

Get Focused, Real-World Instruction on Revit 2020

BIM software is the number one tool for architects and construction engineers, and that Autodesk Revit is its gold standard. Whether you have used earlier versions of Revit or are encountering it for the first time, this bestselling guide by Autodesk Authorized Authors is the fastest, most effective way to get up to speed when using Revit for architecture. Responding to feedback from readers and instructors, this edition presents the concepts and procedures in ways that enable you to accomplish vital Revit tasks right from the start. Hands-on tutorials show how Revit is used in every project, while available online downloads provide additional "how-to" guidance and advanced content. And if you plan to sit for the Autodesk certification exam, you'll be prepared for that too.

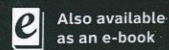
Coverage includes:

- Understanding key Revit concepts
- Mastering the interface
- Using templates and managing Revit projects
- Work-sharing with other users
- Modeling and massing
- Working with the Family Editor
- Applying visualization techniques in different industries
- Documenting with annotation and detailing
- Working with complex walls, roofs, and floors
- Dealing with curtain walls, advanced stairs, and railings

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Learn From
Real-World Scenarios

Understand All Roles
Within a BIM Team

Create a Plan to
Manage Your Revit
Projects

Develop Your Models
and Work With
Complex Features

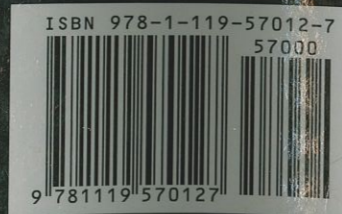
Benefit From Online
Before-and-After
Tutorials

Mastering
Autodesk Revit 2020

Yori
Kim
Kirby



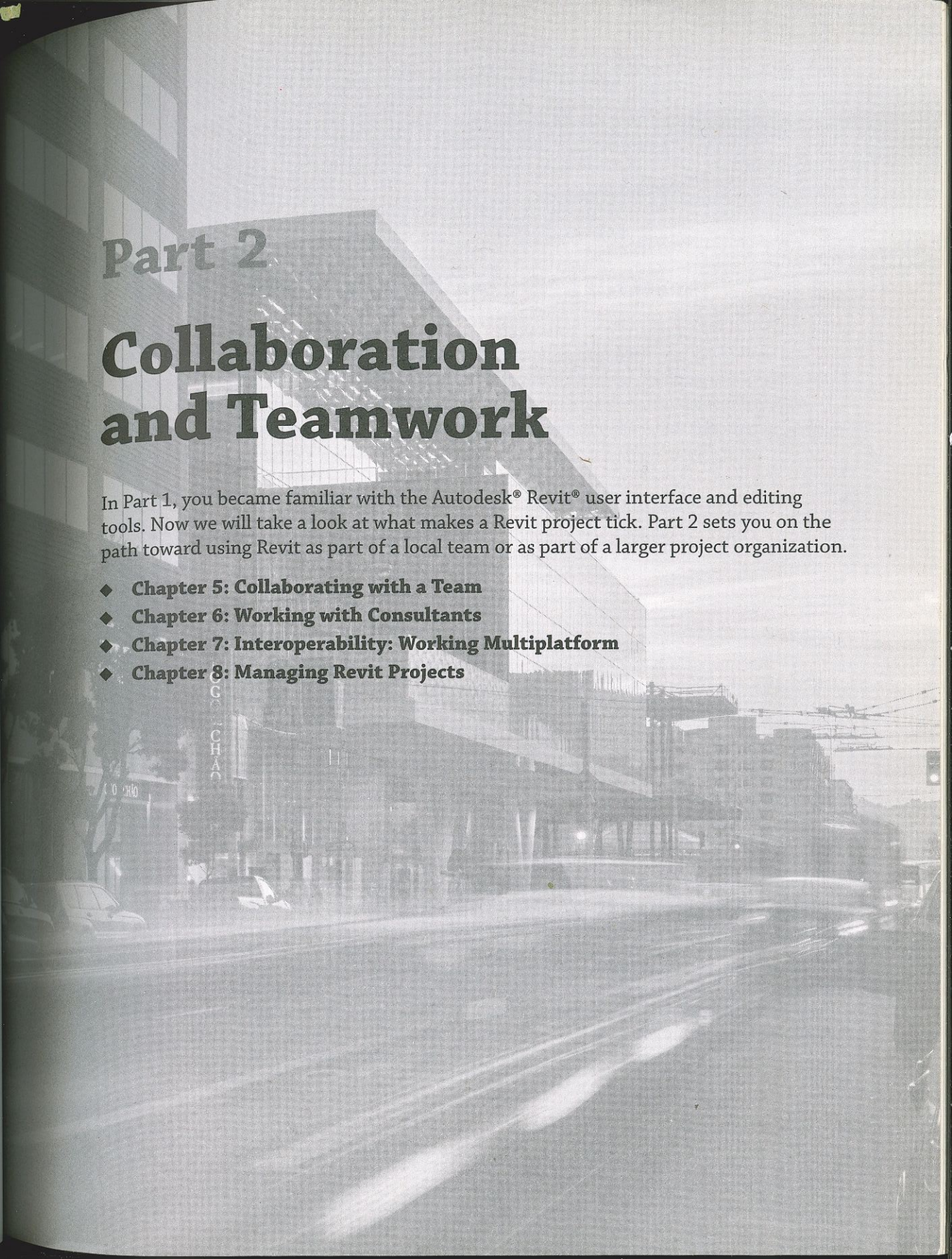
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Mastering Autodesk® Revit® 2020

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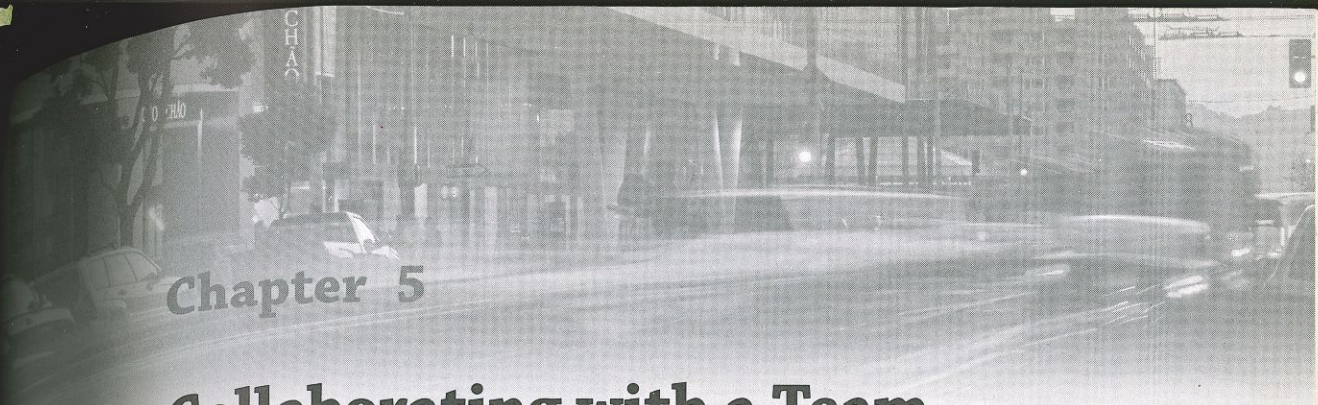


Part 2

Collaboration and Teamwork

In Part 1, you became familiar with the Autodesk® Revit® user interface and editing tools. Now we will take a look at what makes a Revit project tick. Part 2 sets you on the path toward using Revit as part of a local team or as part of a larger project organization.

- ◆ **Chapter 5: Collaborating with a Team**
- ◆ **Chapter 6: Working with Consultants**
- ◆ **Chapter 7: Interoperability: Working Multiplatform**
- ◆ **Chapter 8: Managing Revit Projects**



Chapter 5

Collaborating with a Team

Most architecture projects involve multiple people working together at any given time. It is common in design for many people to work collaboratively to meet deadlines and create a set of design documents. Revit has tools that allow for a collaborative design and documentation process while giving multiple people simultaneous access to the same file. This unique functionality is known as *worksharing*.

IN THIS CHAPTER, YOU'LL LEARN TO

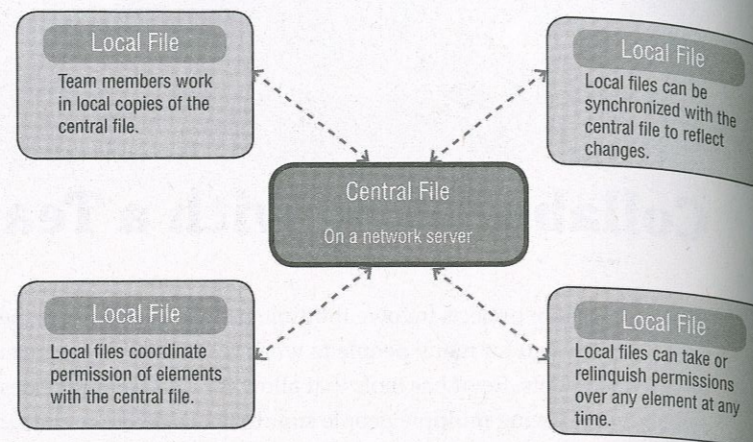
- ◆ Understand key worksharing concepts
- ◆ Enable worksharing on your project
- ◆ Organize worksets in your model
- ◆ Manage workflow with worksharing
- ◆ Understand element ownership in worksets
- ◆ Collaborate in the cloud

Understanding Worksharing Basics

Worksharing refers to the use of *worksets* to divide a model for the purpose of sharing project work among multiple people. A workset is an assigned group of building elements that can be used to manage project responsibilities. Typical worksets might be Building Shell or Core or Interiors. By associating various building elements with worksets, the design team is given the ability to subdivide the model to retain additional control over element ownership. Using worksets, several people can collaborate and work within the same file without fear that their decisions will conflict directly with their teammates. By default, worksharing is not enabled when you start a project because it is assumed you are in a single-user environment.

Worksharing occurs when worksets are enabled and a project file is saved as a *central file* located on a network drive or in the cloud. This central file becomes the repository where all the design team's work is saved. Team members then create local copies of the central file on their own workstations in which they will work as usual. The local copies of the model are individual versions of the file connected to the central file (Figure 5.1).

FIGURE 5.1
The worksharing concept



The only information that flows instantly between the local copies and the central file are permissions. As you work within the model when worksharing is enabled, edits to model elements or settings are not dynamically transferred among the project team members. This would significantly decrease computer performance and would be distracting to your workflow to see the model constantly changing on the screen. Instead, model updates are published to the central file and pulled from the central file to your file when you synchronize with the central model.

Even though worksets are established to break up a model into manageable chunks, permissions for a worksharing-enabled project are managed at the element level. This means you could have a worksharing-enabled project with only one workset but still have multiple users in the file. A project file is essentially a database. As you are creating, selecting, and modifying elements within the model, you are automatically obtaining permission to edit elements from the central database. Once permission to modify an element is granted, no one else can make changes to that element until the changes are reconciled with the central file. This occurs when you use the Synchronize With Central (SWC) command on the Collaborate tab to save changes you have made back to the central file. It also simultaneously updates your local file with any other changes that have been published to the central file by other team members.

THE LIBRARY WORKSHARING ANALOGY

Another way to understand worksets and how they relate to element permissions is to think of a workset as a shelf of books in a library and of the model elements as individual books on the shelf. If you are working on a research paper about beavers, you can go to the library and do one of two things: check out the entire shelf of books about animals or check out the book about beavers. Checking out an entire shelf of books within a certain category is the same as making an entire workset editable—no one else can do their animal research paper because you have all the animal books. You have become the owner of that workset, and there can be only one owner per workset.

As an alternative, you would likely borrow only the book or books on beavers so that your fellow students could access other animal books to complete their own papers. In this analogy, you have

become an element borrower, and there can be many borrowers within each workset. Of course, the teacher probably made a mistake if she assigned two students to complete a research paper on the same animal. This mistake may also hold true when your team is working in Revit. The same model element cannot be edited simultaneously by more than one person. After all, you probably should not be working on the same model area as your teammate anyway, right?

The actual use of worksets can vary greatly from project to project. Quite frankly, creating more worksets beyond the defaults is technically not necessary; however, you can use worksets to take advantage of other benefits:

- ◆ Use worksets to control the visibility of groupings of building components, such as building skin, core, interior walls, and so on, without the need to use temporary view settings or control visibility manually.
- ◆ Close worksets as needed to remove those parts of your project from active memory, thus improving performance.
- ◆ Use workset ownership to prevent others from editing a part of the project you are currently designing.

Enabling Worksharing on Your Project

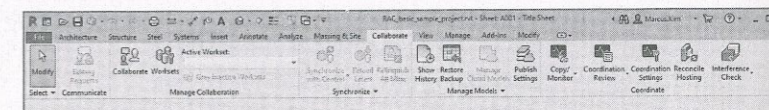
The worksharing feature can be enabled in any Revit project file. You can begin worksharing, create and remove worksets, or move elements between worksets during any stage of the project.

WORKSHARING IN THE PROJECT PROCESS

When the team has chosen to enable the worksharing feature, make sure everyone is aware of the change to the file and that it is planned within the project process.

To follow along with the text in this chapter, you can download the sample building project file from this book's web page at www.wiley.com/go/masteringrevit2020. One version of the project does not have worksets, whereas the other has retained worksets but is not configured for worksharing. Open the file `c05-Sample-Building_Start.rvt` and switch to the Collaborate tab in the ribbon. Figure 5.2 shows the worksharing tools.

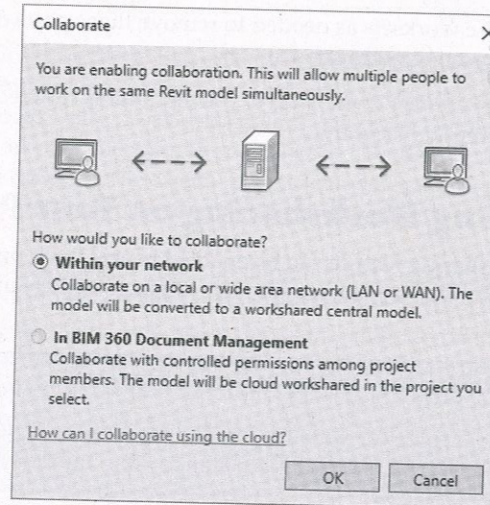
FIGURE 5.2
The Collaborate tab





You can initiate worksharing by clicking the Collaborate button. Selecting this tool opens the Collaborate dialog box, alerting you that you are about to enable collaboration for your project (Figure 5.3). You can choose to collaborate within your network or using the cloud. Both options allow you to enable worksets. For those who have utilized previous versions of Revit, you can still invoke worksharing by clicking Worksets; however, you are limited to a worksharing workflow within your network. To begin managing your worksets regardless of having chosen to workshare within your network or in the cloud, select the Worksets button in the Manage Collaboration panel. Two worksets are automatically created within your project: Shared Levels And Grids, to which any existing levels and grids in your project will be assigned; and Workset1, to which all other building elements will be assigned. You can rename these worksets; however, we recommend not renaming Workset1 because this is the default system workset that can never be deleted—even if it has been renamed. You will read about an alternative way to use Workset1 in the section “Organizing Worksets” later in this chapter.

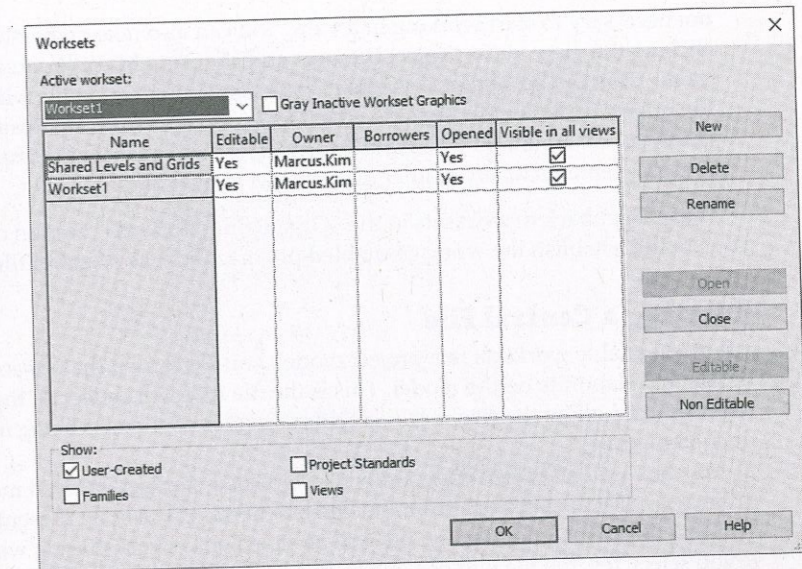
FIGURE 5.3
Activating worksharing



Click OK to confirm that you want to enable worksharing. Depending on the size of your model and your processor speed, this process can take a few minutes to complete. Once it is done, the Worksets dialog box opens (Figure 5.4).

In the Worksets dialog box, you can create as many user-defined worksets as necessary; we offer some tips in the section “Organizing Worksets” later in this chapter. By default, when a new workset is created, it does not contain any model elements or components. You can add model elements to worksets as you build them or reassign existing elements to worksets. The Worksets dialog box also lets you take and relinquish permissions over existing worksets. First, you should understand the different types of worksets illustrated by the options in the Show area at the bottom of the Worksets dialog box, shown in Figure 5.4.

FIGURE 5.4
The Worksets dialog box



Types of Worksets

There are four types of worksets in any project: user-created, families, project standards, and views. User-created worksets such as Shared Levels And Grids and Workset1 are shown by default, and you have the option to list the others by selecting the check boxes at the bottom of the Worksets dialog box.

User-Created Worksets In addition to the two worksets automatically generated when you first enable worksharing, all of the worksets you add in the Worksets dialog box will fall under this category. All building elements, spaces, and datum objects you place in the project are assigned to user-created worksets. Only elements in user-created worksets can be moved to other user-created worksets.

Families Worksets For each family loaded in the project, a workset is automatically created. When editing the properties of a family, you will automatically take ownership over that family.

Project Standards Worksets The project standards workset type is dedicated to all the project settings, such as materials, dimension styles, annotations, tags, line styles, and so on. Any time you need to edit a project standard, such as modifying the type properties of dimensions, you will be taking ownership of the element's workset.

Views Worksets Every view created in a project has its own workset. The views workset type controls ownership of the view properties and any view-specific elements, such as annotations, dimensions, tags, detail lines, and so on. You can take ownership of a particular view workset by selecting it from the workset list and clicking the Editable button, but this is

not necessary to start working in a view. You can also take ownership of a view by right-clicking the view in the Project Browser and choosing Make Workset Editable from the context menu. This can be a helpful shortcut in construction documents when much of the effort on the project is more view-specific. Regardless of ownership, any team member always has the ability to *add* annotation elements to any view—you just cannot *change* any existing view-specific elements when another user owns a view workset.

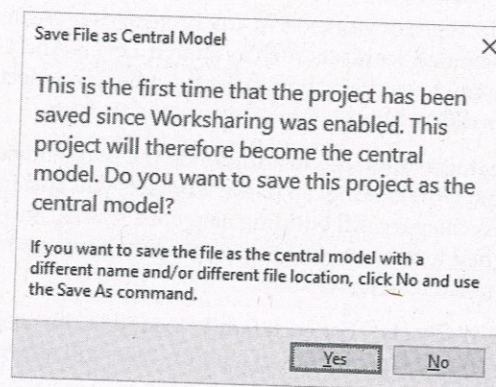
We will get back to worksets in the “Organizing Worksets” section of this chapter. For now, you should establish the workset-enabled project model as a central file.

Creating a Central File

After you enable worksets in a project model, you must save the project as a central file to enable others to collaborate on the model. This is the file that will collect all the work done by your team members and allow them to receive regular updates of changes being made to the model and documentation.

You can use one of two commands to establish a workset-enabled model as a central file: Save or Save As. If you click Save from the File tab menu, you will be presented with a warning telling you that this is the first time the file will be saved since worksharing was enabled (Figure 5.5). If you select Yes, the file will become a central file with only the default settings in its current location.

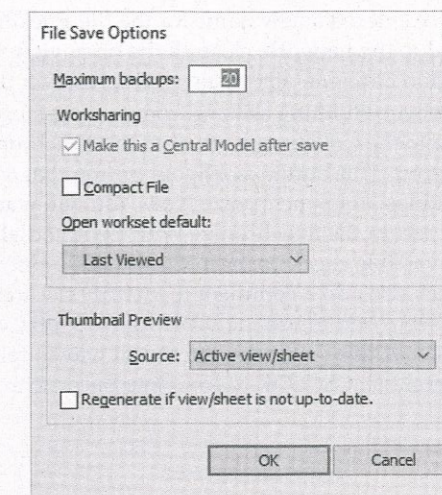
FIGURE 5.5
The Save command will create a central file with only the default settings.



As an alternative, we recommend using the Save As > Project command from the Application menu. When you click this button instead of Save, the Save As dialog box will appear. In the Save As dialog box, click the Options button to access the options shown in Figure 5.6.

This dialog box contains some important settings. At the top, you can set the number of backups the file will keep in the folder history after saves. The default value is 20. Depending on the storage availability on your network, how often your network is backed up, and the number of people working in the model (remember, local files are also backups), you might want to increase this number. For example, if three users are synchronizing with the central file every 30 minutes over the course of a workday, that might be 48 saves before the next backup. Better safe than sorry. Also, the Make This A Central Model After Save check box is selected and grayed out. This is because we have activated worksharing in this file and it is assumed that we will be making a central file on the next save.

FIGURE 5.6
Options for saving a project file



You can also specify default settings for opening the project file (shown under Open Workset Default). We will discuss opening a file in the section “Creating a Local File” later in this chapter, but we recommend setting this option to Specify for most project scenarios. This will always prompt your team members with the Worksets dialog box when a local file is opened. Click OK to exit the File Save Options dialog box.

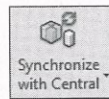
Back in the Save As dialog box, choose a network location that everyone on the team has access to for your central file. Be sure that when you are naming your new central file, you choose a new name. We recommend you do *not* save over the existing Revit project file. There are two reasons for this. First, this workflow automatically gives you a backup of your file as it existed before worksharing was enabled. Second, saving over an open Revit file can sometimes cause corruption, even if it is the same model. It is also a good idea to name the file with some clarity that helps identify it as a central file, such as MyProject-Central.rvt.

NAMING FILES IN REVIT

When you are working with a project team in Revit, it is important to give your various team members some guidance when you name your files. We just touched on the idea of making sure you include “Central” in your filename so team members know they will need to make a local copy when opening the file, but there are some other guidelines you might want to consider.

When working with other disciplines, consider naming your file with a denominator to let the larger team know which file is architectural, which is structural, and so on. Also, because your office might be working on several Revit projects at one time, you might be working in more than one version of Revit if you’re working on more than one project. So it’s a good idea to include the Revit version in your filename so team members don’t accidentally open the file with a newer version. An example filename might be c05-Sample-Building-A20-Central.rvt. “c05-Sample-Building” is the project name, “A” designates the discipline as architectural, “20” is the version of Revit (2020), and “Central” notes it is a central file.

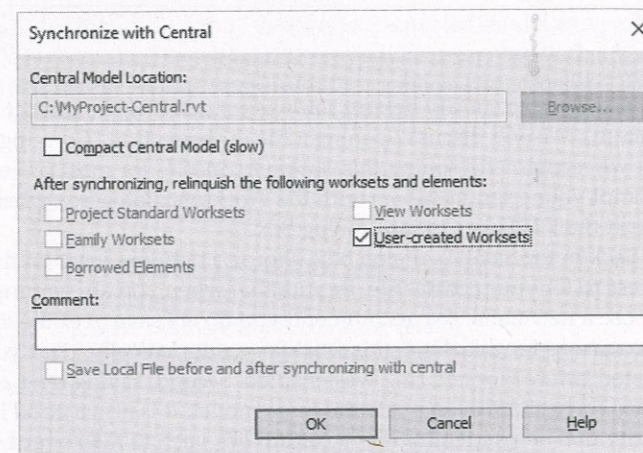
Once you have entered a new name for the file, click the Save button to save the file. Now that your file is saved to the network, close all the open view windows. As one final step, you need to make sure you don't accidentally retain any rights over the objects and elements within the central file, thereby prohibiting anyone from editing those elements.



To do this, go to the Collaborate tab, find the Synchronize panel, and click the Synchronize With Central button. This button is a flyout button that contains two commands: Synchronize And Modify Settings and Synchronize Now. You will want to use Synchronize And Modify Settings in this case. In the Synchronize With Central dialog box, shown in Figure 5.7, make sure you select any available check boxes in the middle portion to relinquish ownership of all worksets. You can also add a comment to identify the action taken prior to this synchronization.

Yes, it might seem odd to use the Synchronize With Central command when you are actually in the central file, but this method is the fastest way to relinquish all worksets and complete the setup of the central file. Click OK to complete the synchronization.

FIGURE 5.7
Synchronizing with the central file to relinquish permissions



USING AN AUTODESK® REVIT® SERVER ACCELERATOR

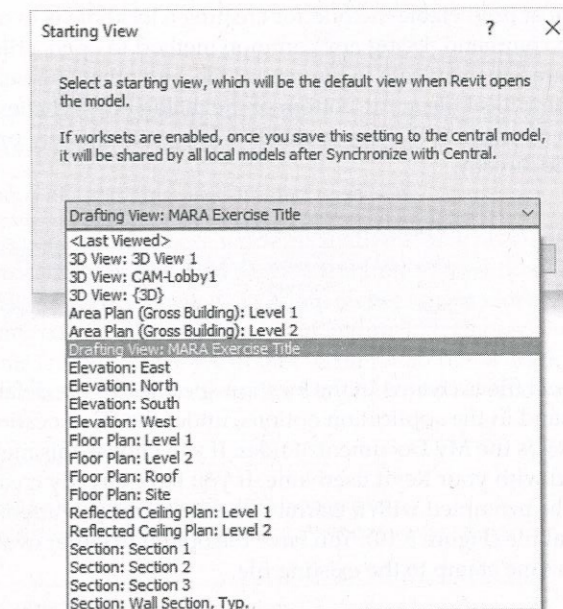
If your project team is distributed in various geographic locations, an alternative to synchronizing with the central model directly over the wide area network (WAN) is to use an Autodesk® Revit® Server Accelerator. This technology was developed by Autodesk to support extended collaboration through the use of server technology that creates a layer of virtual central models. The Revit Server then manages changes into a single central model without burdening the WAN with full synchronization traffic.

Another tool that allows collaboration between offices within the same model is Autodesk® BIM 360 Design®, which we discuss more in the “Collaborating in the Cloud” section later in this chapter. BIM 360 Design is different from Revit Server in that it uses cloud technologies to pass model changes between users, and all that is required is an Internet connection. This approach is easier on IT departments as it requires less server support but might add security concerns if the project models need to be kept localized to an office.

Selecting a Starting View

On the Manage tab of the ribbon, locate the Manage Project panel and click the Starting View command. With this command, you can select any project view to be the first view displayed when the model is opened (Figure 5.8). Because 3D views take longer to regenerate when your project opens, we recommend you select a 2D view to speed this process; you can even create a drafting view that contains the project name and image as the starting view.

FIGURE 5.8
Selecting the starting view



Another use for the starting view is as a project bulletin board. Simply create a drafting view for the starting view and keep it populated with project standards, modeling action items, and other notes your team might need to know like upcoming deadlines.

Synchronize the central file once again, and remember to relinquish any worksets you might have obtained during the configuration of the central file. From the Application menu, click Close to close the central file.

USING CAUTION WHEN USING A CENTRAL FILE

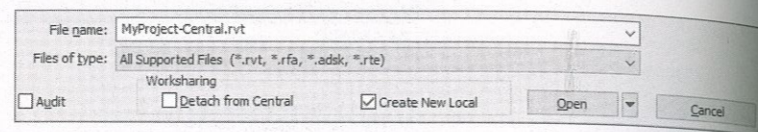
Once you have created a central file, there are a couple of things you cannot do. Do not open it directly again and do not change the filename. Opening the file will change its attributes, and none of your team members will be able to synchronize with central. If they were actively working in the local file, their work would be lost. The same problem occurs if you change the filename—those with a local copy will lose their association to the central file, and they will not be able to save their work.

Creating a Local File

Now that you have made a central file, you will need to create a local copy of it in which you will organize worksets for team collaboration and continue your design and documentation. There are several ways to perform this action. One option is to simply open the network location of the central file and copy the file from the network to your desktop or anywhere on your local hard drive. Be careful not to *move* the file—only copy it. It is also a good idea to rename the file to something that identifies it as a local file, such as c05-Sample-Building-Local.rvt.

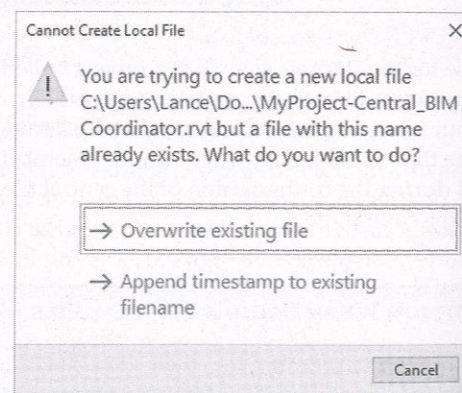
The most predictable method for creating a local file is to use the functionality integrated with the Open command. Using any common method to open a file, you will get to the Open dialog box (Figure 5.9). Navigate to the central file, and when it is selected, you will have the option to create a new local file at the bottom of the dialog box. Whenever you select a central file through the Open dialog box, this box is checked for you as a safety precaution against you opening the central file directly.

FIGURE 5.9
Create a new local file from the Open dialog box.



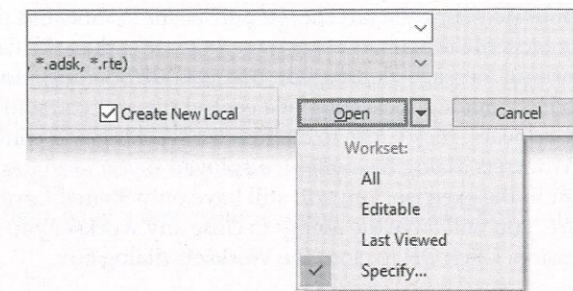
The local file is created in the location specified as the default path for user files. This setting can be found in the application options, under the File Locations settings. The default location for this setting is the My Documents folder. If you choose this method, the local file will be appended with your Revit username. If you have already created a local file with this method, you will be prompted with a warning the next time you attempt to create a new local copy from the central file (Figure 5.10). You have the option to either overwrite the existing local copy or append a time stamp to the existing file.

FIGURE 5.10
Overwriting existing local files



Before you proceed to open the file, you can change the way you interact with worksets. If you click the small arrow to the right of the Open button, you will see a list of options, as shown in Figure 5.11.

FIGURE 5.11
Workset options when opening a file

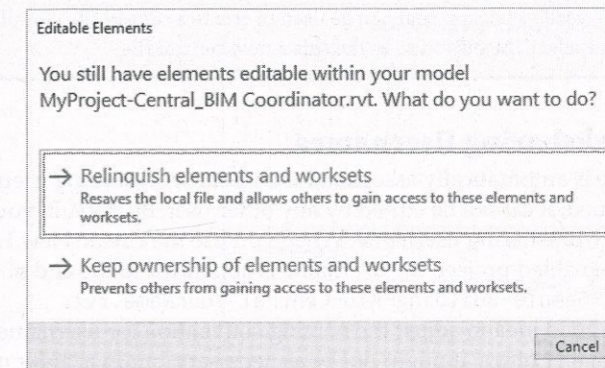


The default setting for opening worksharing files is Last Viewed, but each of the available settings is helpful to your workflow. Let's review these settings in detail:

All This setting opens all available user-created worksets.

Editable This setting opens only those worksets that you have previously made editable. If you did not retain ownership of any worksets the last time you worked on a local file, none of the user-created worksets will be opened. To retain ownership of worksets when you close a file, you will be prompted with the alert shown in Figure 5.12. Choose the option to keep ownership of elements and worksets. We do not recommend this workflow because it restricts others on your team from working on elements for which you retain ownership.

FIGURE 5.12
Closing a file while relinquishing ownership of worksets



Last Viewed The file will be opened with the Last Viewed worksets configuration. If you use this option when opening a new local file for the first time, all worksets will be opened.

Specify We highly recommend this option because it will give you the most flexibility when opening a local file and is helpful with cutting down the open time for large files. When Specify is selected, you will be presented with the Worksets dialog box immediately after you click the Open button. You can then choose the worksets you would like to open or close before the file is loaded into memory.

To continue your exercise, choose the Specify option and then click the Open button. The first time any local file is opened using a method other than the Create New Local option, you will see a warning message alerting you that you are opening a local file. This is simply a notification that you have made a local copy of a central file and you will be the owner of the local file. If this warning appears, click Close to dismiss the warning and continue the file-opening process.

The Worksets dialog box will be displayed if you used the Specify option to open the file. At this point in the exercise, you will still have only Shared Levels And Grids and Workset1, but in the future, you will have the ability to close any workset you may not need for editing in your work session. Click OK to close the Worksets dialog box.

THE BENEFITS OF REVIT LOCAL FILES

Using a worksharing environment allows you to do something your IT department typically asks you *not* to do: work directly on your workstation's hard drive. Although working off a network file is typically a good idea, there are several reasons why a local copy offers additional benefits:

- ◆ It allows more than one user to make changes to the central file by editing local files and synchronizing those changes with the central file.
- ◆ Your local copy will be more responsive than a networked local file because your access speed to your hard drive is much faster than it is across most networks.
- ◆ If anything bad happens to your network or your central file, such as file corruption, each local file is basically a backup that can be used to create a central file. Simply perform a Save As operation and select the option to make this a new central file.

Using Worksharing Usernames

Each local file is automatically associated with your worksharing username once it is opened; after it is opened, it cannot be edited by any other user. By default, your Windows login name is used as your worksharing username. When you use the Create New Local option to open a worksharing-enabled project, the username is appended to the end of the local filename—for example, c05-Sample-Building-A16-Central_YourName.rvt.

It can be a good idea to adjust the naming convention for usernames to help team communication. In a smaller office, it might not be as necessary, but in a larger office or multi-office team, clarification of element ownership is vital. One option is to change your Revit username to first name, last name, and phone extension. Alternatively, with the use of tools like Slack or instant messaging, including a slack handle or IM name would also aid communication. This way, team members can quickly identify and contact you if they need you to relinquish permission of an element. As Autodesk tools move more to cloud technologies, it is recommended that you coordinate any renaming of your A360 account with your larger team. Changing your username can lead to other issues with online tools.

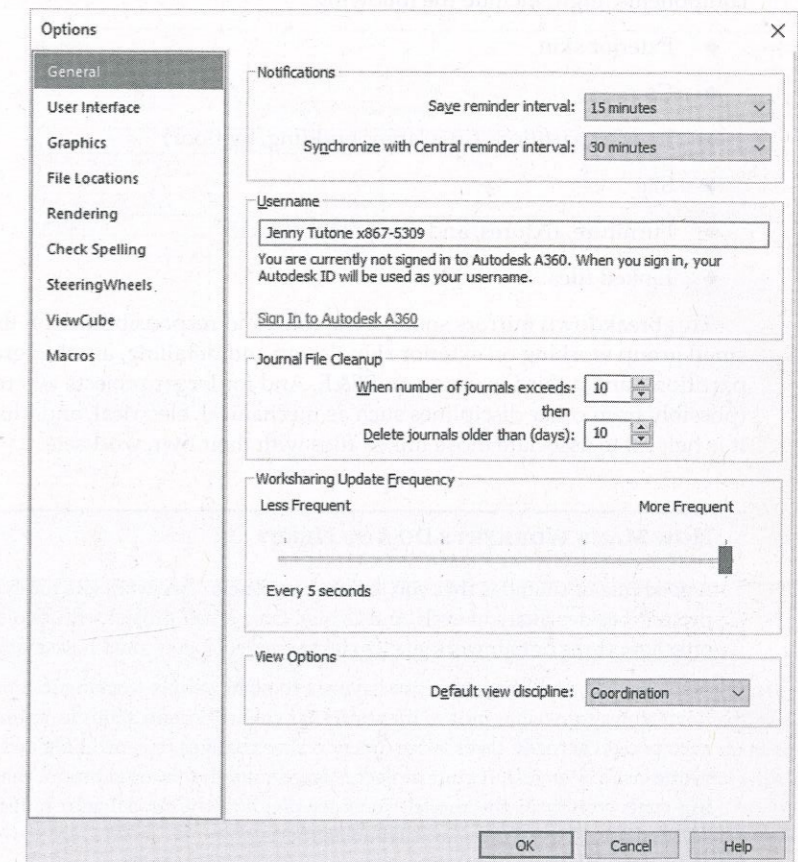
To make this modification, follow these steps:

1. Close all your open project files. You can change the username only when no workshared projects are open (you cannot change your username while it is active in open projects). You will also not be allowed to change your username if you have signed into Revit with

your Autodesk ID, in which case it will use your Autodesk ID as your username. After you change your workset username, you will need to create a new local file because the old local file is associated with a different username.

2. From the Application menu, choose Options at the bottom.
3. In the Options dialog box, select the General category.
4. In the Username field, enter a new value (Figure 5.13). Click OK to exit.

FIGURE 5.13
Changing the
default username



If you have signed in to an Autodesk® 360 (A360) services account, your username will automatically switch to your A360 username. A360 is an online service with Autodesk accessible from the upper-right portion of your application window. If you are not signed in, you should see the button as a small figure with Sign In next to it. More information on the A360 account is provided later in this chapter.

