

AS464886

Shared Coordinates: Because After All These Years I Still Don't Get It!

Krigh Bachmann
DIALOG

Learning Objectives

- Learn how Revit software's shared coordinate system works.
- Learn how to properly manipulate and use the shared coordinates within a file and between files.
- Learn how to apply shared coordinates when dealing with a project using real-world coordinate systems.
- Learn how to overcome the challenge of projects in real-world locations inside Revit software's 20-mile limit.

Description

Revit Shared Coordinates are essential for setting up a project's real-world location and coordinating the alignment of models linked between consultants. With the adoption of BIM (Building Information Modeling) in the field, digital setting out of projects is becoming more prevalent—and getting the coordinates right is increasingly critical. However, a project's setup is usually done only once at the beginning by one person, so there are few opportunities to learn it. This makes understanding and getting it right a bit of a dark art. Drawing on years of experience working with projects in the real world, this session will cover the theory of shared coordinates, reveal the system behind the curtain, and show the application with a real-world example. Whether you're trying to get your model to report spot coordinates, or you just want to know how to align that structural model with yours because origin-to-origin isn't working, this class will show you how it's done right.

Speaker(s)



Krigh Bachmann is the Leader of Digital Innovation for the international design and engineering practice DIALOG. Focused on the research and implementation of emerging technology in the AECO industry, Krigh ensure his practice keeps up with the leading edge. He joined DIALOG in 2016 after returning from 8 years in the UK, where he was the BIM Manager and EMEA Digital Design Leader for Gensler, and BIM Manager for Pollard Thomas Edwards. Krigh is an active member of the Canadian AEC community, chairing the Designer & Engineering Think Tank for the Canadian BIM Council CanBIM. Krigh has previously presented at Autodesk University, BiLT NA (8th Best Speaker 2017), the Digital Shoreditch Festival, and the London Revit user Group.

Introduction

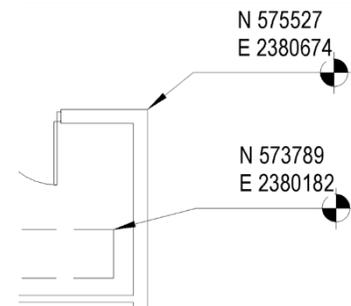
Shared coordinates, I would argue, is one of the hardest things to get to grips within Revit. They are essential for setting up project locations and coordinating the alignment of models from other consultants. However, as the set-up of a project usually happens only once at the beginning by one person, there are few opportunities to learn it. It may be for months or years before you revisit the process. This alone makes it difficult to learn. I believe Revit does not make it very easy to see how the system works. It hides some of the visual aids that would allow users to understand it properly. The end result is a challenge to say the least.

Drawing on years of experience working in the UK with Revit projects that were required to be delivered in real world (ordnance survey) coordinates, I have learned the Revit tools, how to use them, and more importantly, developed training files that show my staff how the coordinates work. In an effort to reveal the system behind it all, this session will be an in-depth look at how shared coordinates work, and how we can utilize them to better align our projects not only in the vacuum of Revit, but in real world too.

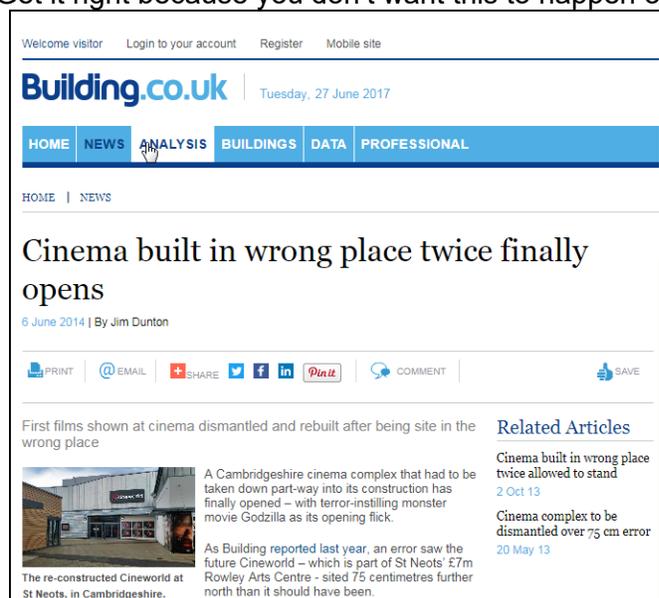
Why Would You Want To Use Shared Coordinates:

You want to:

- Display coordinates setting out
- Display your project in real world coordinates (which Revit cannot model beyond 20 miles).
- Link files together that were started in different positions (possibly by different consultants) and ensure they stay aligned.
- Link a single model into another model multiple times/locations or options.



Get it right because you don't want this to happen on your project...



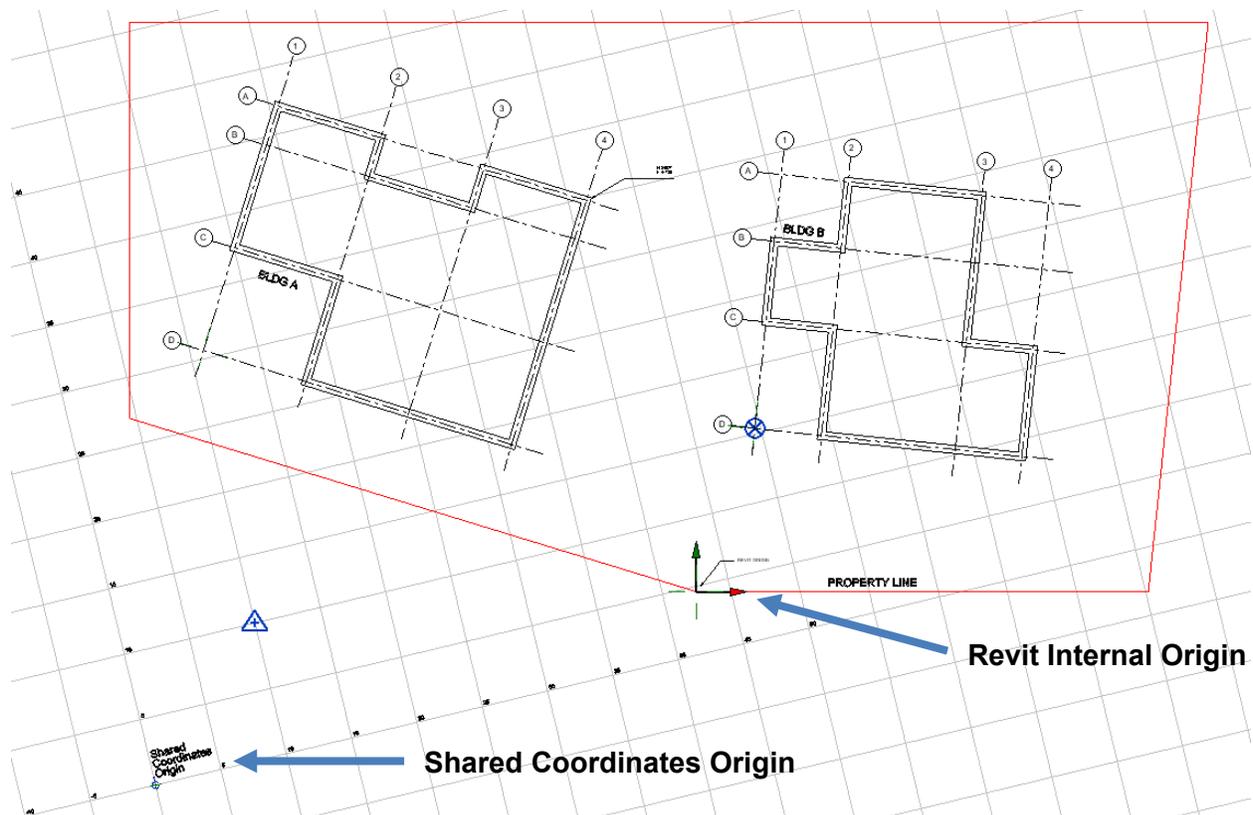
The screenshot shows a news article on the website Building.co.uk. The article title is "Cinema built in wrong place twice finally opens" and it is dated 6 June 2014. The article text describes a cinema complex in Cambridgeshire that was dismantled and rebuilt after being sited 75 centimetres further north than intended. A related article link is provided: "Cinema built in wrong place twice allowed to stand" dated 2 Oct 13.

