

**Robert Yori  
Marcus Kim  
Lance Kirby**

# Mastering Autodesk® Revit® 2020







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**Robert Yori  
Marcus Kim  
Lance Kirby**

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We dedicate *Mastering Autodesk® Revit® 2020* to our wives, families, and loved ones, who have supported the pursuit of our careers and the authoring of this book. Their encouragement, understanding, and flexibility with personal time is what made this body of work possible. We would also like to say thank you to Eddy Krygiel, who has contributed so much to previous volumes of this book; his insight, humor, and friendship are truly appreciated.

—Bob, Marcus, Lance





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And finally, a few words for the cover picture! The authoring team always finds the selection process our biggest challenge. With all the wonderful Revit projects developed each year, selecting one to represent our book is always a difficult task. For this year, we are pleased to show Moscone Center (photo credit - Cesar Rubio).

**Designed by SOM with Mark Cavagnero Associates**, the expanded and improved Moscone Center is a memorable work of architecture that brings natural light and transparency to interior spaces while activating the adjacent streetscape and public realm. Above-grade improvements and additions were made within the building's existing footprint, allowing for the enhancement of current open space and potential new retail opportunities. Former surface parking and vehicular circulation were replaced with 25,000 square feet of pedestrian-friendly areas, and an additional 8,000 square feet created a new children's play area and multiple outdoor terraces that provide dramatic city views and can be used for a variety of events.

The improved Moscone Center creates fewer carbon emissions per visitor than any major convention center in North America. It also saves more than five million gallons of water annually and generates clean energy with the largest rooftop solar installation in San Francisco.





# About the Authors



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Marcus lives in the Chicagoland area with his family, and spends much of his spare time chasing after his five-year-old son, discussing with him the finer points of Kaiju movies.



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In 2000, he left the practice of architecture to join a new tech startup outside Boston to help produce a new design tool called Revit. In addition to helping develop Revit since version 1, Lance created its early tutorials and has supported hundreds of BIM projects and trained thousands of its users over the past 19 years.

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# Foreword

The yearly Revit series of books created by Robert Yori, Marcus Kim, and Lance Kirby is a valuable resource to record and push forward the evolution of Revit, which is the leading BIM (building information model) product. I remember the founder of Revit, Leonid Riaz, saying the goal of BIM is to allow the construction industry to virtually design buildings, virtually build buildings, and virtually fly buildings just as he had helped make this happen for the Boeing 777 in the 1990s. Revit is definitely on this path with recent progress toward enabling architects, engineers, general contractors, trade contractors, and building product manufacturers to come together through BIM and virtually build the buildings, achieving the similar high standards accomplished with the jet.

I also remember an early board meeting at Revit in 2000 when we approved the term BIM to be the tagline to describe what we do at Revit. BIM has expanded its definition and influence beyond Revit to include other powerful software and applications to create platforms that allow our industry to virtually design, build, and fly (test) our buildings. Kudos to people like Chuck Eastman, Leonid Riaz, Carl Bass, Phil Bernstein, the authors of this book, and many others who have been making the dream of BIM come alive over the last 20 years.

The authors of this book have advanced the power of BIM by expanding our knowledge of the capabilities of Revit along with the BIM process and platform, which encompasses many software solutions and applications. The BIM advancements have allowed the pursuit of virtual buildings demonstrated in the relatively new pursuit of Virtual Design and Construction (VDC). In just the last few years, the VDC revolution, which includes the actual virtual construction of the building, is being followed immediately by virtually flying/testing the building. The promise of the avionics industry experience is now occurring within the AEC industry.

I believe virtually flying the building is the ultimate goal. Being able to virtually test the design and test the quality of the virtually built building demonstrates the balancing of the design and the build quality of a building. I refer to this review using the acronym FACE, which represents the (F) Function of the building; (A) the Aesthetic of the building; (C) the Cost of the building; and (E) the Environmental impact of the building.

The function must be addressed because the design and its resulting building are falling far short of what it should be. For instance, in hospitals in the United States, more than 15% of the people get sick during their stay, while this same statistic is less than 5% in Norway and Sweden. Additionally, Carnegie Mellon Architectural School studies have shown that elementary schools with generous natural lighting raise test scores for their students. (F)unction in design and the quality of the construction of the building is critical.