Organizing Worksets

Now that you have enabled worksets and configured your project file for worksharing, you have the opportunity to further organize your model into more worksets. When dividing your project into worksets, it is important to think about the larger building system rather than try to isolate its individual components. In other words, worksets should not be used like layers in a CAD application. A good way to think about dividing up worksets is to consider the building elements and the number of people working on each of these elements. A basic breakdown of a project's components might include the following:

- ◆ Exterior skin
- ◆ Core
- ◆ Interior partitions (in a larger building, by floor)
- ◆ Site
- ◆ Furniture, fixtures, and equipment (FF&E)
- ◆ Linked files

This breakdown mirrors some of the roles and responsibilities on the project. There might be a small group working on exterior skin design and detailing, another group working on interior partitions, and a third working on FF&E. And for larger projects where you have linked files (possibly from other disciplines such as mechanical, electrical, and plumbing [MEP] or structure), it is helpful to associate those linked files with their own worksets.

HOW MANY WORKSETS DO YOU NEED?

A good rule of thumb is that you should have one or two worksets for every person working on the project (besides Shared Levels And Grids). On a small project with two or three people, you might only have three or four worksets. On larger projects, you could have a dozen or more.

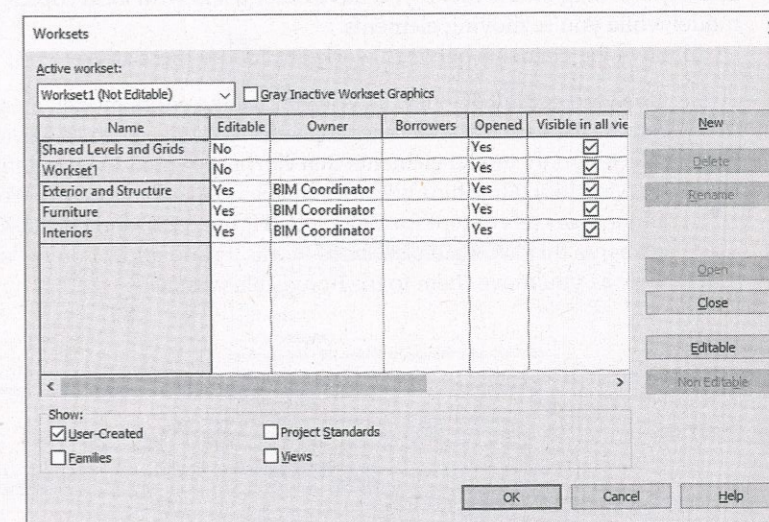
Also keep in mind that once you have six to eight people working in a project, the performance of Revit slows somewhat, not to mention that you will spend a bit more time saving local files because each person actually saves twice (once to save changes to central file and another to download everyone else's changes). If your project is large enough to warrant more than six to eight people working concurrently in the model, consider dividing the model into multiple files, as we discuss in Appendix B, "Tips, Tricks, and Troubleshooting."

Continuing with the Sample Building exercise file, open a local copy of the central file and click the Worksets button from the Collaborate tab or from the status bar. Click the New button and create each of the following new worksets (keep the Visible In All Views option selected each time):

- ◆ Exterior and Structure
- ◆ Furniture
- ◆ Interiors

When you have done this, you should see a total of five user-created worksets, as shown in Figure 5.14. The worksets we have set up demonstrate how a typical breakdown might occur in a project of this size, but creating, defining, and assigning worksets is by no means limited to this scheme. Depending on how you structure work in your office, the worksets might be quite different. Note that once you complete the exercise, you will need to identify which workset you would like to make active. The Active workset is the one where any new model elements will be placed. You can make the workset active in the Worksets dialog box or with the Workset selector at the bottom of the screen.

FIGURE 5.14
Creating new worksets
in the project



SHOULD YOU KEEP WORKSET1?

Why keep Workset1? Well, it is a great holding place when new users need to work on the project, but they are not certain to which workset they should assign the new elements they create. Tell them not to worry! Simply ask them to make Workset1 their active workset. After they have finished their work, they can isolate all the elements they have created and then assign them to the right workset later (maybe with some oversight). You can even have a custom 3D view with only Workset1 visible to visually check whether elements are placed correctly.

As we stated previously, one of the biggest challenges facing teams new to Revit is understanding the difference between layers in a CAD application as compared to worksets. These teams typically want to try to manage worksets as they managed layers in CAD, which can result in worksets named Doors, Windows, Walls, and so on. Although this is effective management in a CAD environment, you do not want to create all of this structure for worksets. Not only is it time-consuming, but it does not provide any benefit.

Much like layers, the workset is a tool that the team will need to understand in order to use it successfully. Worksets should be structured by a team's BIM coordinator or a project manager familiar with a BIM workflow. Ultimately, though, it is up to the team members to place elements in the proper worksets and ensure that project standards are being followed.

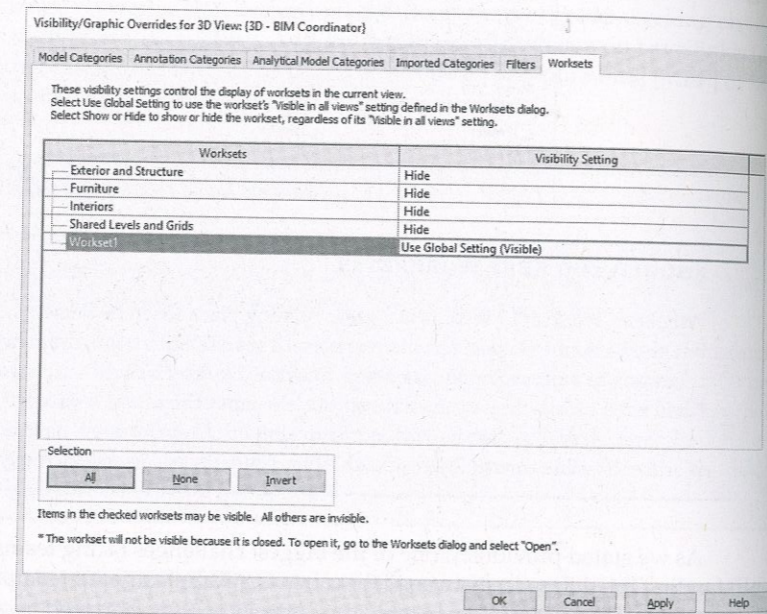
Moving Elements between Worksets

With this chapter's exercises, you are applying worksharing to an existing model; therefore, you will need to assign the existing model elements to the worksets you have created. The easiest way to move elements between user-defined worksets is by using a customized 3D view. The following exercise will walk you through moving elements from Workset1 to the new worksets you have established, using a subtractive method to reassign the model geometry. This should be done by a single person who owns all the elements to ensure that no permissions issues occur when elements are being moved between worksets. This is also best done with only one person actively working on the file. If you have other users with local copies, ask them to not use the model while you're moving elements.

To move the elements between worksets, follow these steps:

1. Open the default 3D view so you can see the entire model. By selecting a 3D view, you cannot accidentally select view-specific elements (such as elevation or sections)—you'll be selecting only model elements that can be assigned to user-defined worksets. Now open the Visibility/Graphic Overrides dialog box and choose the Worksets tab. Choose to hide all the worksets except for Workset1 (Figure 5.15), and click OK. This will turn off any elements that are visible on those worksets and allow you to "subtract" elements from this view as you move them to the nonvisible worksets.

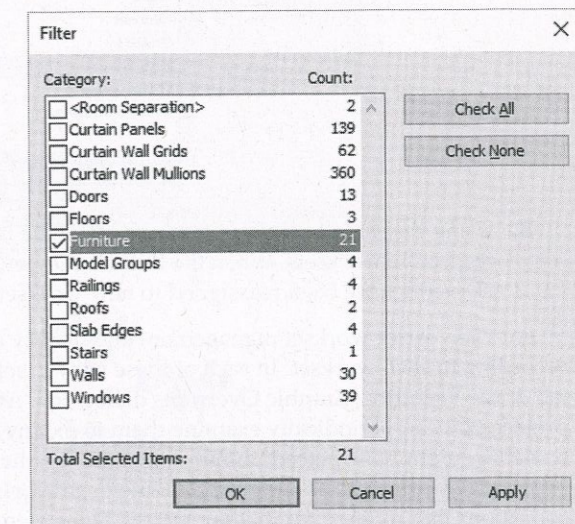
FIGURE 5.15
Isolating Workset1 in
Visibility/
Graphic Overrides



In a worksharing-enabled file, the default 3D view is unique to each user participating in the model. The name of the view will be appended with the team member's username; for example, {3D - BIM Coordinator}.

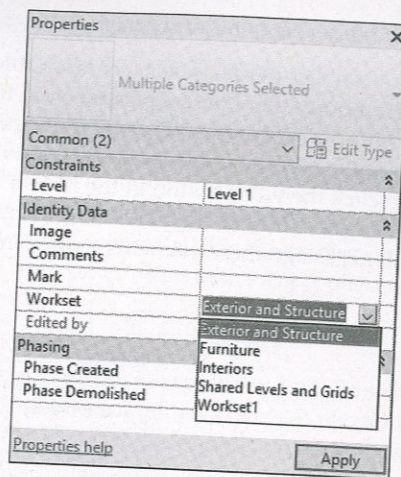
2. To select model elements and assign them to different worksets, you have a few options:
 - ◆ For a smaller model, select a comfortable number of elements using the Filter tool and then modify the Workset parameter in the Properties palette. What constitutes a "comfortable" number of elements depends on your computer's capabilities. As an example, if you window-select all the elements in the Sample Building model, you can click the Filter button in the ribbon and choose to keep the Furniture category active and uncheck the remaining items (Figure 5.16). Click OK. In the Properties palette, assign these elements to the Furniture workset.

FIGURE 5.16
Use the Filter tool to
select specific object
categories.



- ◆ For a larger model, it might first be necessary to select some individual components and move them separately. Although the process remains the same (select elements then change the workset in the Properties palette), the selection system can vary. Another example of moving elements by selection would be to highlight an exterior wall and use the Tab key to select a chain of exterior walls. Those exterior walls can be moved to the Exterior And Structure workset.
- ◆ You can also select one or more types of elements in the model and use the Temporary Hide/Isolate tools in the view control bar. In the exercise file, try to locate a single window and select it. From the view control bar, click the Temporary Hide/Isolate icon and select Isolate Category. The boundary of the 3D view will be highlighted, indicating a temporary view setting, and you will see only windows. Window-select all the windows and then go to the Properties palette to assign them to the Exterior And Structure workset (Figure 5.17). Return to the Temporary Hide/Isolate icon in the view control bar and select Reset Temporary Hide/Isolate.

FIGURE 5.17
Assign the Workset property to multiple elements.



- Using the same technique, you can move the remainder of the model elements to their respective worksets. When the default 3D view is empty, you will know that all the elements have been reassigned to new worksets.

For even easier workset management and quality control, you can create a 3D view named according to each workset. In each of these views, isolate the respective workset in the Worksets tab of the Visibility/Graphic Overrides dialog box. After these views are established in the project, you can periodically examine them to fix any workset assignment mistakes. For example, someone might have placed plumbing fixtures on the Site workset.

As you continue to assign model elements to worksets, you should be aware of some special conditions that might exist in your project. Some elements that can be selected and/or filtered are actually subcomponents of other systems, and as such, their Workset property cannot be changed independently of the parent system. For example, you can select and filter curtain wall panels and mullions, but you can change only the Workset property of the curtain wall object, which is simply categorized as a wall.

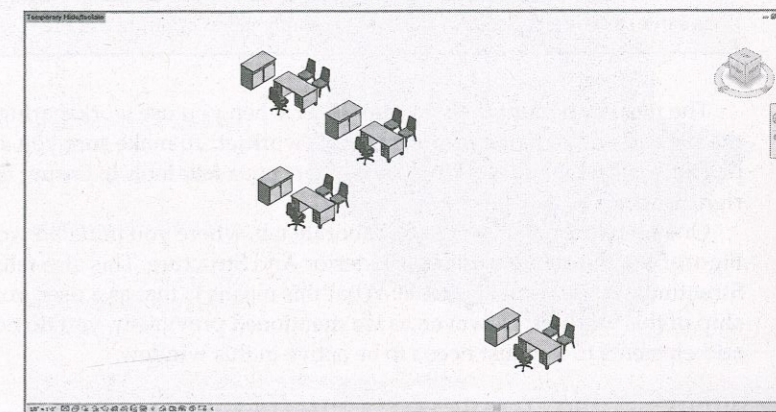
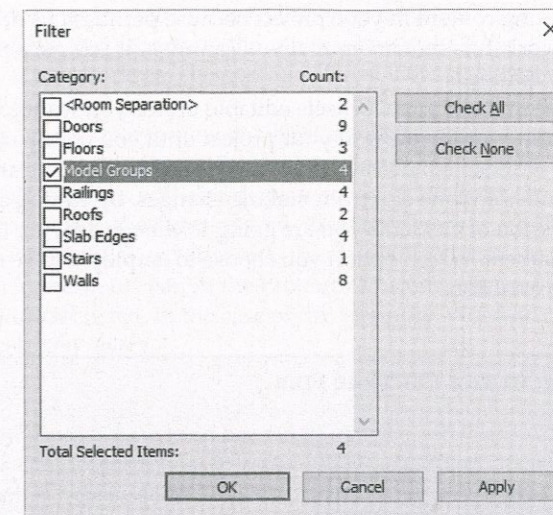
Another special condition to look for is the presence of groups. Grouped objects will show up in the filter list as Groups and not in their respective categories. As an example, in Figure 5.18, the filter list shows Model Groups. Select only Model Groups in the Filter dialog box and use the Isolate Elements command in the view control bar, and you will see that the groups contain elements in the Casework and Furniture categories.

MOVING EVERY INSTANCE OF AN ELEMENT

A quick way to move every instance of an element type to a new workset is to use the Select All Instances option from the context menu. For example, select a chair in the model and right-click it. From the context menu, choose Select All Instances > In Entire Project. This selects all the family elements in the entire model, allowing you to quickly move them all to the same workset in the Properties palette. Please note that in certain situations where some of the elements selected are also hosted in groups, the Workset property will not be editable.

Another way to select all instances of an element is to right-click the family name in the Project Browser under the Families node. Simply navigate to your family in its proper category.

FIGURE 5.18
Select only Model Groups in the Filter dialog box.



At any point in this process, you can check your work by opening the Worksets tab in the Visibility/Graphic Overrides dialog box and setting all but one workset to Hide. Use this method to inspect the contents of each workset.

The workflow described in the preceding exercise is necessary only if you have developed a model *before* enabling worksharing for collaboration. You can always start a new project enabled with worksets, and your team can develop the model simultaneously. The only important thing to remember is to ensure your team uses the appropriate active workset when working in a worksharing-enabled project. We will cover that in greater detail in the following section.

Managing Workflow with Worksets

Now that you or your BIM Coordinator has established a central file and organized your project into worksets, you can get ready to work in a local copy of the central file. Do you need to do anything special to begin working in a project that is enabled with worksets? No. You can simply

start adding or editing content in your project because permissions are being automatically managed as you work. Just remember that you cannot edit any elements (2D or 3D) that someone else is already editing.

You do not have to make any worksets editable unless you want to prevent other team members from editing certain parts of your project until you have completed some work. Making the entire workset editable allows you to freely manipulate any of the geometry on that workset but precludes anyone else from making changes. By editing at the element level, you are only taking permission of elements you are going to change, leaving the other elements available for other team members. Which option you choose to employ will be dependent on the workflow you are looking to establish.

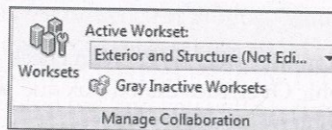
DO NOT WORK IN THE CENTRAL FILE

Once you create a central file, make sure that you *never* work directly within that central file. Only work directly in local files. Working in the central file will change the file attributes on the server and prohibit anyone with a local file from being able to synchronize with the central file and likely lead to a loss of work. The possibility of losing a lot of work and effort from team members exists, so it is safer to err on the side of caution by simply never opening the file.

The most important thing to remember when you use worksharing is that every element in the file and added to the file belongs to a workset. To make sure you are placing elements in the proper workset while working, know there are a few tools to ensure that you select the right workset.

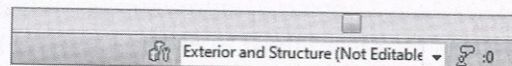
One such location is on the Collaborate tab, where you initiated worksharing. As shown in Figure 5.19, the active workset is Exterior And Structure. This also tells you that the Exterior And Structure workset is not editable. What this means is that as a user, you have not taken ownership of this workset. However, as we mentioned previously, you do not need to own a workset to add elements to it. It just needs to be active in this window.

FIGURE 5.19
Setting the active workset in the ribbon



The second location is in the status bar at the bottom of the application (Figure 5.20). The drop-down menu on the left serves the same function as the Active Workset drop-down in the Collaborate tab, but it allows you to verify that the proper workset is active without the need to bounce between tabs in the ribbon and interrupt your workflow. From this location you can also change the active workset and even open the Worksets dialog box using the small button to the left of the drop-down menu.

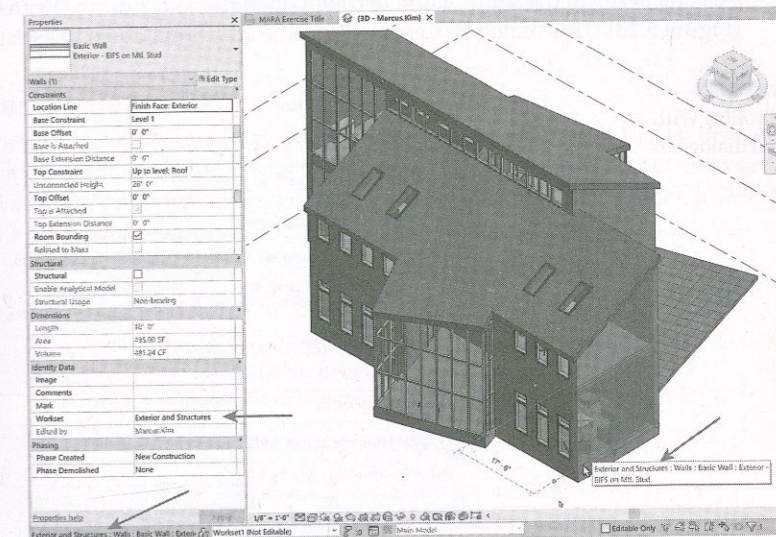
FIGURE 5.20
Setting the active workset in the status bar



Another helpful tool located on the Collaborate tab is the Gray Inactive Worksets button. This dims all the elements that are not on the active workset, helping you identify what elements are in your current, active workset. This is a temporary view state and will not affect any printing or other output.

In addition, you can always view an object's workset assignment by hovering your mouse pointer over the object and viewing its workset shown in the tooltip and in the status bar (Figure 5.21). Both locations will also display an object's family and category. In the example shown here, the wall is in the Exterior And Structures workset, in the Walls category, and its type is Basic Wall: Exterior - EIFS on Mtl. Stud. There are three locations in Figure 5.21 where you can see the workset: in the status bar, in the Properties palette, and in the tooltip. As a useful tip, note that the active workset listed, in the case of this example, Workset 1 (not editable), is not the workset of the selected object.

FIGURE 5.21
Workset assignment displayed in status bar, Properties palette, and tooltip information



Saving Work

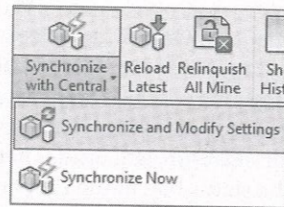
It will eventually become necessary to save your work and share your progress with others in the model. You have three ways to both save your work and view the work of others: Save, Synchronize And Modify Settings, and Synchronize Now.

Save The Save button saves the work you have done to your local file only; the work is not shared or published to the central file. This can be a useful step if you are in the middle of a process and want to make sure your work is saved but are not ready to share the changes with the rest of the team. You can find the Save tool either by choosing File > Save or by clicking the Save icon on the Quick Access toolbar (QAT).

Synchronize With Central > Synchronize And Modify Settings When you are ready to publish your work for the rest of your team to see, you have two command choices to synchronize with the central file. The first of two synchronizing commands is known as Synchronize And Modify Settings. You can access this command in a couple of ways. The first

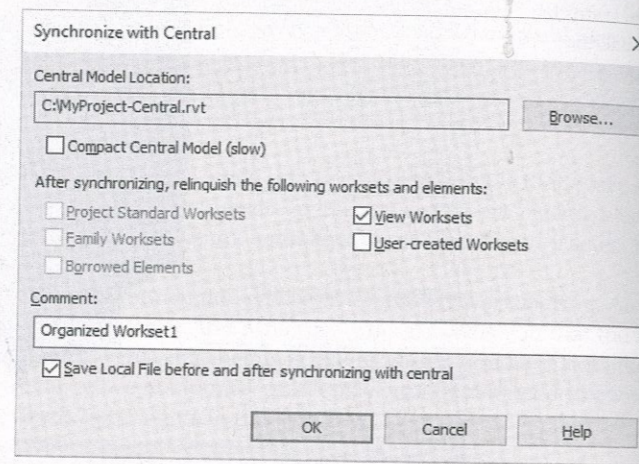
is on the Collaborate tab in the Synchronize panel, as shown in Figure 5.22. The Synchronize With Central flyout button is located on the left of this panel.

FIGURE 5.22
Synchronize With Central command on the ribbon



As an alternative, you can use the Synchronize With Central button located on the QAT. Both buttons perform the same action and will open the Synchronize With Central dialog box (Figure 5.23). This dialog box gives you some additional tools to assist your workflow.

FIGURE 5.23
Synchronize With Central dialog box



- ◆ The Compact Central Model check box allows you to compact the model to save on disk space. It will take some additional save time, but it can temporarily decrease your file size significantly. This should not be seen as a permanent solution to managing a large file, however. Compaction will decrease the file size, but use of the file will expand the compacted elements. Tips and techniques for reducing file size are discussed in Appendix B.
- ◆ Five additional check boxes will be available (depending on what work you have done to the file) to allow you to relinquish or keep permission over the elements you have previously edited. Unchecking these boxes means that you will retain ownership over all the elements you currently own with the model. This can be useful if you are planning to continue working on the same elements and want to publish only recent changes of the model.

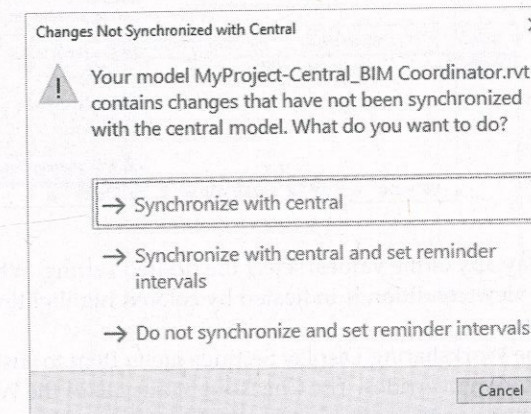
- ◆ You can add comments to the synchronization that can be useful for tracing potential model conflicts later in the production process.
- ◆ A final check box, Save Local File Before And After Synchronizing With Central, allows you to save your changes locally, get any new changes from the central file, and then save locally again, ensuring that your local copy is up to date. This is the save option that takes the longest, and you might choose to uncheck this periodically if you are pressed for time or have a large file that typically takes longer to save.

Synchronize With Central > Synchronize Now The second command choice to publish your changes is called Synchronize Now. Choosing this option allows you to bypass the Synchronize With Central dialog box and simply sync your file immediately. With this option, you will be relinquishing all your permissions over any elements you have borrowed; however, you will remain the owner of any worksets you have made editable in the Worksets dialog box.

Saving at Intervals

You will be prompted to save your work at regular intervals. Once worksharing is enabled, you will receive an additional reminder to synchronize with the central file as well as to save your work (Figure 5.24). You can dismiss these dialog boxes by clicking Cancel at the lower right, but remember, it is a good idea to save regularly so you do not lose any work.

FIGURE 5.24
Changes Not Synchronized With Central dialog box



If the Changes Not Synchronized With Central dialog box appears, you will have three options to choose from:

- ◆ Synchronize With Central, which will perform a save operation identical to that of the Synchronize Now command.
- ◆ Synchronize With Central And Set Reminder Intervals, which will synchronize your file and then pull up the Options dialog box, allowing you to set the intervals in which you receive this message.

- ◆ Do Not Synchronize And Set Reminder Intervals. Selecting this option will open the Revit Options dialog box where you can disable any further reminders.

You can modify the reminder time shown in the dialog box at any time by clicking the File tab, selecting Options, and then choosing the General tab. Note that this feature is intended to be a reminder only; it does not save the file for you.

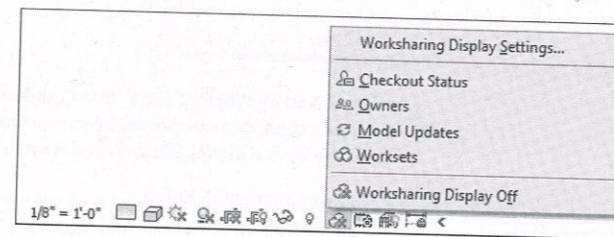
Loading Work from Other Team Members

It is possible to update your model and load work from other team members without publishing your own work back to the central file. This process, called Reload Latest, basically downloads the latest changes from the central file to your local file. Because you are only downloading content from the central file and not uploading, this process takes only a portion of the time a full SWC does. To do this, click the Collaborate tab on the ribbon, and choose Reload Latest from the Synchronize panel. The default keyboard shortcut for this command is RL.

Using Worksharing Visualization

Sometimes it helps to have the ability to graphically display worksets and their status in the project using the Worksharing Display tool found on the view control bar (Figure 5.25). With worksharing visualization, you can visualize four different values: ownership status, individual ownership, updated elements, and workset assignment.

FIGURE 5.25
Worksharing
Display tool



To display any of the values, select the desired setting. When any value is selected, the temporary view condition is indicated by colored highlighting around the edges of the view window.

Select the Worksharing Display Settings menu item to customize the graphic appearance of the visualization overrides. The Checkout Status tab of the Worksharing Display Settings dialog box shows three values: what is owned by you, owned by others, or not owned at all (Figure 5.26).

The Owners tab of the Worksharing Display Settings dialog box illustrates which elements are owned by the users in your project. If you see users listed who do not have any enabled elements or worksets, you can remove them from the list by selecting their username and clicking the Remove User icon at the lower left (Figure 5.27).

FIGURE 5.26
Checkout Status tab

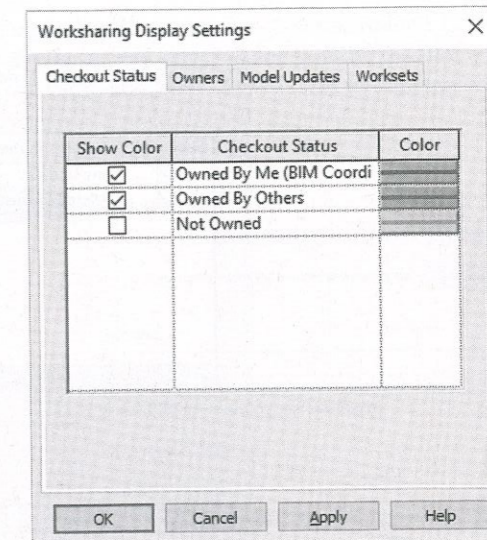
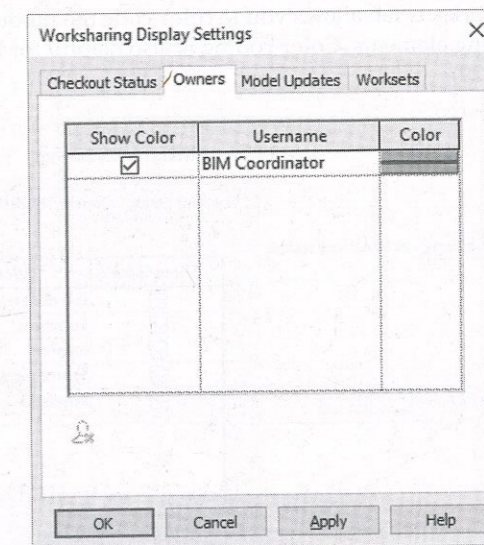
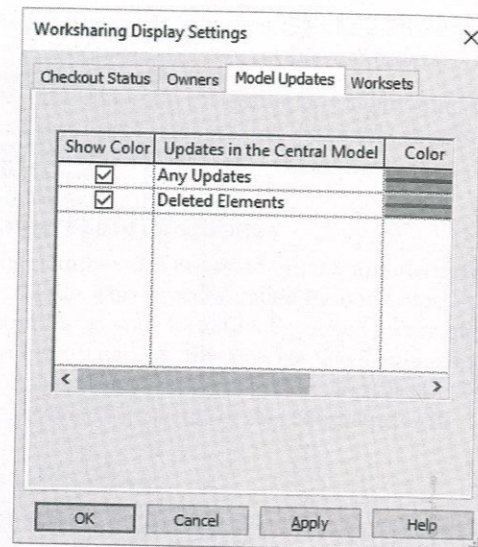


FIGURE 5.27
Owners tab



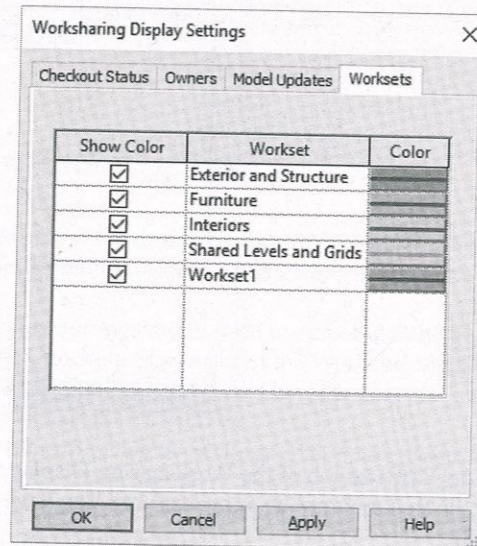
The Model Updates tab of the Worksharing Display Settings dialog box indicates changes to the central file that may not be apparent until you have synchronized with the central file (Figure 5.28).

FIGURE 5.28
Model Updates tab



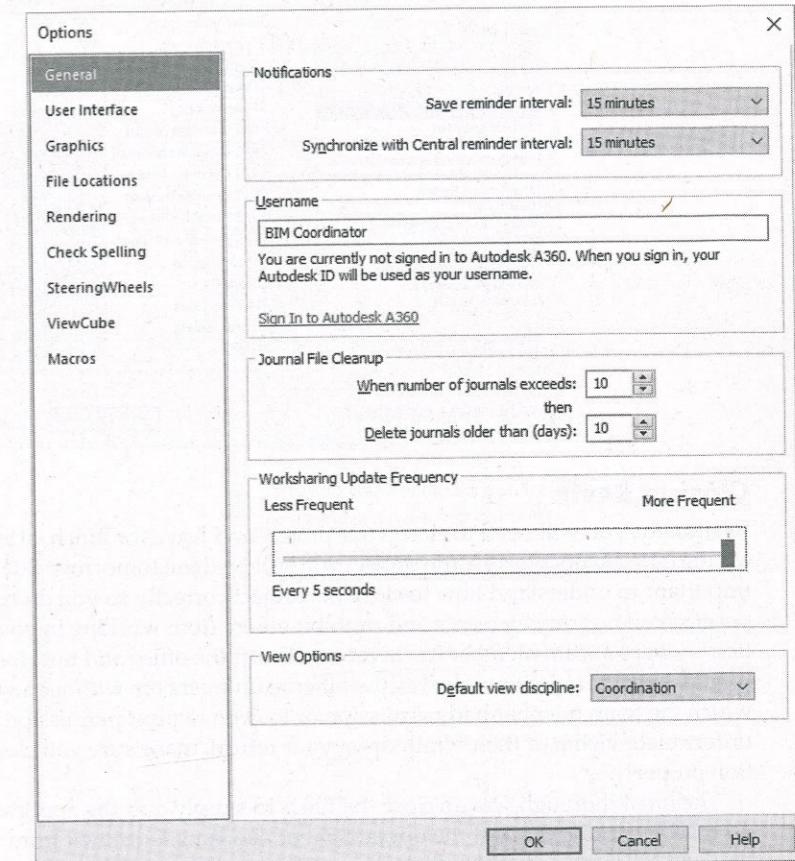
The Worksets tab allows you to color-code the model based on the workset assignment of all the building elements. Color-coding is also helpful for keeping track of your active workset (Figure 5.29).

FIGURE 5.29
Worksets tab



Finally, how often the display settings update in your project is up to you. To modify these settings, choose File > Options to modify the Worksharing Update Frequency option (Figure 5.30). Moving the slider to the far left will set the description below the Updates slider to

FIGURE 5.30
Modifying the settings
for Worksharing
Update Frequency

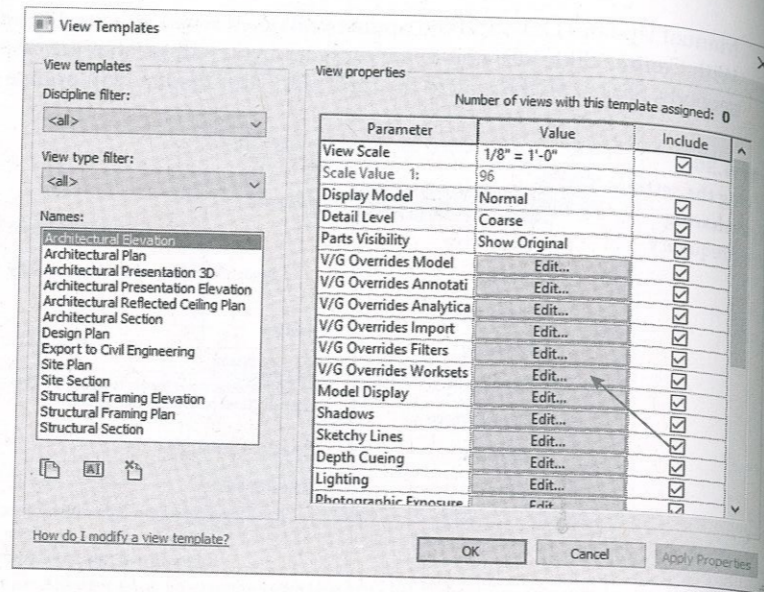


Manual Updates Only, and the update will occur when you use Reload Latest or Synchronize With Central. Slide just a bit to the right, and you will see that the display will update every 60 seconds. Slide it all the way to the right, and your display will update every 5 seconds.

Managing Workset Visibility in View Templates

As we described in the section "Moving Elements Between Worksets," worksets can be used as a different way to visualize your project using the Visibility/Graphic Overrides dialog box. Workset visibility can also be managed as part of a view template. To modify these settings, go to the View tab, locate the Graphics panel, and select View Templates > Manage View Templates. In the View Templates dialog box (Figure 5.31), select V/G Overrides Worksets to modify the visibility settings in any view template. Refer to Chapter 4, "Configuring Templates and Standards," for more information on view templates.

FIGURE 5.31
Workset settings in
view templates



Closing Revit

Eventually, you will need to close your project and leave for lunch, attend a meeting, or go home for the day. Do not worry—the project will still be there tomorrow. But in the meantime, it is important to understand how to close the project correctly so you do not accidentally retain permission over any elements and prohibit others from working in your absence. This situation—where a team member has accidentally left the office and not closed the project file or relinquished permissions—leaves the other team members without a way to edit elements for which the team member had permission or to even request permission. So that you are not the unfortunate victim of their wrath upon your return, make sure you close the application properly.

The most thorough way to close the file is to simply quit the application completely. You can do this by clicking the X at the upper right or choosing Exit Revit from the Application menu. You will be presented with a dialog box in which you can choose to synchronize with the central file, save your changes locally, or discard the changes (Figure 5.32). Obviously, the best choice is to use Synchronize With Central, allowing your changes to be published and any objects you own to be relinquished; however, you might be in the middle of a design study and not ready to share your changes. In that case, you may choose to save locally and retain ownership of certain elements. Just be aware that no one else on your team can edit elements you own until you relinquish them. Our recommendation is to always relinquish all elements at the end of your work session.

What if you were only reviewing the model and making some minor changes, and you do not want to save the changes? Close the file or application with any of the methods previously mentioned and select Do Not Save The Project from the Changes Not Saved dialog box. You will then be presented with another dialog box with two choices concerning borrowed elements (Figure 5.33). In the Close Project Without Saving dialog box, you can either relinquish any borrowed elements and worksets or retain ownership of them. Clearly, the best choice is to relinquish all elements and worksets.