NOTE: I CANNOT CONFIRM THAT SHARED COORDINATES WERE TO BLAME FOR THIS, BUT IT SURE SOUNDS LIKE IT COULD HAVE BEEN.

FULL ARTICLE:
[HTTPS://WWW.BUILDING.CO.UK/NEWS/CINEMA-BUILT-IN-WRONG-PLACE-TWICE-FINALLY-OPENS/5068952.ARTICLE](https://www.building.co.uk/news/cinema-built-in-wrong-place-twice-finally-opens/5068952.article)

How Do Coordinates Work In Revit?

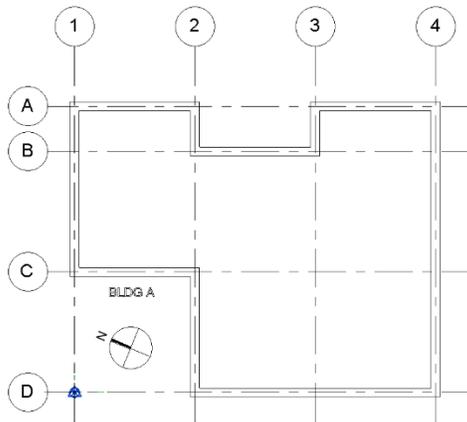
The coordinate system in Revit is split into two systems. The first is the internal system based around its internal origin. Everything in Revit is modeled in relation to this point. Every model element has an X, Y & Z coordinate in relation to this point.



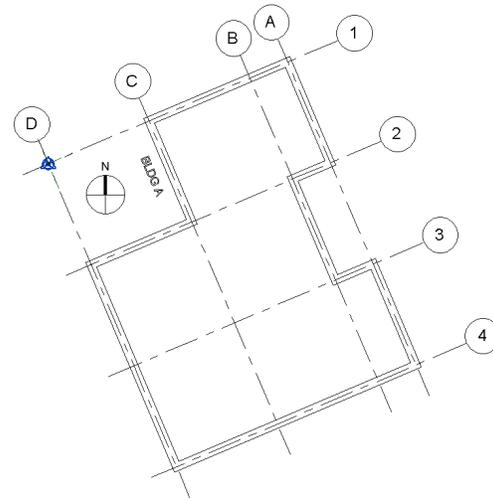
EXAMPLE OF TWO BUILDINGS THAT ARE LINKED INTO A SITE MODEL. EACH BUILDING HAS IT'S OWN PROJECT NORTH AND INTERNAL ORIGIN, BUT SHOWN HERE, THEY BOTH HAVE THE SAME SHARED COORDINATES SETTING OUT.

Revit's second system which we will call the shared coordinate system (also called project coordinate system), allows you to apply different coordinates, effectively telling Revit to display that item as if it is in a different position or angle. The important thing to remember about this shared system is that nothing ever moves. No matter what you see happen on the screen (if it looks like it moves left, right, up, down, or rotates to a different angle, the objects remain in the same position relative to the Revit Internal origin. This is similar to the way UCS in AutoCAD works, but different in how you set it up and control it. **The shared coordinates system maintains that everything sits in the same place and you move the world (or coordinates) around it. Not the model moving around in the world.** Instead of cutting your model out and positioning it on a map, you are effectively keeping your model in the same place and moving the map under it.

A simple application of shared coordinates can be seen in how you set up your project to display in true north. Most projects are drawn with buildings at 90 degrees to the paper you print them on and the screens you model on. This is called project north. Revit is based on the idea that you model a building at project north, and then use the coordinates to tell it the relation to true north. Revit will display the model in true north, but it's an illusion. The model never rotates, it's just the graphical view that makes the model appear at true north, but is set out in Revit's internal coordinates and project north.



MODEL IS DISPLAYED IN PROJECT NORTH



MODEL IS GRAPHICALLY DISPLAYED IN TRUE NORTH BUT IT IS STILL COMPUTED AT PROJECT NORTH

Similarly, when you want to model your project so that the levels display at a 645m geodetic elevation, you do not actually have to model at 645m above Revit origin, you just simply tell Revit you want it to act that way.

Revit presents the illusion of your project moving or rotating. It is important to understand that this is just a graphical “trick” because sometimes your project and the tools you use will ignore the shared coordinates and base their action on the Revit internal coordinates. Other times they will use the shared coordinates. It is important to understand the difference between the two scenarios to determine which is in use.

Coordinates When Dealing With Linked Files

The coordinates inside Revit are not limited to just working with a single file. When you link Revit models together, you can set up relationships between the files where the coordinates talk to each other. This is where they earn their name, shared coordinates. The system is designed so that once you set your building to appear in a specific position (remember it's not physically moving), you can tell Revit the second building is positioned on the same coordinate system, and where it sits in relation to the first building.

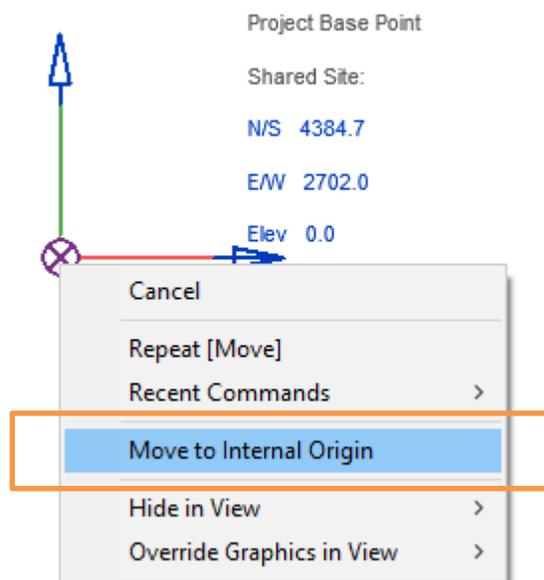
Between links, shared coordinates are very powerful. The coordinates can actually be pushed and pulled between files and can be affected by moving one file linked inside another. You can

even save more than one site inside a file to record either optional locations or multiple locations of the same model.

