manageable sized layouts that are much easier to navigate.



Putting it all together

Although 3D is our destination, 2D in AutoCAD is the best way to set it all up to work. Utilizing a 2D strategy to map out where everything will go lines up where everything resides in 3D. The AutoCAD coordinates will control where everything drops into place when you build the 3D viewable. With the Sync To Navisworks command you may not need to utilize Inventor if the layouts are one level and fairly simple in nature – your 3d Navisworks viewable of the line is created automatically. The best part is you can use workflows that are very similar to how you or your layout personnel are used to working in AutoCAD today – and the work can be easily divided up so a larger team can work concurrently.



Which tools for which task?
Factory Design Suite offers several tools that can be used to streamline a multitude of tasks, reduce errors, and all in all reduce the time it takes to create a layout. Here is a quick breakdown of the tools and where you would use them.

AutoCAD (Architecture or Mechanical)
AutoCAD is the tool of choice for most folks doing layout today. It is easy to use once standards are set up and very familiar for most doing this sort of work. Although AutoCAD can do 3D work, in the factory space is it primarily a 2D tool. All library components that are in the AutoCAD library have 3D counterparts and 3D versions of layouts are created upon sync. In our workflow, we utilize AutoCAD in the following ways:

- Overall layout map
- Locations of lines (0,0 coordinate lineup)
- Rapid line rough layout
- 2D plan documentation

Inventor
Inventor provides the 3D design component of the suite. As it is parametric, the plant objects (or assets) can be made to change size and represent families of components as required. Manufacturing areas and lines can be further detailed in 3D. An important note – Inventor is NOT the tool for displaying the entire plant in 3D. In our workflow, Inventor is utilized in the following ways:

- Creation of library objects (assets)
- Designs where Z dimension placement and alignment are critical (objects not on the floor)
- Checking for interference with data gathered via laser scan
- Designing in context of the laser scan data
- Creation of Bill of Equipment

Navisworks
Navisworks is responsible for 3D viewing and design review. It is used for:

- Aggregation of all of the data
- Clash detection
- 3D design review and markup
- 4D timelining of the installation process

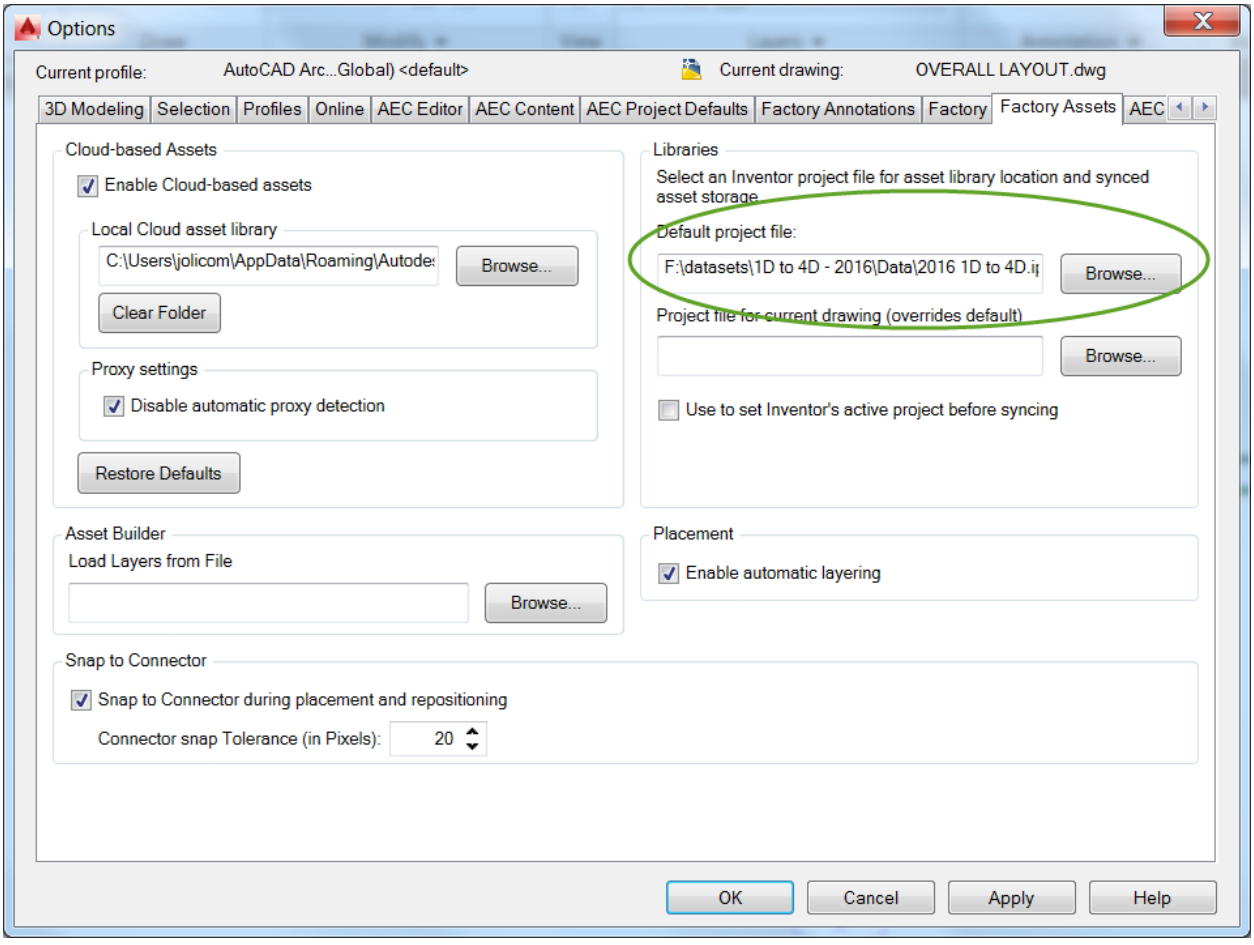
Getting started – Inventor project file.