(A)esthetic is also critical to the quality of the design. This is an aspect of design that the many architects I know are very passionate about and extremely capable of delivering. If they used the same energy and genius on the Function, Cost, and Environmental aspects of FACE, we would have a revolutionary breakthrough in the quality of our design and actual construction of our buildings.

Unfortunately, architects and engineers of buildings in the United States continuously underestimate the (C)ost of their buildings when the constructors actually come in with their bid. I personally thought I had a breakthrough when we sold Revit to Autodesk and Carl Bass, the new person in charge of Revit, said that he would provide Quantity Survey Software with Revit

if I would build out a full system of BIM objects in the early 2000s (SmartBIM and Autodesk Seek were created for this purpose), which I would then connect with the RS Means Costing Systems (a company I had owned and later had a strong influence over).

Therefore, with a capable staff that included early software construction pioneers like Dennis Neely, Raghi Iyengar, Andrew Arnold, Blaine Wishart, Charles de Andrade, and Marc Fagan, we created a reasonably accurate (within 10%) Estimated Cost of a Building done in Revit by using the SmartBIM Objects, Revit Quantity Survey, and RS Means. I personally contacted executives at least half of the top 40 architectural firms in the United States and offered this Cost Software System for free, and only two firms were interested. Basically, each architectural firm/executive said they wanted nothing to do with the cost of the building because of lack of interest, expertise, and liability problems. Though more money in the United States is spent on counting and measuring (Quantity Survey) by trade contractors, manufacturer representatives, and distributors than all the money paid to architects and engineers for their design work, I believe this is still a huge opportunity for improvement in our industry.

I believe owners really would like better cost numbers than they now get during the design process and with BIM, the architects and engineers should be a lot more capable of being within 10% to 15% of the cost of their designed building. Unfortunately, today, when the architect/engineer does give an estimate for the cost of their new building, it is often at least 15%–20% too low. We then are stuck with Value Engineering, which is a euphemism for making it cheaper, and the environmental (the E of FACE) concepts—which are longer-term cost benefits—get eviscerated to attain the desired price. This new price is totally cost-based with too little regard for longer-term environmental concerns. Hopefully, using the principles of FACE with BIM, the architects/engineers and the constructors can help our industry achieve productivity gains as well as environmental advances.

Starting around 1920, Gropius, Corbusier, and Mies van der Rohe were looking at modern design paradigms to streamline the cost and production of buildings that would allow a stronger and less expensive building. These founders of modern architecture were using manufacturing principles and techniques that were used for making cars and airplanes at their infancy.

BIM was started with the concept of virtually designing and virtually constructing the buildings of the future, to attain better construction and environmental design characteristics. Combined with more sophisticated manufacturing materials like steel, aluminum, glass, and concrete, which permit stronger, taller, and faster-built buildings, BIM empowers more manufacturing techniques. BIM enables the construction of modern tall and strong buildings being built with the precision and strength of a jet. Sustainability in a building is advanced and created with the use of modern materials and sophisticated techniques of manufacturing. These techniques advance the clean, strong, and safer manufacturing of buildings needed for the high quality and precision required for the highest achievement of a sustainable building.

BIM and VIM (Virtual Information Model) offer the next steps ahead for the construction industry, which can provide profound processes for the design and building of high-performance buildings that achieve the appropriate balance of FACE (Function, Aesthetics, Cost, Environment) for a building's ultimate performance, especially as it serves to enhance the quality and performance of the people in the building.

Our cost engineers and analytical staff led by our president, Durwood Snead, at RS Means Construction Cost Corporation, throughout the 1990s and the early 2000s demonstrated to me

following. Over 25 years of a building's life, the first 5 years accounted for 25% of the building cost through design/construction. The final 75% of the cost was covered over 20 years through facility management, including rehab/maintenance. The RS Means team stressed to me that in reality, the real costs of a building should be measured by productivity, wellness, and happiness of the people in the building—Hello WeWork!