So Why Is This So Hard To Understand?

Revit does not by default show you a lot of visual cues to understanding share coordinates.

- The Revit template doesn't show you the project base point or survey point (two of the tools you use to control the shared coordinates) unless you turn them on in your view. They are hidden most of the time (rightfully so because you don't want someone to accidentally move them and possibly affect the coordinate system).
- Revit doesn't show you the shared coordinates origin. I'm not sure why, but there is no ability to see this the way AutoCAD allows you to toggle the UCS origin point on or off.
- Revit can show you the internal origin (NEW in Revit 2020), but by default it's hidden.



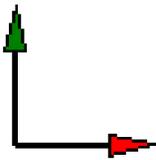
Alternatively, you can right-click the project base point and choose "Move to Internal Origin" and it will move back to the Revit Internal Origin in your current view.

Ground Rules for Project Setup

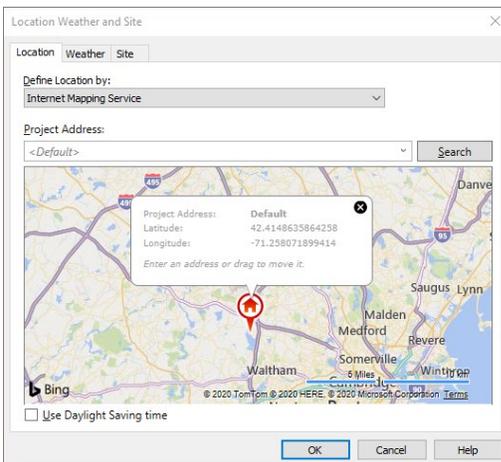
1. You need to pick a project north within each Revit model. As mentioned above this should be the "up" for the way you want to draw your model. You can always change the way certain views appear in your project, but most will appear at project north, so choose wisely as it can cause issues to change it later (see note below).
2. You start to draw your model in project north, not true north. Revit is designed so that you model everything in project north and then graphically display it in true north.
3. When dealing with a site file, your project north and true north might be the same, but not usually for a building.
4. You want to avoid changing project north after you have started to model. The "Rotate Project North," function in Revit physically moves model elements in your file in relation to the Revit Origin. Conversely, the "Rotate True North" tool does not move anything, it just

graphically displays it at a different angle. Changing your true north angle at a later time does not affect the model because nothing is moving. Although Revit does give you the option to Rotate Project North, there are certain elements in Revit that will ignore this function and therefore can cause your model to generate errors (these include masses and in-place families).

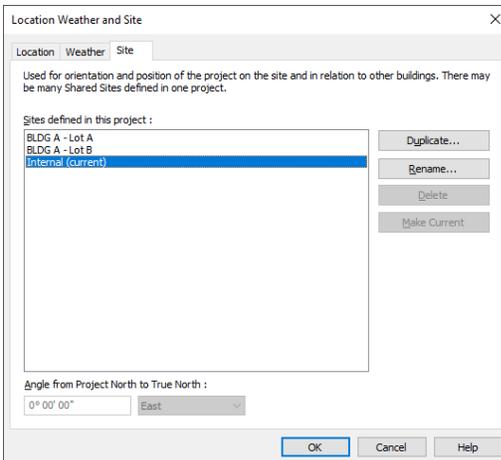
Tools & Concepts



Revit Origin: This is the point from which Revit models everything and will be the origin when you select the “project internal” option on exports. It is not always visible so as a best practice mark this point with two reference planes. This allows you to link something in origin-to-origin and see if it came in the right spot. If you do not know where this point is, turn it on under visibility settings: Model > Site > Revit Internal Origin.



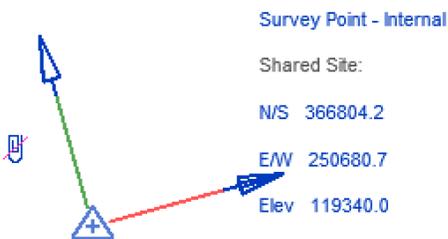
Location: You would assume that if we are discussing real world coordinate that this map in Revit would have something to do with it, but in fact it does not. The Location tool modifies the location for shadow studies and energy analysis, but actually has no impact on shared coordinates.



Site: This is where you can name your different Shared Coordinate sites. The default site in Revit is called Internal because it aligns with the internal Revit origin. As best practice, you should rename this if you intend to use Shared Coordinates to locate your project at a position other than the Revit internal 0,0. You can also have more than one site if you have options or if you have multiple positions for the same links.



Project Base Point: Autodesk explains “The project base point can be used to establish a reference for measuring distances and positioning objects in relation to the model.” It can be used for aligning models being linked into one another and for controlling setting out from a local point on-site. As of Revit 2020, when you move the point, it no longer modifies the Shared Coordinate grid however typing into the Angle to True North still modifies the project.



Survey Point: “The survey point provides a real-world context for the Revit model. It represents a known point in the physical world, such as a geodetic survey marker or the intersection of 2 property lines.” It does not always have to, but this is the best way to use it. This point has the ability to move the shared coordinates grid around the model (if clipped).



Acquire Coordinates: Found on the toolbar under Manage > Project Location > Coordinates, this tool is used to select a linked model you want to acquire the shared coordinate from.



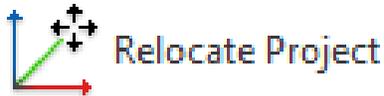
Publish Coordinates: Found on the toolbar under Manage > Project Location > Coordinates, this tool lets you select the linked model you want to push your coordinates into. Note: at the time you are pushing the coordinates into another model, ensure no one else is working in the model and everyone has saved and relinquished.



Specify Coordinates at Point: Found on the toolbar under Manage > Project Location > Coordinates, this tool lets you pick a point or a line (including grids and levels) in your project and specify the coordinates of that point.



Report Shared Coordinates: Found on the toolbar under Manage > Project Location > Coordinates, this just reports the coordinates of a point or line in the model without actually manipulating them.



Relocate Project: Found on the toolbar under Manage > Project Location > Position, this tool allows you to move the project across the coordinate system. It allows you to pick two points, rather than typing in numbers.



Relocate true north: Found on the toolbar under Manage > Project Location > Position, this tool allows you to redefine the true north angle in relation to project north. Graphically, you will see the project rotate on the shared coordinates grid.



Mirror Project: Found on the toolbar under Manage > Project Location > Position, this tool will physically mirror your project. This does not only affect the shared coordinate, but also how the model is set out in relation to the Revit origin.