The very first thing you need to do before embarking on this journey – set up a project file for your layout project in Inventor. (If you are using Vault this should already be set up.) This will tell the application where to save files and where to look for insertion of other files. In addition it will tell Inventor which asset library to use. For this class I have created one called **2016 1D to 4D.ipj.**

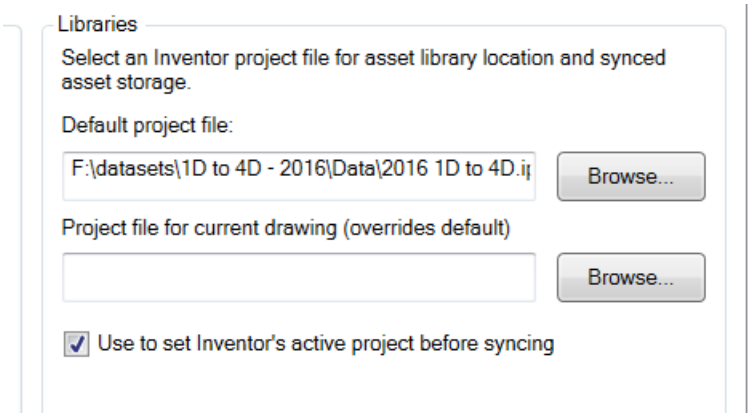
Getting started – settings for Factory in AutoCAD.
Factory settings are located in the AutoCAD options – which can be accessed by right click in the command line and selecting options.

The first thing you will want to set is the project file – this tells AutoCAD how to interact with Inventor for things like the asset library. It needs to match the Inventor project file.

Factory settings are located in the AutoCAD options – which can be accessed by right click in the command line and selecting options.



Make sure the active project box is checked as well. This will eliminate a lot of headaches down the road for you.



Creating the master layout

The master layout is the holding place for all of the data – it would be the place you would go if you were looking to plot out an entire plant, for example. It contains all of the puzzle pieces that were provided – the building, the layout areas, and the production lines themselves. There are a few things to consider when creating the master layout.

Consideration 1:

Which AutoCAD? As FDS ships with AutoCAD Architecture, AutoCAD Mechanical, and AutoCAD MEP – it is important to select which AutoCAD you will be using. For this class I will be using AutoCAD Architecture as it provides me a nice set of tools for creation of walls, doors, column grids, etc.

Consideration 2:

Units. Though FDS can handle data from either metric or imperial, I recommend selecting one or the other and sticking with that. It makes things much easier to understand down the road.

Once you have decided on units it is not a bad idea to set the overall annotation scales for the DWG file. That way your drawing text looks the way it should when all of the pieces are put together. I typically use annotation scaling functionality in AutoCAD. Load all of your required linetypes also.

Consideration 3:

Where is 0,0,0? As all of your line layouts will key off of this 0,0,0 – it is important that this coordinate is referenced in all of the layouts. In the examples that follow I will outline how to do this.