FIGURE 5.32
Saving options when
closing a local file

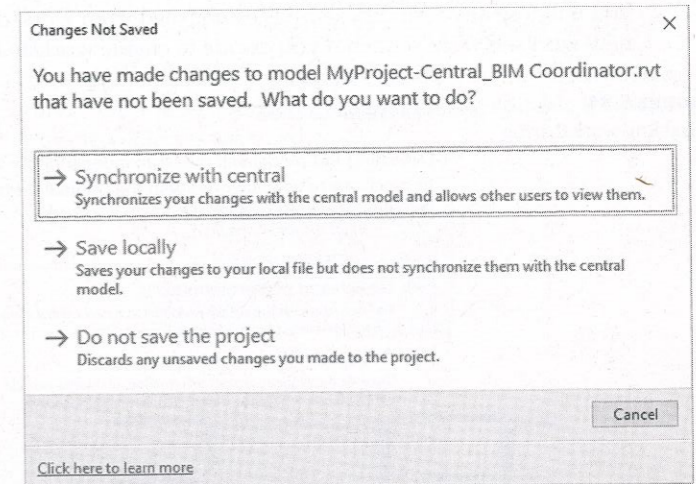
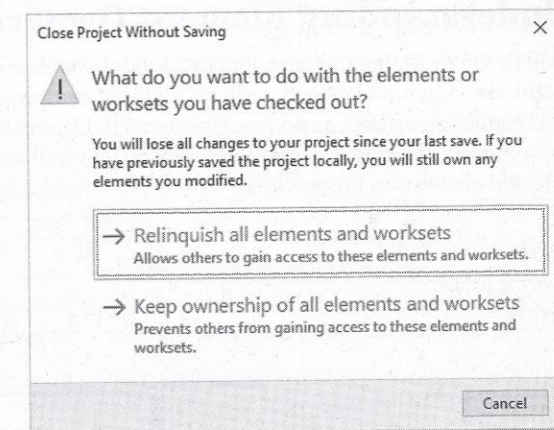


FIGURE 5.33
The Close Project
Without Saving
dialog box



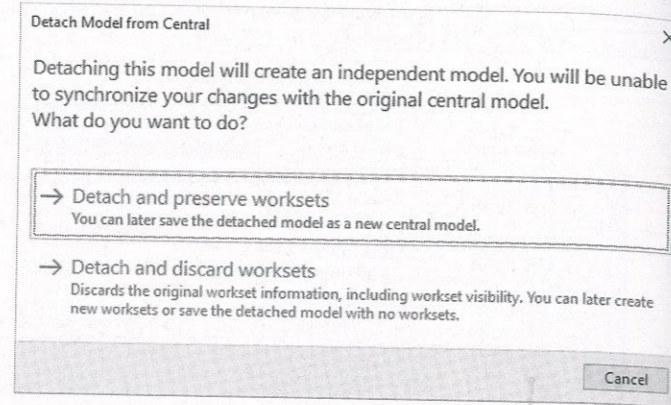
Disabling Worksharing

In a few cases, you might decide that you have enabled worksharing too soon, or after enabling worksharing you would rather go back. Worksharing may be disabled as part of the Detach From Central functionality. This option can be found at the bottom of the Open dialog box. When you elect to detach a copy of the central file, you have the option to discard worksets, as shown in Figure 5.34.

If you choose to preserve worksets, the worksharing functionality remains in the file. This allows you to maintain any visibility configurations you have established that depend on worksets. Although this file retains the worksharing capability, it can no longer be synchronized with the original central file because it will become a new central file as soon as you save it after detaching. This method can also create a file for review by a project manager or quality control reviewer without the fear of changing the model accidentally. If you elect to discard worksets,

you will lose any visibility settings established from worksets. You will also need to create all new worksets from scratch if you decide to enable worksharing again in the future.

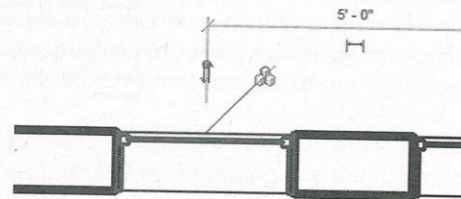
FIGURE 5.34
Disabling worksharing



Understanding Element Ownership in Worksets

One of the fundamental concepts in a model enabled with worksharing is the ownership of elements. When you directly edit an element in a project, you automatically take ownership of that element—as long as no one else owns it. Determining whether you own an element is fairly easy. Simply select it. If you do not own it, you will see a worksharing icon, as shown on the selected element in Figure 5.35.

FIGURE 5.35
The worksharing icon on a selected element



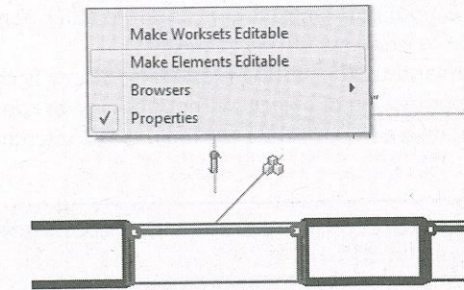
By borrowing elements, team members can take ownership of only portions of a workset, leaving the remainder of the workset to be edited by someone else. Taking ownership of elements in this style creates a more “take what you need” approach to editing and usually results in less overlap between team members.

Besides automatically borrowing elements when they are edited, you can obtain ownership of an element or group of elements in a few other ways:

- ◆ In the Worksets dialog box, you can make any workset editable. You then become the owner of the workset instead of borrowing elements within one.
- ◆ You can select any element or series of elements, and take ownership of them by clicking the worksharing icon.

- ◆ You can right-click any element in the Project Browser under the Families node. In the context menu that appears, you can take ownership of families, groups, or views.
- ◆ You can right-click any element in a view and choose Make Elements Editable from the context menu (see Figure 5.36). You also have the ability to make editable the entire workset to which the selected object is assigned.

FIGURE 5.36
Making an element editable using the context menu



If you use any of these options, if the selected element is already owned by another team member, Revit will alert you and you will not be able to modify the element or make it editable.

Real World Scenario

ACCIDENTS HAPPEN

However proficient a team, accidents may occur on a project, and elements will get modified or deleted unexpectedly. It is important to know how to recover your work when these accidents occur.

On one project, someone new to using Revit and new to the team was working on window details on a three-sided building. In the detailing process, the new team member accidentally deleted one of the walls in the project. Because the wall had sections and callouts associated with the geometry, deleting the wall also deleted elevations, wall sections associated with that wall, and the associated details in plan and section. When the new team member deleted the element, he was not aware of the mistake and performed a Synchronize With Central operation, publishing all the deletions to the central file. Fortunately, the error was caught before everyone else performed a Synchronize With Central, and the team did not have to resort to restoring the model from the previous night's backup. The team was able to use another member's local file to create a new central file, thereby minimizing the loss of work. Once everyone on the team made a new local copy, he was able to get back to work.

Had the deleted elements been more isolated (like a conference room layout), recovery would have been much less invasive. In such a case, you simply create a group from all the elements you would like to save and then right-click the group in the Project Browser. You will have the option to save the group out of the file, which can then be inserted into a different project file and ungrouped again.

Understanding Editing Requests

When working in a worksharing project, you do not always have to take ownership of an entire workset to begin editing elements. As we discussed earlier in this chapter, it is possible to take ownership of individual model elements. This process is referred to as *borrowing*. Remember, there can be only one *owner* of a workset but multiple *borrowers* of elements within a workset.

If you need to work on elements that already belong to someone else, you will receive an alert that you cannot edit the elements until the other person relinquishes them, and you will be given the option to place an editing request.

Understanding the editing request workflow is critical for multiuser teams; it allows users to transfer permission of objects without having to constantly save all their work to the central file and relinquish all worksets. Let's look at this interchange of permissions in more detail.

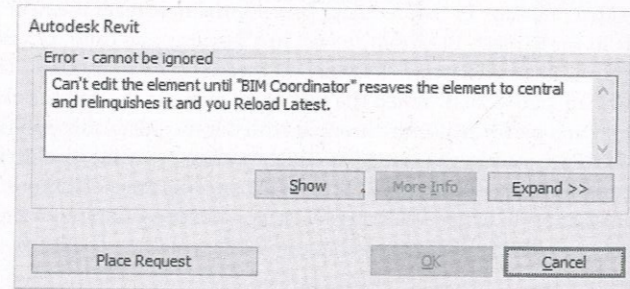
SIMULATING A WORKSHARING ENVIRONMENT

Practicing with a multiuser environment is not easy to describe in text, although it is possible to configure on your own computer. If you would like to work through the exercises in this section, you can launch Revit twice. Remember to change the worksharing username in the application options in one of your Revit sessions before you create a new local file. And of course, remember to restore your original username once you have completed the training exercises. This will give you a good understanding of how workshared elements are controlled in a real-life project. If you are signed into your A360 account, you will have to sign out in order to change your username.

Placing an Editing Request

Imagine you are happily working away on your model in a worksharing environment and you try to edit an element that someone else owns. What do you do? When that situation occurs, you will be presented with a dialog box that allows you to request permission to edit the element from the other user (Figure 5.37).

FIGURE 5.37
Placing a request for permission

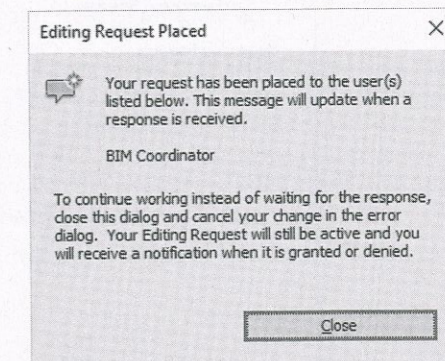


Looking at the dialog box, you have two options:

- ◆ You can click Cancel and not take possession of the element, and then focus your efforts on another part of the design.

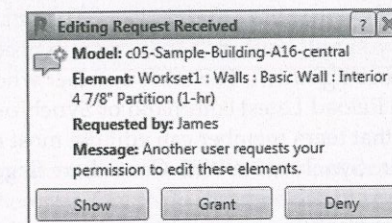
- ◆ You can click Place Request to ask your team member to relinquish possession over the element in question. When you click Place Request, the dialog box shown in Figure 5.38 opens.

FIGURE 5.38
Editing Request Placed dialog box



The recipient of an editing request will see a pop-up notification appear at the bottom of the application, as shown in Figure 5.39. The notification gives the recipient instant information about the element in question and who made the request and provides buttons to grant or deny the request. It also provides a Show button that finds the element in a view so the recipient can determine the most appropriate response to the request.

FIGURE 5.39
Editing request notification



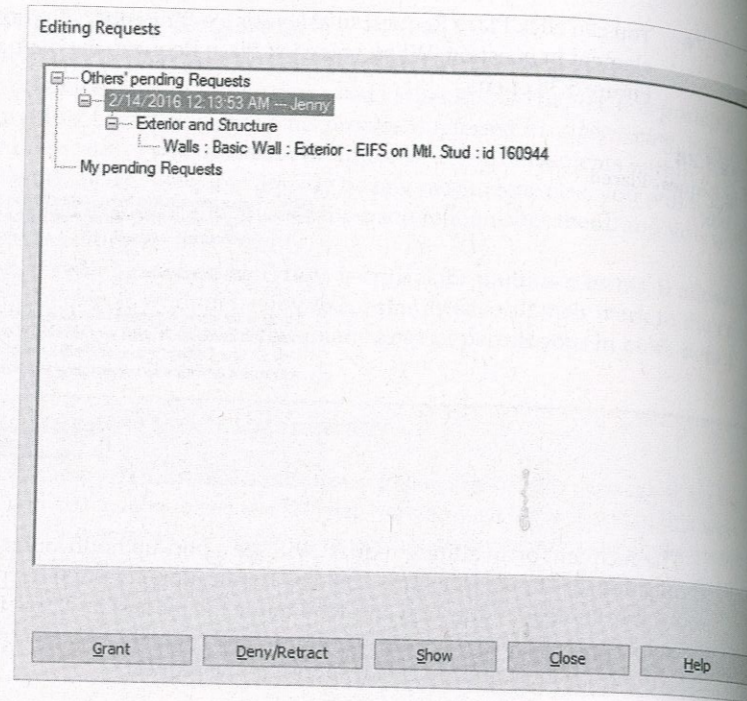
If you happen to miss or accidentally close the request notification, there is also a small visual indicator on the status bar at the bottom of your screen.

It indicates whether there are any outstanding requests (both to and from you). Clicking this icon opens the Editing Requests dialog box (Figure 5.40). Any requests indicated by an asterisk require you to Synchronize With Central before granting the editing request.

Granting an Editing Request

Let's discuss the other side of this scenario: you are the recipient of an editing request and you are ready to grant it. Now, one of two things will happen. If you have not changed the element, you can simply click Grant and the permission for the element will be transferred to the requesting team member.

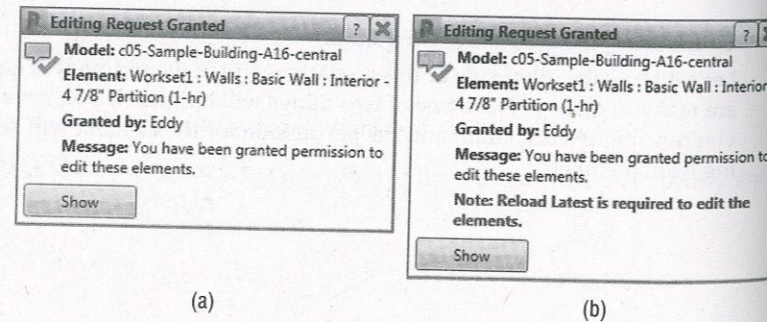
FIGURE 5.40
The Editing Requests dialog box



If you have modified the element or one that is dependent on or hosted by the element in question, you will be alerted that you will need to synchronize with the central file before the request can be granted. The team member who placed the editing request will subsequently need to use the Reload Latest command or Synchronize With Central to receive the recent changes, and then that team member can edit the most recent version of that element. Permission requests that require Synchronize With Central are flagged in the Editing Requests dialog box by an asterisk next to the request.

After your editing request has been granted, you will receive a notification similar to those shown in Figure 5.41. If the request did not require a Synchronize With Central operation from the other team member (as indicated in the left image in Figure 5.41), you can continue the editing command that prompted the request. Otherwise, you will need to use Reload Latest before you can continue the editing command. If you need to return to a view of the element or elements related to the editing request, you can click the Show button. Click the X to close the notification box.

FIGURE 5.41
(a) Notification of a granted editing request;
(b) Alternate notification of a granted request alerting you to Reload Latest



Real World Scenario

GETTING PERMISSION FOR SOMEONE ELSE'S OBJECTS

This situation may happen on one of your projects: someone leaves for a meeting or goes home without relinquishing permission of borrowed elements and worksets. This scenario would prevent other team members from editing any of the borrowed elements until that person returns to the office and synchronizes the changes with the central file. If that person cannot return to the office, there is a workaround for this problem. The workaround will result in the loss of the work by the missing team member, but it will clear up all the permissions issues.

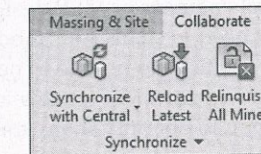
If the immediate team needs outweigh the potential loss of the missing person's work, follow these steps:

1. Open a new session of Revit.
2. Click the Application menu, select Options, and choose the General tab in the resulting dialog box.
3. Change the name listed in the Username field from your username to the person's whose permissions you are looking to release.
4. Create a new local file of the project and open it. Now simply perform a Synchronize With Central operation, and all the person's elements will be available to the team to edit. Then close the file.
5. Before closing Revit, be sure to go back to the Application menu, click Options, and select the General tab so you can change the username back to your own.

Relinquishing Permission

It is not always necessary to wait for a request from another team member to relinquish permission over your elements. Fortunately, there is a tool to do just that. On the Synchronize panel of the Collaborate tab is a button called Relinquish All Mine (Figure 5.42). This feature returns the permissions for any elements you have not edited back to the central file so they are available to the rest of your team.

FIGURE 5.42
Relinquish All Mine

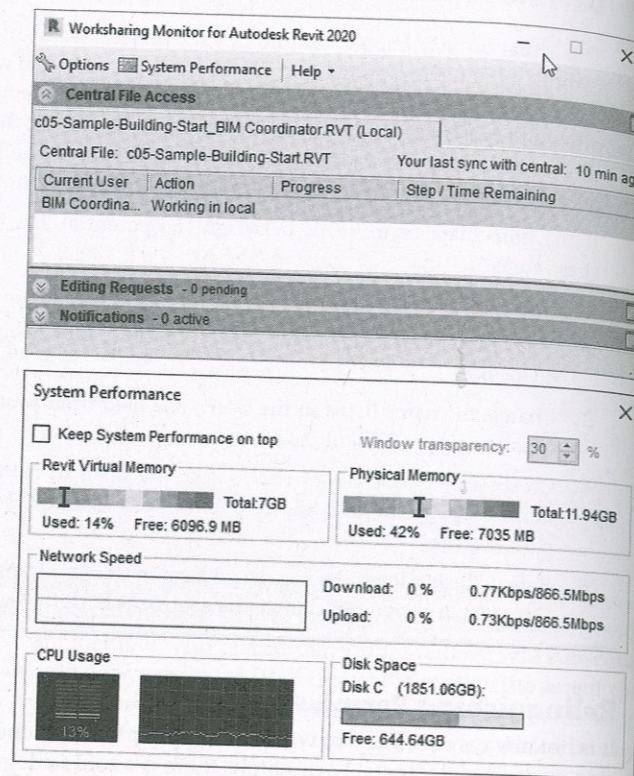


Using the Worksharing Monitor

If you are an Autodesk® Subscription customer, you will have access to a useful extension application called Worksharing Monitor, shown in Figure 5.43. This tool is available from Autodesk's subscription site, manage.autodesk.com. When you are working on a team project that is enabled for worksharing, this utility gives you real-time information about the users participating in the project file. It also has a convenient resources monitor to keep you informed

of your computer's available RAM, virtual memory, and disk space. The Worksharing Monitor is only available for file-based workshared files; it is not compatible with Autodesk® Revit® Server or Revit Cloud Worksharing.

FIGURE 5.43
The Worksharing Monitor is available for Autodesk® Subscription customers.



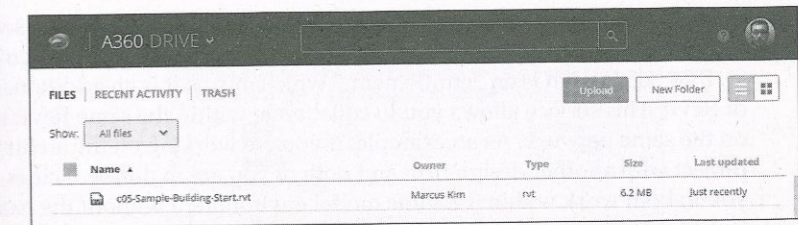
Collaborating in the Cloud

Eventually you will need to collaborate with other designers. Maybe this partnership—if it is with your structural engineer or MEP designer—will require the both of you to share models. Maybe you simply need to share your modeling work with people within your own office who are not Revit savvy enough to be able to negotiate their way through the software, and you are looking for an easy way for them to view and comment on what you have created. Fortunately, there is a way for you to not only share your model but also comment on models created by your team.

Autodesk has created a web-based resource to share and mark up Revit files. The site is A360 Drive (360.autodesk.com). The site requires an A360 account, which you can register for on the website. Once signed up, you can sign in through Revit to take advantage of online applications like daylighting or cloud rendering or use the site as an online collaboration portal.

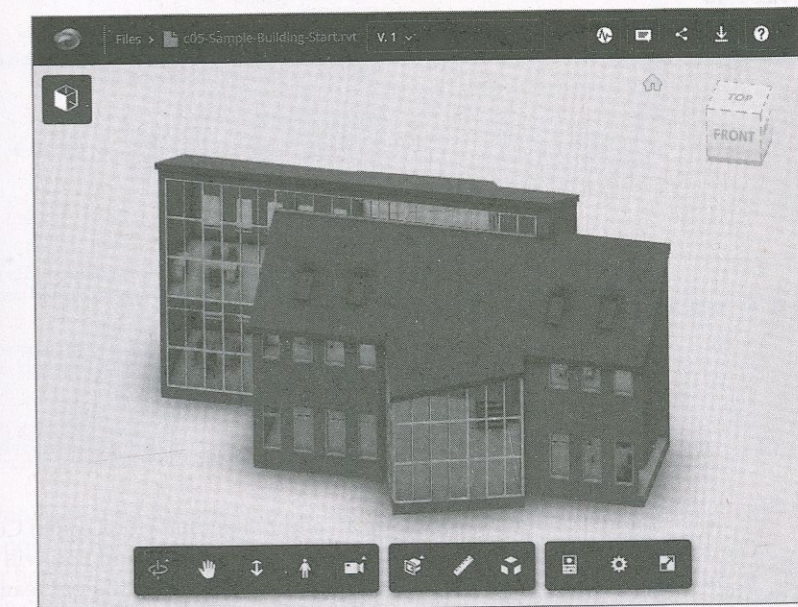
The site (Figure 5.44) allows you to upload and share models with collaborators. You can make models public or you can share them with only certain individuals.

FIGURE 5.44
Viewing models online with A360 Drive



One of the great benefits of the site beyond just document management and sharing is the ability for non-Revit users to be able to navigate the model in a read-only format. Using the sample model we will work on throughout this book, a non-Revit user can navigate any of the views within the model (plans, elevations, 3D views, and so forth) as well as spin the model around in an interactive 3D format. Figure 5.45 shows the interactive 3D view.

FIGURE 5.45
Using the A360 online viewing engine



This is an easy way to share models and allow nonusers to make comments on preset views. The site works best with Google's Chrome web browser and works on either a Mac or a PC.

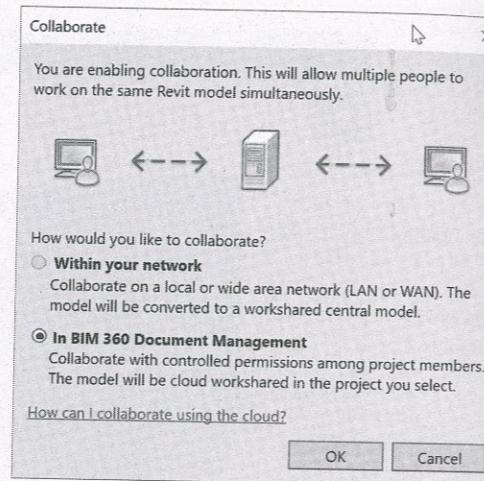
BIM 360 Design

Although the A360 Drive website allows you to upload and download files as well as view Revit models, it does not provide an alternative to true collaboration with Revit worksharing. A service called Autodesk® BIM 360 Design® allows teams to synchronize changes using Autodesk's cloud services instead of an Autodesk® Revit® Server Accelerator on your WAN.

Cloud collaboration for Revit is a paid service that can be purchased per registered user. You can learn more about the service at www.autodesk.com/products/collaboration-for-revit. BIM 360 Design is an “entitlement,” which means it is an additional service that runs on top of Revit. This service allows you to collaborate within the same Revit model without having to be on the same network. As an example, if you are working on the architectural design of a large project with another design firm and both of you are in different cities, BIM 360 Design will allow you to both work within the same model environment without the hassle of setting up VPNs, a Revit Server, or any sort of network sharing.

BIM 360 Design can be initiated in the same way that worksharing can be: simply click the Collaborate button on the Manage Collaboration panel of the Collaborate tab. By clicking this, you’ll get the Collaborate dialog box (Figure 5.46). However, instead of selecting the Collaborate Within Your Network option, choose In BIM 360 Document Management.

FIGURE 5.46
Collaborating using BIM 360 Design



Selecting this option will bring up an additional dialog box called Collaborate Using The Cloud (Figure 5.47). Here you can give the model a name, and you will need to choose a location to publish the model. Since you can be collaborating with different teams on different projects, it’s important to assign your new model to the right project location.

Note that with any BIM 360 Design® project, it is recommended that you first set up a site to host the model. Think of the site like a folder. This will keep you from having multiple models for multiple projects stored in the same location.

Once the BIM 360 Design® model is established, additional users can be invited using the BIM 360 web portal. The limits you have to working in a BIM 360 Design environment are the same as working within any other shared Revit project. You can still use worksharing and Synchronize With Central, check out elements or worksets, and so on. The primary difference will be opening your project. In Revit, there is an icon in the Open dialog box (Figure 5.48). Your central files will reside on the cloud in a location called BIM 360.

FIGURE 5.47
Collaborating using BIM 360 Design

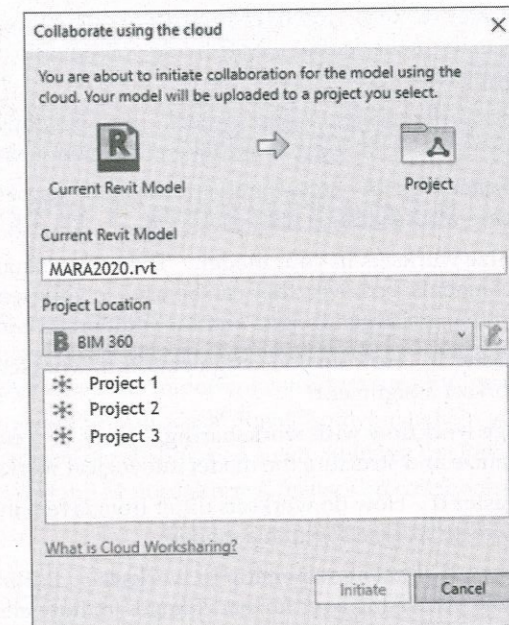
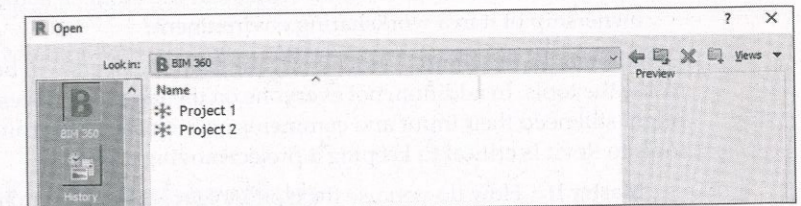


FIGURE 5.48
Opening a model using BIM 360 Design



For those who have used the previous iteration of BIM 360 Design, previously known as C4R, you may have noticed that the software feature Communicator has been removed. Communicator had many useful tools; it had a chat window and showed when a team member was performing commands like Synchronize With Central. Though this feature is missed by many, we await Autodesk’s direction on a new feature set similar to Communicator.

The Bottom Line

Understand key worksharing concepts. Once the team has created local files, it is necessary to understand how to keep both the local files and the central file up-to-date as changes occur on the project. Doing so ensures that everyone is working from an updated and recent copy of the model at all times.

Master It Once you have begun working in your local file, how do you publish your changes to the central file? How do you download changes from the central file to your local file?

Enable worksharing on your project. Knowing how to activate and use worksharing is indispensable to working in a team environment using Revit.

Master It How do you transition a single-user Revit file to a multiuser environment using worksharing?

Organize worksets in your model. There is no single rule for organizing worksets in your project models; however, they can be used to your team's advantage. You can use worksets to better organize larger projects and for additional visibility control.

Master It How do you assign objects to worksets? How do you change an object's workset assignment?

Manage workflow with worksharing. Once the central file has been created, you will need to organize and structure the model into logical worksets to maintain workflow with Revit.

Master It How do worksets differ from layers in 2D CAD? What are some logical ways to create worksets within a model?

Understand element ownership in worksets. Editing elements in a central file means you have sole ownership over further changes to those elements. Understanding the permissions is critical to working in a team.

Master It How do you edit an element in the model if someone has already taken ownership of it in a worksharing environment?

Collaborate in the cloud. Not all of your team members will be Revit-savvy and know how to use the tools. In addition, not everyone on the team will have a copy of Revit, but you might still need their input and comments on the design. Learning to leverage complementary tools to Revit is critical to keeping a project moving smoothly.

Master It How do you use the cloud to get feedback from non-Revit users on a project team?

Chapter 6

Working with Consultants

Whether you work on large or small projects—residential, commercial, or industrial building types—collaboration is an almost certain aspect of the workflow you will encounter when implementing BIM. This chapter discusses important considerations for interdisciplinary coordination as well as the tools within Autodesk® Revit® software to help you manage the process. This chapter covers aspects of collaboration solely utilizing the Revit platform, and Chapter 7, “Interoperability: Working Multiplatform,” focuses on collaborating with other software programs.

IN THIS CHAPTER, YOU'LL LEARN TO

- ◆ Prepare for interdisciplinary collaboration
- ◆ Collaborate using linked Revit models
- ◆ Use Copy/Monitor between linked models
- ◆ Run interference checks

Preparing for Collaboration

Working alone in the Revit environment will deliver measurable increases in productivity, quality, and consistency; however, the true benefit of building information modeling (BIM) is the ability to effectively collaborate between design disciplines, share model data with contractors, and deliver useful information to facility operators.

The difference between these working paradigms has been described as *lonely BIM* versus *social BIM*. Lonely BIM can be thought of as the use of isolated BIM techniques for targeted tasks such as architectural design or structural analysis. Social BIM is the act of sharing model data between project stakeholders in order to enhance collaboration while developing a building design. The importance of increased efficiency in collaboration is the underpinning for the goals set forth by organizations such as buildingSMART International (www.buildingsmart.org) or the UK's Centre for Digital Built Britain (www.cdbb.cam.ac.uk).

The ability to support high-quality information exchanges necessitates the proper use of 3D models and nongraphic data in a highly collaborative environment. Although we will be discussing collaboration solely within the Revit platform in this chapter, the buildingSMART Alliance, part of the National Institute of Building Sciences (NIBS), and the National BIM Standard (NBIMS-US) stress the need for open interoperability between BIM applications.

Once a project team decides to participate in social BIM—either through a team's desire or the requirements of a client—they must decide how to collaborate with BIM in a manner that is useful to all constituents throughout the project lifecycle. Whether or not your client requires it, you should develop a BIM execution plan in order to set clear expectations related to the use of BIM.

The buildingSMART Alliance (www.nibs.org/page/bsa), in an effort sponsored by the Charles Pankow Foundation, the Construction Industry Institute, the Penn State Office of Physical Plant, and the Partnership for Achieving Construction Excellence (PACE), has created a "BIM Project Execution Planning Guide" and template for a BIM execution plan. You can find this information at the Penn State Computer Integrated Construction (CIC) website (www.bim.psu.edu).

One of the most critical parts of a BIM execution plan is the definition of the project goals and uses of BIM to achieve the stated goals. If you are just beginning your implementation of Revit software, you may be using it to create 3D visualizations, or perhaps you are attempting to increase your drafting productivity. Defining clear and concise reasons for implementing BIM on each project will help you define where to concentrate your modeling efforts. According to the buildingSMART Alliance, "[A] current challenge and opportunity faced by the early project planning team is to identify the most appropriate uses for Building Information Modeling on a project given the project characteristics, participants' goals and capabilities, and the desired risk allocations." A listing of the common uses of BIM along with potential value opportunities and required resources is also available on the Penn State CIC website.

According to the American Institute of Architects' "Integrated Project Delivery: A Guide," a BIM execution plan "should define the scope of BIM implementation on the project, identify the process flow for BIM tasks, define the information exchanges between parties, and describe the required project and company infrastructure needed to support the implementation." To be clear, the development of such a plan does not imply the application of integrated project delivery (IPD). IPD is "a project delivery approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction." For the purposes of this chapter, we will consider only the collaboration and coordination between members of a project design team, not the interactions with a client or contractor.

For additional reading on IPD, refer to these sources:

- ◆ Integrated Practice/Integrated Project Delivery: www.aiacc.org/integrated-project-delivery/
- ◆ Whole Building Design Guide: www.wbdg.org

Managing the Coordination Process

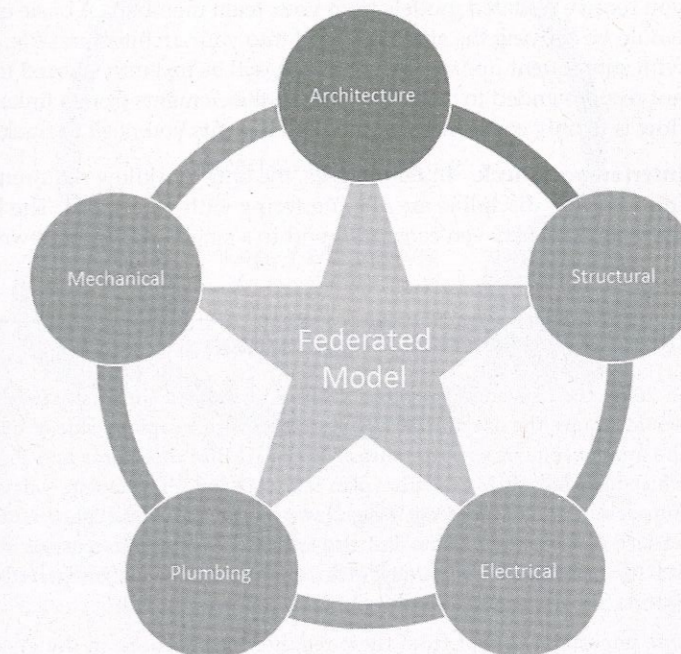
The coordination process in a Revit environment begins with linking multiple files to form a composite view of your building project. Even though smaller projects might be coordinated within a single Revit project file, most moderate to large projects will be designed by multiple disciplines or trades working in different offices. A project can be divided in many different ways to meet a variety of workflow requirements. Most often, each discipline will develop at least one separate Revit project file, and many of these project files will be linked into each other for

reference. Because there are several workflow possibilities, this chapter will focus on the coordination among a traditional design team consisting of the following:

- ◆ Architect
- ◆ Structural engineer
- ◆ Mechanical, electrical, and plumbing (MEP) engineers

The workflow within a traditional design team is more complex than you might assume. If you were to graph the dependencies and coordination between these parties (Figure 6.1), you would see a web of primary relationships (architect to/from structure, and architect to MEP) and secondary relationships (structure to/from mechanical and piping).

FIGURE 6.1
The relationships of interdisciplinary coordination



These relationships can be further parsed into physical and logical relationships. If we use mechanical and electrical as an example, you can see that a physical relationship means making sure a light fixture is not interfering with the bottom of a mechanical duct, whereas a logical relationship means making sure the electrical design (created by the electrical engineer) properly accounts for the load of the heating coil in a variable air volume (VAV) box (created by the mechanical engineer).

It is the complexity of these possible workflow scenarios that makes this process prone to errors and illustrates the importance of proper coordination between the different disciplines of a design team. So, what are the tools that can be used for collaboration between Revit products? Three distinct tools are typically used in a collaboration scenario.

Linked Models Linking models together using the Link Revit tool provides full visual fidelity of the referenced content, showing the complete context of the other disciplines' data, and fostering a complete understanding of their geometry. The data can also be controlled and shown in any manner appropriate to the use. You can turn it on or off, half-tone the data, or enhance it with color or line pattern overrides. Linking also provides support for the Interference Check, Copy/Monitor, and Coordination Review tools.

CERT
OBJECTIVE

Copy/Monitor Copy/Monitor is a powerful tool available in all products built on the Revit platform and is considered the most intelligent of the coordination tools. It offers several benefits. It lets you link Revit files from other team members (structural engineers or MEP engineers) and copy key elements from their model into yours. Once that link is created, you can monitor that relationship and know whether the element has moved or changed when you receive updated models from your team members. A basic example of using this tool would be copying the structural grid into your architectural file. If the grid moves or changes with subsequent updated models, you will be instantly alerted to the change. Note that it is not recommended to copy/monitor all the elements from a linked file. The suggested workflow is to only copy/monitor the key elements you need to track.

Interference Check In many cases, the only workflow requirement is to verify that items from another discipline are not interfering with your items. The Interference Check tool can be used to check between categories within a single model or between linked models.

INDIANA UNIVERSITY BIM REQUIREMENTS

In 2009, the University Architect's Office at Indiana University (www.iu.edu) announced that it would require the use of BIM on all projects with a capital value of over \$5 million. Accompanying the announcement was the release of the IU BIM Standards and Project Delivery Requirements, which included a BIM execution plan template and IPD template—developed under the guidance of Autodesk and SHP Leading Design (www.shp.com). Although the university's BIM requirements seemed new at the time, the desire to ensure the maximum reuse of information had been evolving at IU for several years, beginning with its implementation of integrated GIS (Geographic Information System) tools for campus and facility management in 1996.

One important excerpt from these requirements focuses on the organization of the interference checking (aka clash detection) process. Within the IU BIM Standards & Guidelines for Architects, Engineers, & Contractors, rules have been established for classifying clashes between modeled elements. Level One clashes are considered critical and include ductwork and piping clashing with ceilings, rated walls, or structure; equipment clearances interfering with structure are included in Level One as well. Level Two clashes are less critical but include casework clashing with electrical fixtures and structure versus specialty equipment. Finally, Level Three clashes are still important but are a lower priority. These include casework clashing with walls and plumbing interfering with mechanical equipment.

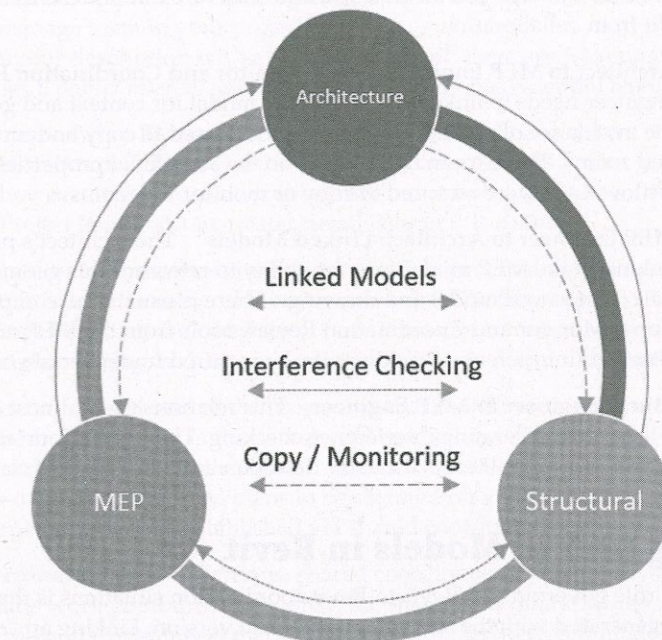
These requirements may be defined differently by other clients, but it is critical to understand the importance of using interference-checking tools for logical groups of model elements. Checking for clashes throughout an entire model will yield a plethora of unusable data and will limit the effectiveness of model-based coordination.