Rotate project north: Found on the toolbar under Manage > Project Location > Position, this tool will physically rotate the geometry in your model in relation to the Revit origin to designate which way is “up” in the model. As mentioned previously, this can cause errors in the model as not all model elements will rotate correctly (massing and in-place families have been known to ignore this function).

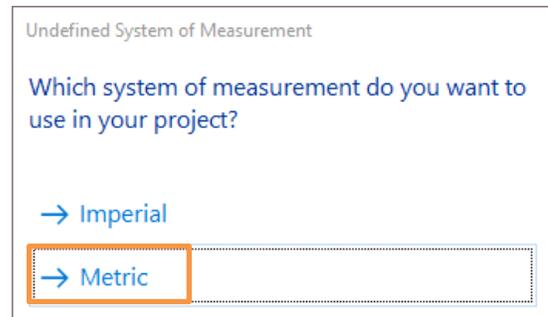
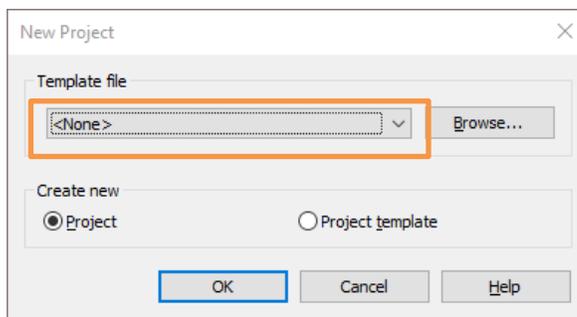


Shared Coordinates Origin: With all of these tools you would assume to be able to see the shared coordinates origin, but you cannot. Below are instructions on revealing the hidden origin as I have shown in my examples.

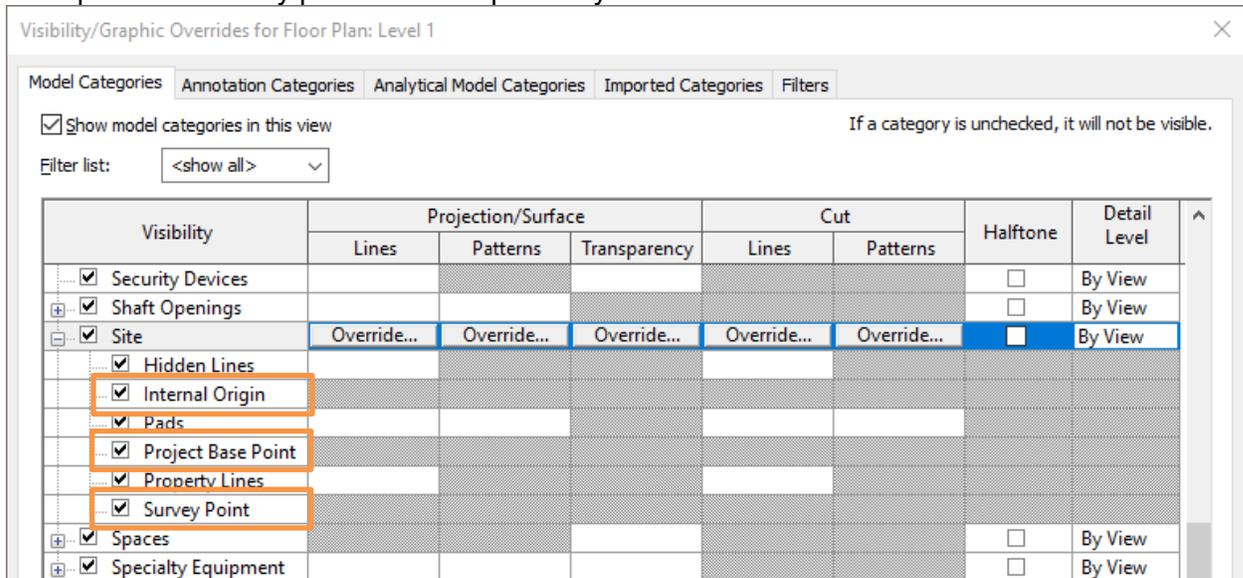
Revealing the Shared Coordinates Origin

The following is how I learned to reveal the shared coordinates origin for the purpose of training, practicing and trouble shooting. This is not recommended for all project files, but works to show you the impact of using these tools. Once you have a better understanding by using the example files, you can proceed to apply the same logic to project files. I have included example files, and files I will reference in the instructions below.

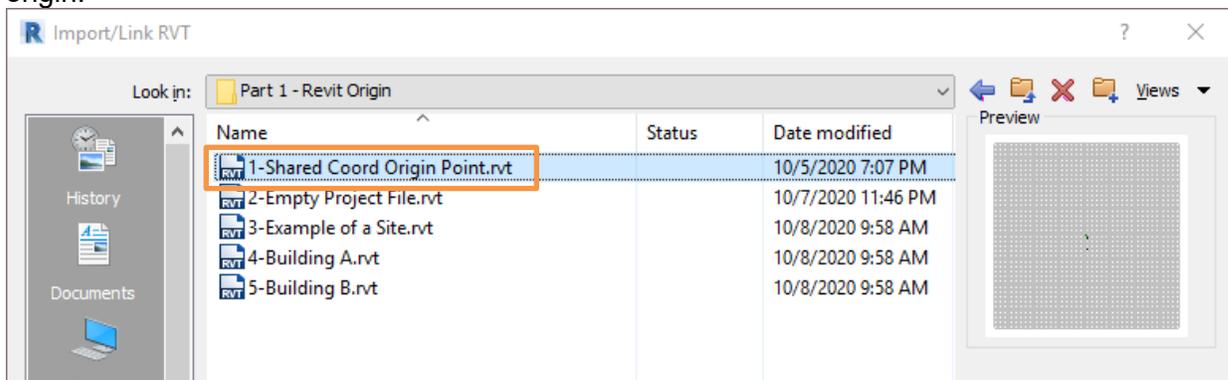
1. Start a blank file in Revit. When asked to start which template, select “None” and then choose metric. If you are more comfortable with imperial measurements you can use an imperial one, but for the purpose of this example, I will use metric.



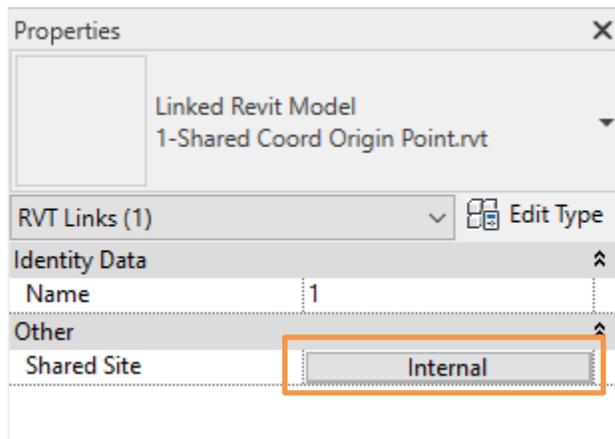
- In your empty model file, use the visibility graphics to turn on the internal origin, project base point and survey point in a floor plan so you can see them.