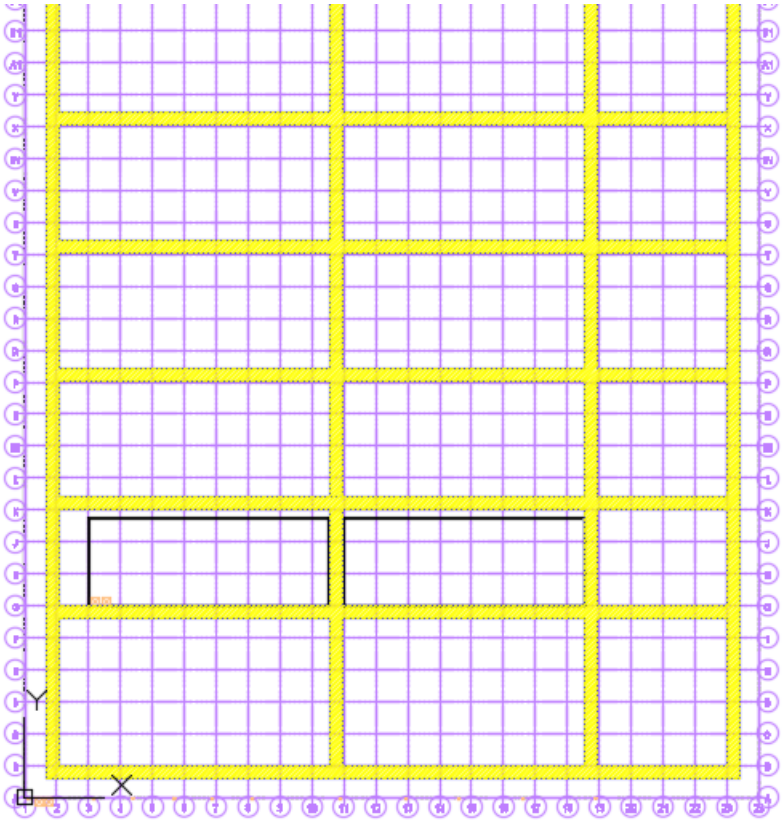
You should also set all other template variables that you'd normally use for AutoCAD layouts – such as layers, dimension and text styles, etc. Save this file off as a template.

Preparing the building file

For our use in the 2D layout environment, our primary concern is all things "floor related". Think of it as taking a slice of the building at approximately 500 mm off of the floor – everything you see from there down. Important considerations are:

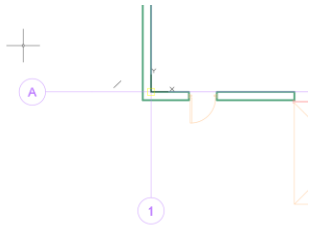
- Building walls, doors, openings, and columns
- Main aisles in the plant
- Any monument which cannot be easily moved without major construction
- The column grid

The doors and the column grid, as well as the columns, are placed on AutoCAD Architecture specified layers. I recommend putting the aisles on a layer as well.



Set the insertion point of the building as 0,0,0.
You may use any point within the building as the 0,0,0 point – I typically use the center of the southwest column – the A1 column – as the building insert point or 0,0,0 coordinate. At the command prompt, type in line, and 0,0,0 as the starting point – set the end point anywhere convenient. If the 0,0,0 point is anywhere other than the center intersection of the desired 0,0,0 (in my case the center of A1 column) you can either:

a. Set a user coordinate system to reference the point as 0,0,0
b. Move the building to that point, selecting the center of the column as the move start point and 0,0,0 as the end point.



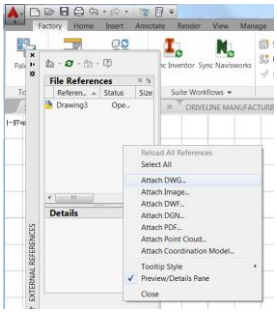
Set the units.
As mentioned earlier, it is preferable to work in a consistent unit system. It does not matter if it is imperial or metric – just choose one. For this class we will use metric units.

Save the file.
For the purposes of this class and for the sake of simplicity, we will save everything in a single sub-directory. You may use any file organization you see fit – but keep in mind that you will be making heavy use of X-References so path becomes important if you are sharing the file with others. Also keep in mind that if you are using Vault (recommended) you can re-structure the data any way you wish after it is checked in.