For more information, visit the IU BIM site at:

<https://cpf.iu.edu/capital-projects/consultants-contractors/index.html>

Given the range of available tools for collaboration, they are not necessarily applicable to all interdisciplinary relationships. As shown in Figure 6.2, only the most appropriate tools should be applied to each collaborative situation. These situations are merely suggestions based on our experience. The needs for your collaborative workflows may vary.

FIGURE 6.2
Suggestions for
collaboration tools to
be used between
disciplines



Architect to Structural Engineer The relationship between the architect and the structural engineer is becoming closer as we strive for lighter structures and more innovative design. In many respects, structural engineers may be affecting the building aesthetic as much as the architects. Thus, this workflow may be considered the most crucial and should be bidirectional.

Architect to Structural Engineer: Copy/Monitor and Coordination Review By using Copy/Monitor, structural engineers can create a strong, intelligent link between the structural and architectural models. In doing so, they can easily track the changes in the architect's model that will affect the structural design. Structural designers are also able to create geometry in their model using these tools, which can be directly or indirectly related to architectural elements such as walls and floors.

Remember that coordination of relationships for datum (grids and/or levels) should be established at the beginning of a project. For example, does the architect "own" the levels and the grids—or will the structural engineer? Conflicts due to a lack of proper planning will negatively impact the effective use of the Copy/Monitor tools on your projects.

Structural Engineer to Architect: Interference Check The architect's primary requirement for the structural model is to include the structure in context and to know if the structure is interfering with any architectural elements. For this workflow, it is

recommended that the architect link in the structural model and use interference checking. The rules governing what clashes are considered critical may be established by a client's BIM standards and protocols.

Architect to MEP Engineer The relationship between architecture and MEP is not quite as dynamic as that between architecture and structure but represents specific opportunities to benefit from collaboration.

Architect to MEP Engineer: Copy/Monitor and Coordination Review The MEP engineer needs to link in the architect's model for context and geometry relationships and the avoidance of clashes. Copy/Monitor is used to copy and monitor the architect's levels and rooms. These room objects take on the additional properties, such as light levels and airflow. Levels are required to copy or monitor the rooms.

MEP Engineer to Architect: Linked Models The architect's primary benefit from linking in the MEP model(s) is the ability to reference this geometry within the context of the architectural model and drawings. There is usually no compelling reason to use the Copy/Monitor and Coordination Review tools from the MEP on the architectural project, although interference checking may be required under certain circumstances.

Structural Engineer to MEP Engineer This relationship is almost always best served by cross-linked models using interference checking. The most important aspect of collaboration between these disciplines is the early detection and correction of clashes.

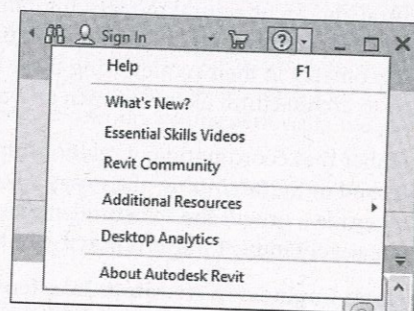
Using Linked Models in Revit

The first rule governing all Revit-to-Revit coordination situations is that all linked project files must be generated with the same Revit platform version. Linking an "older" file into a "newer" one will cause an irreversible upgrade to the older file.

In a worksharing environment with other disciplines, it is important to ensure that the computers of all team members working on a project have the same Revit build installed. As discussed previously in this chapter, a BIM execution plan should include an agreement on all modeling and coordination software to be used on a project, including the version of each listed program.

You can find the build information for your Revit product by clicking the Help drop-down button in the InfoCenter and selecting About Autodesk Revit (Figure 6.3). The build appears at the upper right of the About Autodesk Revit dialog box.

FIGURE 6.3
Linked files must use the same platform version, and all worksharing team members should use the same build. The build number can be found in About Autodesk Revit.



Shared Positioning

In the collaborative process of sharing information via linked models, the coordinated positioning of each model is of paramount importance. To ensure accuracy, every project's BIM execution plan must include agreement on a common coordinate system and origin. This section will help you develop a fundamental understanding of the coordinate systems within Revit so you can configure and manage them in your projects.

We will begin our description with a simple statement: there are two coordinate systems in every Revit project, *project internal* and *shared*. Each system has essential features and limitations.

Project Internal Every Revit project has an internal coordinate system referred to in several places as project internal. The origin of this coordinate system is at first marked by a Project Base Point; however, this reference point can be moved away from the internal origin. We discuss the Project Base Point in greater detail later in this chapter.

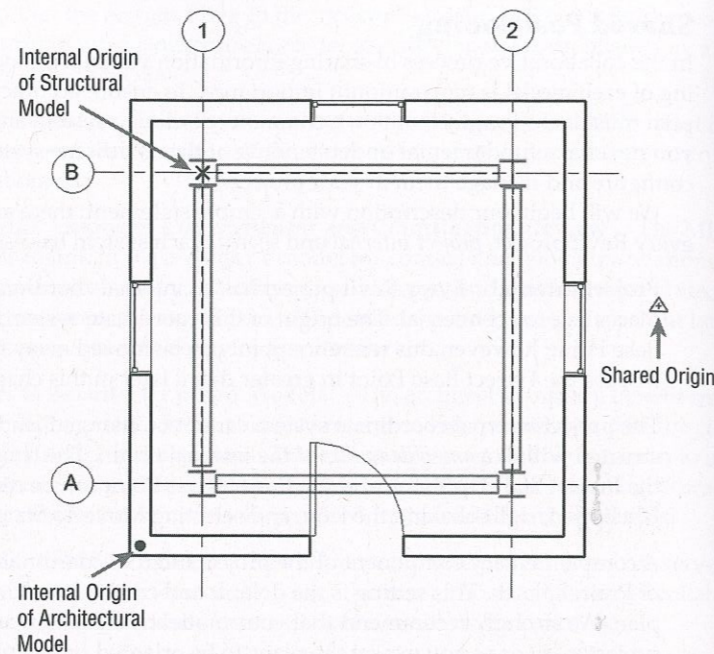
The project internal coordinate system cannot be changed, and your model should be constructed within a *one-mile radius* of the internal origin. The true origin in Revit is referred to as the Project Start Up Point, and the Project Base Point can be reset to this point by setting it to Unclipped, right-clicking the icon, and selecting Move To Startup Location.

A complementary component of the project internal coordinate system is the view orientation of Project North. This setting is the default and can be found in the View Properties of any plan. We strongly recommend that your model be created in an orthogonal relationship to the project view or as you expect the plans to be oriented on a typical sheet. Your project's actual relation to true north will be established via shared coordinates.

Shared Coordinates In simple terms, shared coordinates are just a way for the project team to use the same work point. In other words, the shared coordinate system consists of a single origin and true north orientation that can be synchronized between models and even Autodesk® AutoCAD® and Autodesk™ Civil 3D® drawings. In the diagram shown in Figure 6.4, you can see an architectural model and structural model linked together. Each model was created using a different project internal origin (not the recommended method), but their shared coordinates were synchronized.

It is critical to establish the location of the Project Base Point and Survey Point as early as possible in a project. Once the project is underway, moving these elements without disrupting the project schedule is almost impossible. On larger-scale projects or campuses, many agencies (such as universities or other owners who have multiple buildings) are mandating where the Survey Point and Project Base Point should fall as part of their standards. It is recommended that both the owner and project teams coordinate the location of the Survey Point and Project Base Point as part of the project kick-off process.

FIGURE 6.4
Diagram of the relationship between project internal origins and shared coordinates in linked models



LIMITATIONS ON USING SHARED COORDINATES FOR EXPORTING

Although you can use either Project Internal or Shared as the setting for Coordinate System Basis when exporting CAD formats, there are some limitations. If you are exporting sheet views, the plan data will always use the project internal coordinate system. Using the Export Views On Sheets And Links As External References option during export does not change this limitation. We recommend using plan views—not sheets—for issuing 2D CAD backgrounds to project participants who are not using Revit. Refer to Chapter 7 for more detailed information on exporting to other file types.

Acquiring or Publishing Coordinates

There are two ways to synchronize shared coordinates between linked projects: Acquire Coordinates and Publish Coordinates. A simple way to understand the difference between these tools is to think of them in terms of pulling versus pushing:

- ◆ Acquire = pull
- ◆ Publish = push

It is important to understand the situations in which you would pull or push coordinates between linked files. A typical workflow for establishing a synchronized, shared coordinate system on a single building project is as follows:

1. A separate site model is generated in which the Survey Point (SP) in the Revit project is coordinated with geodetic survey markers or station lines. The site model is linked into

the architectural model. This file is located manually in a position relative to the building. *Do not move or rotate your building to the linked site model!*

2. From the Manage tab, select Coordinates > Acquire Coordinates. Pick the linked file, and the origin of the shared coordinate system and the angle of true north in your model will be synchronized with those in the linked file.
3. All engineers or consultants using Revit should obtain a copy of the site model and repeat steps 1 and 2. When linking other project models that have already been synchronized with the site model, they can be placed using the Auto-By Shared Coordinates option in the Insert Link dialog box.

ACQUIRING COORDINATES FROM A CAD FILE

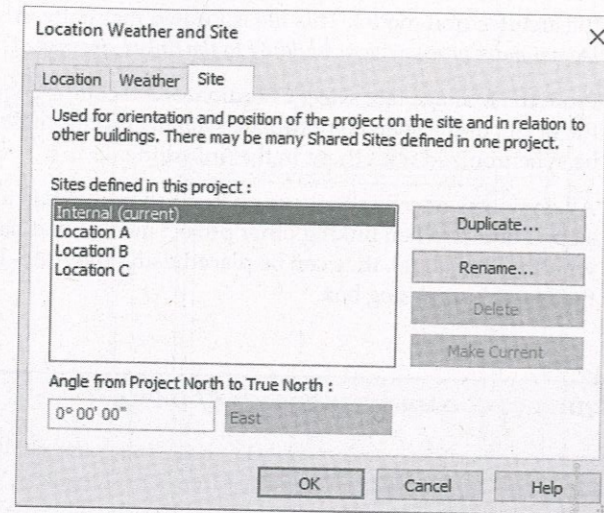
A common scenario in a project workflow begins with the architect beginning a design model and receiving a 2D survey file in DWG format from a civil engineer. The survey is drawn in coordinates that are geospatially correct but may not be orthogonal to true north. The architect should create the model close to the internal project origin; however, the architect will need to ensure that the building and survey coordinates are synchronized for properly oriented CAD exports and for coordination with additional linked Revit models from engineers in later phases of the project.

The architect will link the 2D CAD file into the Revit model but will first manually place it—moving and rotating the CAD file to be in proper alignment with the building model. Once the link is in place and constrained (or locked), the architect will acquire the coordinates from the DWG survey by switching to the Manage tab, selecting Coordinates > Acquire Coordinates from the Project Location panel, and then clicking the DWG link. This will not affect any views that are oriented to project north—only those set to true north will display the orientation established by the coordinates acquired from the survey file.

For a campus-style project in which you might be creating multiple instances of a linked building model, you would most likely use Publish Coordinates to push information from a site model into the linked building model. Here is how that would work in a hypothetical scenario:

1. Assuming a site model and building model were created in Revit, you would begin by opening the site model and linking the building model into the site.
2. Adjust the position of the first instance of the linked building model to location A.
3. From the Manage tab, select Coordinates from the Project Location panel and then click Publish Coordinates. Pick the linked building model.
4. The Location Weather and Site dialog box will open, and you will create a duplicate location named Location A.
5. Copy the linked building model as required for each subsequent location. Repeat steps 2 through 4 for each copy. As shown in Figure 6.5, there are three locations (Location A, Location B, and Location C) that represent each instance of the linked project model.
6. When you close the site model and open the building model, you can link the site model to the building using any of the named location references you *pushed* into the building model.

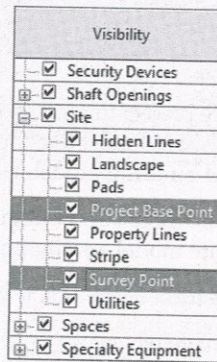
FIGURE 6.5
Creating multiple locations for a single linked model



Using Project Base Point and Survey Point

Revit provides two graphic objects to identify the *Project Base Point* and the *Survey Point*. In the default templates, these points are visible in the floor plan named *Site*; however, they can also be displayed in any other plan view by opening the *Visibility/Graphic Overrides* dialog box, selecting the *Model Categories* tab, and expanding the *Site* category, as shown in Figure 6.6. You can also use the *Reveal Hidden Elements* command in the *View Control Bar* to temporarily display these points in a 3D view.

FIGURE 6.6
The Project Base Point and Survey Point settings are found under *Site* in *Visibility/Graphic Overrides*.



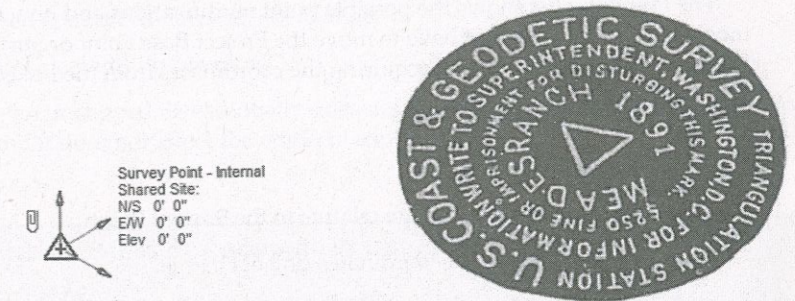
Project Base Point The Project Base Point (PBP) is a reference point that is usually located at the origin of the internal project origin. The PBP is used to define a common reference for project-specific annotation such as spot coordinates. The PBP cannot be used for exporting your project to CAD or Navisworks® formats. The only choices you have for exporting are Internal or Shared. Remember, the internal project coordinates cannot be modified, but you can move the PBP using the paperclip icon you will see when the PBP is selected. Let's review what the paper clip icon means when you need to relocate the base point.

The unclipped PBP *can* be moved in relation to the internal origin, thus creating a secondary reference point for spot coordinates, spot elevations, and levels—as long as the measuring parameter (either Coordinate Origin or Elevation Base) is set to Project Base Point in the respective type properties of such annotation elements. Moving the *clipped* PBP icon is the equivalent of using the *Relocate Project* tool, which moves the project relative to the shared coordinates system.

Unless your project requires the use of a secondary point of reference other than the Survey Point, we recommend you do not adjust the PBP and that you make sure your building model lies within a close reference of this point, such as the corner of a property line or intersection of column grids A and 1.

Survey Point The Survey Point (SP) is the equivalent of a station pin or geodetic survey marker in a civil engineering drawing (Figure 6.7). This is the point that will be coordinated to real geospatial coordinates. For coordination with Autodesk® Civil 3D® software, the SP is used when a Revit project is exported to the ADSK file format.

FIGURE 6.7
The Survey Point can be considered similar to a real-world geodetic survey marker.

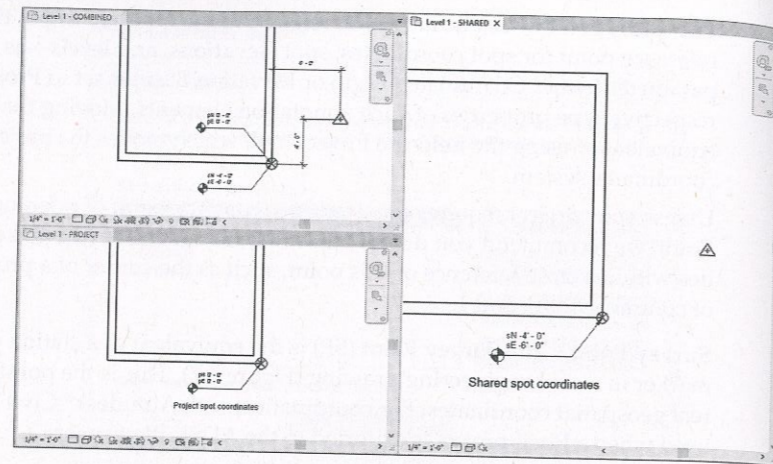


Specifying a particular location for the SP based on civil engineering data is not a requirement. For smaller projects, the SP and shared coordinates may never be used at all; however, they are critical in the use of analytical tools for daylighting and solar analysis.

To further expand your understanding of these points and what happens when they are modified, we created a sample file for your reference. Open the file *c06-Shared-Points.rvt*, which you can download from this book's web page at www.wiley.com/go/masteringrevit2020. In this file, you will find three copies of the Level 1 floor plan. One view is configured to display the project coordinates, another view displays the shared coordinates, and the third view displays a combination of the two. There are also two types of spot coordinates: one indicating project coordinates in which the values are prefixed with the letter *p*, and the other indicating shared coordinates with the prefix of *s*. You can open these three floor plans and tile the windows (click the *View* tab, select the *Window* panel, and choose *Tile*, or type the keyboard shortcut *WT*) to get a better sense of how these points affect one another (Figure 6.8).

In this sample file, you can explore the effects on your model's coordinates of moving the Project Base Point and Survey Point. When selected, the Project Base Point and Survey Point have paperclip icons that determine the behavior of the points when you move them. Clicking the paperclip icon changes the state from clipped to unclipped and back to clipped.

FIGURE 6.8
Using tiled windows helps you examine the effect of project and shared coordinates.



The following list shows the possible point modifications and how they affect the project. In most cases, you should not have to move the Project Base Point or Survey Point if you are using a linked Civil 2D or 3D file and acquiring the coordinates from the linked file.

- ◆ Project Base Point: Clipped
 - ◆ Move the PBP.
 - ◆ PBP coordinates change relative to the Survey Point.
 - ◆ Project-based spot coordinates do not change.
 - ◆ Model elements “move” relative to shared coordinates.

Moving a clipped PBP is the same as using Relocate Project—that is, the model elements maintain their relationship to the PBP, but the relationship of the PBP to the Survey Point is changed.

- ◆ Project Base Point: Unclipped
 - ◆ Move the PBP.
 - ◆ PBP coordinates change relative to the Survey Point.
 - ◆ Project-based spot coordinates change.
 - ◆ Model elements do not move.

Unclipping the PBP essentially detaches it from the internal project origin. Moving the unclipped PBP is used only to affect the values reported in spot coordinates set to the project origin base. It does not have any effect on exported files.

- ◆ Survey Point: Clipped
 - ◆ Move the SP (Survey Point).

- ◆ SP coordinates do not change.
- ◆ Shared spot coordinates change.
- ◆ Model elements do not move.

The clipped SP represents the origin of the shared coordinate system. Moving it is the equivalent of setting a new origin point. Use caution if you must move the shared coordinates origin if linked models already exist in which the shared coordinates have already been synchronized. In such a case, each linked model must be opened and manually reconciled with the model in which the origin has changed.

- ◆ Survey Point: Unclipped
 - ◆ Move the SP.
 - ◆ SP coordinates change.
 - ◆ Shared spot coordinates do not change.
 - ◆ Model elements do not move.

Moving an unclipped SP essentially does not do anything. It does not affect spot coordinates, and it does not affect the origin of exported files.

USE PINNING TO PROTECT COORDINATE ORIGINS

An excellent way to prevent accidental modification of your project’s coordinate systems is to pin them. To do so, you must first make sure the Survey Point and Project Base Point are visible in a view (as we discussed previously in this section). Next, select each point and click the Pin button on the Modify panel when the Modify | Project Base Point or Modify | Survey Point ribbon appears.

Attachment vs. Overlay

Linked Revit models use what we will call a *portability setting* that is similar to the way Xrefs are handled in AutoCAD. Although this setting is not exposed when you initially link a Revit model, you can modify the setting by switching to the Insert tab and selecting Manage Links. Change the setting in the Reference Type column as desired (Figure 6.9).

Attachment The Attachment option ensures that the linked model will be included if the host model is subsequently linked into other hosts. For example, if Project A is linked into Project B as an *attachment*, when Project B is linked into Project C, Project A will automatically be included as well.

Overlay The Overlay option prevents linked models from being included if the host model is subsequently linked into other hosts. For example, if Project A is linked into Project B as an *overlay*, when Project B is linked into Project C, Project A will not be included. When you initially link a model that contains other linked models with the Overlay option, you will be notified that those links will be invisible (Figure 6.10).

FIGURE 6.9
Determining the reference type of linked Revit models

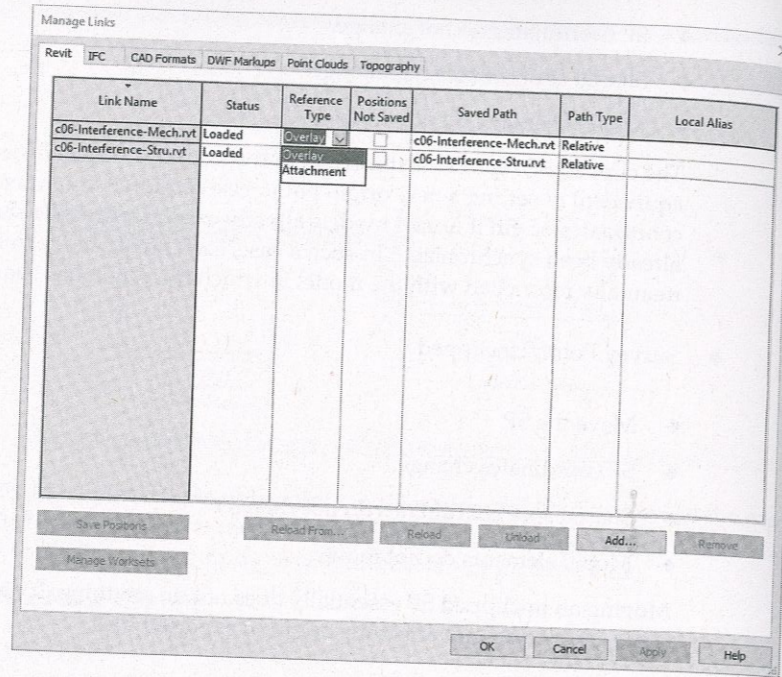
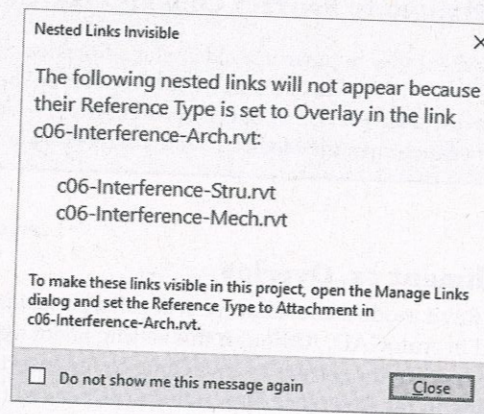


FIGURE 6.10
Notification of nested models using the Overlay setting



Linking Files with Worksharing

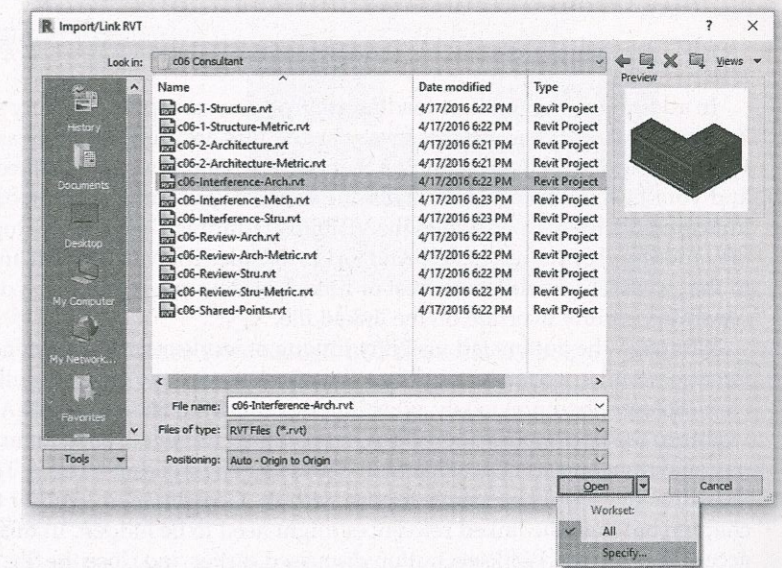
If you are using linked Revit models where one or more of the project files have worksharing enabled, there are a few guidelines to follow as well as some tangible benefits, such as linked visibility control between worksets. Be sure to read more about worksharing in Chapter 5, “Collaborating with a Team,” before continuing with this section.

When you are linking worksharing-enabled files from consultants, you will first need to decide whether you need to maintain the worksets in the linked files. Even though you may not have direct access to your consultants’ servers, the software will attempt to reconcile the location of each project model’s central file location. We recommend handling each received project file using one of the following options:

- ◆ Open the project using the Detach From Central option, choose Preserve Worksets, and then save the project as a new central file on your server. Refer to Chapter 5 for specific instructions on this process.
- ◆ Open the project using the Detach From Central option, choose Discard Worksets, and then save the file.

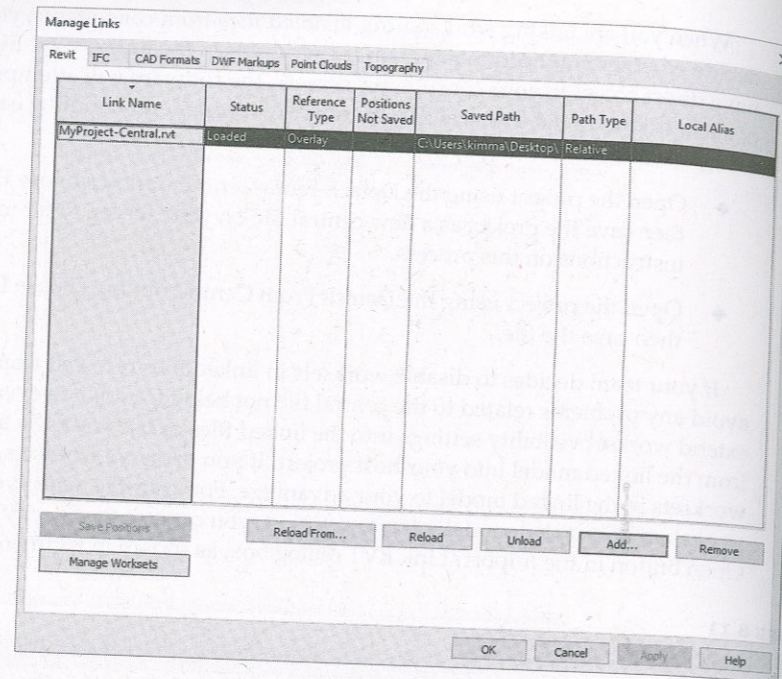
If your team decides to disable worksets in linked files received from consultants, you will avoid any problems related to the central file not being found; however, you will not be able to extend workset visibility settings into the linked files or use worksets to selectively load content from the linked model into your host project. If you preserve worksets, you can continue to use worksets in the linked model to your advantage. For example, when you first link a worksharing-enabled model into your project, you can use the Specify option associated with the Open button in the Import/Link RVT dialog box, as shown in Figure 6.11.

FIGURE 6.11
Use the Specify option to close worksets when linking.



At any time throughout the development of the project, you can adjust the loaded worksets from linked files very easily. From the Manage tab or the Insert tab in the ribbon, click the Manage Links button. In the Manage Links dialog box (Figure 6.12), select one of the linked RVT files, and if it is a worksharing-enabled file, click the Manage Worksets button to open the Worksets dialog box. We describe this process in greater detail in the next section of this chapter.

FIGURE 6.12
Access worksets of
linked files from
Manage Links.



In addition to the workset-loading control, you can apply visibility settings automatically to linked models—if the worksets in any linked files are named exactly as they are in the host file. For example, if you linked a model that had the default workset named Shared Levels and Grids and your host model also had that same workset, you can hide the workset in both the host and linked model in one step. Open the Visibility/Graphic Overrides dialog box, select the Worksets tab, and then set Shared Levels And Grids to Hide. You will see that any datum objects assigned to that workset—in either the host or linked model—are hidden. You do not need to perform a separate visibility override on the linked file.

Although the automated visibility linking of worksets can be beneficial, it can also be problematic when you need to coordinate content between the host and linked models. In the same scenario described previously, what if you wanted the Shared Levels And Grids workset to be visible in the host model but hidden in the linked model? This is common when you are coordinating datum objects between architectural and engineering models. The grids and levels from a linked model should be visible for use with the Coordination Monitor tools described in this chapter, but then the linked references might need to be hidden. In this case, you might choose to access the Manage Worksets button discussed earlier and close the Shared Levels And Grids workset in the linked file. You could also adjust the linked view; however, this would require you to adjust every view in which the linked model appears. We discuss linked views in greater detail in Chapter 18, “Documenting Your Design.”

Using Worksets to Organize Linked Models

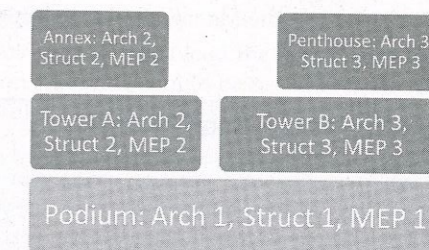
As we discussed in Chapter 5, we recommend that you create and reserve a workset for each linked Revit model, such as Link-RVT-Structure or Link-RVT-HVAC. This simple step will allow your team members to choose whether they would like any, all, or none of the linked models to be loaded when working on a host model. To enable this functionality, use the Specify setting in the drop-down options next to the Open button.

When the Worksets dialog box appears, select the worksets reserved for the linked models and set their Open/Closed status as you desire. The benefit of using worksets to manage linked Revit models is the flexibility it offers a project team. When a team member closes a workset containing a linked model, the linked model is unloaded only for that person—it does not unload for the entire team.

Expanding Workset Properties for Linked Models

Additional flexibility can be leveraged with the Workset parameter in both the instance and type properties of a linked model. In a large and complex project that consists of multiple building elements where some of the elements are identical, each may consist of multiple linked models: architecture, structure, and MEP. Figure 6.13 shows a simplified representation of such a design where the Podium has one set of models and Tower A and Annex are identical to one another, as are Tower B and the Penthouse.

FIGURE 6.13
Schematic
representation of a
complex project
assembled with multiple
linked models



In Figure 6.13, there are three Revit models that represent the podium and the two towers (A and B) for each discipline (Arch1, Arch2, and so on). There are multiple instances of several of the linked models. For each instance of a linked model, you can specify the Workset parameter so that the workset instance property represents the building element, and the type property reflects either the entire discipline or one of the discipline models, as in this example:

- ◆ Instance workset: Tower A
- ◆ Type workset: Link-Architecture1 or simply Link-Architecture

Using this example, you can choose to open the Tower A workset, which would load all the discipline models but only for Tower A, or you could choose to open the Link-Architecture workset, which would load only the architectural models but for all the building elements. You

can modify the workset-type properties only after placing a linked model in your project. Access this setting by selecting an instance of a linked model and opening the Properties palette, and then click Edit Type. Although this functionality can offer a variety of benefits to your project team, it should be used with care and proper planning because it can adversely affect model visibility if you are using worksets for visibility manipulation.

Worksharing-enabled linked models also afford you the flexibility to adjust the visibility of project elements for the entire project, without relying on individual settings per view or maintenance of view templates. For example, grids and levels are not usually displayed from linked models because their extents are not editable in the host model and the graphics may not match those in the host model. Without worksets, the owner of the host model would have to establish visibility settings for the linked model within all views and hopefully manage those settings in view templates. Assuming the owner of the linked model maintains the levels and grids on an agreed-upon workset such as Shared Levels And Grids, you will be able to close that workset in one place, thus affecting the entire host project. To modify the workset options for linked Revit models, follow these steps:

1. Open the Manage Links dialog box and switch to the Revit tab.
2. Select one of the linked files and click the Manage Worksets button.
3. In the Manage Worksets For Link dialog box, select the worksets you would like to close, click the Close button, and then click Reload.
4. Click OK to close the Manage Links dialog box.

RELATIVE PATHS OF LINKED MODELS

If your team is working in a situation where your project files are regularly transferred between multiple locations throughout the design process, you may find it difficult to maintain linked files (they are automatically unloaded when the file is exchanged), even if you are using relative paths. To alleviate this problem, try keeping the linked models and CAD files within subdirectories of the central file. For example, if your central file is saved in W:\Architecture\BIM, try keeping linked CAD files in W:\Architecture\BIM\Links-CAD and linked Revit models from consultants in W:\Architecture\BIM\Links-RVT.

Summarizing the Benefits and Limitations of Linked Models

Let's review some of the benefits and limitations of using linked Revit models. You should carefully consider these aspects not only when preparing for interdisciplinary coordination but also when managing large, complex projects with linked files.

The following list highlights some of the benefits:

Tagging Elements in Linked Files Most model elements from a linked model can be tagged in a host model. Linked views can also be used if the annotation exists in the linked model and needs to be displayed in the host.

Scheduling Elements in Linked Files In the Fields tab of the Schedule Properties dialog box, check the option Include Elements In Links.

Copying/Pasting Elements from Linked Files In a host model, use the Tab key to select any individual element within a linked file, and you can use standard copy-and-paste techniques to create a copy of the element in the host model.

Hiding Elements in Linked Files In addition to having full control of a linked model's visual fidelity through object styles, you can use the Tab key to select an individual element in a linked file and use the Hide In View commands as you would on any element within the host model.

The following list highlights some of the limitations:

Joining Walls Walls cannot be joined between linked Revit models. Consider alternative graphic techniques such as using coarse-scale black solid fill to mask unjoined walls.

Opening Linked Models You cannot have a host model with loaded linked models open in the same Revit session as the linked model files. Either separate Revit sessions must be launched or the host file must be closed before opening a linked model. If you choose not to follow either of these options and open the link in your current session, the linked model will be unloaded and need to be reloaded after the edits are made.

Using Linked Models—Exercises

Before you begin the exercises in this chapter, download the related files from this book's web page. The project files in each section's exercise should be saved because the lessons will build on the data. In this first exercise, you will do the following:

- ◆ Link the architectural model to a structural project.
- ◆ Establish shared coordinates.

The structural model is essentially a blank project with a few element types specifically built for this chapter's lessons. Let's get started working with shared coordinates:

1. Open the sample project file c06-1-Structure.rvt or c06-1-Structure-Metric.rvt and activate the Level 1 floor plan.
2. Switch to the Insert tab and select Link Revit or click Manage Links, go to the Revit tab dialog, and click the Add button to add a new linked model. To make the steps easier to follow, the rest of this chapter will use the Link Revit button on the Insert tab, but both buttons will give you the same result.
3. Using either method from step 2, navigate to the file c06-2-Architecture.rvt or c06-2-Architecture-Metric.rvt.
4. Set the Positioning option to Auto - Center To Center and click Open.
5. Activate the South elevation view and use the Align tool to bring the linked model's Level 1 down to align with Level 1 in the host model if necessary.

Remember, linked models should be aligned to the geometry in the host model. The modeled elements in the host model should be as close to the internal project origin as possible.

- Switch to the Manage tab, and from the Project Location panel, select Coordinates > Acquire Coordinates. Pick the linked model.

The elevation value displayed in the level within the host file has changed to match the shared elevation in the linked file. This is because the Elevation Base parameter of the level's type properties has been set to Survey Point.

- Save the project file for subsequent exercises in this chapter.

MODIFYING ELEMENT VISIBILITY IN LINKED FILES

Once you have linked one or more Revit files into your source project file, you may want to adjust the visibility of elements within the linked files. By default, the display settings in the Visibility/Graphic Overrides dialog box are set to By Host View for linked files, which means model objects in the linked files will adopt the same appearance as the host file. In the following exercise, we will show you how to customize these settings to turn the furniture off in the linked file and then display the room tags:

- Continue this exercise with the structural model that you saved with the linked architectural model.
- Activate the Level 1 floor plan from the Project Browser.
- Go to the View tab in the ribbon, locate the Graphics panel, and select Visibility/Graphics. In the Visibility/Graphic Overrides dialog box, select the Revit Links tab.

You will see the linked architectural model listed as an expandable tree. Click the plus sign next to the name of the linked file, and you will see a numbered instance of the link. This allows you to customize the visibility for each instance of a linked file if you have multiple copies of the link in the host file.

- In the row displaying the name of the linked file, click the button in the Display Settings column that is labeled By Host View.

Doing so opens the RVT Link Display Settings dialog box.

- To begin customizing the display of elements in the linked file, you must first choose the Custom option in the Basics tab, as shown in Figure 6.14. This enables all the options in each tab of the RVT Link Display Settings dialog box.
- Select the Model Categories tab and choose <Custom> in the drop-down list at the top of the dialog box, as shown in Figure 6.15.
- Clear the check marks from the following categories: Casework, Furniture, and Furniture Systems.
- Click OK to close all open dialog boxes.

FIGURE 6.14
Enable all custom display settings for a linked RVT file.