- From the exercise files in the included ZIP file, locate the folder “Part 1 - Revit Origin” and link into your model “1-Shared Coord Origin Point.rvt”. Be sure to link it origin-to-origin.



- On the ribbon under Manage > Project Location > Coordinates > ... choose acquire coordinates. Select the Link.
- If everything worked, you should see “Internal” displayed on the instance properties palette of link. Alternatively, if it did not work, you can just open the example file “2-Empty Project File.rvt”



- The linked file will now be locked onto the shared coordinates origin. DO NOT move it manually. To assist in this, I disable the “Select Links” option in the bottom right of the Revit window or pin it in place.

At this point, spend some time to manipulate the different points (both clipped and unclipped) and see the result. It might help to add a small building or some model lines at the origin to start. You can link in other models and acquire and publish coordinates to them to see the result on the shared coordinates origin.

Modifying the Coordinates

As mentioned above there are a lot of ways to change the coordinates in your project. I find it easiest to input values into the “Specify Coordinates at Point” command. There are two states to the survey point: clipped and unclipped. When clipped, moving it has an effect on the project and the coordinates. If unclipped, you are just moving the point around. It’s a best practice to pin and hide these points on projects to avoid any human error of staff accidentally moving them.

	Clipped 	Unclipped 
Project Base Point 	Typing a value into the project base point or moving it, will move that point and therefore the model to a new position on the coordinate system. This is good for relocating your project. Remove in Revit 2020	Typing into an unclipped point will relocate the point, but not the project. The project will stay in the same place on the coordinate system. The exception is the true north angle, which will still modify the project.
Survey Point 	You cannot type coordinates into a clipped survey point, but you can move it. This moves the coordinate system around the model.	Unclipped, you can type coordinates into the survey point to position it at a specific coordinate location in without modifying the coordinate system. Or you can select it and move it.

Shared Coordinates Between Linked Models

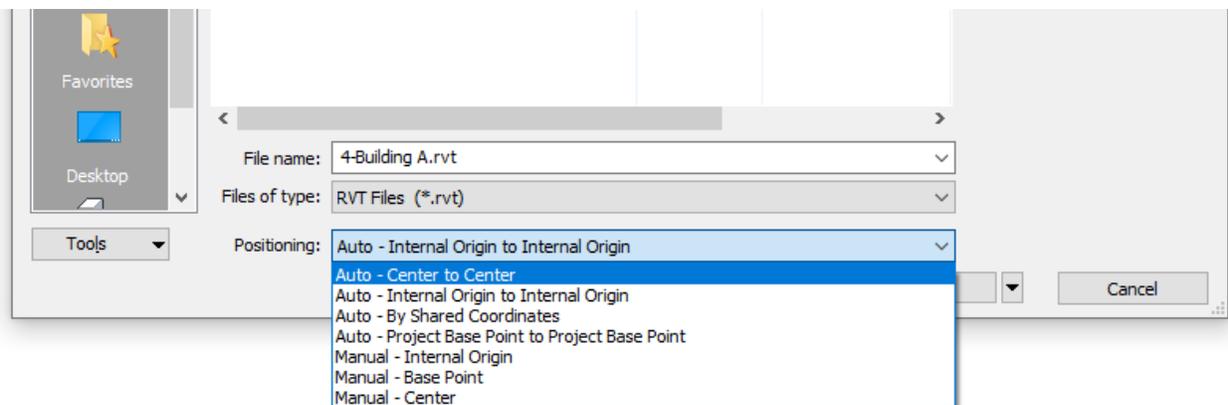
Setting out your project on a coordinate system can be a little tricky, but once you understand how everything is still in the same place and the world is just moving around it, you can learn to master them. The next challenge is how you get all of your models to understand that they are on the same coordinate grid and that they maintain their relationship to each other. The first thing is to establish a connection.

The Hand Shake

When you link Revit models into each other and you either acquire or publish coordinates between models, you activate the shared coordinates through a sort of handshake between files. Once that connection is made, it cannot be undone. This is important to understand because the settings and options will change once the initial handshake has happened. You will find you no longer have the option to acquire or publish, but to only update.

How to Link in Models

When you link a model in for the first time, there are a few options for placement.



POSITION	WHEN TO USE....
AUTO - CENTRE TO CENTRE	This option is not useful for aligning your models other than generally dropping them in the middle of each other.
AUTO - ORIGIN TO ORIGIN	Aligning models origin-to-origin is best for models that are for the same area (ex. Building A Architectural model with Building A Structural Model). Use this method for most new links, especially if you have not started modeling your portion of the project yet, as it ensures you can relink and align.
AUTO - SHARED COORDINATES	You can only use this method for models that have previously had shared coordinates activated.
AUTO - PROJECT BASE POINT TO PROJECT BASE POINT	Use this method if you know two points in each model that align, and they do not share a common origin point.
MANUAL - ETC.	All manual methods should only be used as a last resort since they are not as accurate as linking by auto-alignment (the options above).

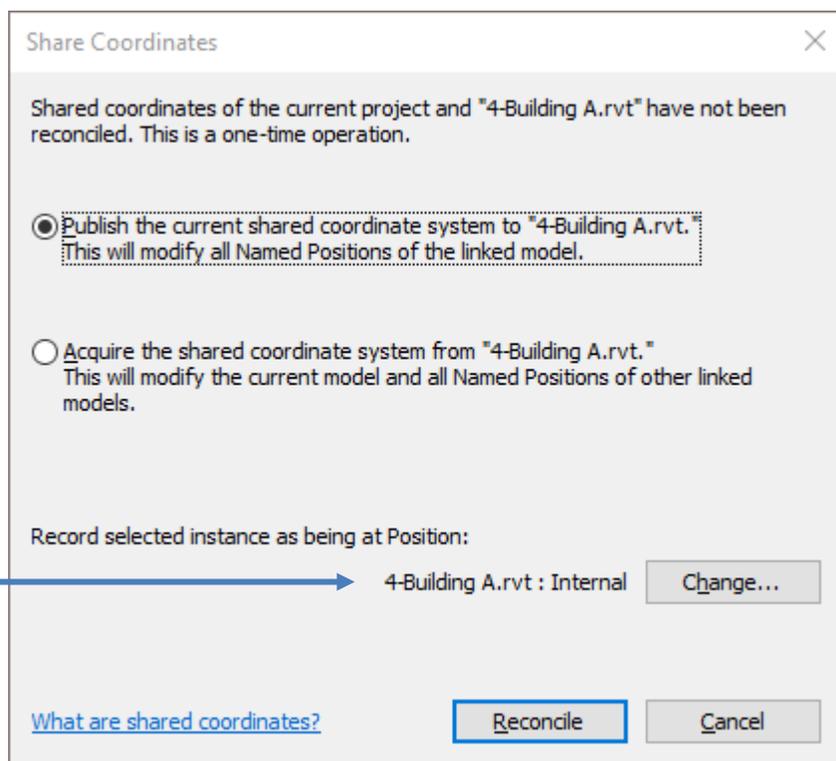
Activating Coordinates

Once the files are linked in and aligned together there are two options: acquire or publish coordinates. The method used will depend on who's got access to the files and how they are getting exchanged (if not on the same system). See below for different workflows.