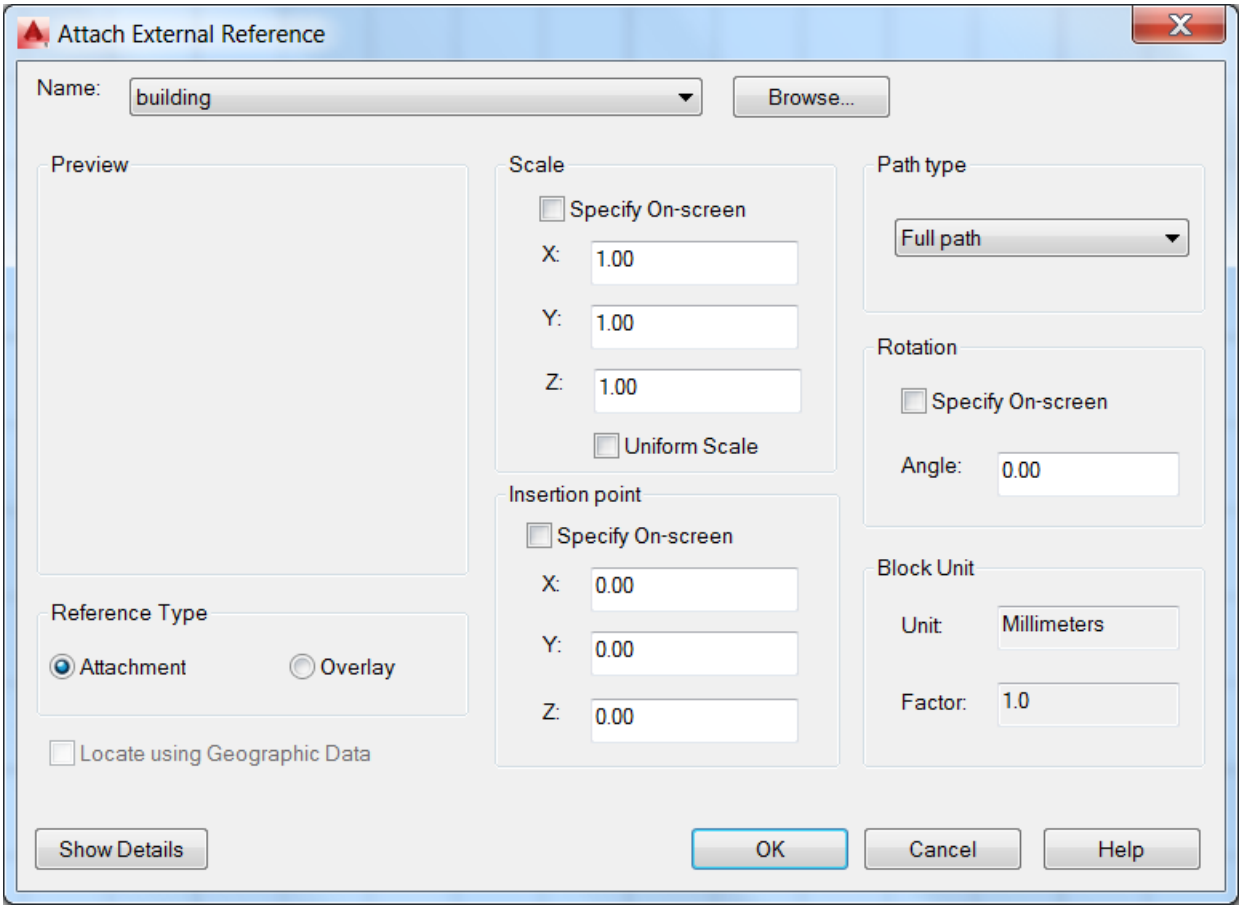
Building out the master file

Step 1. Insert the building file.

1. Select XREF. Right click in the pane and select attach drawing.



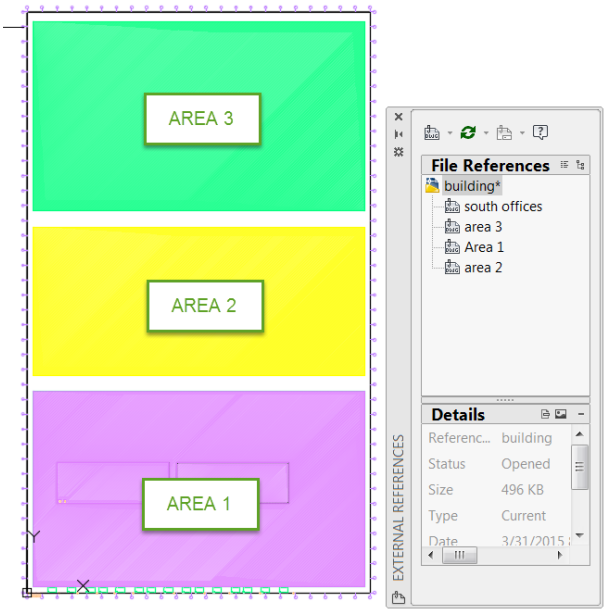
2. Select your building. Set all options as shown below.



Step 2. Create the areas.

Once the building is in place, you can begin breaking it down into areas. I draw a simple rectangle around what I want to represent as an area. I typically put this on a layer as well.