We can set higher standards for the quality of life of the people in the building if we not only design and build it with BIM, but we actually test or fly the building before it's built, for safety, health, and productivity. Modernism in buildings does not mandate sterility or boring design, but to the contrary, it can bring more complexity, sophistication, and beauty at lower costs if it is empowered with an advanced form of BIM that is used to achieve the high standards of a jet. The new challenge is to make BIM join with VIM to allow us to help pursue the challenge of properly addressing FACE for the future so we can create the next step of modern buildings that serve the productivity and the health quality of the people using the buildings we design and build. BIM as software, like Revit, is rapidly evolving each year, and the actual evolution is accurately depicted in this book.

In this book, hundreds of pages are needed to depict in necessary exquisite detail the actual changes to the Revit software. BIM is a process that is not only enhanced by the evolution of the Revit software, but also by its necessary connection to new BIM software that is created by others than Autodesk, which has greatly enhanced and expanded the BIM platform and therefore the BIM process. New enhancements to the BIM process are chronicled and explained in this yearly publication, which is achieved by multiple authors with wide expertise creating a necessary new extensive book each year. I believe this book and past publications will help us on this quest to achieve a new dimension of what a modern building can be.

—Arol Wolford

*Arol has served on the boards of Revit, CMD (Construction Market Data), and RS Means, and currently serves on the boards of Manufactory, BCI (Building Construction Information), Vizz, VIMaec, BSD, SIG (Sustainable Investment Group), and TDG (The Digit Group).*



# Introduction

What you hold in your hands is regarded as the definitive source of Autodesk Revit expertise available in written form. It has been a leading book in educating novice and experienced users alike for the better part of a decade. Those of you who have read previous editions know there is a wealth of information regarding the practical usage and application of the program in producing many different architectural designs. If you have used these preceding editions to help you gain a better understanding of this complex application, then you know that new information is provided in each edition to update you on the newest features and how they might improve your workflow every day. What you may not know is that this specific edition seeks to go further. Its purpose is to provide you with not only the best understanding of the available tools, but also many of the skills sorely needed by professionals to manage these tools in an architectural building information modeling (BIM) workflow.

Often when working with architects around the world, we find that the terms *Revit* and *BIM* are used interchangeably in describing what is new about the profession and the way we execute work. From the typical user all the way to the principal members of a firm, there is a misconception that if you are using Revit, you are doing BIM. The challenge, of course, is separating the tool from the technique. Although Autodesk® Revit® is a wonderful apparatus for joining three-dimensional geometry with incredibly powerful and accurate data, it is not a process or a road map for producing architectural work. Although Revit is an important foundational asset to a BIM-based workflow, it is still a resource that needs associated procedures and the intent for reaching planned deliverables. Where is technology without technique?

BIM is a methodology used to produce a complete design, construction, and operations solution. It has become a catalyst for transforming design and production processes in the architecture, engineering, and construction industry. More than a decade ago in 2005, BIM was represented solely as architectural design and documentation authoring tools. Today, BIM has grown to form the basis of the process from design discipline authorship to construction and operation management of built assets. It is also being adopted for infrastructure as well as buildings. As the use of BIM tools and processes has become more mature, nations have changed legislation to accommodate the immediacy of centralized collaborative working practices in contrast with traditional sequential paper workflows. Global organizations within specific industries have defined exchange classifications such as Industry Foundation Classes (IFC) and COBie, and owners and their customers now expect to see full 3D media to describe a building at any stage of the design and build process. They even expect to see it as part of the construction process on-site, controlling and validating the build environment.

The challenge for any company in the architecture, engineering, and construction (AEC) industry is to recognize the BIM areas that match its business niche and to ensure that the

information that it attributes to a model can be generated efficiently and maximized by all other information-model users. With this comes much more responsibility to users of the tools and managers of the information, beyond lines and arcs generated by zeros and ones. It entails that you work with intent beyond what you see displayed on monitors. It is not enough to know every button and setting contained in the program; the BIM practitioner must know why to use a feature and when it is appropriate. It is not enough to know how to customize the templates for your specific workflow; it involves user understanding, knowing when customization is needed to create a specific output, and when settings are best left unchanged. It is not enough to know how to create iterative forms through the manipulation of Python coding; it also requires an understanding of design criteria and how BIM uses align with them. Most important, it is not enough to just have the knowledge of how to model a thing; it is necessary to have the wisdom to know when and why to do so.