METHOD	WHEN TO USE AND WHY...
<p>PUBLISH COORDINATES</p>	<p>When you have access to the link you want to push the coordinates into (i.e. they are all your models on your server). Note it is best practice to have no one in the linked model when you want to push the coordinates into a link. This method does not work when you are exchanging files with another consultant because you would have to give them the model back after you have published the coordinates.</p>
<p>ACQUIRE COORDINATES</p>	<p>This adopts the coordinates from the link and updates the coordinates in your model. This is used when the other model is the one that is dictating where the coordinates are, such as being a file obtained from a prime consultant.</p>

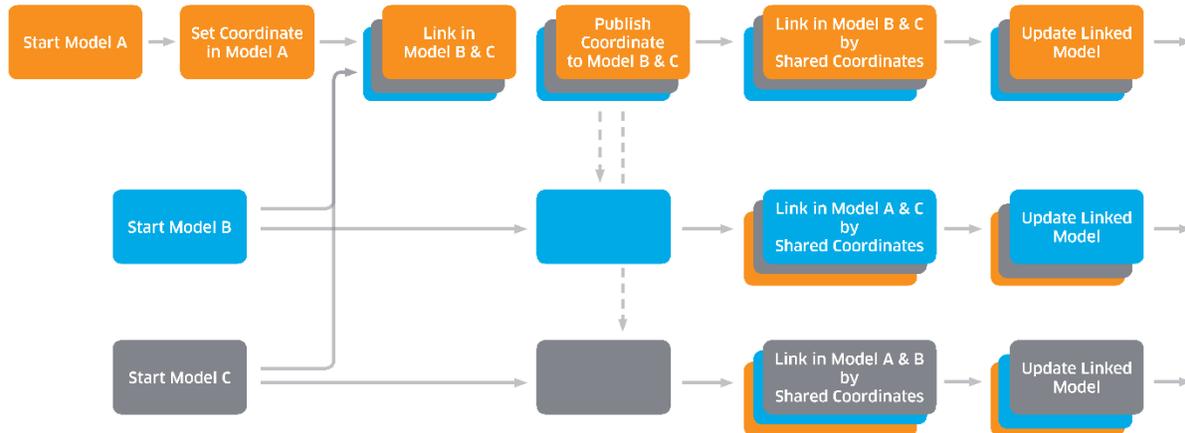
Choose the **publish** option if you want to push your coordinates into the other model or **acquire** if you want to pull them from the other model.

Note that the default site is called "**Internal**" because it is based on Revit's internal origin. When you modify the coordinates for your project, it is best practice to name this to something else relevant to your project.



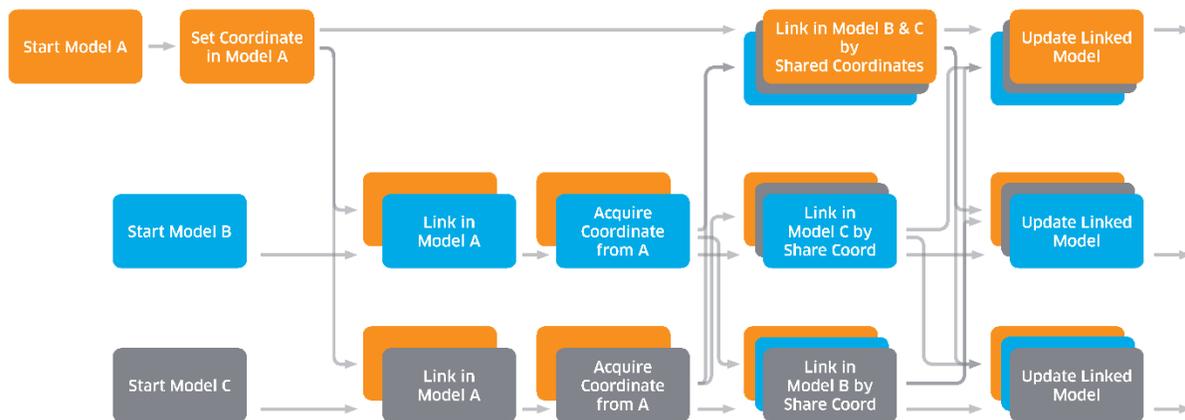
Publishing Coordinates Within A Single Team

Below is the workflow you would use if all the models resided on the same system, allowing you to push the coordinates from Model A into the rest..



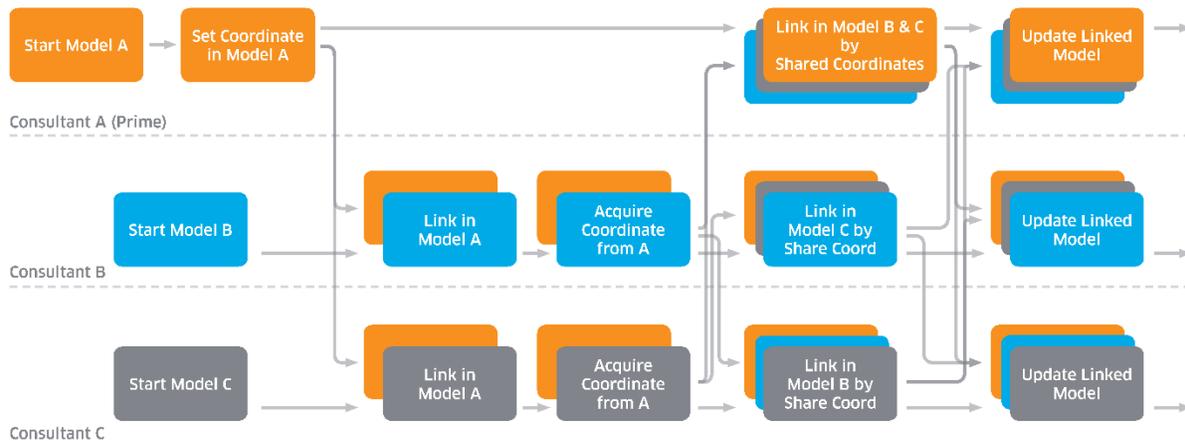
Acquiring Coordinates Within A Single Team

Below is the workflow you would use if the models all resided on the same system and you want to acquire (pull) the coordinates from Model A into the rest.