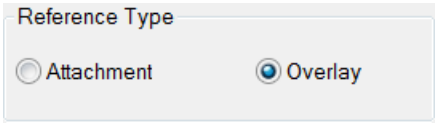
You will now want to WBLOCK the rectangle out, using 0,0,0 as the insert point when you save it – and then XREF it back into the drawing, at 0,0,0. Do this with each area.

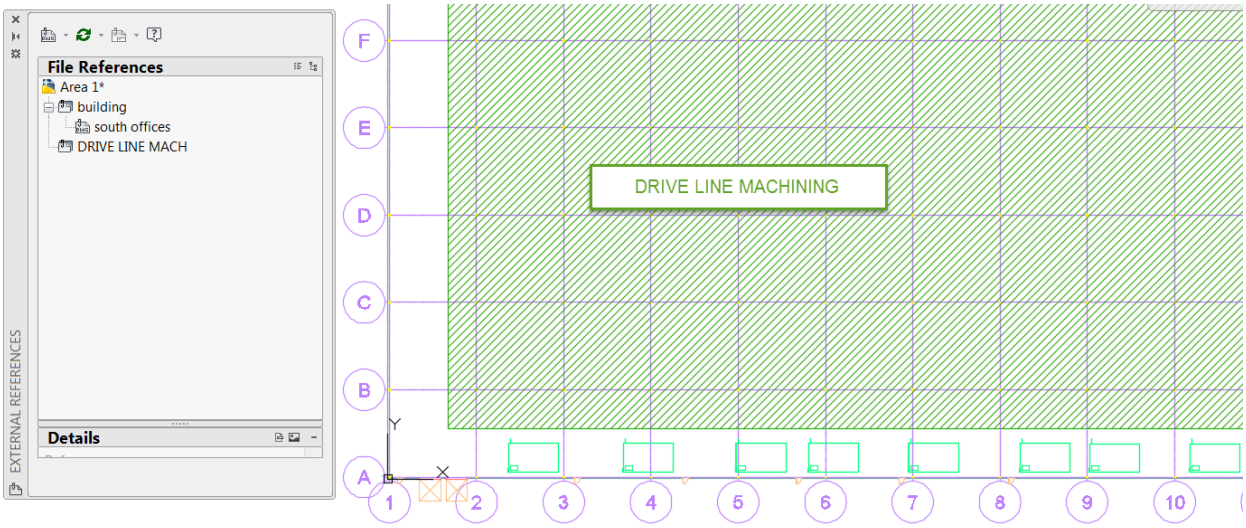


From here it becomes very easy to work as a group. Instead of opening the upper level master file to work, you open the area you are interested in. In this example I will open Area 1.

Once the file is opened, you'll see a rectangle representing the area. We would also want to see the building columns, aisles, grids, etc. Utilizing XREF for this allows you to see the building file in reference within that file. Again, right click in the left pane and select attach drawing – but we will be using a different setting than we used before - rather than using the ATTACH function we will use OVERLAY instead – that way the building is merely displayed for our reference in the Area 1 file but will not display in the master layout.

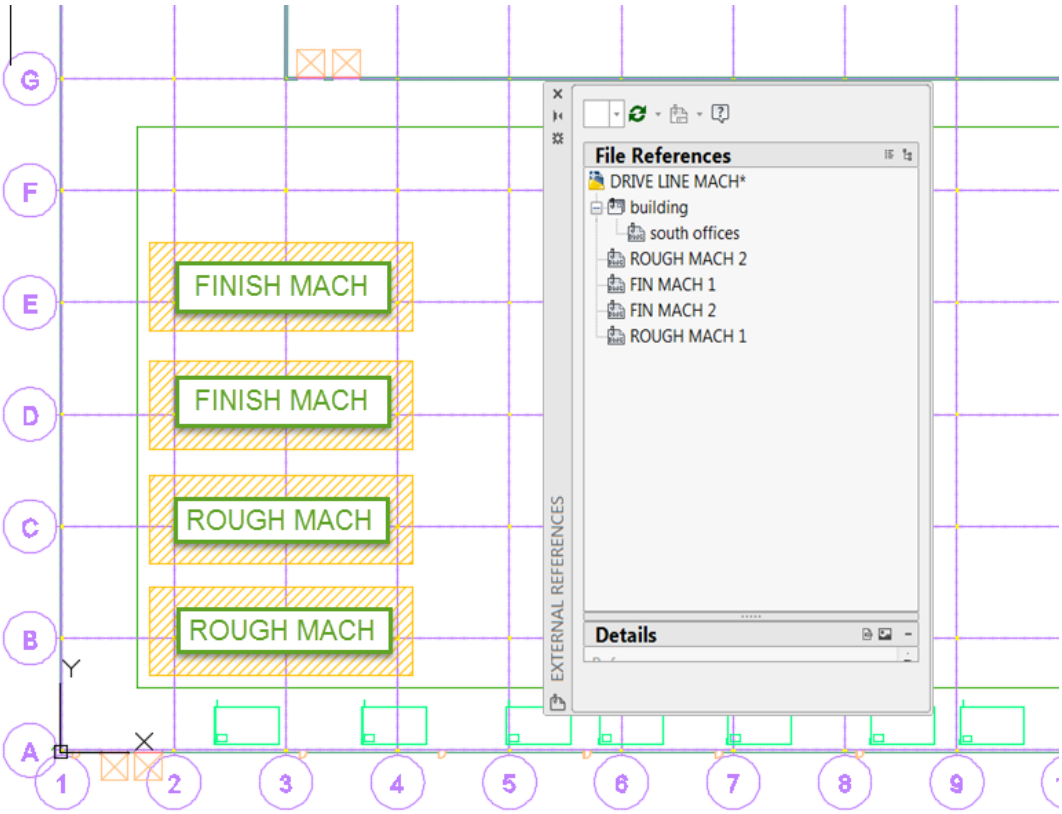
REMEMBER TO SAVE!!!