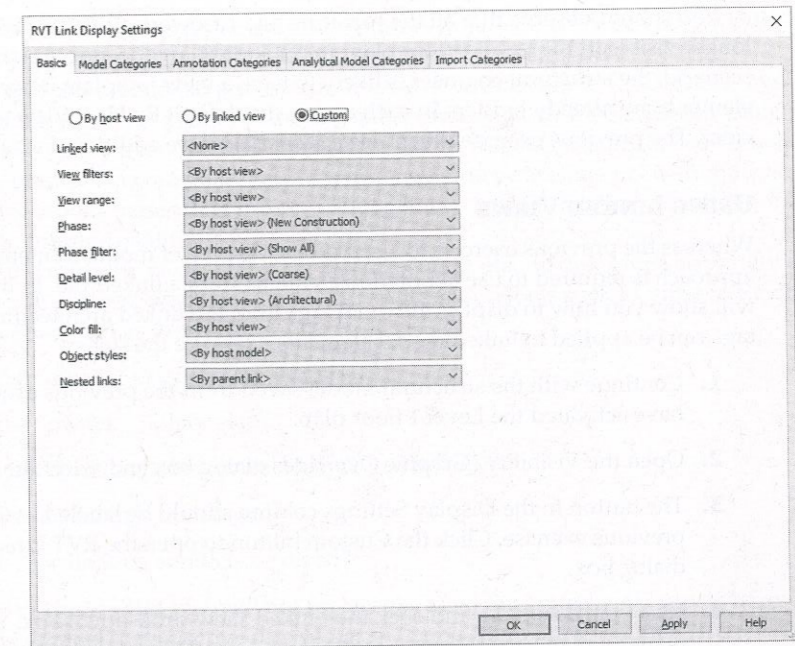
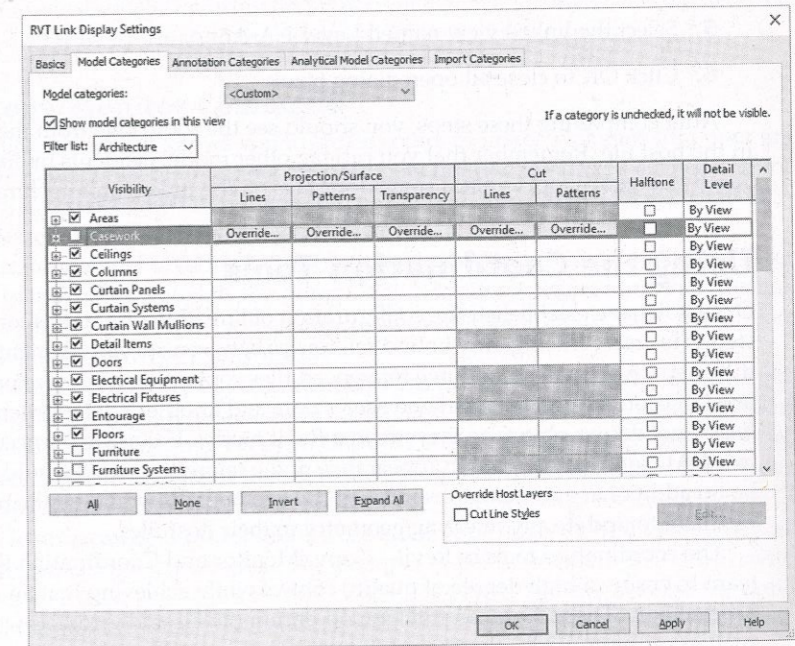


FIGURE 6.15
Enable custom display settings for model categories of a linked RVT file.



You should observe that all the furniture and casework from the linked architecture file are no longer visible in the Level 1 floor plan. In a standard architecture-to-structure collaboration scenario, the structural engineer is likely to have a view template in which typical architectural elements are already hidden. In such a case, the default By Host View settings would be sufficient. The previous exercise illustrates a scenario where additional visual control is required.

USING LINKED VIEWS

Whereas the previous exercise focused on the display of model elements, a slightly different approach is required to use annotation elements from a linked file. In the following exercise, we will show you how to display the room tags from the linked architectural model. Many other tags can be applied to linked model elements. Here are the steps:

1. Continue with the structural model saved from the previous exercise and make sure you have activated the Level 1 floor plan.
2. Open the Visibility/Graphic Overrides dialog box and select the Revit Links tab.
3. The button in the Display Settings column should be labeled as Custom based on the previous exercise. Click the Custom button to open the RVT Link Display Settings dialog box.
4. Select the Basics tab and click the Linked View drop-down box. You will see the floor plans available for reference in the linked file. Only view types similar to the current view in the host file will be available for use as a linked view.
5. Select the linked view named Level 1-A-Anno.
6. Click OK to close all open dialog boxes.

After completing these steps, you should see the room tags from the linked architectural file in the host file. Remember that you can tag other model elements in linked files. Try using the Tag By Category tool to place some door tags on the linked architectural model.

Using the Coordination Tools

Once you have established the configuration of linked Revit models for your project, the next step is to create intelligently bound references between specific elements within the models. In the past, CAD users might have referenced files containing grid lines or level lines to establish a level of coordination between one user's data and another's. These elements in CAD are merely *lines*—not datum objects as they are in a Revit model. If these referenced elements were modified in a CAD setting, the graphic appearance of the referenced lines would update, but there would be no additional automated response to the geometry. It would be the responsibility of the recipient to update any referring geometry in their host files.

The coordination tools in Revit—Copy/Monitor and Coordination Review—allow a project team to ensure a high degree of quality control while achieving it at an increased level of productivity. These tools can function on datum (levels and grids) as well as model elements such as columns, walls, floors, and fixtures. The Copy/Monitor command is used first to establish the intelligent bonds between linked elements and host elements, whereas the

Coordination Review command automatically monitors differences between host and linked elements that were previously bound with the Copy/Monitor command.

Although these tools are indeed powerful and have no similarities to CAD workflows of the past, it is important to employ proper planning and coordination with your design team. The familiar adage of “quality over quantity” holds true for the implementation of coordination tools. It may not be necessary to create monitored copies of all structural elements within the architectural model. How would these affect project-wide quantity takeoffs for the sake of minor improvements in graphic quality?

We reiterate the necessity of developing a BIM execution plan to determine important aspects of the collaboration process. When using specific coordination tools such as those in Revit, teams might plan on issues such as these:

- ◆ Who is the “owner” of grids and levels?
- ◆ Who is the “owner” of floor slabs?
- ◆ Are structural walls copied, monitored, or just linked?
- ◆ How often are models exchanged?
- ◆ How are coordination conflicts resolved?

A seemingly powerful BIM tool will not replace the need for professional supervision and the standard of care implicit to respective disciplines in the building industry. Thus, there is no substitution for the most important part of effective collaboration: *communication*. Without open and honest communication, the coordination tools will discover conflicts, but the results may be ignored, dismissed, or overwritten to the detriment of the team's progress.

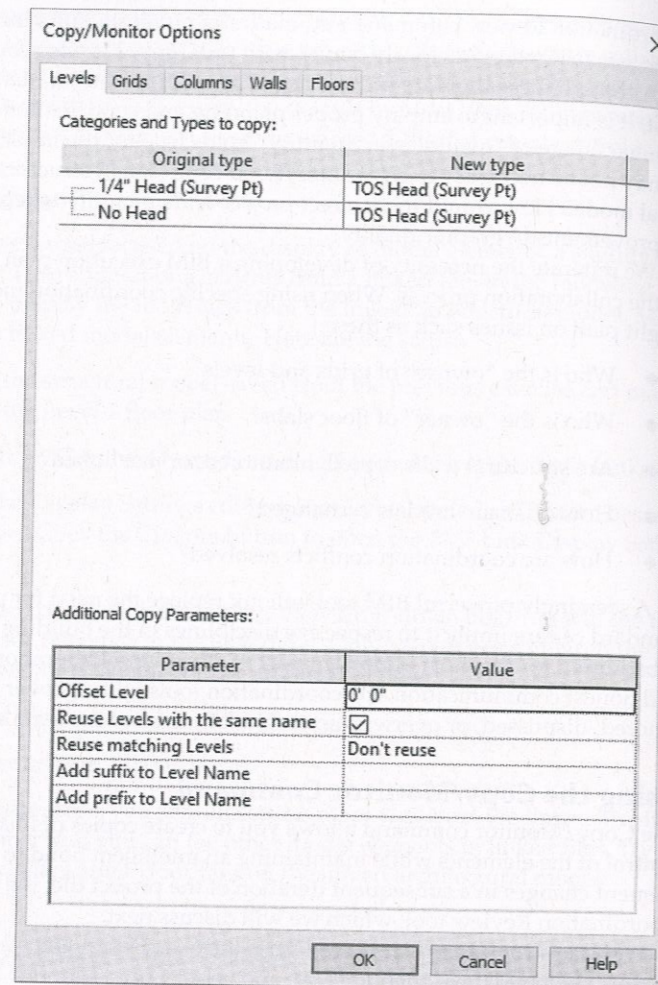
Using the Copy/Monitor Command

The Copy/Monitor command allows you to create copies of linked elements for better graphic control of the elements while maintaining an intelligent bond to the linked elements. If the linked element changes in a subsequent iteration of the project file, the changes are detected in the Coordination Review tool, which we will discuss next.

With the structural model saved from the exercises in the “Using Linked Models—Exercises” section, switch to the Collaborate tab and select Copy/Monitor > Select Link. Pick the linked architectural model, and the ribbon will change to Copy/Monitor mode. Click the Options icon to open the dialog box shown in Figure 6.16.

As shown in Figure 6.16, the Copy/Monitor Options dialog box in Revit is divided into five tabs representing the elements available to be copied and/or monitored. For each element tab, there is a list called Categories And Types To Copy. As shown in Figure 6.17, the Floors tab lists the available floor types in the linked model in the left column and host model floor types in the right column. Notice that any of the linked types can be specified with the option Don't Copy This Type. This feature can be used for quality control if your project's BIM execution plan states that certain elements are not to be copied. For example, if walls are not to be copied, switch to the Walls tab and set all linked wall types to Don't Copy This Type. You can also use the option Copy Original Type if the element type exists in the linked file but not in the host file. After one or more of these elements are selected using Copy/Monitor, the type mapping will be synchronized.

FIGURE 6.16
Element tabs available
for Copy/
Monitor in Revit

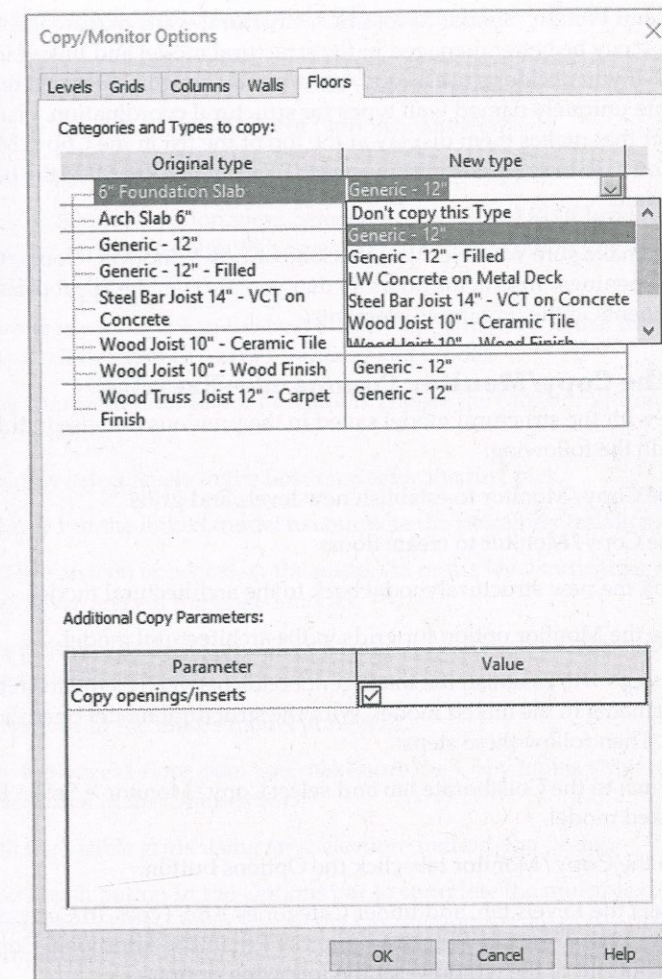


At the bottom of the Copy/Monitor Options dialog box, you will find a section called Additional Copy Parameters for each element tab (refer to Figures 6.16 and 6.17). The additional parameters are different for each element category. For example, when levels are copied and monitored, an offset and naming prefix can be applied to accommodate the difference between the finish floor level in a linked architectural model and the top-of-steel level in the host structural model.

Let's take a closer look at each of the element category options available for the Copy/Monitor tool.

Levels In most cases, the difference between the location of a structural level and an architectural level may lead to the presumption that you would not want to copy levels between files. However, maintaining an offset between linked and host levels can be quite desirable. Keep in mind that the offset will apply to all copy/monitor selections. Thus, if a structural level needs to be offset by a different value, create the level in the host model and use the Monitor command to create the intelligent bond to the linked model's level. The difference will be maintained through any modifications in the linked model.

FIGURE 6.17
The Copy/Monitor
Options dialog box
allows customization
for intelligent
collaboration.



Grids Copying the grids is usually a strong workflow. You can use the options on these tabs to convert the grid bubbles used by the architect into those used by the structural engineer. It is also possible to add a prefix to the grid names. For instance, you could add the value S- in the prefix field, and then grid A from the architectural model will come into the structural model as S-A.

Columns The structural engineer can choose to replace any column—architectural or structural—in the architectural model with an appropriate structural column; however, this implies that the architect will maintain an understanding of where differentiating column types would exist. Realistically, the structural elements should exist only in the structural engineer's model and then link into the architectural model. The architect may then choose to either copy/monitor the linked structural columns with architectural columns (which act as finish wrappers) or place architectural columns along the monitored grid lines. In the latter option, architectural columns will move along with changes in grid line locations but will not update if structural columns are removed in the linked model.

Walls and Floors Similar to columns, structural walls that are important to the coordination process may be better managed in the structural model and linked into the architectural model. If you decide to use a copy/monitor relationship for these types of elements, it is best to create uniquely named wall types for structural coordination. Name such wall types in a manner that makes them display at the top of the list in the Copy/Monitor Options dialog box. You can do so by adding a hyphen (-) or underscore (_) at the beginning of the wall type name.

Finally, make sure you select the check box Copy Windows/Doors/Openings for walls or Copy Openings/Inserts for floors so that you also get the appropriate openings for those components in the monitored elements.

Using the Copy/Monitor Command—Exercise

Continue with the structural model saved in the previous exercise in this chapter. In this exercise, you will do the following:

- ◆ Use Copy/Monitor to establish new levels and grids.
- ◆ Use Copy/Monitor to create floors.
- ◆ Link the new structural model back to the architectural model.
- ◆ Use the Monitor option for grids in the architectural model.

These steps will establish the intelligent bonds between elements in the host file with the related elements in the linked model. With the structural model open, activate the South elevation view. Then follow these steps:

1. Switch to the Collaborate tab and select Copy/Monitor > Select Link. Choose the linked model.
2. On the Copy/Monitor tab, click the Options button.
3. Select the Levels tab, and under Categories And Types To Copy, make sure the rows under New Type are set to TOS Head (Survey Pt). In the Additional Copy Parameters section, at the bottom of the window, set the following options:
 - ◆ Offset Level: 0' 6" (-150 mm)
 - ◆ Add prefix to Level Name: T.O.S.
4. Select the Grids tab, and under Categories And Types To Copy, make sure the rows under New Type are set to 1/4" Square (6.5 mm Square).
5. Select the Floors tab and set the following options under Categories And Types To Copy:
 - ◆ Arch Slab 6" (150 mm): LW Concrete on Metal Deck
 - ◆ Set all other entries under Original Type to Don't Copy This Type.

Remember that you can select multiple rows in the Categories And Types To Copy list by pressing the Shift key while selecting a range of rows. You may then make a selection in the New Type column for any row, and all the selected rows will be modified.

In the Additional Copy Parameters section, set the following option:

- ◆ Copy Openings/Inserts: Yes (checked)
6. Click OK to close the Copy/Monitor Options dialog box.
 7. From the Copy/Monitor tab of the ribbon, click the Copy button.
 8. Activate the South Elevation view. Select the Level 2 and Roof levels in the linked model. Levels in the host model should be created 6" (150 mm) below the linked levels with the prefix T.O.S. (Top Of Structure).

There is already a Level 1 in the host model. You will need to use the Monitor tool to establish a relationship to Level 1 in the linked model.
 9. From the Copy/Monitor tab of the ribbon, choose the Monitor button and select Level 1 in the host model.

You can only select levels in the host model for the first pick.
 10. Select Level 1 in the linked model to complete the monitored relationship.

You will see an icon appear near the midpoint of the level indicating that it is now monitoring the level in the linked model.
 11. Activate Section 1 and return to Copy mode by clicking the Copy button in the Copy/Monitor tab of the ribbon.
 12. Select the floor in the linked model at Level 2.
 13. Activate the Level 1 floor plan and make sure the Copy tool is still active. Check the Multiple option in the Options bar.
 14. Select all the visible grids using any selection method you prefer.
 15. Click the Finish button in the Options bar to complete the multiple copy process for the grids. Do not click the Finish icon in the Copy/Monitor tab of the ribbon without finishing the Multiple selection mode first.
 16. Click the Finish icon in the Copy/Monitor tab of the ribbon to exit Copy/Monitor mode.

If you now select any of the grids or levels in the host file, you will see a monitor icon near the center of the element. This icon indicates that the intelligent bond has been created between the host and the linked element and will evaluate any modifications in the linked file whenever the file is reloaded.

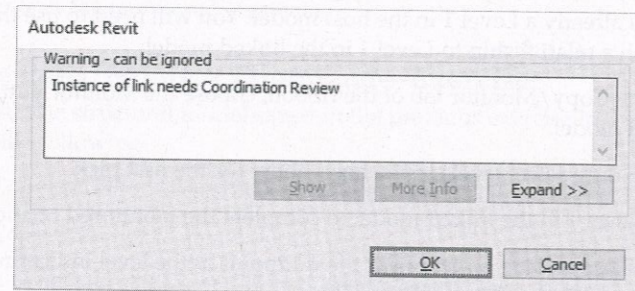
Save and close the structural model and then open the architectural model, c06-2-Architecture.rvt or c06-2-Architecture-Metric.rvt. Using the procedures you have learned in this chapter, link the structural file into the architectural model. Placement should be done in the Level 1 floor plan using Auto - By Shared Coordinates positioning.

Use the Copy/Monitor tools in Monitor mode to establish the relationships of the grids between host and linked models. Doing so will ensure that changes to grids in either model will be coordinated.

Using the Coordination Review Tool

After intelligent connections have been established between elements in linked models, it is the purpose of the Coordination Review tool to support the workflow when datum or model elements are modified. This tool was designed to allow the recipient of linked data to control how and when elements in host models are modified based on changes in the linked models.

When a linked model is reloaded—which will happen automatically when the host model is opened or when you manually reload the linked model in the Manage Links dialog box—monitored elements will check for any inconsistencies. If any are found, you will see a warning message that a linked instance needs a coordination review.



The Coordination Review warning is triggered when any of the following scenarios occur:

- ◆ A monitored element in the linked model is changed, moved, or deleted.
- ◆ A monitored element in the host model is changed, moved, or deleted.
- ◆ Both the original monitored element and the copied element are changed, moved, or deleted.
- ◆ A hosted element (door, window, or opening) is added, moved, changed, or deleted in a monitored wall or floor.
- ◆ The copied element in the host file is deleted.

To perform a coordination review, switch to the Collaborate tab and click Coordination Review > Select Link. After picking one of the linked models, you will see the Coordination Review dialog box, which lists any inconsistencies in monitored elements (Figure 6.18).

For each of the changes detected in the Coordination Review dialog box, one of the following actions can be applied. Actions that result in changes to elements will be applied only to the host model; they do not modify elements in a linked model. Also, not all options are available for all monitored elements.

Postpone Takes no action on the monitored element and changes the message status so that it can be filtered out or considered later.

Reject Select this action if you believe the change made to the element in the linked file is incorrect. A change must then be made to the element in the linked file.

Accept Difference Accepts the change made to the element and updates the relationship. For example, if a pair of grids was 8" (200 mm) apart and one was moved to 12" (300 mm) away, the change would be accepted and the relationship would now consist of a dimensional offset.

Modify, Rename, Move The command name changes based on the action. If the name of the monitored element has changed, the command reads Rename. If a column or level is moved, the command is Move. If a grid is changed or moved, the command is Modify.

Ignore New Elements A new hosted element has been added to a monitored wall or floor. Select this action to ignore the new element in the host. It will not be monitored for changes.

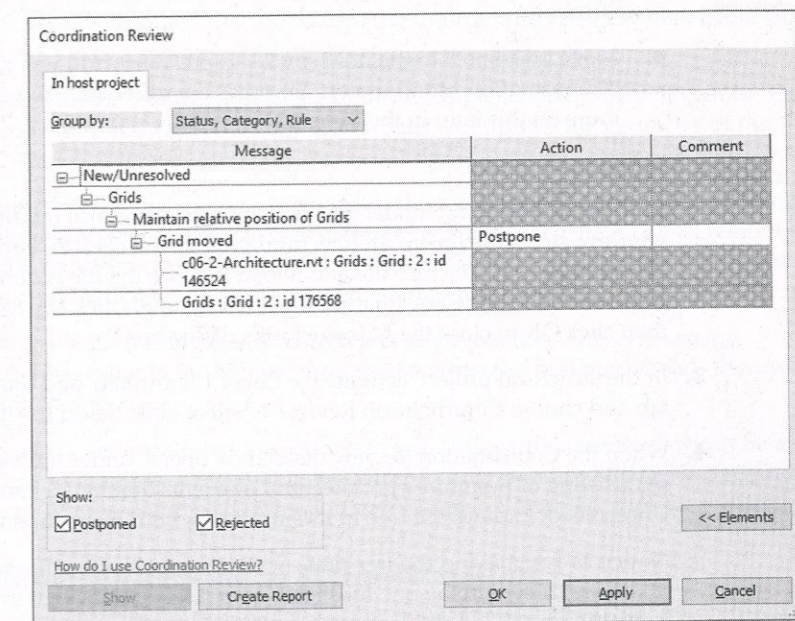
Copy New Elements A new hosted element has been added to a monitored wall or floor. Select this action to add the new element to the host and monitor it for changes.

Delete Element A monitored element has been deleted. Select this action to delete the corresponding element in the current project.

Copy Sketch The sketch or boundary of a monitored opening has changed. Select this action to change the corresponding opening in the current project.

Update Extents The extents of a monitored element have changed. Select this action to change the corresponding element in the current project.

FIGURE 6.18
The Coordination Review dialog box lists inconsistencies in monitored elements.



As you can see, Coordination Review can be a powerful tool to support the collaboration process. Remember that such a tool may not be appropriate for all elements at all times. For example, instead of copying and monitoring columns and grids, it may be sufficient to copy and monitor only grids because the columns placed in your host model will move with the grids anyway.

Using the Coordination Review Tool—Exercise

In this exercise, you will use two files that have already been linked together with monitored elements between both files. You can download the files `c06-Review-Arch.rvt` or `c06-Review-Arch-Metric.rvt` (architectural model) and `c06-Review-Stru.rvt` or `c06-Review-Stru-Metric.rvt` (structural model) from this book's web page. In this exercise, you will do the following:

- ◆ Modify elements in the architectural model.
- ◆ Use Coordination Review to address these changes in the structural model.

Remember that you cannot have a host model and a linked model open in the same Revit session. To make this lesson easier, you can launch a second Revit session. Open `c06-Review-Arch.rvt` or `c06-Review-Arch-Metric.rvt` in one session and `c06-Review-Stru.rvt` or `c06-Review-Stru-Metric.rvt` in the other. Then follow these steps:

1. In the architectural model, activate the Level 1 floor plan and make the following modifications:
 - ◆ Move grid line F to the north by 2'-0" (600 mm). You will get a warning message, "Coordination Monitor alert: Sketches are different." You can ignore the warning, more on this later in the exercise.
 - ◆ Rename grid 6 to 8.
2. Save the architectural model and switch to the structural model. Open the Manage Links window, select the linked architectural model, and click Reload From. Browse to the downloaded Architecture file and reload it. Once the file is done reloading, you are presented with the Coordination Review warning. Click OK to close the dialog box, and then click OK to close the Manage Links dialog box.
3. In the structural project, activate the Level 1 floor plan, and then switch to the Collaborate tab and choose Coordination Review > Select Link. Select the linked architectural model.
4. When the Coordination Review dialog box opens, under the Message column, you will see a listing of monitored architectural elements that have changed under New/Unresolved. Expand the tree in its entirety for both Floors and Grids.

Notice as you expand the tree that certain rows will allow for you to specify an Action. There are three in total: one for Floors, two for Grids. By default, the Action listed is Postpone.

5. For each row with an Action option, click the Action field and apply the following:
 - ◆ Sketches are different: **Postpone**
 - ◆ Name changed: **Rename Element '6'**
 - ◆ Grid moved: **Modify Grid 'F'**
6. Click Apply and OK to close the dialog box.

Notice that Grid F has moved up to be in alignment with the architectural counterpart, Grid 6 has been renamed to 8, and no changes were made to the structural slab due to the Postpone action.

Let's talk about the structural slab for which we postponed the action. In the previous exercise, you might have noticed the appearance of a monitored floor sketch. Why did a floor sketch change if you only moved a grid and renamed another? The answer lies in constraints and relationships. The exterior wall in the architectural model was constrained to be 2'-0" (600 mm) offset from grid line F. When it was moved, the exterior wall was moved to maintain the offset. The sketches of the model's floor slabs were created using the Pick Walls tools, creating an intelligent relationship to the wall. The modified grid affected the wall, which modified the floor, and the Coordination Monitor tools ensured that all changes were detected and presented to you for action.

As a best practice, for any action during Coordination Review that impacts geometry, set the Action to Postpone. Thoroughly investigate how the change in geometry will impact your design. Once you have determined this, go back to the Coordination Review dialog and do one of the following:

- ◆ If you agree with the change, in the case of this example, choose **Copy Sketch to 'Floor: LW Concrete on Metal Deck'** as your action. This will update the geometry of the structural slab.
- ◆ If you agree with the change to the architectural floor but it does not require a change to the structural slab, then choose **Accept difference**. This will create an offset relationship between the architectural slab and the structural slab. Revit will consider the elements coordinated and will remove the listing in Coordination Review.
- ◆ If you disagree with the change, choose **Reject** as your action. This will cause a Coordination warning in the architectural model when the designer reloads the updated structural model.

In conclusion, we've demonstrated the process in which Coordination Review can be a powerful workflow to monitor changes in linked files. To fully take advantage, we recommend that all participants involved in the coordination process are on-boarded with the toolset.

Using Interference Checking in 3D Coordination

In addition to asset management, digital fabrication, and cost estimation, 3D coordination is one of the most important uses of building information modeling. It has enormous potential to reduce the costs of construction through the computerized resolution of clashing building

elements as well as exposing opportunities for alternate trade scheduling or prefabrication. The key component to achieving 3D coordination is interference checking, also known as *clash detection*.

INDIANA UNIVERSITY DEFINES CLASHES

As we mentioned previously in this chapter, not only are some building and facility owners requiring BIM processes and deliverables for new projects, but they are also defining how these processes are to be used. When you focus on interference checking, myriad potential clashes can be distilled into a prioritized grouping of building elements. Borrowing from Indiana University's BIM Standards & Guidelines for Architects, Engineers, & Contractors, the following is an intelligent approach to the organization of potential interferences. (Always remember that the priorities listed here are based on the requirements of one organization. The needs of your firm and those of your clients may vary.)

LEVEL ONE CLASHES

Clashes in these categories are considered the most critical to the coordination process. They usually relate to systems or construction techniques that are more costly to delay or reschedule:

- ◆ Mechanical Ductwork and Piping vs. Ceilings
- ◆ Mechanical Ductwork and Piping vs. Rated Walls (for coordination of dampers and other mechanical equipment needs)
- ◆ Mechanical Ductwork and Piping vs. Structure (columns, beams, framing, etc.)
- ◆ All Equipment and Their Applicable Clearances vs. Walls
- ◆ All Equipment and Their Applicable Clearances vs. Structure
- ◆ Mechanical Equipment and Fixtures vs. Electrical Equipment and Fixtures
- ◆ Mechanical Ductwork and Piping vs. Plumbing Piping

LEVEL TWO CLASHES

These categories of clashes are considered important to the design and construction process but are less critical than those designated as Level One:

- ◆ Casework vs. Electrical Fixtures and Devices
- ◆ Furnishings vs. Electrical Fixtures and Devices
- ◆ Structure vs. Specialty Equipment
- ◆ Structure vs. Electrical Equipment, Fixtures, and Devices
- ◆ Ductwork and Piping vs. Electrical Equipment, Fixtures, and Devices
- ◆ Ductwork vs. Floors

LEVEL THREE CLASHES

These clashes are considered important to the correctness of the model; however, they will usually change on a regular basis throughout the design and construction process:

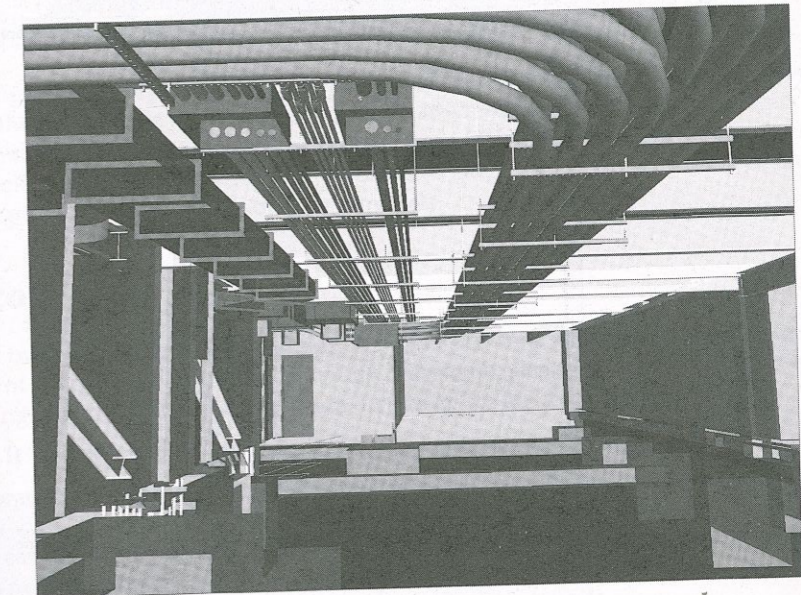
- ◆ Casework vs. Walls
- ◆ Plumbing Piping vs. Electrical Equipment, Fixtures, and Devices
- ◆ Plumbing Piping vs. Mechanical Equipment, Fixtures, and Devices
- ◆ ADA Clear Space Requirements vs. Doors, Fixtures, Walls, and Structure

USING THE INTERFERENCE CHECK TOOL

The Interference Check tool is a basic tool supporting 3D coordination. You can use it within a single project model or between linked models. You can also select elements prior to running the tool in order to detect clashes within a limited set of geometry instead of the entire project.

For more powerful clash-detection capabilities, Autodesk offers Navisworks® Manage (www.autodesk.com/navisworks), which is a multiformat model-reviewing tool with various modules supporting phasing simulation, visualization, and clash detection. Figure 6.19 shows an example of a model in Navisworks Manage comprising Revit, Tekla Structures, and AutoCAD MEP components. Some of the benefits of using Navisworks for interference-checking over Revit include automated views of each clash, grouping of related clashes, enhanced reporting, clash-resolution tracking, and markup capabilities. Revit models can be opened directly in Navisworks or exported directly to the Navisworks format from the Application menu.

FIGURE 6.19
3D coordination model
in Navisworks Manage



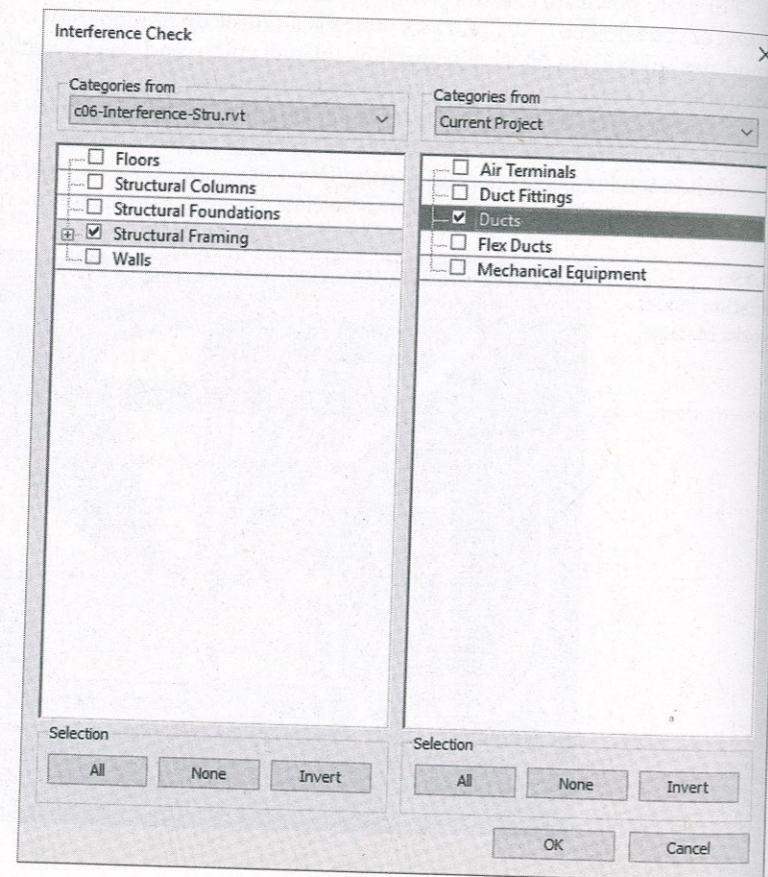
Revit also allows you to link in Navisworks files (.nwc and .nwd). We will review those workflows in more detail in the next chapter.

RUNNING AN INTERFERENCE CHECK—EXERCISE

Let's take a look at the Revit interference-checking process. For this exercise, you will need to download three sample files to your computer or network: c06-Interference-Arch.rvt, c06-Interference-Mech.rvt, and c06-Interference-Stru.rvt. You can download these files from this book's web page. The sample files are already linked to each other using relative paths, so be sure to place all three files in the same folder. Then follow these steps:

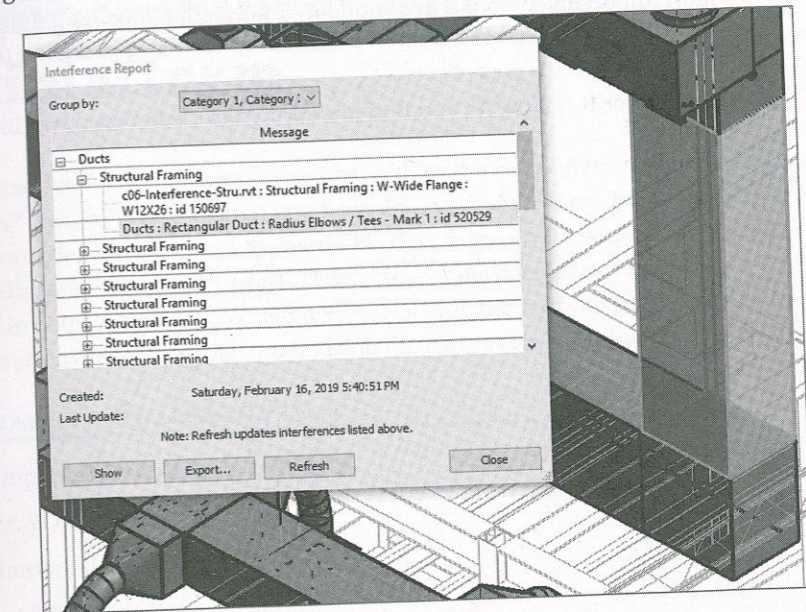
1. Open the file c06-Interference-Mech.rvt and activate the default 3D view.
2. Switch to the Collaborate tab, find the Coordinate panel, and choose Interference Check > Run Interference Check.
3. When the Interference Check dialog box appears, choose c06-Interference-Stru.rvt available in the drop-down of the Categories From list located in the left column. Select Structural Framing in the left column and Ducts in the right column (Figure 6.20).

FIGURE 6.20
Select categories to be included in an interference check.



4. Click OK to close the dialog box.
5. The Interference Report window will appear, listing all clashes detected between the categories you selected. The list can be sorted by either Category 1 or Category 2, representing the left and right columns in the Interference Check dialog box, respectively. In Figure 6.21, one interference condition has been selected, and the corresponding element is highlighted in the 3D view.

FIGURE 6.21
The results of an interference check are displayed in the Interference Report window.



You can navigate in the 3D view using any method (mouse, ViewCube®, or SteeringWheels®) while keeping the interference report open. This facilitates resolution of the clashing items. The results of the interference check can also be exported to an HTML format report. Click the Export button and specify a location for the report. You can then share this report with other members of your design team for remedial actions on linked models.

The Bottom Line

Prepare for interdisciplinary collaboration. Proper planning and communication are the foundation of effective collaboration. Although only some client organizations may require a BIM planning document, it is a recommended strategy for all design teams.

Master It What are the key elements of a BIM execution plan?

Collaborate using linked models. The most basic tool for collaboration is the ability to view consultants' data directly within the context of your own model. Project files from other disciplines can be linked and displayed with predictable visual fidelity without complex conversion processes.

Master It How can worksharing complement the use of linked models?

Use Copy/Monitor between linked models. The Coordination Monitor tools establish intelligent bonds between elements in a host file and correlating elements in a linked model. They also support a workflow that respects the needs of discrete teams developing their own data, perhaps on a different schedule than that of other team members.

Master It How can grids in two different Revit projects be related?

Run interference checks. Interference checking—also known as *clash detection*—is one of the most important components of building information modeling. It is the essence of virtual construction and has the greatest potential for cost savings during the physical construction process.

Master It How do you find interfering objects between two linked Revit models?

Chapter 7

Interoperability: Working Multiplatform

In the previous chapter, we discussed working with others in an environment in which all parties use Autodesk® Revit®; however, often you'll need to work with data from other software platforms. For example, you may need to coordinate data from other disciplines, reuse legacy data, or integrate disparate design platforms. There are several ways to use external data within your Revit model in both 2D and 3D. We will discuss not only the methods of importing and exporting data, but also when to use each method and the reasons for using specific settings.