Rest assured, this book's purpose is to educate you on the best techniques and practices of Revit, regardless of your responsibilities as an architectural project team member. New users will find a plethora of information regarding everything from simple concepts to complex techniques in executing modeling, documentation, and data input/output. All the while, we have included some lesser-known tips and tricks for seasoned veterans. All readers, regardless of their experience, will benefit from the authors' knowledge in planning, collaborating, governing, and supporting BIM projects with Revit at the center. The goal is not to turn all readers into BIM managers, but to extend the amazing information provided in previous volumes with additional recommendations for supporting your work for more efficiency and better quality.

Anyone involved in any aspect of BIM, even tangentially, can benefit from knowledge of the bigger picture. This edition's coverage of the collaboration process, the management of practices, and the governance of data standards has been expanded so that even novices can increase their value to the team. By understanding principles that show that every action should have a method and every method should have a purpose, readers will continue to progress their expertise in providing precise modeling and valid data to their teams at the right time and in the right format.

If you seek a greater understanding of the BIM process and strive to transcend your traditional responsibilities, this edition will help you toward the goal of BIM management. Pursuing knowledge of planning, organizing, leading, and controlling your projects through new techniques and tools will help you take those next steps. By planning, you will establish strategies for achieving BIM use objectives. By organizing, you will be structuring the workflow to maximize the collaborative integration of your team. By leading, you will optimize your project team's potential for providing quality deliverables efficiently. By controlling, you will be able to measure the team's performance and provide continual self-improvement with the goal of raising the level of excellence. Regardless of your role, you will contribute more.

As you begin delving into this book, keep an active mind about how each of the provided recommendations might fit your company's culture, your experience, and your customer's needs. Not all of these ideas may be of interest or value to every project, but the goal of this book is that you will grow beyond any of the tools or techniques you deploy on your BIM projects, that the tools become second nature and an extension of your creativity, and that through this you will realize great architecture.

Architecture is the process of turning a thought into a space. Although it's so simple to convey that in the written word, the actual act of doing so is much more than it is possible to write. It's glory, it's torment, it's frustration, it's freedom, it's the realization that one miscalculation means a complete redesign, and it's the 3 a.m. epiphany when you realize that the new design was what

you were meant to get to in the first place. With all of that, it's also the burning desire to work relentlessly to make something better one step at a time.

Autodesk® Revit® 2020 is one of the many tools we employ to help us through this organic process. It's one tool in the toolbox, but it can be much more than that. It can be the workflow that helps to empower a team. That team is the designers, the contractors, and ultimately the owners who are all looking to speak the same language.

We hope that in the process of using this book, you will experience a bit of the struggle to realize a bit of the satisfaction of finding the solution. We hope what you learn in this book helps inspire you to your own bit of greatness, because what's most important is that architecture isn't about buildings. It's about what we are able to accomplish with what little time we have. This is the elegant essence of Revit. Before we go much further, we have a few semantics to discuss.

First, all the tutorial files necessary to complete the book's exercises plus sample families are hosted online at:

[www.wiley.com/go/masteringrevit2020](http://www.wiley.com/go/masteringrevit2020)

Don't have a copy of Revit 2020? Download the trial version of Revit from:

<https://www.autodesk.com/products/revit/free-trial>

Here you'll also find complete system requirements for running Revit.

Are you a student or educator? Someone with an .edu e-mail address? You can get a copy of Revit for free at:

<https://www.autodesk.com/education/home>

For the clearest direction when following the exercises in this book, please make sure to install all the Revit support files that come with the default installation. We reference them heavily, and you will need them to best leverage the software.

Since Revit 2018, there is only a single version of Revit that offers the Architecture, Structures, and MEP packages in one application. We have focused this book on the architectural features and have set the user interface to remove some of the Structural and MEP tools for better visual clarity. The variations will be slight and ideally manageable, which really means you have some extra tools for Structure and MEP design. For ease of reading, we removed those from the book's images.

Finally, Revit extends its capabilities with some additional cloud-based tools that require an Autodesk account. We cover these tools throughout the book. You can go to

<https://accounts.autodesk.com>

to create an Autodesk® account to access those additional tools.