Step 3. Setting up the lines.

Now we break it down further – drawing in an area for example for machining – and use the same process as above. We then open machining, and break that one down into departments or lines.



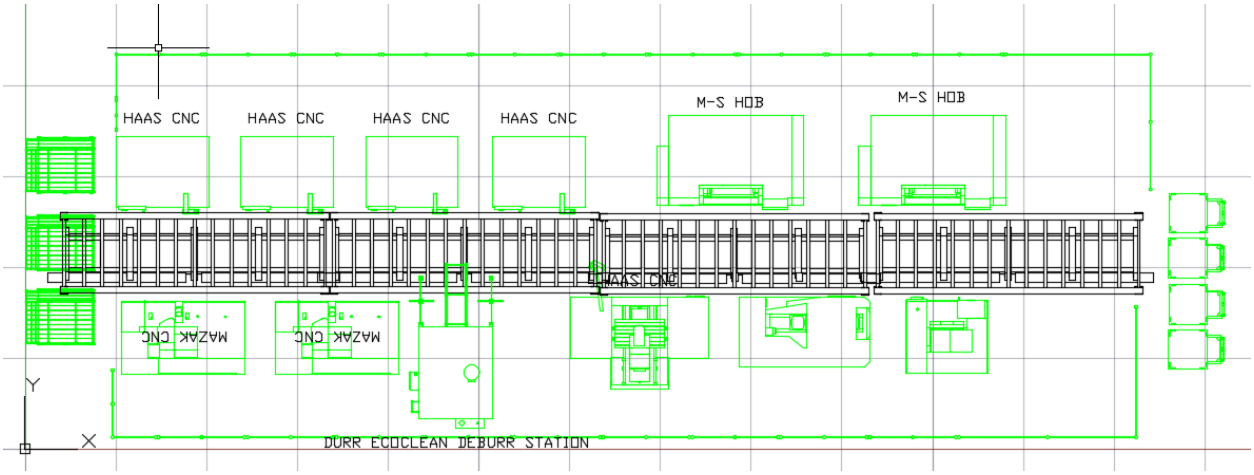
An important concept here – the XREFS in this file represent the positional relationship in the overall layout. This will carry over to 3D as well for placement in Navisworks when the layout is compiled.

Step 4. Creation of the layout – using this map to pull it all together.

Now that we have the areas, it is very easy to manage the layout. We will highlight two different workflows that could be utilized. Bear in mind that FDS assets are in each of these workflows.

Workflow 1 – dropping in a layout that was created elsewhere.

In this example, I have a supplier that created a line layout within the confines of the area that I provided to him. (you could send them the rectangle)



In this case, I would do the following steps:

1. Open Rough Mach 1.dwg
2. Open the drawing that represents the detailed line.
3. Select all of the objects in the detailed line – use ctrl – c to copy them.
4. Activate Rough Mach 1.dwg
5. Use ctrl – v to paste the objects in. Position as needed.
6. SAVE Rough Mach 1.dwg.

Workflow 2 – starting line from scratch

Basically, it is the same process, except you now add the assets you need to the 2D layout and arrange them as necessary.

1. Open Rough Mach 2.dwg
2. Place the assets in the line as required.
3. SAVE Rough Mach 2.dwg.
4. Utilize the appropriate sync workflow to Navisworks.
5. Save the file.

In either case, open the composite file, and update the XREFS. Your composite drawing will now always be up to date – if a line changes, the change will be reflected.

REMEMBER TO SAVE!!! In this case we would be saving master.dwg. This file would allow you to be able to print out the floorplan of the plant in 2D.