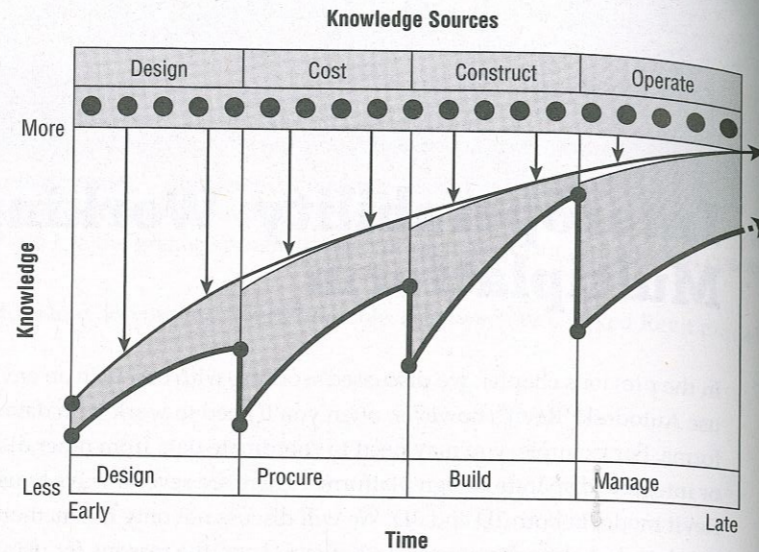
IN THIS CHAPTER, YOU'LL LEARN TO

- ◆ Use imported 2D CAD data
- ◆ Export 2D CAD data
- ◆ Use imported 3D model data
- ◆ Export 3D model data
- ◆ Work with IFC imports and exports

Examining Interoperability on a BIM Curve

In 2007, McGraw Hill Construction published a study titled *Interoperability in the Construction Industry*. They reported that on average, 3.1% of project costs, which potentially equated to \$36 billion in annual losses, were caused by insufficient interoperability between software. Although the study is now a bit dated, it underscores a problem that building information modeling (BIM) still tries to address. Adequate interoperability will help rectify the problem illustrated in Figure 7.1, sometimes known as the BIM curve. In Figure 7.1, the downward spikes in the lower line at the end of each project phase represent a loss of knowledge and acquired data. This loss usually occurs when a project is exported from BIM to a 2D CAD format or is printed to paper. Project data is then gradually reconstructed in another software platform. The upper line represents a more ideal paradigm where data and knowledge are gradually increased throughout the life of the project—a paradigm supported by BIM and full interoperability.

FIGURE 7.1
The BIM curve shows loss of data without interoperability at project milestones.
Source: P. Bernstein, Autodesk AEC Solutions



Although full interoperability between BIM platforms is the ideal scenario, we realize that even today with the maturity and adoption of BIM throughout the industry, you are likely to be working with constituents who are using 2D CAD or non-BIM 3D software.

CERT OBJECTIVE

Inserting CAD Data

Although Revit provides ample means to generate 2D documentation based on a rich multi-dimensional (3D, 4D, 5D, and so on) model, there are a few real-world scenarios in which CAD data must be integrated with the building information model. Such scenarios might include the following:

- ◆ Using CAD details developed within your firm
- ◆ Coordinating with other firms using CAD software
- ◆ Converting projects from CAD to a Revit model
- ◆ Using external modeling tools for conceptual massing
- ◆ Using complex component models from other software

Using Predefined Settings for Inserted CAD Data

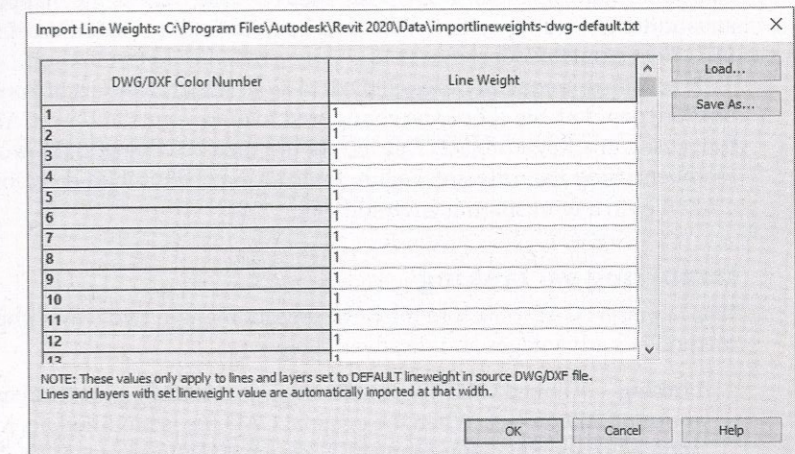
When you are inserting data from a DWG or DXF file, you can establish some predefined settings to control its appearance within the Revit environment. Some settings are controlled at the time you link or insert a CAD file, but other settings can be configured more deliberately in saved configuration files. The two ways you can configure this data are by mapping layer colors to Revit line weights and by converting font types.

MAPPING LAYER COLORS

For inserted CAD files, layers within the file are assigned a Revit line weight based on the weight assigned to each layer by the CAD software application that created the files. If the layer line

weights are set to Default in the CAD file, they will follow a configurable translation template that maps the layer colors to Revit line weights. To access these settings, select the Insert tab and click the dialog launcher at the bottom right of the Import panel. Doing so opens the Import Line Weights dialog box, shown in Figure 7.2.

FIGURE 7.2
Defining settings for imported DWG/DXF line weights



As you can see in the title bar of this dialog box, these settings are stored in a text file (TXT) in the Data folder where Revit is installed. There are several predefined text files based on international CAD standards for layer color:

- ◆ AIA (American Institute of Architects)
- ◆ BS1192 (British Standard)
- ◆ CP83 (Singapore Standard)
- ◆ ISO13567 (International Standards Organization)

Click the Load button to select one of these predefined line weight templates or your own. On the basis of the unique needs of some projects, you might also consider creating customized import setting files and storing them along with the rest of your project data.

DEFINING THE IMPORTED LINE WEIGHTS TEMPLATE IN REVIT.INI FILES

You can define the default Import Line Weight template directly from the Revit.ini file. The file location for the template is stored in the Revit.ini file in the following category:

```
[Directories]
ImportLineWeightsNameDWG=< Full path to TXT file >
```

If you are using any kind of automation scripts to set up standards, your imported Line Weights template file location can be written into the Revit.ini file for all your users. Doing so ensures consistency for all team members inserting CAD data into your Revit project.

MAPPING FONT TYPES

Another important aspect for inserted CAD data is the ability to map shape-based fonts to TrueType fonts. Usually a remnant of older CAD standards based on graphic performance, CAD files may contain fonts such as Simplex, RomanS, or Monotxt that do not have matches in standard Windows fonts. The `shxfontmap.txt` file defines the mapping of TrueType fonts as substitutes for each specified SHX font. You can find this text file at `C:\ProgramData\Autodesk\RVT_2020\UserDataCache`.

If your firm frequently uses CAD data as an integrated part of your final documentation, the `shxfontmap.txt` file should be configured to map your standard CAD fonts to your standard fonts used in a Revit project. This file should then be copied to the workstations of all team members using the software. Failure to do so may result in undesirable outcomes when using CAD files in a worksharing environment.

Importing vs. Linking

You can insert CAD data into the Revit environment in two ways: importing and linking. Each method has advantages and disadvantages.

Linking A linked CAD file in a Revit project is analogous to an external reference (XREF) in an AutoCAD project. When the original CAD file is modified, its reference is automatically updated in the Revit environment. Linking also allows you to easily unload or remove a file when it is no longer needed, which will leave no trace of the file's contents after removal.

Linked data cannot be modified directly in a Revit project unless it is converted to an import in the Manage Links dialog box (Insert > Manage Links) and then exploded. We discuss this process in the "Manipulating Inserted CAD Data" section later in this chapter. As an alternative, it can be modified in its original authoring application and then updated within Revit.

Importing Similar to using the Insert command in Autodesk® AutoCAD®, importing data integrates the CAD data into the Revit project but does not allow the imported data to be updated if the original CAD file is modified. In such a case, the imported data would have to be deleted and reimported. It also does not give you an easy way to purge the layers, linetypes, and hatch patterns of an imported file if the data has been exploded and then deleted.

Linking is the preferred method for external data integration. This is primarily because linked CAD files, like linked Revit files, can be temporarily unlinked and cleared out of active memory. This gives you more flexibility with the file. However, too many linked files will make it slower to open a Revit project. For example, ceiling plan fixture layouts may change with every design iteration (where linking is preferred); however, standard details that all share a minimal amount of standardized layers, linetypes, hatch patterns, text, and dimension styles might be better suited as imports.

COLLECTING CAD LINKS IN A LINKED REVIT FILE

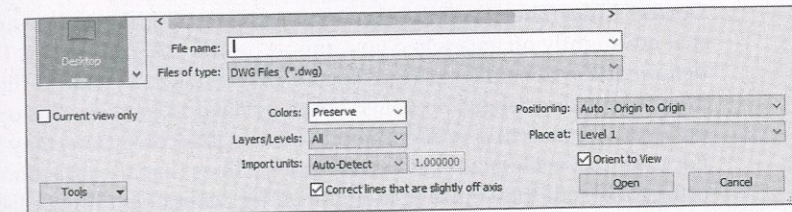
Another option to manage many CAD references in larger projects is to create a separate Revit project that contains only the inserted CAD data. If the CAD data is placed with the Current View Only option, you must use linked views between Revit models. If the linked data does not use this option, it will be visible like any other modeled element in a linked Revit model. Refer to Chapter 6, "Working with Consultants," for more information about linked Revit models.

Using Options During Importing/Linking

After you have configured the necessary settings for inserted CAD data and decided whether to import or link, you need to understand certain options during the import/link process. We'll discuss the preferred settings for each of the options based on real-world situations in the sections "Using Inserted 2D Data" and "Using Inserted 3D Data."

To place your first CAD file into a Revit project, switch to the Insert tab and select either the Link CAD or the Import CAD button. No matter which tool you use, there will be several important options at the bottom of the respective dialog box, as shown in Figure 7.3.

FIGURE 7.3
Options available for
import/link



Let's examine the meaning of the settings in this situation.

Current View Only When this option is selected, the linked or imported file can be seen only in the view in which it was inserted and is thus considered a view-specific element. In a worksharing-enabled project, this data will be assigned to the view's workset. Mostly, you will want to choose this option to limit the number of views in which the referenced data will appear. If you need this data in other views, you can copy and paste it from one view to another.

If the option is not selected, the linked file can be seen in all views, including 3D, elevations, and sections. In a worksharing-enabled project, this data will be assigned to the active workset. A benefit to using links in a worksharing environment is the ability to create a workset specifically for linked data and uncheck its Visible In All Views option. The CAD files placed in this manner will not appear in every view but are available when you need them by adjusting the workset visibility in the Visibility/Graphic Overrides dialog box.

Colors Colors don't matter for CAD files being used as a basis to create a Revit model; however, using Invert or Preserve may help distinguish the CAD data from the modeled elements during the conversion process. If you are going to integrate the inserted data with other elements in your project for final design or construction documentation, you'll want to select the Black And White option, because printing from Revit is mostly WYSIWYG (what you see is what you get). Read the section "Using CAD Data for Coordination" for more detailed recommendations on this process.

Layers/Levels These options allow you to import or link all the layers, only the layers visible when the CAD file was last saved, or a selected group of layers you choose from the linked file in a separate dialog box. (*Layers* is a DWG-based term. Revit supports the same functionality with *Levels* from DGN files.)

Import Units For CAD files generated in an original program (that is, DWG from AutoCAD or DGN from MicroStation), the Auto-Detect option works well. If you are linking CAD data that has been exported from a different program, such as a DWG file exported from Rhino, you should specify the units relative to the respective CAD file.

Positioning To maintain consistency in a multilevel project during a CAD-to-Revit coordination or conversion process, you should use Auto – Origin To Origin or Auto – By Shared Coordinates. Origin To Origin will align the world coordinates origin of the CAD file with the project internal origin. Although Autodesk has stated Auto – By Shared Coordinates is only for use with linked Revit files, it can be used with CAD files if the rotation of True North becomes inconsistent using the Origin To Origin option.

Place At This option is available only if Current View Only is not selected; it specifies the level at which the inserted data will be placed.

Correct Lines That Are Slightly Off Axis Selecting this option automatically corrects lines that are slightly off axis when you import or link CAD geometry. This option is selected by default and will help keep your Revit elements (such as walls or linework) that tie to CAD lines from being askew; however, you may need to consider this option carefully. If the CAD data you are inserting is intentionally off axis, the corrections may lead to inaccurate results. For example, a site plan may have property lines that are a fraction of a degree from being orthogonal, but they must be maintained for accurate building placement in your Revit project.

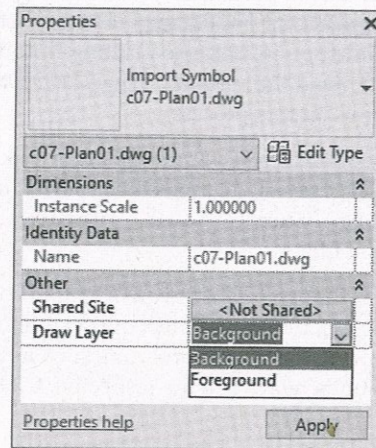
Orient To View This option can be used if True North has been rotated away from Project North. If that is the case and you are linking a CAD file into a view that is set to True North, deselect this option to align the CAD file’s World Coordinate System with True North as defined in your Revit project.

If you do check the Orient To View option, the CAD file will align with Project North regardless of the view orientation.

Manipulating Inserted CAD Data

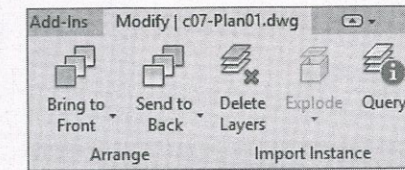
Once you have CAD data imported or linked into a Revit project, you have several ways of manipulating the data to suit your needs.

Foreground/Background This setting applies only to linked or imported CAD files placed with the Current View Only option. With the inserted file selected, a drop-down menu will appear in the Options bar so you can adjust whether the data appears above or below your modeled Revit content. You can also access this setting in the Properties palette when the inserted file is selected.



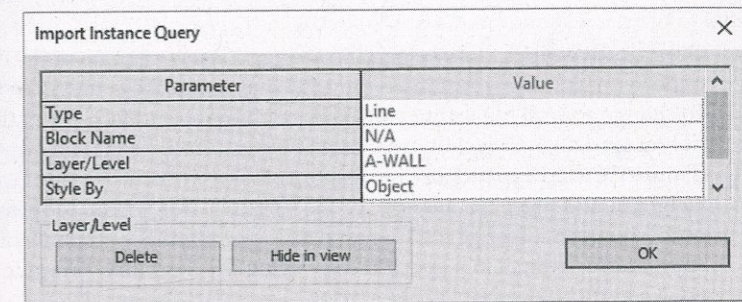
Pay close attention to this option when integrating 2D CAD data with an existing Revit model—sometimes linked or imported CAD data may not appear at all until you set the option to Foreground because of floors or ceilings obscuring the 2D data.

Visibility of Layers/Levels The layers or levels within a linked or imported CAD file can be accessed in two ways, the easiest of which is the Query tool. First, select a linked or imported CAD file; then, from the contextual tab in the ribbon, select the Query tool and pick an object in the CAD file.



You will see the Import Instance Query dialog box (Figure 7.4). Using this tool, you can hide the layer or level by clicking the Hide In View button. The Query tool will remain active even after you click any of the command buttons in the Import Instance Query dialog box, and you must press the Esc key or click the Modify button to end the command.

FIGURE 7.4 Querying objects within a linked CAD file

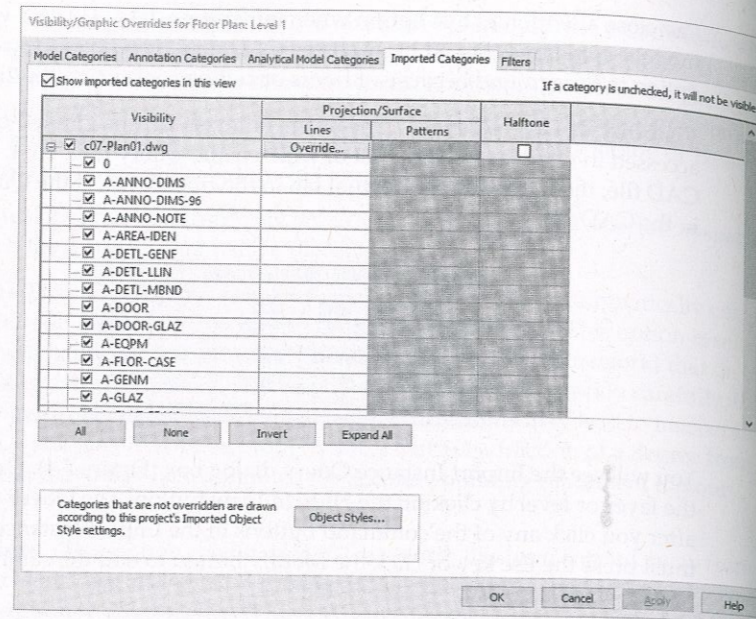


The second way to make layers or levels in imported or linked CAD files invisible is to use the Visibility/Graphic Overrides dialog box by switching to the View tab and selecting Visibility/Graphics from the Graphics panel. Once the dialog box opens, select the Imported Categories tab, as shown in Figure 7.5. Only the inserted CAD files that are visible in the active view will be listed in this tab. Expand any listed file to expose the layers/levels within that file, and use the check boxes to customize visibility of the link within the current view. This method is the only way to restore visibility of layers/levels that were hidden with the Query tool.

CAD DATA IN FAMILIES

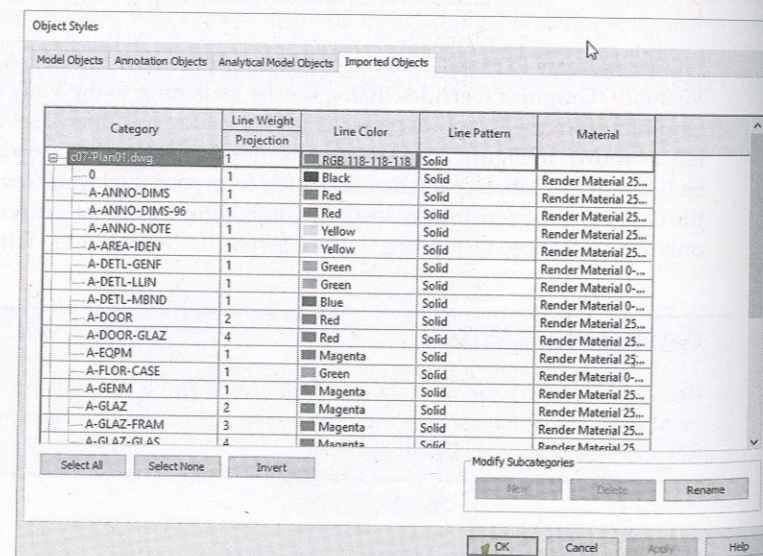
Remember that 2D and 3D data imported into Revit families will be listed under the Imports In Families category in both the Visibility/Graphic Overrides and Object Styles dialog boxes. They will not appear as separately listed files.

FIGURE 7.5
Controlling visibility of layers within imported objects



Graphic Overrides If you need to change the appearance of the content within a linked or imported CAD file, you can accomplish that at the project level or within an individual view. To change a CAD file's appearance throughout the project, select the Manage tab on the ribbon, and click Object Styles in the Settings panel. Select the Imported Objects tab (Figure 7.6) and expand any of the imported or linked CAD files to change the color, line weight, line pattern, or material of the layers/levels within the referenced file. Changing these properties in the row of the filename does not affect the contents of that file. You can also apply these settings in a specific view using the Visibility/Graphic Overrides dialog box.

FIGURE 7.6
Changing the graphic appearance of imported layers via object styles



Exploding Although we do not recommend exploding CAD data within a Revit project, you can do it to facilitate the modification of such data. Linked content must first be converted to an import in order to be exploded. You do this by selecting the Insert tab on the ribbon, choosing Manage Links from the Link panel, choosing a listed link, and clicking the Import button. To explode the imported file, select it, and choose Explode > Full Explode or Partial Explode from the contextual tab in the ribbon. The lines, text, and hatch patterns will become new line styles, text types, and fill regions in your project. Remember that these types of objects cannot be removed from your project via the Purge Unused command; you must remove them manually.

TIPS ON IMPORTING CAD FILES

To minimize the adverse impact of unnecessary styles and types carried into the Revit environment with exploding imported CAD data, we recommend removing extraneous data in the CAD file *before* linking it. We suggest purging the file as well prior to linking. Here are some general tips for this workflow:

- ◆ If your import contains elements such as hatches or annotations not intended for use in the Revit project, delete them before importing.
- ◆ Consider consolidating data within the CAD file to a minimum number of layers or levels. Doing so will ease the process of converting to Revit line styles if the file is exploded. This process will also facilitate graphic overrides.
- ◆ If it is allowable within your workflow for the imported CAD file, import it into a family, and then insert that family into your project. This will not reduce the overall file size, but it will make it a lot easier to find and manipulate should your imported CAD file need additional changes. It will also give you some extra control over the graphic display of the imported file.

Revit doesn't allow line segments shorter than 1/32" (0.8 mm). Although it might seem like you wouldn't have a lot of lines that length, many manufacturers' details contain small fillets in sections and plans and will fall into this range. Take care when exploding these CAD details; the very small line segments that fall within the minimum length will be removed upon exploding. Note that manufacturing CAD files have the level of detail needed to create the part (for example, a window mullion), but are not necessary for architectural detailing. Because of this, in some cases it might be quicker to simply trace over the detail rather than insert and explode it.

Using Inserted 2D Data

In the following sections, we will discuss how to import 2D CAD data from platforms such as AutoCAD (DWG) and MicroStation (DGN) or in the generic Drawing Exchange Format (DXF). You can also use files from other software platforms, but only if they are DWG, DGN, or DXF format. Most commercially available CAD programs are able to export in DWG or DXF format.

2D CAD data can be used in three fundamental ways with respect to a building project's floor plans, ceiling plans, or site plans:

- ◆ Using 2D data as backgrounds for BIM conversion
- ◆ Integrating 2D data with the model
- ◆ Importing CAD details

Setting Options for BIM Conversion

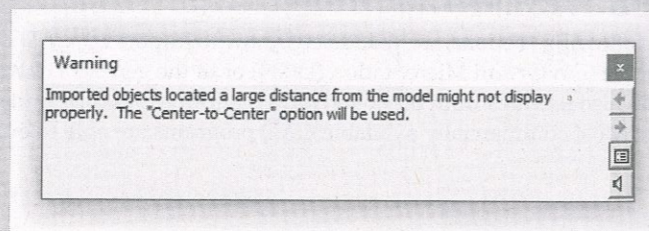
On the basis of a common situation, we will assume that 2D CAD data will be linked into the Revit model to be converted into building elements. Although the positioning of the files is important, the color and line weights of the imported data are not.

To begin the next exercise, you will need the files c07-Plan01.dwg and c07-Conversion-Start.rvt. You can download these files from this book's web page at www.wiley.com/go/masteringrevit2020. After downloading, open the c07-Conversion-Start.rvt file, and activate the Level 1 floor plan. Then follow these steps:

1. Switch to the Insert tab and select Link CAD from the Link panel. Browse to the file c07-Plan01.dwg.
2. In the Link CAD Formats dialog box, set the following options:
 - ◆ Current View Only: Selected
 - ◆ Colors: Invert
 - ◆ Layers/Levels: All
 - ◆ Import Units: Auto-Detect
 - ◆ Positioning: Auto - Origin To Origin
 - ◆ Correct Lines That Are Slightly Off Axis: Selected
3. With those settings in place, choose Open to link in the CAD file.

LINKING LARGE CAD DATA

Use caution when attempting to link or import CAD files with vector data very far from the origin. Revit has distance limitations of 10 miles (16 KM) from the origin point that—if exceeded—may result in a warning, as shown here.



The warning message indicates that the software will automatically use Center To Center positioning if the distance limitations are exceeded. This will preclude you from using the origin of the linked file for Origin To Origin placement. If you must link data that has a physically large spatial requirement—which may occur in projects such as airports or master plans—you should separate the data into smaller portions before linking. If the imported geometry is located beyond a 10-mile radius from Revit's origin point, an alternate origin should be coordinated with your project team, and the data should be moved closer to the origin.

Using CAD Data for Coordination

If you need to use 2D CAD data as an integrated component of your project coordination, the different Link CAD/Import CAD settings become important. The following are a few examples of these project coordination scenarios:

- ◆ Showing light fixture layouts from a lighting designer
- ◆ Integrating landscape design into a site plan
- ◆ Reusing existing CAD data for a renovation project

Most of the settings and procedures for conversion apply to the coordination process; however, the color and the placement visibility will be different. Because this data will be included in the Revit output, you will usually want the color option to be set to Black And White in the options during linking. It is also likely that some sort of background plans will be exported from the Revit model for use in coordination by one or more consultants using a CAD-based program. The data returned in this process may still contain the background information originally exported from Revit; thus, we recommend agreement on a standard that establishes unique layers for the consultants' content. This will help you select layers to be loaded when linking your consultants' files into the Revit project.

Use these options when linking CAD files into a Revit project for plan-based coordination:

- ◆ Current View Only: Selected if data is needed in one view; unselected if data is needed in many views
- ◆ Colors: Black And White
- ◆ Layers: Specify (choose only designated layers to isolate consultants' content)
- ◆ Positioning: Auto - By Shared Coordinates

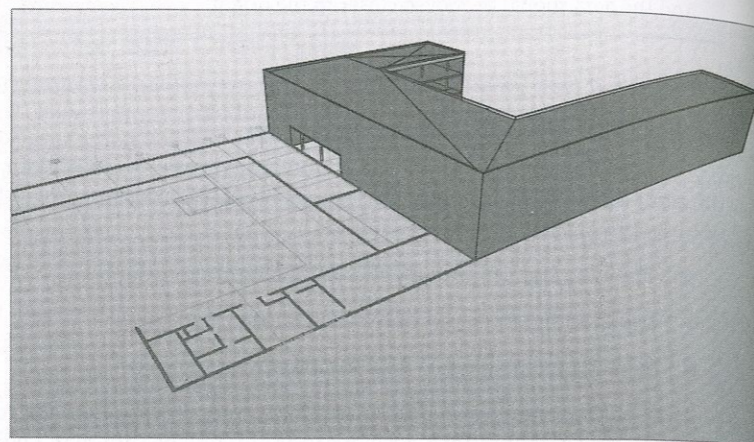
If Current View Only is not selected, the 2D CAD data will be visible in all other views. This could be a nuisance in views such as sections and elevations; however, you might find it useful to visualize the data alongside the Revit model, as shown in Figure 7.7.

Linking Details

Your company's CAD detail library does not need to go to waste when you start working in a Revit environment. CAD data can be linked or imported into drafting views, allowing you to leverage the powerful view coordination tools within Revit. Entire sheets of CAD details can be inserted to reduce the number of linked files you have to reconcile; however, we recommend

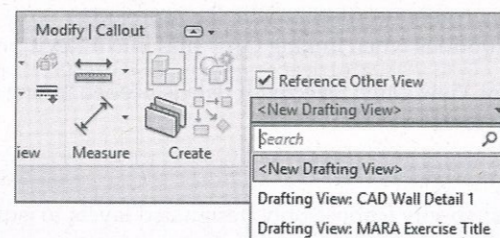
linking one detail into each drafting view and using the software's ability to automatically manage the view references with callouts, sections, and detail views. You may also want to name these drafting views with a unique prefix to help keep track of where any linked CAD data might reside. For example, a drafting view might be named CAD-Roof Detail 04. Also refer to Chapter 4, "Configuring Templates and Standards," for additional information on view organization.

FIGURE 7.7
Existing 2D CAD data
integrated with the
Revit model



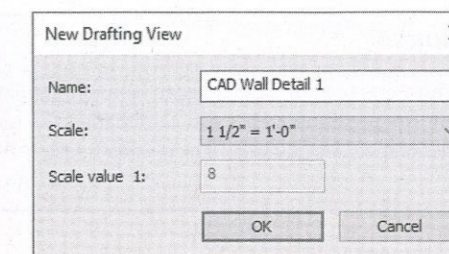
In this exercise, you will create a drafting view into which a single CAD detail will be linked. This view can be referenced throughout your Revit model using a section, callout, or elevation view with the Reference Other View option selected in the contextual tab of the ribbon, as shown in Figure 7.8.

FIGURE 7.8
Creating a view as a
reference to a
drafting view



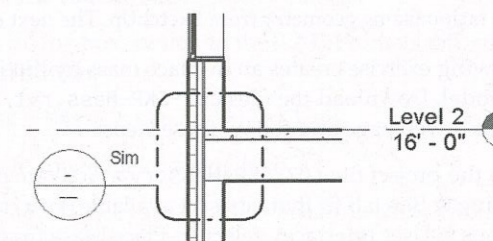
To begin this exercise, open the c07-Sample-Building-Start.rvt file. You can download this file and the associated CAD file (c07-Detail.dwg) from the book's web page.

1. Switch to the View tab and select Drafting View from the Create panel.
2. Name the new drafting view **CAD Wall Detail 1**, and set the scale to $1\ 1/2'' = 1''-0''$. Click OK to close the dialog box. Revit will create and open the view just created.



3. Switch to the Insert tab and select Link CAD.
4. In the Link CAD Formats dialog box, navigate to the c07-Detail.dwg file and set the following options:
 - ◆ Colors: Black And White
 - ◆ Layers/Levels: All
 - ◆ Units: Auto-Detect
 - ◆ Positioning: Auto - Center To Center
 - ◆ Correct Lines That Are Slightly Off Axis: Unchecked
5. Click Open to complete the command. If you don't see the linked detail in the drafting view, use Zoom To Fit (or type ZF on the keyboard) to reset the extents of the view.
6. From the Project Browser, located under the Sections (Wall Section) node, open the view listed as Wall Section, Typ. Zoom to a portion of the view where a floor meets an exterior wall.
7. On the View tab, select Callout from the Create panel, and select Reference Other View in the contextual tab of the ribbon (similar to Figure 7.8). Choose Drafting View: CAD Wall Detail 1 from the drop-down list. In the drawing window, drag the callout rectangle around the area where the floor at Level 2 intersects the exterior wall.
8. After the callout is placed, select the callout you just created and use the grip where the leader line meets the callout head to drag the callout head to the left. The result should look like the image shown in Figure 7.9.

FIGURE 7.9
Callout created to
reference a drafting view
containing a linked
CAD detail



9. Double-click the callout head, and you will be taken to the drafting view with the CAD detail linked in the previous steps.

CUSTOMIZING CALLOUTS

You also have the option to create your callouts with nonrectangular shapes. Additionally, for any view you reference using the previous steps, you can change the target view after you've created the callout or sectional reference. Simply highlight it and choose a new detail to reference from the Options bar.

Using Inserted 3D Data

Now that we have discussed using 2D reference data, we will show you how to use 3D model data from other design software within your Revit project. There are many valid reasons for modeling outside of the Revit environment, including software expertise, the availability of content, and optimization of complex geometry. The following sections will explore some situations in which model data can be shared between programs:

- ◆ Inserted data as a mass
- ◆ Inserted data as a face
- ◆ Inserted data as an object

Using CAD Data as a Mass

In Chapter 10, "Conceptual Design," you will learn more about harnessing the impressive modeling toolset in Revit and Autodesk® FormIt® for conceptual design; however, the fast and flexible process of design may lead architects to a tool in which they have more expertise or comfort. This type of massing design workflow is supported in the Revit environment under the following conditions:

- ◆ Inserted model data requires solid geometry to calculate volume, surface area, and floor area faces.
- ◆ Finely detailed complex geometry should be avoided because the Host By Face tools may not be able to generate meaningful objects.

NOTE As of the writing of this book, linking/importing SKP files in Revit 2020 is inconsistent. There are issues rationalizing geometry from SketchUp. The next exercise works as intended in Revit 2019.

The following exercise creates an in-place mass by linking an external model—in this case, a SketchUp model. Download the files `c07-SKP-Mass.rvt`, `c07-Mass.skp`, and `c07-Mass-2.skp` from the book's web page and follow these steps:

1. Open the project file `c07-SKP-Mass.rvt`. Activate the Level 1 floor plan, and from the Massing & Site tab (if that tab isn't available, you can turn it on under the File Tab menu > Options > User Interface), select In-Place Mass from the Conceptual Mass panel. A message window will appear, notifying you that Revit has enabled the Show Mass mode. You can close this window.

2. Name the new mass family **SKP Mass** and click OK.
3. Switch to the Insert tab and select Link CAD from the Link panel; be sure to switch your Files Of Type filter to *.skp files.
4. Navigate to the `c07-Mass.skp` file downloaded from the book's web page and set the following options:
 - ◆ Current View Only: Unchecked
 - ◆ Colors: Preserve
 - ◆ Layers/Levels: All
 - ◆ Import Units: Auto-Detect
 - ◆ Positioning: Auto – Center To Center
 - ◆ Place At: Level 1
5. Click Open to complete the link process.
6. Click Finish Mass in the In-Place Editor panel of the ribbon.
7. Activate the Mass Schedule view from the Project Browser and observe the values for Gross Surface Area and Gross Volume.

Now that a new mass has been created, you can assign mass floors and begin to see calculated results in schedules of masses and mass floors. Calculation of volumes, perimeters, and mass floor areas will work well in this workflow, but be careful when using imported model geometry with the By Face tools because face updates will likely be more difficult for the software to maintain than native Revit massing.

Using linking instead of importing enables continued iteration of the form in the original software. In the case of this example, you can edit the original file in SketchUp, available as a free download with a 30-day trial, or you can try using the free web application—you can find both at www.sketchup.com. If you want to skip editing the SketchUp file, download the file `c07-Mass-2.skp` from this book's web page.

If you modify and save the original SKP file yourself, save, close, and reopen the Revit project. As an alternative, open the Manage Links dialog box, select the SKP file, and click Reload. If you want to use the alternative file downloaded from the book's web page, use the following steps:

1. From the Insert tab of the ribbon, click Manage Links.
2. In the Manage Links dialog box, switch to the CAD Formats tab, select the SKP file, and click the Reload From button.
3. Navigate to the file `c07-Mass-2.skp` and click Open.
4. Click OK to close the Manage Links dialog box.

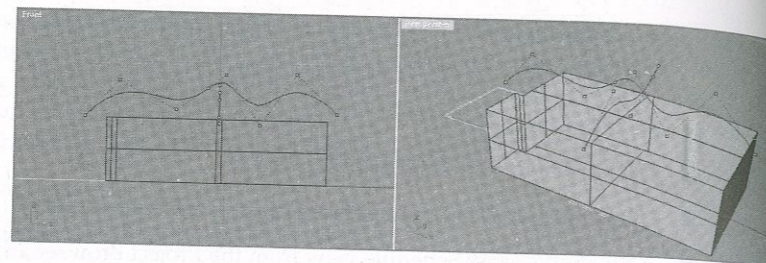
With the modified mass loaded, activate the Mass Schedule view and notice the changes of Gross Volume and Gross Surface Area.

Using CAD Data as a Face

Similar to the data-as-mass workflow, externally modeled data can be used as a planar host for more complex forms. An example might be the need to generate a complex curved roof surface. We will demonstrate this workflow using Rhinoceros (commonly referred to as Rhino) by McNeel (www.rhino3d.com) to generate a shape, link the shape into the project as a .sat file, and create a roof by face on the shape. (If you have Rhino, feel free to follow the examples shown; however, for the later Revit exercise, we have provided all necessary files.)

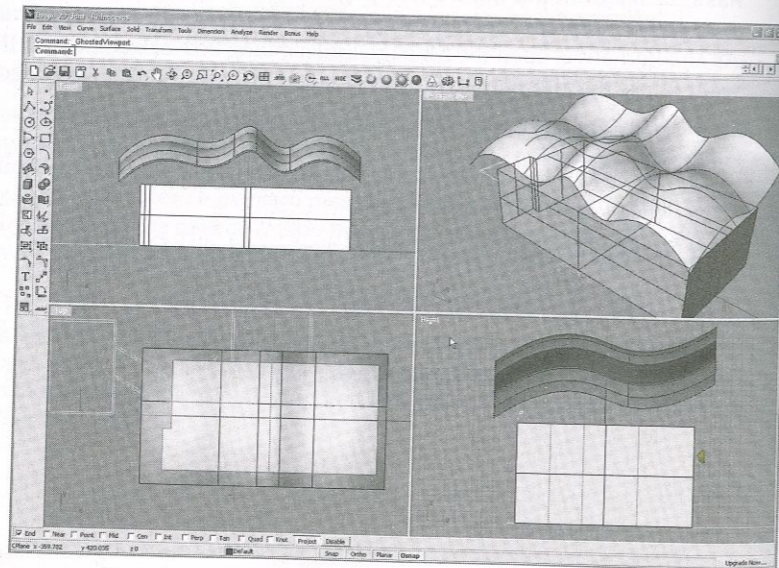
As shown in Figure 7.10, a complex surface is generated in Rhino by drawing two curves and using the Extrude Curve Along Curve tool. Note that some reference geometry was exported from a Revit model to DWG and linked into this study in Rhino.