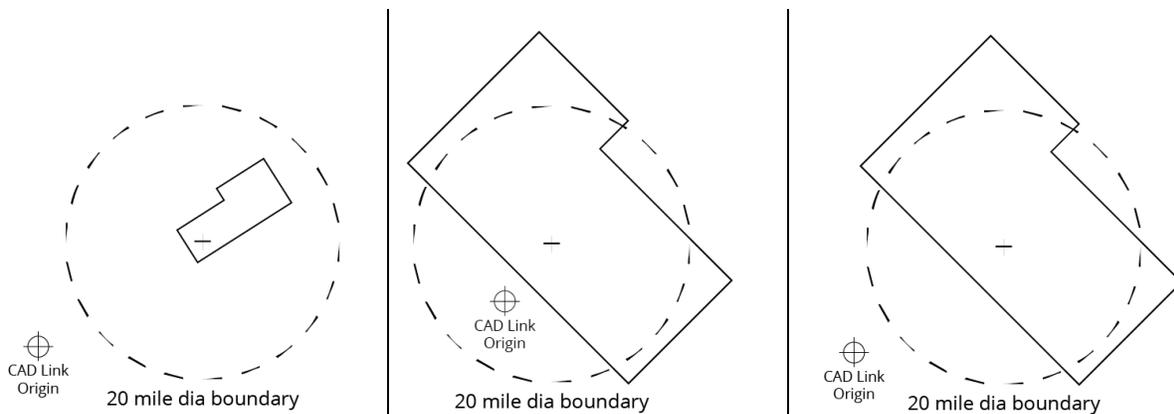
Acquiring Coordinates From Exchanged Models

Below is the workflow you would use if the models are being exchanged between consultants. A single model that dictates the position will be sent to the other teams who will then acquire or pull the coordinates from Model A.

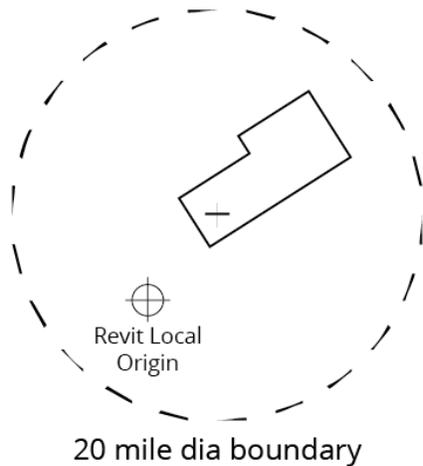


Dealing with Real World Coordinates

Above we mentioned that model elements in Revit stay in the same place relative to the Revit internal origin. Revit also has a limitation that nothing can be farther than 10 miles from that origin. You will find this if you try to link in DWG files that are greater than 20 miles from their origin. Below are some of the scenarios that trigger this error.



Since Revit does not like anything beyond 20 miles, this is a perfect opportunity to use shared coordinates. The 20 miles limit only applies to objects modeled 20 miles from the Revit origin, but you can model right next to the internal origin and use shared coordinates to tell it that it's much farther away. The shared coordinates origin can be located 10,000 miles away as long as the model geometry is within the 20 miles.

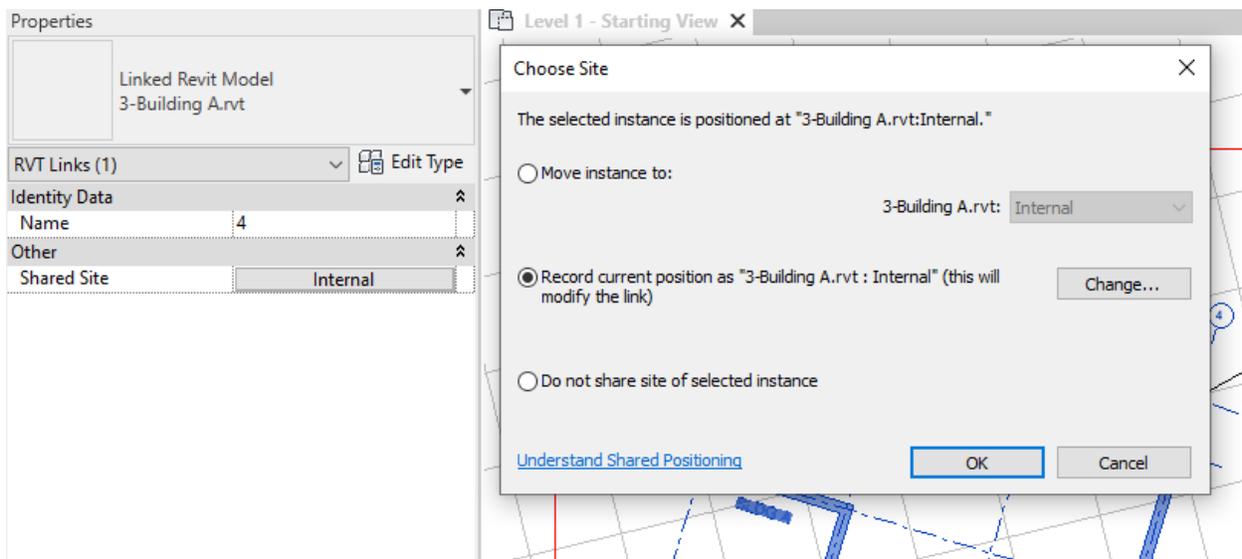


Setting up a project in real world coordinates can be a little tricky because you have to reference DWG files that contain a distance that Revit does not compute. The result can be a DWG linked into Revit that is not accurate or stable. To avoid this, I recommend localizing the files. This means bringing them closer to the origin point. If you do it in a recorded and repeatable way, you can reduce the risk that the files will be linked incorrectly.

To localize the files, pick a coordinate point in your real world DWG and move the whole CAD file so that point is on the 0,0. Then link it into your Revit model (preferably origin-to-origin). If you do this every time you update it, then it will always fall in the same place.

Updating Shared Coordinates

As the project progresses, you may be required to update the location of your files. There are a few methods by which you can update the location/orientation of a model. You will notice that you cannot select a model and use the publish or aquire once it's already been established. You will get new options if you select the model's Shared Site.