Step 5. Creation of the 3D version – Sync Inventor.

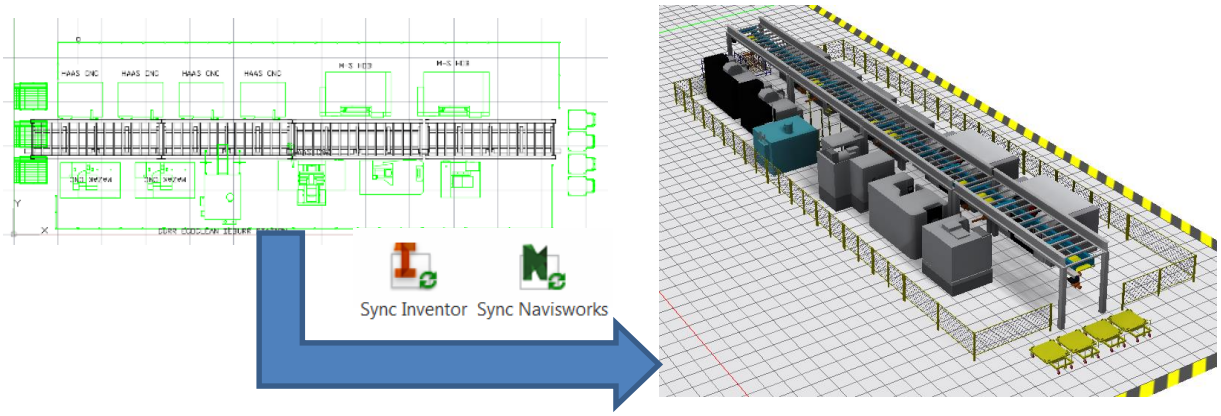
We are now ready to create the 3D version of this file. You can sync it to 3D for a few different needs.

A. If more design work is required in 3D, you would sync to Inventor.
B. If you need to create installation docs that have section views etc. you would sync to Inventor and use the Inventor drawing workflows to create them.
C. If you only need a 3D viewable that would be used in a larger layout, you would sync to Navisworks directly.

The process is simple….

1. Save the AutoCAD file.
2. Sync to either Inventor or to Navisworks.

Sync to Inventor would need to be done if more work to the layout is required in 3D – such as adding objects that do not reside on the floor or designing 3D components in context of the layout. This would require you to sync to Navisworks from Inventor as required. With the workflow we will use, any changes in the design products (Inventor, AutoCAD, Revit) would update in Navisworks upon either refresh or re-open of the Navisworks NWF file.



Also remember – any changes you make, either in 2D or 3D, require you to do the following steps:

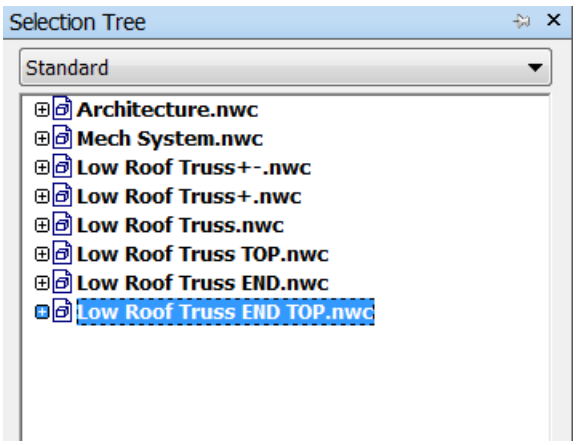
1. Sync the corresponding file – if in 2D, sync Inventor. SAVE THE INVENTOR FILE.
2. Sync the corresponding file – if in 3D, sync AutoCAD. SAVE THE AUTOCAD FILE.
3. Sync the corresponding Navisworks file. SAVE THE NAVISWORKS FILE.

Navisworks composite – your overall 3D view

Perhaps the most important concept to keep in mind – you do not compile large portions of the 3D model in Inventor. Navisworks is the environment for compiling the larger view.

If you have a building that is a Revit file – it is a good idea to create an NWF file of all of the components of that building and reference that into your master.

Your building's structure might look something like this….



Save the building file – Building.NWF.