FIGURE 7.10
Curves for a complex surface in Rhino



A flat surface model is enough to generate a roof by face; however, it may be difficult to see the imported surface, so use the Extrude Surface tool to give it a thickness. Once the surface is complete (Figure 7.11), select only the double-curved geometry, choose File > Export Selected Objects, and choose the .sat filename extension. SAT will generate the cleanest geometry for curved solids and surfaces. Note that Revit does have the ability to directly import (not link) Rhino forms without first having to perform an export; however, directly importing native Rhino files can be unreliable when preserving the form of the geometry. Because of the geometry inconsistency, we are going to be using a SAT file for the exercise. This will make the exercise more generic and still illustrate a workflow that is accessible to other design platforms beyond Rhino.

FIGURE 7.11
Completed complex surface in Rhino

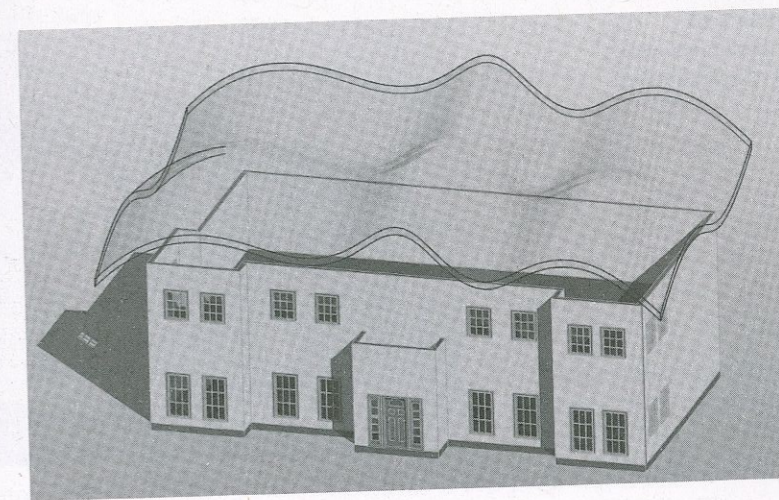


For this exercise, download the SAT export (c07-Roof-Face.sat) from this book's web page. If you have Rhino, we've also made available c07-Roof-Face.3dm, but is not necessary to complete this exercise. You can also download the sample Revit project and continue the process as follows:

1. Open the file c07-Roof-by-Face.rvt and open the 3D view named 00-Start.
2. On the Massing & Site tab, choose In-Place Mass and name it **Rhino Roof**. You will see an alert that the Show Mass mode has been enabled. You may choose to not show this message again, but you can always use the Show Mass combination button in the Massing & Site tab of the ribbon to toggle between different visibility modes.
3. Switch to the Insert tab and select Link CAD. In the Files Of Type drop-down, select *.sat and navigate to the c07-Roof-Face.sat file downloaded from the book's web page.
4. Set the placement options as follows:
 - ◆ Positioning: Auto - Origin To Origin
 - ◆ Place At: Level 1
 - ◆ Import Units: Inch
5. Click Open to complete the link and close the dialog box; then click the Finish Mass button in the ribbon.

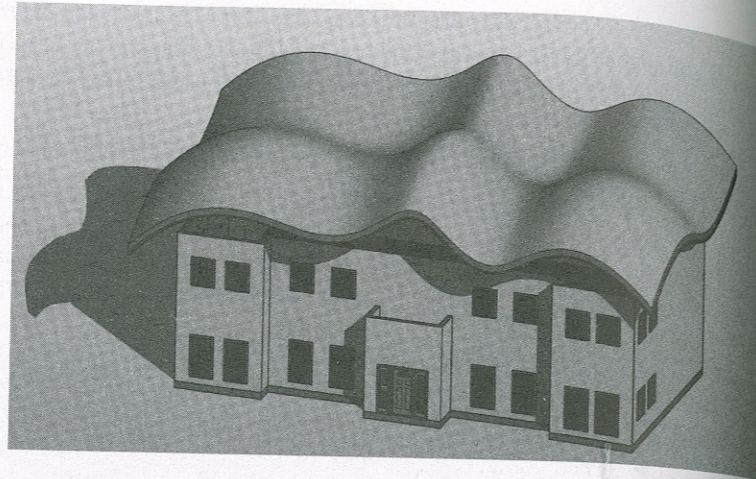
You should be able to see the mass above the tops of the walls in the Revit model, as shown in Figure 7.12.

FIGURE 7.12
Complex surface linked as an in-place mass



6. Return to the Massing & Site tab and select the Roof tool from the Model By Face panel. Choose Basic Roof: Generic - 12" from the Type Selector, and click the top face of the mass created in the previous steps. Click the Create Roof button in the ribbon to complete the command, and the roof will be generated along the mass surface, as shown in Figure 7.13.

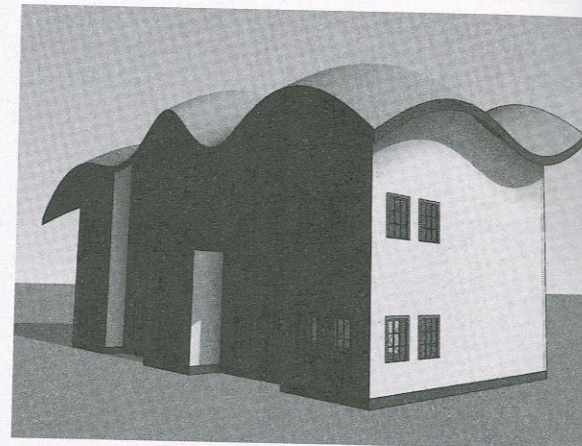
FIGURE 7.13
Roof By Face applied to
the mass with linked
SAT geometry



7. Select all the perimeter walls, using the Tab key or Ctrl to add them individually to the selection.
8. Select the Attach Top/Base tool from the Modify | Walls tab, set the Top option in the Options bar, and pick the Roof By Face created in step 6.

The walls will connect to the underside of the complex roof shape. Activate the 3D view named Camera-Front and you will see the result of the exercise, as shown in Figure 7.14.

FIGURE 7.14
Completed roof with
tops of walls attached



The roof shape can be edited in the original modeling software and will update via the link if the original exported SAT file is overwritten. To update the roof based on the newly modified massing geometry, select the roof and click the Update To Face button in the contextual tab of the ribbon.

Using CAD Data as an Object

Yet another derivation of the reference data workflow supports the use of CAD model geometry for specific instances of building components. Examples of this scenario might include a complex canopy structure being designed in SolidWorks or a building's structural framing being modeled in Tekla Structures. The workflow is again similar to that of using CAD data as a mass or face; however, the file format will help you control the component's visualization. In the previous exercise, we used a SAT format to transfer complex curved geometry from Rhino to Revit; however, a limitation of a SAT file is that the geometry contains only one layer, making it impossible to vary material assignments for different components of the design. We recommend using a solids-based DWG, DGN, or DXF file format, which will maintain a layer structure in most cases.

In the following exercise, you will create an in-place structural framing component that will act as a placeholder for a consultant's structural model, which is in DWG format. You will be using the file c07-3D-Structure.dwg, which you can download from this book's web page.

1. Download and open the file c07-Framing-Start.rvt from the book's web page. Activate the Level 1 floor plan.
2. Switch to the Architecture tab and choose Component > Model In-Place. Set Family Category to Structural Framing and click OK.
3. Name the new in-place model **DWG Structure**.
4. From the Insert tab, select Link CAD.
5. Change the Files Of Type option to DWG Files (*.dwg) and navigate to the file c07-3D-Structure.dwg.
6. Set the following options and then click Open:
 - ◆ Current View Only: Unselected
 - ◆ Colors: Black And White
 - ◆ Layers/Levels: All
 - ◆ Import Units: Auto-Detect
 - ◆ Positioning: Auto - Origin To Origin
 - ◆ Place At: Level 1

The DWG file provided is actually a sample Revit file that was exported to DWG format (Figure 7.15). Models may be provided in this format from any number of other design applications such as Autodesk® AutoCAD® MEP or Tekla Structures.

7. Click Finish Model in the In-Place Editor panel to complete the process.

Activate the default 3D view, and you should see the entire contents of the linked CAD model (Figure 7.16). Because the linked content was created as a structural framing model, the linked data will be displayed similarly to any other structural framing element. Examine the linked model in different plans and sections to observe this behavior.

FIGURE 7.15
The structural model
displayed in AutoCAD

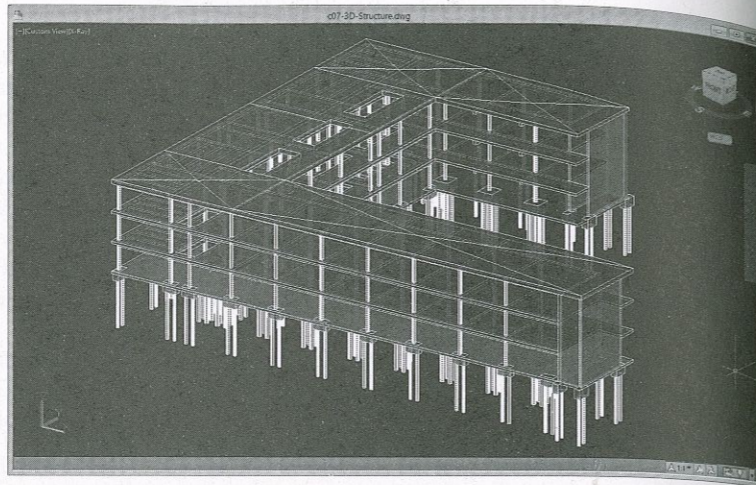
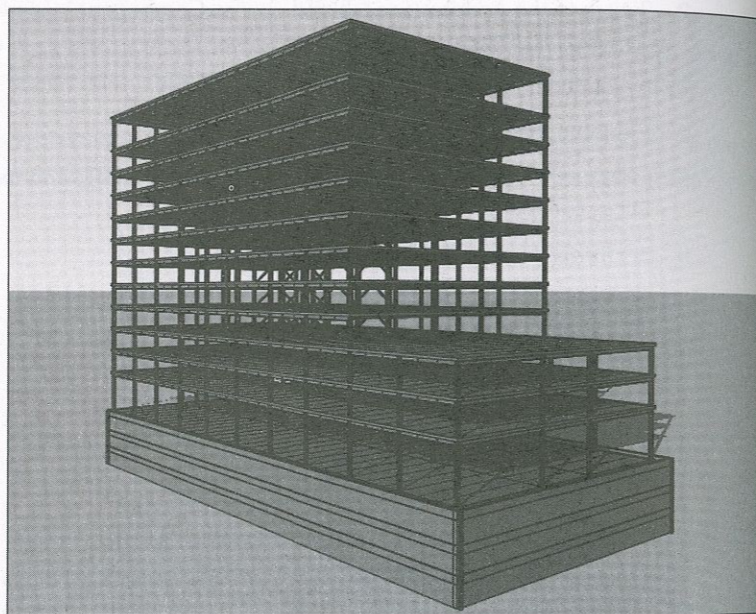


FIGURE 7.16
CAD-based structural
model linked into a
Revit project



If you're not seeing the model as part of your 3D view, you forgot to uncheck the box for Current View Only in step 6. If that is the case, you'll need to either undo your way back or unlink and relink the CAD file.

Using linked models in DWG, DGN, or DXF format also allows you to modify the graphic representation of the elements within the Revit environment. To adjust these settings, follow these steps:

1. Select the Manage tab, click Object Styles, and switch to the Imported Objects tab.
2. Find your linked file, expand it to expose the layers or levels included in it, and modify the graphic settings as desired.

When you are using linked model data for custom components, the consistency of the data you bring into Revit from other programs depends on the ability of that software to generate organized information. Some programs use layers, and some don't. Recognizing this difference will give you the best opportunity for success in coordination through interoperability.

Working with Other Data Types

Revit has the ability to utilize file types from Autodesk® Navisworks® (.nwc and .nwd) and FormIt. Navisworks files are key for model coordination for disciplines that are not native Revit content. While Navisworks focuses on the resolved building design (it is typically incorporated near the end of the construction document phase), FormIt can integrate at the beginning of the project process. FormIt (formit360.autodesk.com) is an early design tool, similar to SketchUp. We will review workflows with both tools.

Working with Navisworks Files

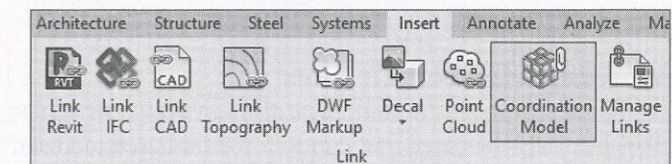
You can now bring Navisworks files directly into Revit for coordination and visualization. Navisworks is typically a tool employed by contractors and used to combine a variety of model types for construction coordination. You can find out more about Navisworks from Autodesk's website:

www.autodesk.com/products/navisworks/overview

In the following exercise, you will insert a Navisworks model into your Revit file. For the sake of this exercise, we have converted the c07-3D-Structure.dwg file to an NWD file. We will insert this file into the c07-Framing-Start.rvt file for structural and architectural coordination.

1. Open the c07-Framing-Start.rvt file you downloaded earlier and open the Coordination view from the Project Browser.
2. On the Link panel of the Insert tab, you'll see a button called Coordination Model (Figure 7.17). Choose this tool to insert a Navisworks model.

FIGURE 7.17
The Coordination Model
tool on the Insert tab



3. Selecting the Coordination Model tool will show you the Coordination Model dialog box (Figure 7.18). This dialog box operates similarly to the Linked Files dialog box. For Positioning, use the drop-down menu and select Origin To Origin; then click the Add button at the bottom left and navigate to the c07-3D-Structure.nwd file you downloaded. Select the file and choose Open. With the file inserted, it should look like Figure 7.18.

Once the model is inserted, you can interact with it in many of the same ways you can with a Revit model. You are able to view different floor plans, cut sections, use crop regions, assign a phase, and so on, in order to use the Navisworks model for coordination or documentation. Once the model is imported into Revit, it will maintain any of the element colors you assigned it in Navisworks. Figure 7.19 shows the model inserted into Revit.

FIGURE 7.18
The Coordination
Models Management
dialog box

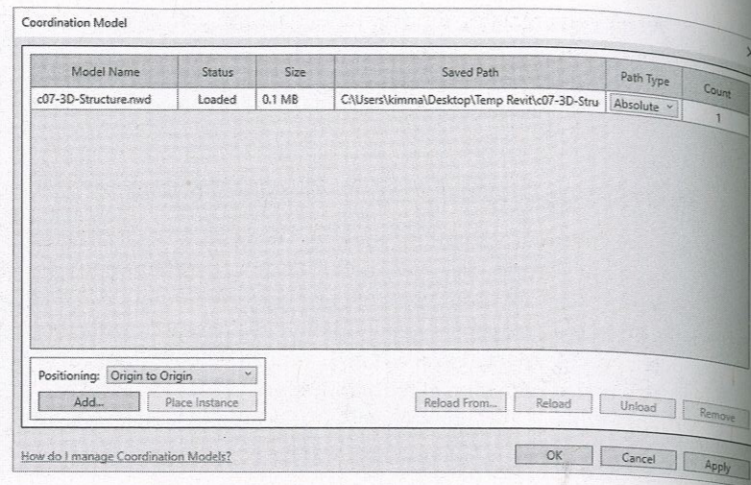
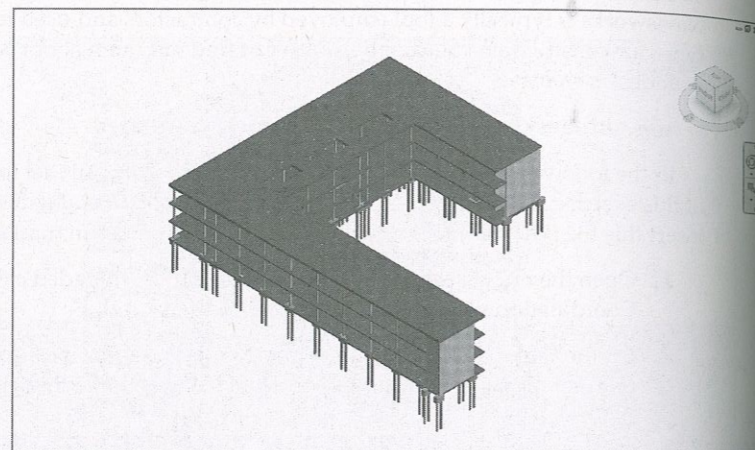


FIGURE 7.19
The Navisworks model
linked into a
Revit project



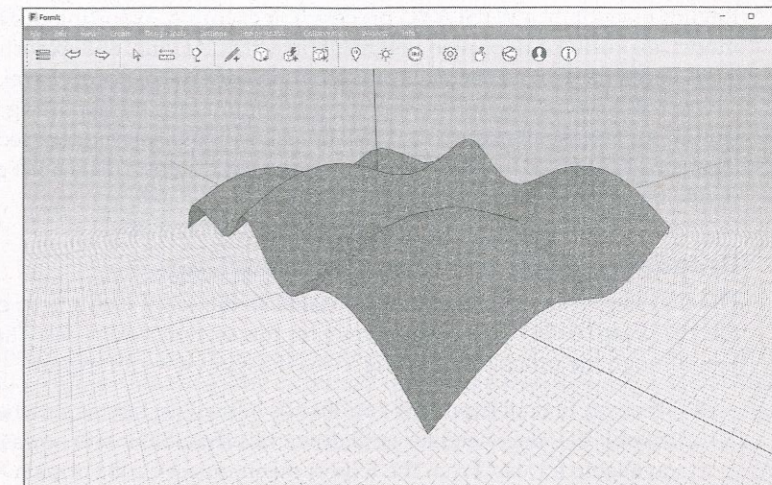
Working with FormIt Files

Autodesk FormIt is a conceptual design tool similar to SketchUp, with the difference being that SketchUp is plane-based and FormIt is a solid-based modeler. This means you can also take FormIt models directly to a 3D printer.

FormIt was originally designed as a web-based tool and saves your content by default to an A360 site (autodesk360.com). With a paid Pro subscription, Autodesk provides a desktop version of the application, which allows you to work with bigger models. The Pro subscription also provides additional functionality to include connectivity with Dynamo, energy analysis with Autodesk Insight, solar analysis, connectivity to a cloud version of the Autodesk Material Library, and real-time collaboration. While FormIt Pro has these features, we are going to focus on FormIt's interoperability with Revit. We leave it to you to investigate FormIt's other features.

Figure 7.20 shows the typical FormIt interface. For this example, we have re-created the c07-Roof-Face file in FormIt and assigned a material to it. Via FormIt's export command, we have exported the file as c07-Roof-Face.axm, which is FormIt's native file format. You can download this file from the book's website.

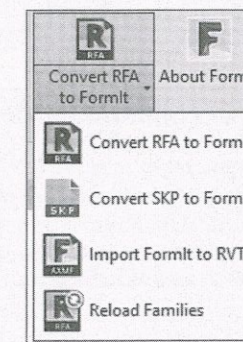
FIGURE 7.20
The FormIt interface



FormIt has the unique ability to interact with Revit as a family file. Essentially, an AXM file is converted to an RFA file when it is imported into Revit. Alternatively, you can export content from Revit to an AXM format to continue working directly with it in FormIt. While there is no "live linking" available right now between the two tools, it is easy to use the import/export mechanism.

You can import FormIt models to Revit or export to FormIt from the same menu in Revit. On the Add In tab from the FormIt Converter panel, choose the Import FormIt To RVT drop-down (Figure 7.21). From here, you can browse to a local or A360 FormIt file to import into your Revit model or export to the same locations from Revit. To view the roof face geometry that was imported, switch to a 3D view. Depending on the Revit template from which you started the file, you may need to go to Visibility/Graphics Overrides and check the Mass category.

FIGURE 7.21
The FormIt drop-down
menu in Revit



Exporting CAD Data

Just as significant as importing data, the ability to export Revit data for use by others is equally important. We will now examine various processes for exporting data from your Revit project to other formats. To achieve your desired results when exporting, remember that exporting from

Revit is essentially a WYSIWYG process. For example, exporting a 3D view will result in a 3D model, exporting a floor plan will result in a 2D CAD file, and exporting a schedule will result in a delimited file that can be used in a program such as Microsoft Excel.

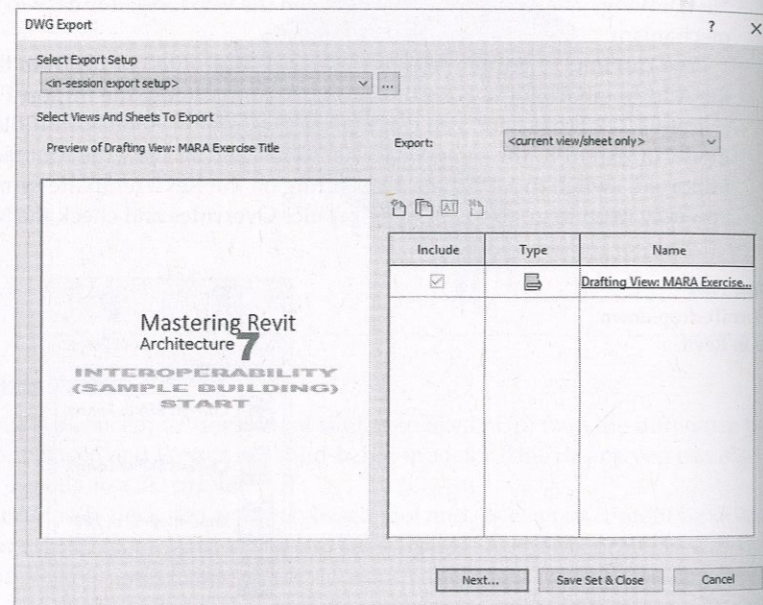
We will first review the settings to be configured for the exporting process. These methods are similar for almost all exports and will be referred to in subsequent sections. The process for exporting CAD files from Revit includes two basic steps: create a list of views to be exported, and define the settings in an export configuration.

Preparing a List of Views for Exporting

The first step to any CAD export is to establish the set of views to be exported. You can use the file c07-Sample-Building-Start.rvt for this section's exercises. The following steps will walk you through the process of creating a saved list of views for export:

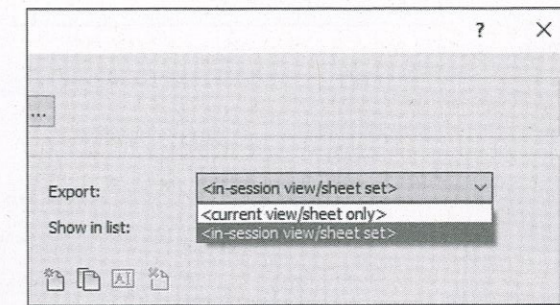
1. You can find all exporting commands in the File Tab menu when you click the Export flyout. You may need to scroll down this flyout menu to access all the export commands available for use. From the Export menu, select CAD Formats > DWG.
2. You will first see the DWG Export dialog box, as shown in Figure 7.22. The Export drop-down list is set to <Current View/Sheet Only> by default. This is where you would select predefined lists of views to be exported from your project.

FIGURE 7.22
First view of DWG
Export dialog box



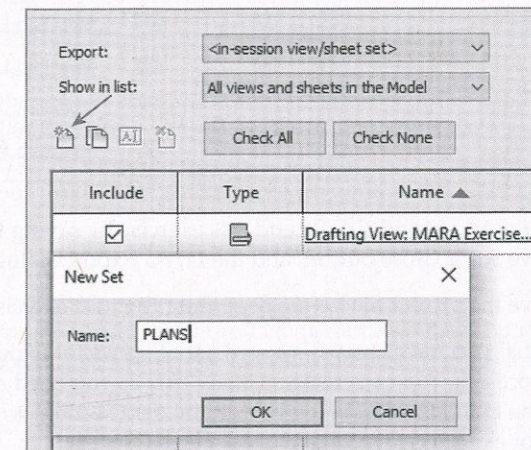
3. Begin to create your own list of views and/or sheets to export by choosing <In-Session View/Sheet Set> from the Export drop-down list, shown in Figure 7.23.

FIGURE 7.23
Viewing available export
sets in the model



4. From this point, you can either use a temporary in-session set or create your own named set. We will continue these steps by creating a new named set so you can export the same sheets later without the additional setup. Click the New Set icon above the view list, shown in Figure 7.24, and name the set **PLANS**. Click OK to close the dialog box.

FIGURE 7.24
Creating a new
export list



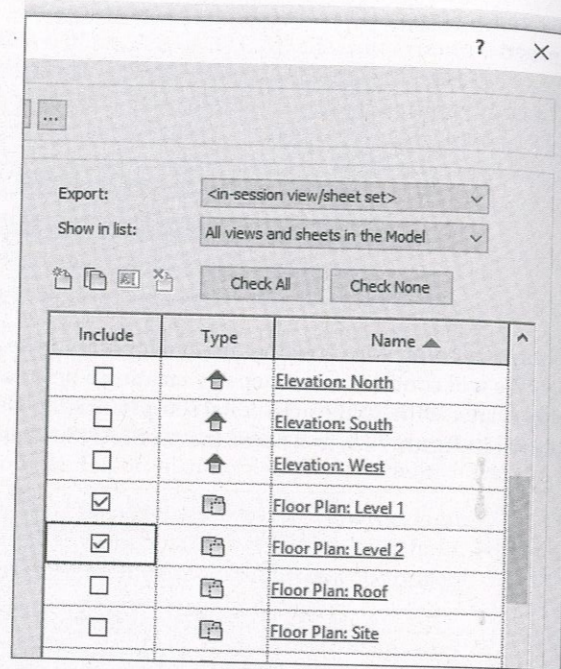
USING IN-SESSION LISTS WITH WORKSHARING

Be careful when using an in-session list for printing or exporting on a worksharing-enabled project. If two or more team members working on the same Revit project attempt to use the in-session set, you may receive errors about the workset not being editable. Instead, always try to use predefined lists for exporting and printing on worksharing projects.

5. To begin adding views and/or sheets to your new export set, from the Show In List drop-down menu, choose All Views And Sheets In The Model.
6. Click the Check None button to clear any extraneously selected views and then find the floor plans with the A- prefix. Select these views by checking the boxes next to the views in the Include column.

Remember, you can sort the list by clicking any of the list headers (Figure 7.25).

FIGURE 7.25
Adding views/sheets to
the export list



- For now, we will simply end this exercise by saving the list of views for later. Click the Save Set & Close button, and the DWG Export dialog box will close.
- Save the project file before beginning the next exercise.

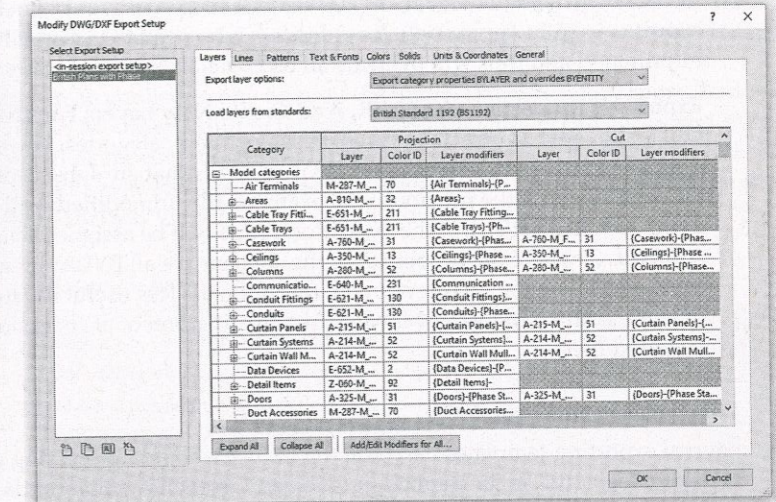
Now that you have created a saved list of views for export, they will be available for any CAD export processes. You can create as many lists as you need as well as duplicate, delete, or rename them in the DWG Export dialog box. In the next section, we will show you how to adjust the settings for exported DWG files.

Settings for DWG Exports

In addition to saving lists of views for exporting, you have the ability to save predefined exporting configurations. To complete an export, you will select a list of files and an export setup before defining an export location and launching the process. Let's examine the various settings that can be customized for DWG export.

Continuing with the c07-Sample-Building.rvt file, go to the File Tab menu, and then choose Export > CAD Formats > DWG. You will return to the DWG Export dialog box. In the previous exercise, you created a named list of views to export. Before we begin an exercise to create a customized configuration for export settings, we will briefly explore the various settings that can be saved and applied to any list of views to complete the export process. Click the ellipsis button (three dots) at the top of the dialog box. A tooltip will appear showing the associated command as Modify Export Setup. The Modify DWG/DXF Export Setup dialog box will appear (Figure 7.26). Alternatively you can go directly to this dialog by clicking the File Tab menu and selecting Export > Options > Export Setups DWG/DXF.

FIGURE 7.26
Modify DWG/DXF
Export Setup dialog box



As you can see, a number of opportunities for customization are offered in this dialog box. First, you'll notice at the left side of the dialog box a list of export setups and icons similar to those found in the main DWG Export dialog box. Use these icons to create, duplicate, rename, or delete export setups in your project. Let's take a look at some of the other export settings in greater detail.

LAYERS

The Layers tab was shown previously in Figure 7.26. It contains many options to completely customize the export of object styles to layers. Let's examine each of these settings more closely.

Export Layer Options

At the top of the Layers tab is a drop-down that allows you to specify the overall behavior of exported elements. This setting accounts for any graphic overrides that might be applied in a Revit view. For example, the Linework tool might have been used to modify the edge of a wall to a dashed line. These options determine how that override will be exported to a CAD format:

Export Category Properties BYLAYER And Overrides BYENTITY This option will export unmodified elements to their respective layer assignments, and their properties will remain assigned to the layer. If an object or part of an object has been overridden, the overridden element will still be assigned to the respective layer, but the graphic override will be applied directly to the entity. In the wall example noted previously, the wall edge would still be assigned to the A-WALL layer but would have a DASHED linetype instead of a BYLAYER assignment.

Export All Properties BYLAYER, But Do Not Export Overrides If the recipients of your CAD file will use scripts or macros to enforce their own graphic standards to the exported data, select this option. Using the wall example again, the wall elements would be assigned to

the A-WALL layer; however, the dashed line overrides would not be exported. This style of export is usually appropriate for engineers who need to use architectural plans as background information and thus will override all elements to halftone.

Export All Properties BYLAYER, And Create New Layers For Overrides This final option will assign default objects to layers based on their categories; however, any elements with graphic overrides will be assigned to new layers that are subsets of the original layer. When we continue with the previous wall example, the unmodified wall elements will be assigned to the A-WALL layer, but the overridden edge will be assigned to a new layer such as A-WALL-3, where the properties of the element are all BYLAYER and the new layer contains the dashed linetype. In our opinion, this option is less useful because there is no control over the naming of the new layers, thus creating potential confusion for the recipients of the exported files.

Load Layers From Standards

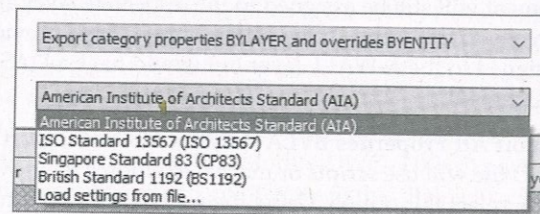
Several exporting templates based on the industry-standard layering guidelines are included with the Revit and can be applied in the Load Layers From Standards drop-down (Figure 7.27). These layer settings can be used as a baseline; you may still need to make modifications to the settings to accommodate your project standards. Once you have configured the export settings, click Save Set & Close in the main DWG Export window. The layer settings for DWG exports will now be part of the Revit project file.

If you wish to re-use the DWG export settings that were defined for other Revit projects, use the Transfer Project Standards function to copy the settings over (see Chapter 4, "Configuring Templates and Standards"). In the Select Items To Copy Window, be sure to check DWG/DXF Export Setup Settings.

We realize that transferring settings from one project to another can be complicated, and because of this we recommend the following:

- ◆ Create a standalone project file that contains the configuration for all your layer settings. This file can be used as an export layer template to copy layer settings to other Revit projects through the Transfer Project Standards function.
- ◆ When transferring export settings, in the Select Items To Copy window, uncheck all items except DWG/DXF Export Setup Settings. This will ensure only the settings that are needed are copied.
- ◆ For any future changes to export layer settings, determine if the change needs to be reflected in the standalone file. If yes, use the Transfer Project Standards to update the Revit project file that contains your export layer template.

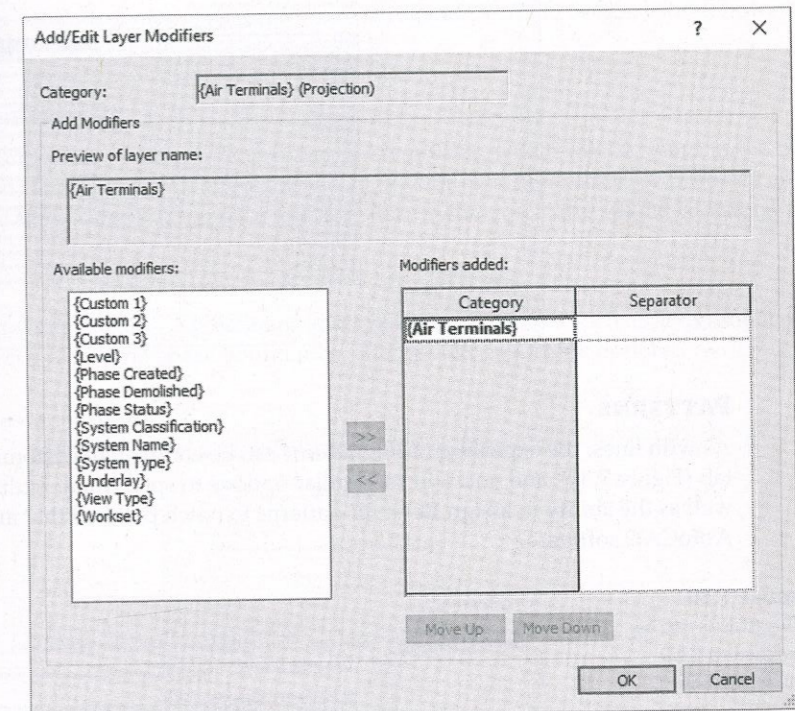
FIGURE 7.27
Industry-standard layering conventions can be applied to export settings



Layer names and colors can also be customized by directly editing the values in the Layers tab in the Modify DWG/DXF Export Setup dialog box. Each category and subcategory is capable of independent color and layer names.

Layer modifiers can be applied to any or all of the model categories for export. To do this, either click in the Layer Modifiers column for any of the listed model categories and then click the Add/Edit button that appears, or click the Add/Edit Modifiers For All button. Either method will open the Add/Edit Layer Modifiers dialog box (Figure 7.28). Here you can assign modifiers such as Phase Status, Workset, View Type, or user-customized fields.

FIGURE 7.28
Modifiers such as Phase Status may be applied to individual or all categories.



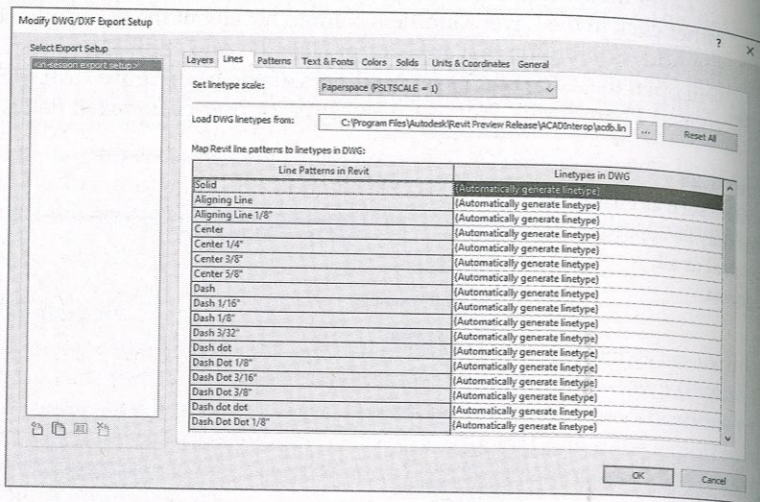
LINES

Switch to the Lines tab in the Modify DWG/DXF Export Setup dialog box, and you will find additional settings for assigning Revit line patterns to CAD-based linetypes (Figure 7.29). The first setting at the top of the tab is to assign the linetype scale in the exported CAD files. This option can be configured to Modelspace, Paperspace, or Scaled Linetype Definitions. This setting can be changed by the recipient of the exported files, so it is common to use the Modelspace setting for any model view exports, such as plans or elevations, and the Paperspace setting for sheet views.

In the main list within the Lines tab, any line patterns defined in your Revit project can be assigned to a specific CAD-based linetype. The default linetype definitions file is included with Revit, but it can be changed with the command buttons above the line patterns list. The default

setting for exporting line patterns is Automatically Generate Linetype, which will replicate the graphic pattern but will not integrate well with any other CAD software if the exported files require additional modification by the recipient.

FIGURE 7.29
Line styles can be assigned to specific CAD linetypes.



PATTERNS

As with lines, the exporting of fill patterns can be completely customized. Switch to the Patterns tab (Figure 7.30), and you will see similar options to specify a default CAD-based pattern file as well as the ability to assign Revit fill patterns to hatch patterns that are native to AutoCAD software.

FIGURE 7.30
Fill patterns can be assigned to CAD hatch patterns.