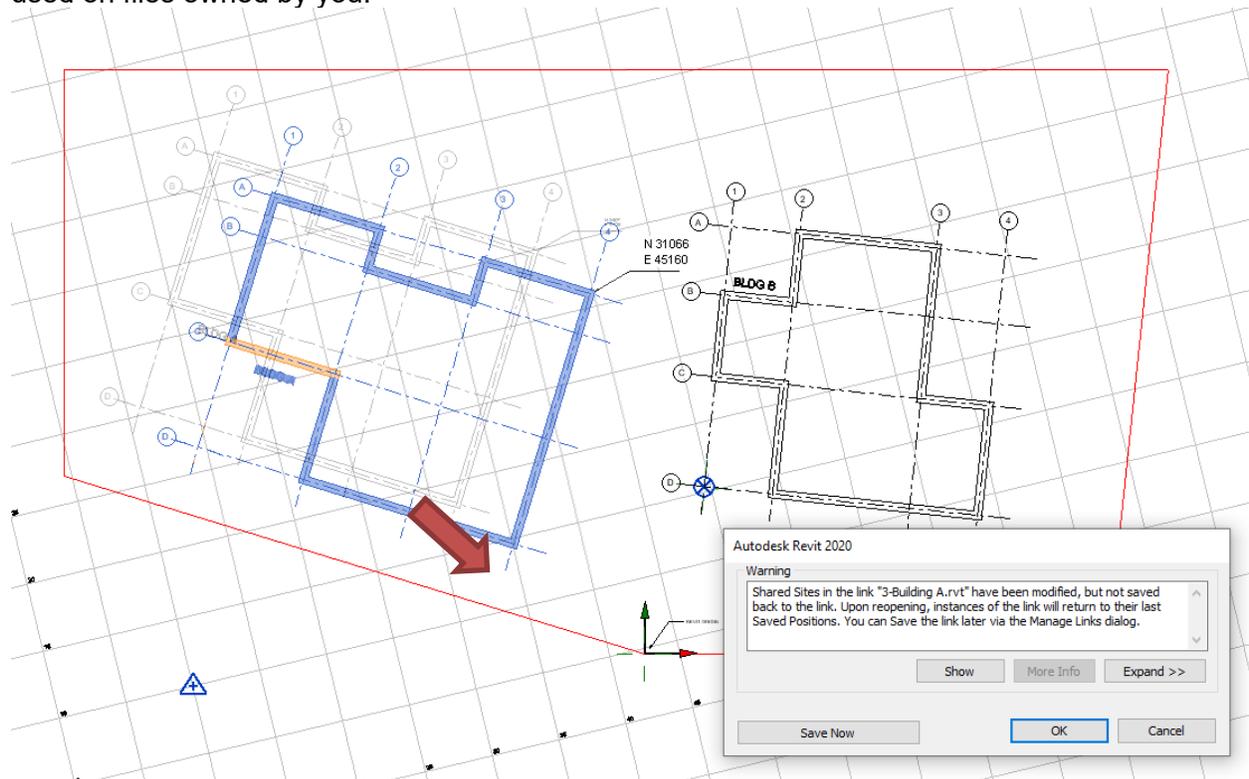


Moving a Link in the Site File

You can disengage the shared coordinates by selecting the “Do not share site of the selected instance” shown above, move the file to the new location and then re-engage the shared coordinates picking the “Record current position as...” to overrright the old location with the new one. Note this is similar to the publish command; It affects the linked file and cannot be performed if anyone is in the linked file. This method should only really be used if all the files are owned by the same team on a single system.

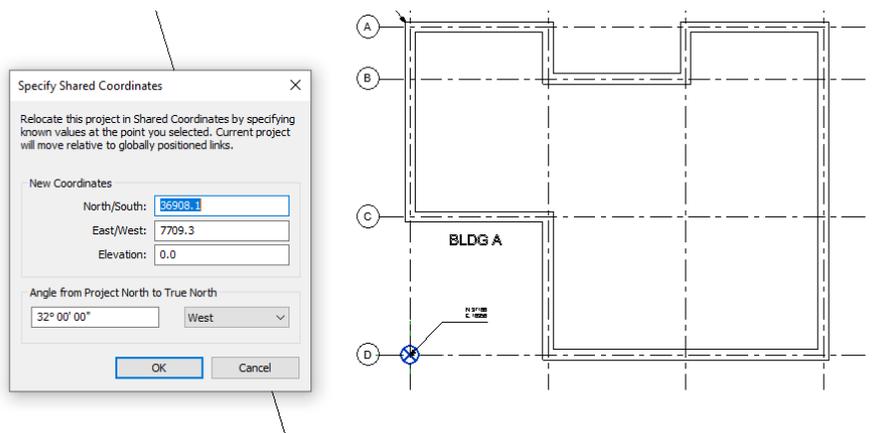
Moving a Link in the Site File

You can update a building's location by physically moving it in a site file and then saving the updated location back into the link. As above, this modifies the linked file and should only be used on files owned by you.



Redefining the Coordinates in your Model

Unfortunately, once the files have established a shared coordinates handshake, you cannot use the "acquire" command a second time. So, you must go into your model and redefine the coordinates by using the "Specify Coordinates at Point" command or use the clipped survey point to move the model across the coordinates grid.

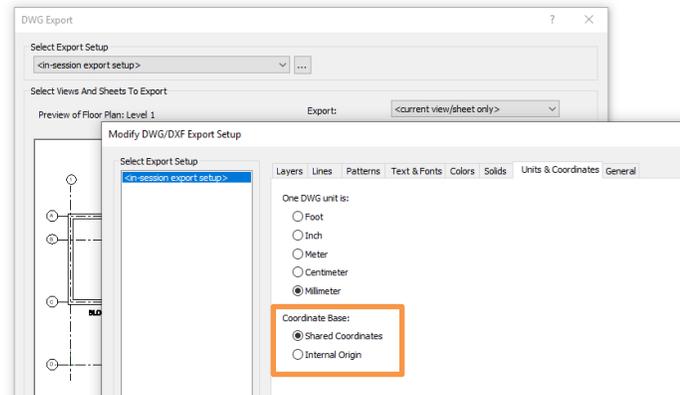


Interoperability

When Revit exports and imports information some of the functions use the shared coordinates, but some will use the internal origin. There are also a few places that you can choose which one Revit uses.

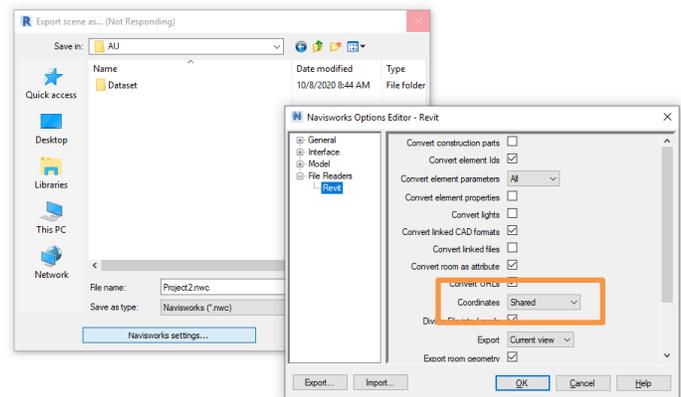
Exporting AutoCAD DWGs

When you are exporting to DWG from Revit, you will notice there is an option to export to “Shared” or “Project Internal.” Note that this only works on views, not on sheets as more than one plan can be on a sheet, but would overlap in model space. Export your views individually if you need them in shared (real world) coordinates.



Exporting Navisworks NWC

When you are exporting Navisworks NWCs from Revit, there is an option to export to Shared or Project Internal under the Navisworks settings. If everyone on the project is using the same shared coordinates and export with this setting, then the models will all be aligned in Navisworks for review.



Conclusion

Shared coordinates is a topic I could easily spend hours going through. They are complex and it does take some time to work through. I’ve included some exercise files that you can try out on your own time to work through different scenarios. But hopefully, this revealed some mysteries from behind the curtain and you have a better understanding of how this system works.