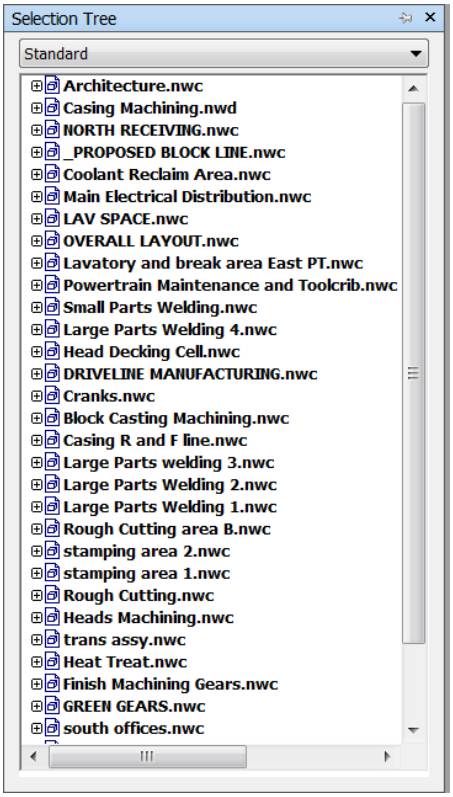
The files that were created by syncing to Navisworks – either from AutoCAD or from Inventor – are the 3D files used to compile the layout. Again, very simple to do.

1. Start a new Navisworks session.
2. From the HOME tab, select append.
3. Select MASTER.DWG.
4. Save the file. In this case we will call it MASTER LAYOUT.NWF.

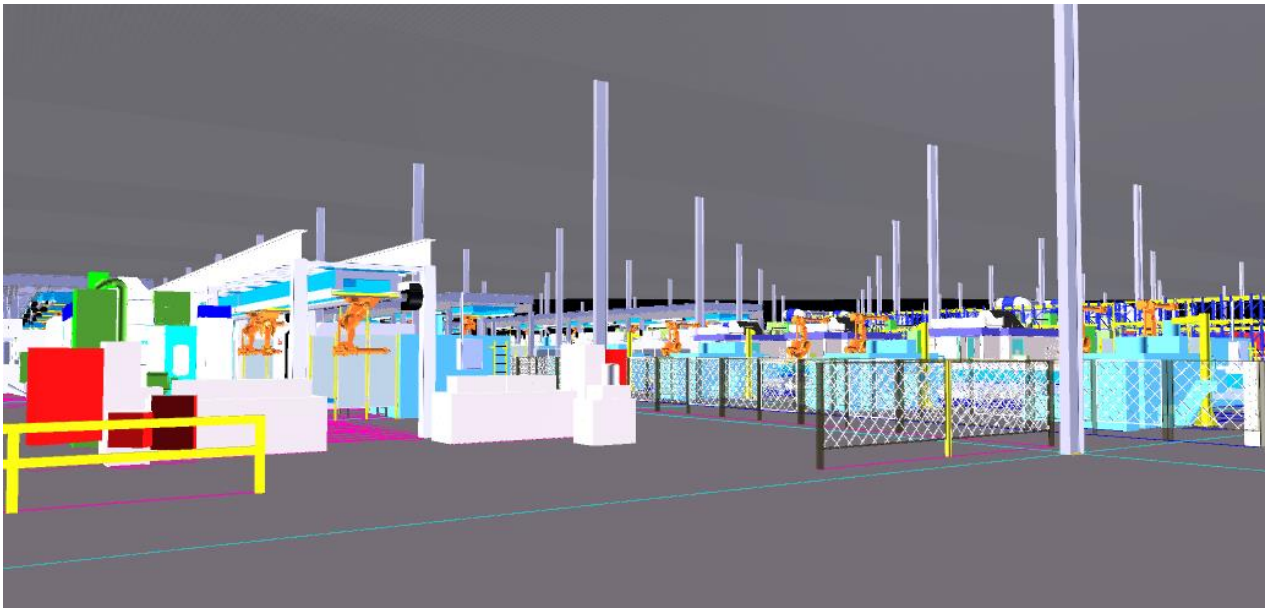
You can now begin appending in all of the children to make up the master layout file.

1. From the HOME tab, select append.
2. Select each NWD file that represents the departments, areas, etc.
3. Because we have used the DWG originally as the layout map – each department will drop in right where it is supposed to because they are referenced from building 0,0,0.

Your resulting selection tree may look like this…..



And your corresponding layout would look like this…..



Key takeaways:

1. Break the file structure up into smaller pieces – this allows better performance overall and makes the design files more manageable. Furthermore it allows teams to be able to work concurrently.
2. Do not try to compile the layout model entirely in Inventor. Utilize Inventor for what it is used for – creation of 3D design data and corresponding section and alternate drawing views as required.
3. Compiling of the 3D viewable occurs in Navisworks.
4. Using Navisworks component files – either NWC or NWD – as the children in the overall layout will greatly increase performance.

To Summarize:

With a bit of forethought and planning, you can lay out very large facilities and get 3D viewables that can be used for design reviews – and they update as the design changes. Furthermore, you end up with a drawing and model structure that can easily be put into vault and / or be managed by vault during both the initial WIP design phase and the released stage.