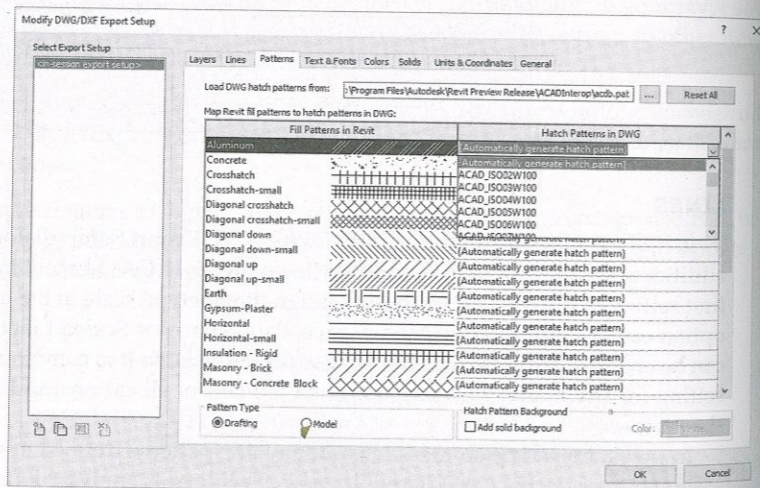


Figure 7.30 shows a few of the Revit fill patterns to be mapped to a respective pattern from the AutoCAD pattern definition.

Similar customizations can also be made for fonts in the Text & Fonts tab, and in the Colors tab you can choose to either use specific layer-based color IDs or use the true color RGB values assigned in your Revit project. Let's take a quick look at the remaining tabs and their importance.

SOLIDS

In the Solids tab, you have the option to select either Polymesh or ACIS Solids for exporting 3D views. For cleaner solid geometry exporting, we recommend the ACIS Solids option; however, this will likely result in a larger file size upon export.

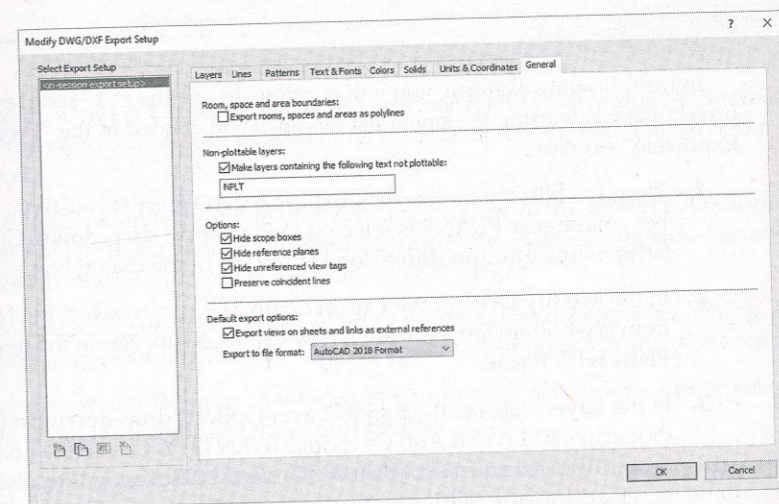
UNITS & COORDINATES

One of the most important settings is Coordinate System Basis, which can be found in the Units & Coordinates tab. This option will affect the ability of your exported files to be properly aligned with other project files. Refer to Chapter 6 for more information on using shared coordinates.

GENERAL

Finally, the General tab (Figure 7.31) contains some additional options such as assignment of non-plotable layers, exporting space boundaries, and default export file options.

FIGURE 7.31
General options allow further customization of CAD exports.



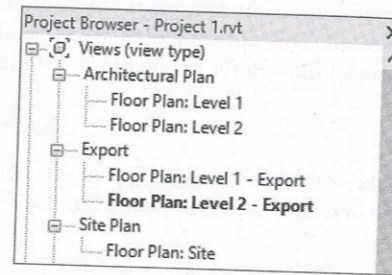
At this time, you can click the Cancel button to close both active dialog boxes. In the next section, you will return to these settings and save a configuration to be applied to the export process.

Exporting 2D CAD Data

When you are collaborating with others who require 2D CAD, developing a planned strategy will allow you to share your Revit data more efficiently and consistently. We highly recommend that you determine and document the scope of data to be shared, the schedule by which the files will be shared (when and how often), and the software platforms to be used on a project. These aspects should be compiled in a BIM execution plan, as explained in Chapter 6.

To facilitate the setup and ultimate export of plan data, you can create copies of floor plans and ceiling plans with a standardized naming convention in your Revit project. These should be easy to recognize, and they help in building the export list. Figure 7.32 shows a series of duplicated plans that have been created and assigned to the floor plan type named Export. The view name conforms to the naming convention specified by the United States National CAD Standard (www.nationalcadstandard.org).

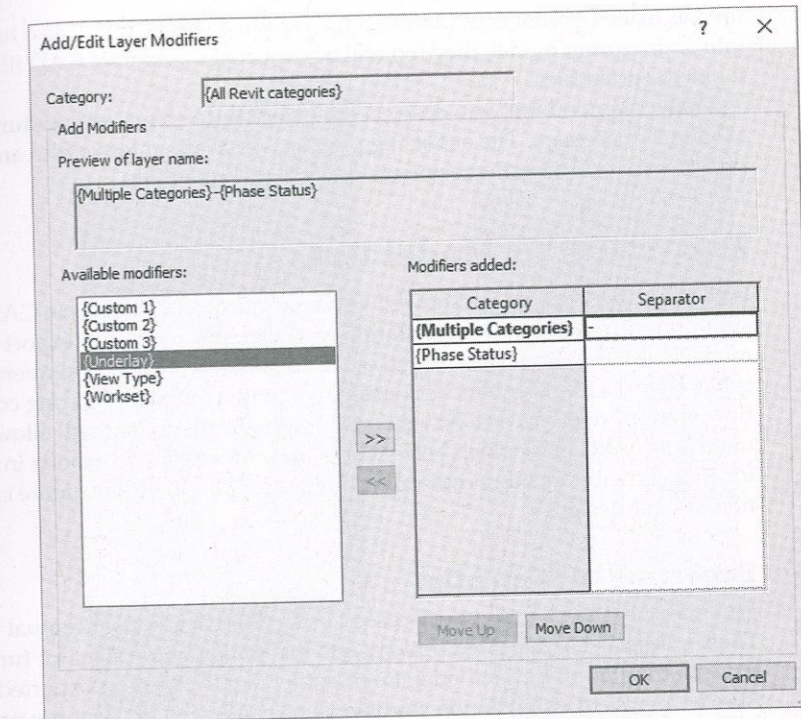
FIGURE 7.32
View organization for plans to be exported



In the following exercise, you will continue to use the `c07-Sample-Building-Start.rvt` project file while using the saved list of views you created in the “Preparing a List of Views for Exporting” exercise:

1. From the File Tab menu, click **Export > CAD Formats > DWG**. In the DWG Export dialog box, make sure **PLANS** is selected in the Export drop-down. Click the **Modify Export Setup** ellipsis button (three dots) at the top of the dialog box.
2. In the **Modify DWG/DXF Export Setup** dialog box, select the **New Export Setup** button from the bottom left to create a new export setup. Name the new export setup **British Plans with Phase**.
3. In the **Layers** tab, set the **Export Layer Options** drop-down list to **Export Category Properties BYLAYER And Overrides BYENTITY**. Locate the **Load Layers From Standards** drop-down list and select **British Standard 1192**. You will receive an error message stating that loading these settings will replace your previous settings. Click **Yes** to accept.
4. While still in the **Layers** tab, click the **Add/Edit Modifiers For All** button. In the **Add/Edit Layer Modifiers** dialog box (Figure 7.33), add the **{Phase Status}** modifier from the list at the left to the **Modifiers Added** list at the right. Next to **{Multiple Categories}** in the **Separator** column, add a hyphen. The preview above should now read **{Multiple Categories}-{Phase Status}**. Click **OK** to close this dialog box.

FIGURE 7.33
Add a {Phase Status} modifier to all categories.



5. Switch to the **Units & Coordinates** tab and set **Coordinate System Basis** to **Shared** by clicking the radio button. Click **OK** to close the **Modify DWG/DXF Export Setup** dialog box.
6. Click the **Next** button to continue the exporting process. In the **Export CAD Formats-Save To Target Folder** dialog box, set the **Naming** drop-down list to **Automatic-Short**. This will create files named similarly to `FloorPlan-A-FP01.dwg`.
7. Uncheck the **Export Views On Sheets And Links As External References** setting. Although this setting does not affect this exercise, we discuss its importance after the exercise.
8. Select an appropriate location on your computer or your network for the exported files and then click **OK** to complete the export process.

Unfortunately, you cannot customize the naming of the exported files when you export more than one view in a batch process. That said, any kind of file-renaming tool can be used to remove the prefix `FloorPlan-` from exported files using the **Automatic-Short** option.

There is one more option that you should understand in the exporting process. In the final **Export CAD Formats** dialog box, you will see the option **Export Views On Sheets And Links As External References**. When this option is selected and you are exporting sheet views, any views that are placed on those sheets will be exported as separate files. Those files will then be config-

ured as external references (Xrefs) in the exported sheets. If you also have other RVT files linked into your current model, they too will be exported as separate CAD files and configured as Xrefs in the exported files.

We recommend that you deselect the External Reference option during exporting unless it is absolutely necessary. The exporting process will result in fewer files and more portable and predictable results for the recipients of your exported data.

Exporting 3D Model Data

In the previous section, we showed you how to export 2D views to CAD formats, which will support more traditional collaboration workflows. You can also export your Revit project as a 3D model in several formats for use in other modeling software. A frequent destination for such data is Navisworks for its enhanced coordination with contractors during construction. This workflow is supported by a free Navisworks plug-in for Revit that will allow you to export your models as NWC files, which Navisworks uses. More generic exports in DWG, DGN, DXF, or SAT formats can provide numerous opportunities for you to become more creative with the presentation of your designs.

Exporting to SketchUp

Previously in this chapter we discussed using SketchUp for conceptual building massing studies. These studies were imported directly into the Revit environment for further development of a true building information model. Revit model data can also be exported via 3D DWG to SketchUp, where visualization studies can be conducted on an entire project or even a simple wall section.

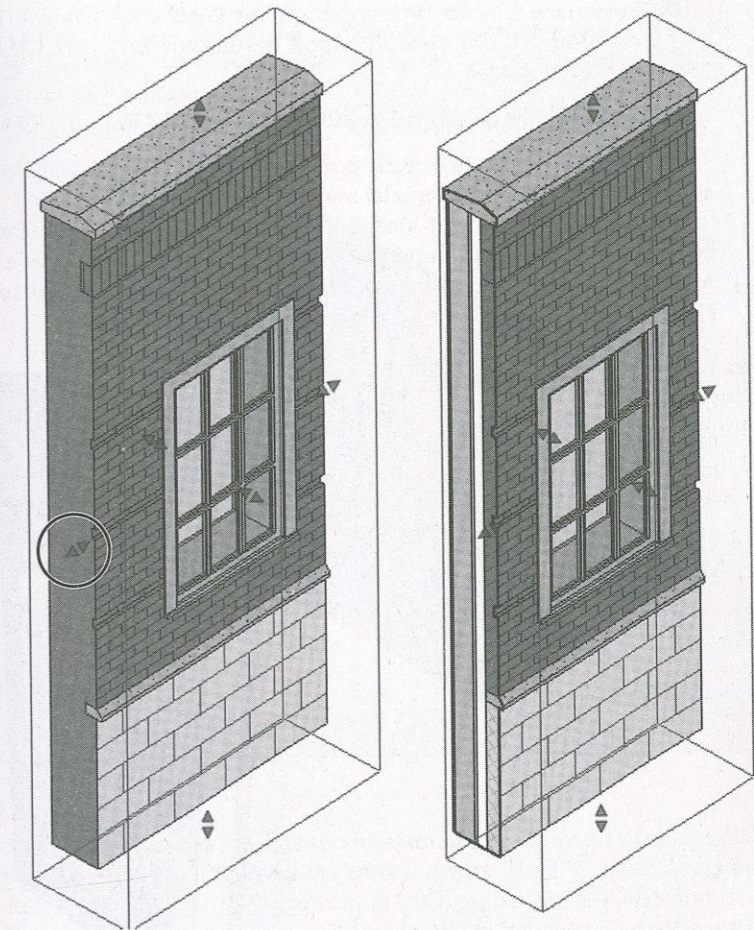
In the following exercise, we will export a wall section study from the Revit environment to SketchUp using files you can download from this book's web page. To complete this exercise, you can either download and install the desktop version of SketchUp or use the web-based version of the application from www.sketchup.com. Please note, some of the SketchUp features in the tutorial are not accessible without a paid subscription. If you are using SketchUp for the first time, then no worries; there is a free 30-day trial that has full functionality.

To begin the exercise, follow these steps:

1. Open the file `c07-Sketchup-Wall-Study.rvt`.
2. Activate the Default 3D view and enable the Section Box option in the Properties palette for the view.
3. Set the detail level of the view to Medium or Fine.
4. Select the section box in the 3D view, and shape handles will appear on each face. Grab the shape handle of one side of the section box parallel to the vertical edge of the wall sample, and drag toward the wall until the section box intersects the wall, as shown in Figure 7.34.

You should see the layers of the wall structure exposed.

FIGURE 7.34
Using the section box to expose the layers of the wall



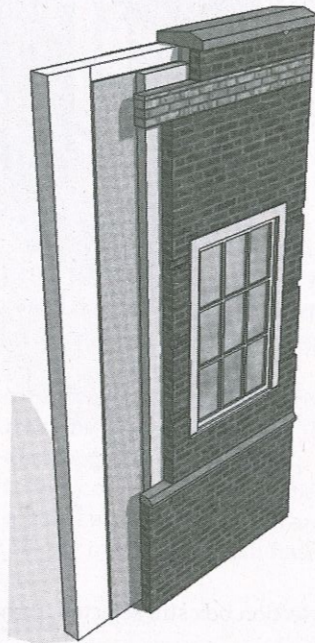
5. With the section box still selected, right-click and choose `Hide In View > Elements`. This will prevent the section box from being exported.
6. Click the File Tab menu and select `Export > CAD Formats > DWG Files`. Set the Export drop-down list to `<Current View/Sheet Only>`.
7. Click the Modify Export Setup ellipsis (three dots) button to open the Modify DWG/DXF Export Setup dialog box. In the Modify DWG/DXF Export Setup dialog box, switch to the Solids tab and set the option to Polymesh. Click OK to close the Modify DWG/DXF Export Setup dialog box.
8. Click Next and set the Files Of Type drop-down to AutoCAD 2018 DWG Files. Select a location on your computer or network and then click OK to save the file.
9. Launch SketchUp and create a new architectural model. Choose `File > Import`.

10. Switch the Files Of Type option to AutoCAD Files, navigate to the file saved in step 8, and click Import. You'll see an Import Results window; click Close to view the imported model.
11. Switch to the Select tool, select the entire DWG import, right-click, and choose Explode.

This will allow you to directly edit the elements in the SketchUp environment. Other components within the exploded model may need to be exploded again.

Once the DWG model is loaded in SketchUp, you can use the Paint Bucket tool to apply materials to individual components, use the Push/Pull tool to hide or expose layers of the wall construction, and use the line tools to customize the profile of the revealed layers, as shown in Figure 7.35.

FIGURE 7.35
Completed wall study
in SketchUp

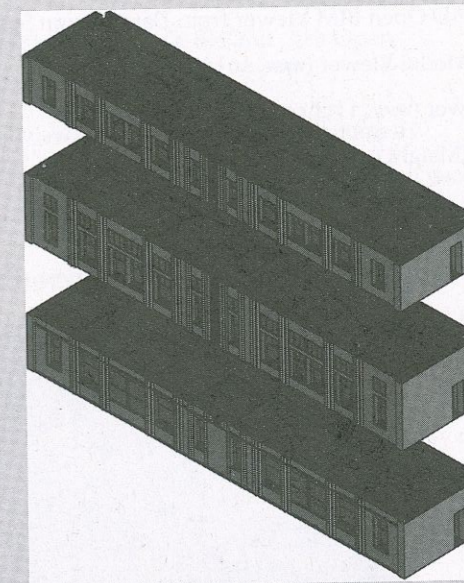


3D EXPORTS BY LEVEL

Effective coordination between Revit and AutoCAD MEP frequently relies on the exchange of 3D DWG files of limited scope with respect to the overall project. MEP engineers using AutoCAD MEP will usually manage their BIM with one model file per level. Even though the entire architectural model can be exported to a single DWG model, they may not be able to reference such a large model efficiently. The good news? Your Revit project can be set up to achieve this by creating 3D views with section boxes for each level.

Begin by creating a series of floor plans designed for exporting (discussed previously in this chapter). In the View Range settings for these plans, set the Top value to Level Above, Offset: 0 and the Bottom value to Associated Level, Offset: 0. Create a 3D view for each level required in the project and rename the views according to your standards. In each duplicated 3D view, right-click the

ViewCube*, select Orient To View > Floor Plans, and choose the corresponding floor plan with the adjusted view range. This series of 3D views can be saved in an export list and batch-exported to 3D DWG when needed for collaboration, as shown here.



Using IFC Interoperability

Industry Foundation Classes (IFC) are the data model standard developed by buildingSMART International to support interoperability in the building industry. The IFC model specification is registered by the International Standards Organization (ISO) as ISO 16739-1:2018 and is now officially certified. Because of its focus on ease of interoperability between BIM software platforms, some government agencies are requiring IFC format deliverables for publicly funded building projects.

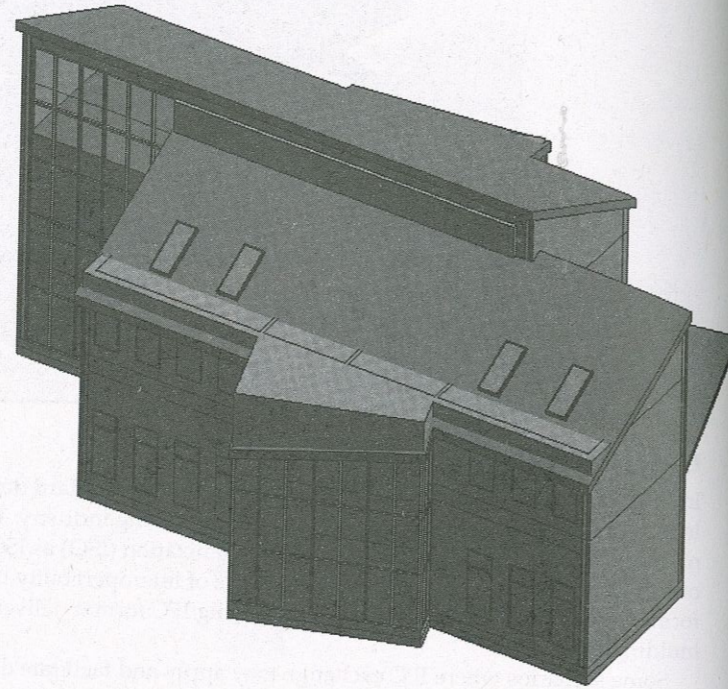
Some scenarios where IFC exchange may apply and facilitate data exchange include, but are not limited to, the following:

- ◆ Linking AutoCAD MEP files into a Revit project
- ◆ Using Solibri Model Checker or Viewer for model quality audits
- ◆ Coordination between Revit projects and Nemetschek Allplan, Vectorworks, or ArchiCAD
- ◆ AutoCodes Project by Fiatch
- ◆ Construction-Operations Building Information Exchange (COBie) deliverables
- ◆ GSA spatial validation

You can export the Revit model quite effectively to IFC 2x2, IFC 2x3, IFC 4, IFC GSA 2x3, or any of the other IFC formats by clicking the Application menu and selecting Export > IFC. The resulting IFC file (Figure 7.36) can be viewed in a number of programs that can be downloaded at no cost from any of the following websites:

- ◆ DDS-CAD Open BIM Viewer from Data Design System (www.dds-cad.net)
- ◆ Solibri Model Viewer (www.solibri.com)
- ◆ IFC Viewer (www.ifcbrowser.com)
- ◆ Tekla BIMsight (www.tekla.com)

FIGURE 7.36
Revit model exported to IFC format



Importing IFC data into the Revit environment is similar to the process for importing 3D CAD geometry; however, the data generated is intended to be more intelligent and editable. Although this method has great potential, the accuracy of the Revit IFC import is highly dependent on the software used to generate the IFC output. We recommend the use of one of the free IFC viewers listed previously to inspect IFC data prior to importing into a Revit project.

VIEWING THE CONTENTS OF AN IFC FORMAT FILE

Did you know that an IFC file can be viewed in a text editor such as Notepad? Download a sample file from the book's companion web page and check it out! Right-click an IFC file, select Open With, and choose Notepad.

After you've reviewed the contents of the IFC file, you can link it into a Revit project and integrate it into your coordination process as follows:

1. Start a new project with any default template. From the Insert tab in the ribbon, click Link IFC.
2. Navigate to the c07-Structure.ifc file and click Open.
3. Save the project file.
4. Open the default 3D view and inspect the linked geometry.

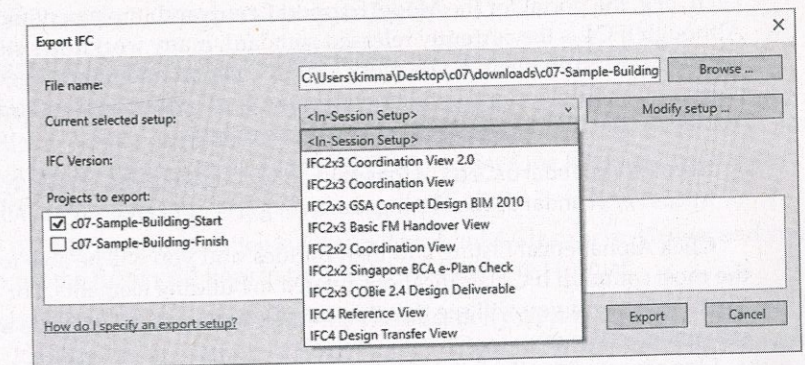
If an updated IFC file is received, overwrite the linked file you used in the previous steps. When the host project file is reopened, the linked IFC content will be updated.

DOWNLOADING AND CUSTOMIZING THE OPEN SOURCE IFC EXPORTER

In addition to offering a basic IFC export command in the default installation of Revit, Autodesk has been developing an improved open source IFC exporter with the development community. This exporter is available in the Autodesk App Store (<https://apps.autodesk.com>). Search for IFC 2019. Anyone can download and install the free IFC exporter, which will seamlessly update the default Revit IFC exporter. We recommend that you periodically check to see if there is a newer version. As of the time of this writing, the version of the exporter is listed as IFC 2019 19.2.0.

After you have installed the IFC exporter, you can still launch the IFC export command from the File Tab menu (Export > IFC). You will see the same Export IFC dialog box (Figure 7.37), but it will have updated IFC setups. Much like the CAD export process described earlier in this chapter, this interface allows you to create, customize, and save export setups.

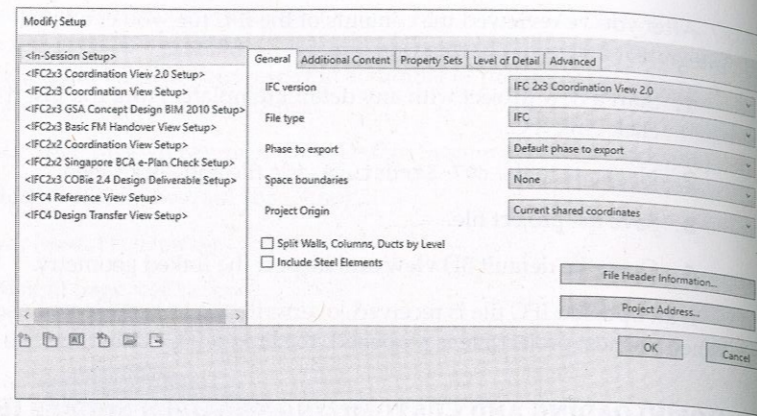
FIGURE 7.37
The IFC exporter user interface



For advanced IFC exporting options, click the Modify Setup button shown in Figure 7.37. There are several tabs across the top of the Modify Setup dialog box that allow you to customize the IFC export setup (Figure 7.38). In addition to the predefined export configurations, you can create and save your own setups that will be maintained in the project file.

An excellent resource for IFC interoperability in Revit is the buildingSMART alliance web page for Common Building Information Model Files (www.nibs.org/?page=bsa_commonbimfiles). You can download sample files as well as a configuration guide with additional instructions related to customizing IFC exports from Revit.

FIGURE 7.38
Customizing and saving
IFC export setups



CLASSIFYING IFC EXPORT SETTINGS

Because exporting to IFC format is about converting one model format to another, settings are not related to layer conversions, linetypes, or text as they are in a CAD export. Rather, it is critical to correctly map the logic of the Revit model organization to the open data standard. In other words, model object categories must be mapped to IFC entities; for example, walls in Revit will be exported as `IfcWall` entities. This translation seems quite logical for walls and other objects, but consider an electric receptacle. Such a device would be categorized in Revit as Electrical Fixture; however, it is classified as `IfcFlowTerminal` in the open standard. Entities are further refined with types—in this case, `IfcFlowTerminalType`—that would help distinguish an electric receptacle from other `IfcFlowTerminal` entities such as a faucet or an air diffuser.

The schema of the currently released standard (IFC4) can be viewed at www.buildingsmart-tech.org, the portal for the Model Support Group and Implementation Support Group. Although IFC4 is the currently released standard, many workflows still use IFC2x3, including native export from Revit. If you work with IFC export and import regularly in the Revit environment, you should become familiar with some of the common classifications in the IFC schema. You'll find the IFC2x3 and IFC4 schema indexes here:

<https://standards.buildingsmart.org/IFC/RELEASE/IFC2x3/FINAL/HTML/>
https://standards.buildingsmart.org/IFC/RELEASE/IFC4/ADD2_TC1/HTML/

Click Alphabetical Listing and then Entities, and you will be able to browse through some of the most common IFC classifications related to building elements. For example, find and click `IfcCovering`, and you will see that this classification is used for wall claddings, flooring, and suspended ceilings.

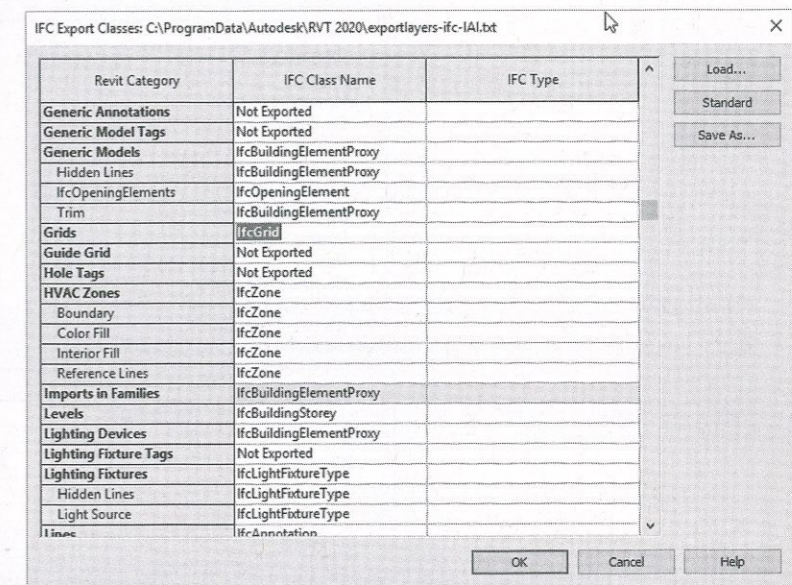
One aspect of the Revit project model that can be exported to IFC is a structural grid. These datum objects are beneficial to the coordination process if you are using Solibri Model Checker or Viewer or Tekla BIMsight; however, they are not exported if you use the default IFC export settings in Revit. Let's solve that problem with a quick exercise. You can continue to use the `c07-Sample-Building-Start.rvt` file.

1. From the File Tab menu, click **Export > Options > IFC Options**.

You might need to scroll down the Export menu to see the Options flyout.

2. In the IFC Export Classes dialog box (Figure 7.39), find the entry for Grids and set IFC Class Name to `IfcGrid`. You must manually enter any IFC entities and types into this dialog box; therefore, you should always refer to the buildingSMART website for accurate classifications.

FIGURE 7.39
Customize the mapping
of Revit categories to
IFC entities.



3. Click OK to close the IFC Export Classes dialog box.

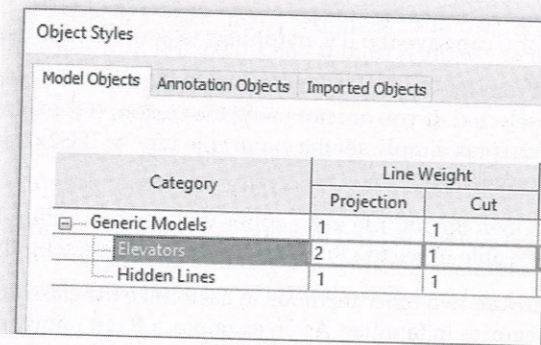
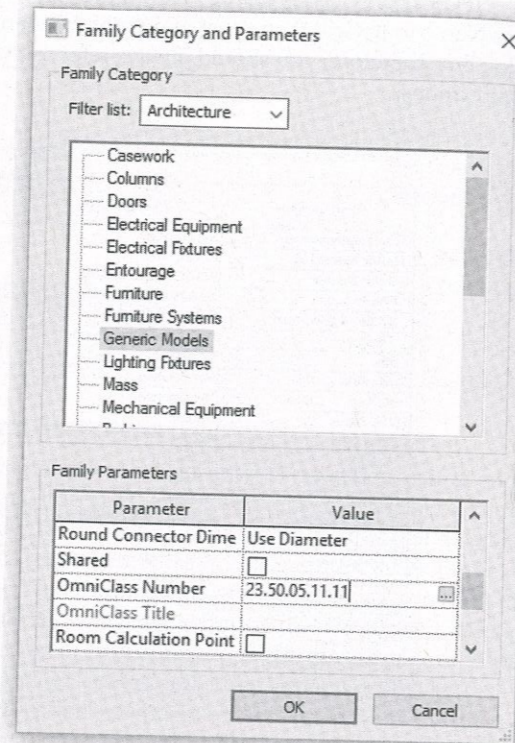
You can save the IFC mappings to a text file for use in other projects.

4. From the Application menu, click **Export > IFC** and export with the In-Session Setup selected. If you are not using the custom IFC exporter that we discussed earlier in this chapter, simply set the export file type to IFC2x3 and save the file to your computer or network.
5. Open the IFC file in an application such as Solibri Model Checker or Viewer, and you will be able to see the Revit grid lines in the model-only exported format.

There are two other methods to customize the classification mappings for IFC. One is to use subcategories in families. As an example, a Revit family created for an elevator has been assigned to the Generic Models category; however, a subcategory named Elevators was created in the family (Figure 7.40).

After the elevator family is loaded into a project, the new subcategories can be assigned to an appropriate IFC classification. Click the Application menu and then click **Export > Options > IFC Options** to open the IFC Export Classes dialog box. Locate the Revit category for Generic Models, and you will also see the Elevators subcategory, as shown in Figure 7.41. For IFC Class Name, enter `IfcTransportElement`, and for IFC Type, enter `IfcTransportElementType`, and you will be ready to export your project with the additional object classifications.

FIGURE 7.40
Create subcategories in a family for customized classification.



The second method of classification customization is to use two specific shared parameters associated with a family. These parameters must be named IfcExportType and IfcExportAs, as shown in Figure 7.42, but they can simply be selected from a shared parameters file downloaded from the Common BIM Files web page mentioned previously in this chapter. When these families are loaded into and placed in a project, the IFC classifications will be automatically mapped according to the values specified in these parameters.

FIGURE 7.41
Subcategories can be mapped directly to IFC classifications

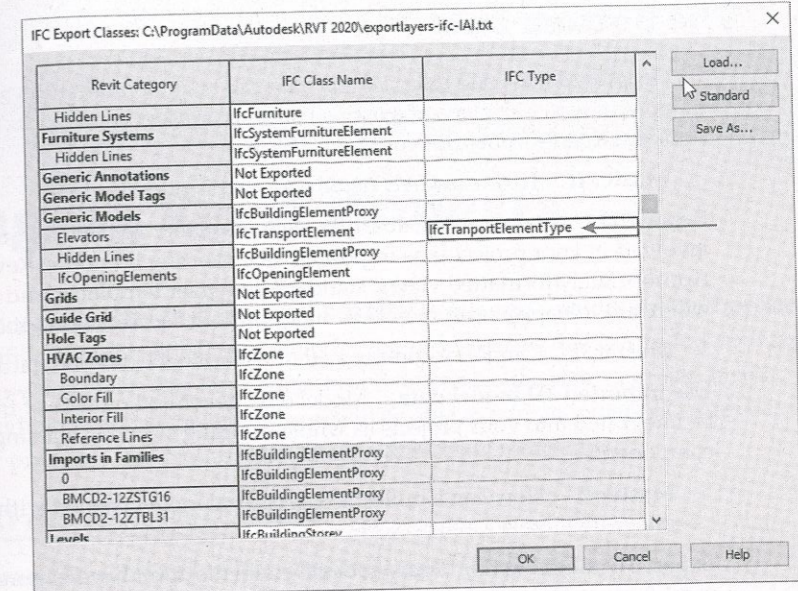
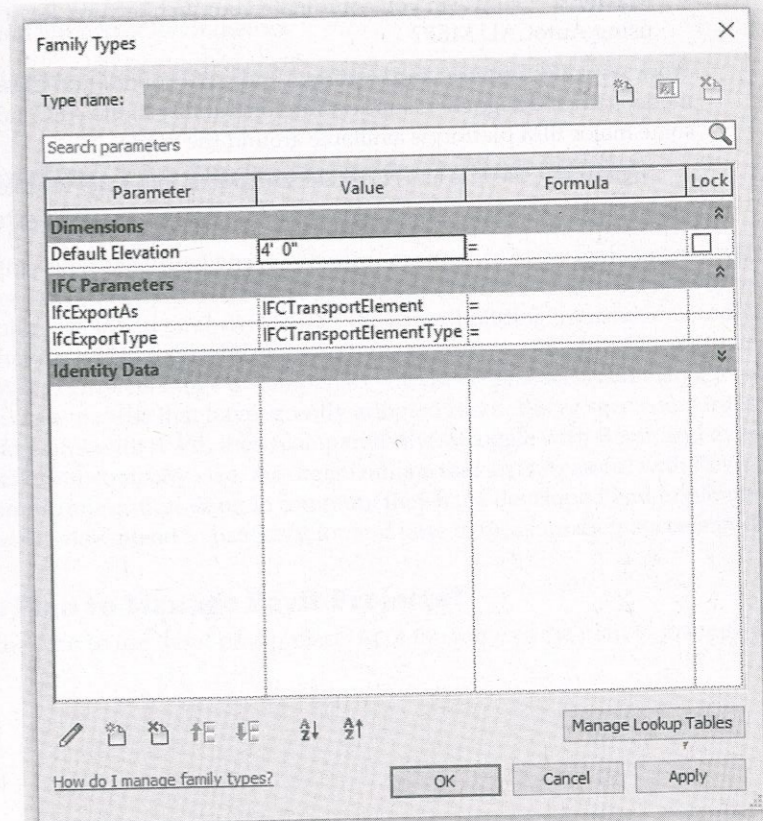


FIGURE 7.42
Use specific shared parameters to customize IFC mapping.



The Bottom Line

Use imported 2D CAD data. CAD data can be integrated into your Revit project in a number of ways: as plans of existing conditions, as fixture layouts from consultants, or as standard details from your company's library.

Master It How can CAD details be used in a Revit project?

Export 2D CAD data. The ability to deliver quality 2D information to other constituents involved in your project is as important as importing it into the Revit environment. Appropriately formatted views, standardized layer templates, and proper coordinate settings will result in happy team members and a smooth coordination process.

Master It Can Revit comply with the National CAD Standard?

Use imported 3D model data. Model data generated outside of the Revit environment can be integrated into your projects as whole-building systems, massing studies, or unique components.

Master It How can a building's structural model created with Bentley Structure be integrated into a Revit project?

Export 3D model data. Your modeled elements don't have to remain in the Revit environment forever. Data can be exported to 3ds Max, SketchUp, AutoCAD MEP, and more.

Master It How can you coordinate your architectural Revit model with an engineer using AutoCAD MEP?

Work with IFC imports and exports. Industry Foundation Classes (IFC) is a vendor-neutral model format designed to support interoperability in the AEC industry. It is widely used by some major BIM platforms available around the world.

Master It How is an IFC model integrated into a Revit project for coordination?

Chapter 8

Managing Revit Projects

In this chapter, you will take an in-depth look at how to manage Autodesk® Revit® projects within your office. We will explain strategies for the processes needed to support your project and discuss how to review your Revit projects and determine the state of project health. As you will see, through proactive management you will be able to address potential issues before they become major problems that require immediate, often costly remediation.

IN THIS CHAPTER, YOU WILL LEARN TO

- ◆ Understand how to conduct Revit/BIM administration
- ◆ Explain how your QA/QC process will work
- ◆ Understand important Revit metrics
- ◆ Learn to leverage tools within Revit to assist with management

Understanding the Importance of Managing Revit Projects

The authors of this book collectively have extensive experience in the architecture, engineering, and construction (AEC) industry. For a large part of our careers, we have been involved in utilizing Revit on projects and have delved into the larger building information modeling (BIM) landscape. We have traveled the globe discussing Revit projects with a wide variety of companies. We've seen the complete range of companies with Revit practices, from large to small and from the best in class to those that have recently adopted Revit. We've seen companies that have become very successful with Revit, those companies that struggle with Revit, and everything in between. Regardless of company size, the organizations that are successful with Revit projects have, at a minimum, one critical thing in common: they have developed and implemented a plan, defining what they intend to use Revit for and how to measure their success in doing so.

What's in a Plan to Manage Revit Projects?

Let's be clear: the plan to use Revit on a project is not the same as the plan to manage a Revit project.