## Who Should Read This Book?

This book is written for architects and designers who have had some exposure to Revit and are eager to learn more. It's for architects of any generation—you don't need to be a computer wizard to understand or appreciate the content within. We designed the book to follow real project workflows and processes to help make the tools easier to use. The chapters are full of handy tips to make Revit easier to leverage in your day-to-day world.

This book is also for the entire range of architects, from those who are fresh out of school to seasoned project managers. We have endeavored to include content for all walks of the profes-



sion so that regardless of your role on a project, you can learn how BIM changes both workflow and culture within a project team. With that, a basic understanding of Revit will make it easier to work through the book. Revit is a robust tool requiring more than one project iteration to master.

For BIM managers, the book offers insights into the best practices for creating good project or office templates; these managers should also take a sneak peek into the powerful world of building content and Revit families. We have added many time-saving and inspiring concepts to the book, supported by examples from our own projects and the rest of the real world, to help motivate and inspire you on your journey through building information modeling.

## What You Will Learn

This book will help you take the basics of Revit and BIM that you already know and expand on them using real-world examples. We will show you how to take a preliminary model and add layers of intelligence to help analyze and augment your designs. We'll show you how to create robust and accurate documentation, and then we'll help you through the construction process.

We go beyond introductory topics. To that end, we won't be starting a project from scratch or teaching you the basics of how to build a simple BIM model. If you are interested in learning at that level or are brand new to Revit, we strongly recommend you pick up *Autodesk® Revit® Architecture 2016 Essentials* (Wiley, 2015) before plunging headlong into this book. Instead, this book begins with a brief overview of the BIM approach. As you are already aware, BIM is more than just a change in software; it's a change in architectural workflow and culture. To leverage the full advantages of both BIM and Revit in your office structure, you will need to make some changes to your practice. We've designed the book around an ideal, integrated workflow to help you make this transition.

Starting with the project team, standards, and culture, we'll discuss how BIM changes your project approach and how to best build your team around a newer workflow. From there, we'll delve into conceptual design and sustainability studies, continuing through best practices for design iteration and refinement. You'll learn how to use powerful modeling techniques, how to design documentation best practices, how to make compelling presentation graphics, and how to take advantage of parametric design with the Family Editor. We'll explore workflow topics such as tracking changes and worksharing as well as some strategies that move beyond traditional concepts of BIM. The book includes an appendix on troubleshooting and best practices, so you can avoid common pitfalls. Throughout the book we've shared our practical experience with you, particularly in the form of real-world scenarios.

Whether you're studying Revit on your own or in a class or training program, you can use the "Master It" questions in the section called "The Bottom Line" at the end of each chapter to test your mastery of the skills you've learned.

### FREE AUTODESK SOFTWARE FOR STUDENTS AND EDUCATORS

The Autodesk Education Community is an online resource with more than five million members that enables educators and students to download—for free (see the website for terms and conditions)—the same software used by professionals worldwide. You can also access additional tools and materials to help you design, visualize, and simulate ideas. Connect with other learners to stay current with the latest industry trends and get the most out of your designs. Get started today at:

[www.autodesk.com/education/free-software/featured](http://www.autodesk.com/education/free-software/featured)

## The Mastering Series

The Mastering series from Sybex provides outstanding instruction for readers with intermediate and advanced skills, in the form of top-notch training and development for those already working in their field and clear, serious education for those aspiring to become pros. Every Mastering book includes the following:

- ◆ Real-world scenarios, ranging from case studies to interviews, that show how the tool, technique, or knowledge presented is applied in actual practice
- ◆ Skill-based instruction, with chapters organized around real tasks rather than abstract concepts or subjects
- ◆ Self-review test questions, so you can be certain you're equipped to do the job right

## What's New?

The Autodesk Revit team works continuously to improve the software, add new features, and eliminate bugs. It's a constant evolution. Here is a list of the items that have been added or enhanced in the 2020 release:

**Cloud Technologies** Revit has made several changes to how it integrates with cloud technologies. This includes updates to Autodesk® BIM 360 Design®, A360®, where documents and models are shared online, and how Revit works with conceptual design applications such as Autodesk® Dynamo® and Autodesk® FormIt®.

**PDF Management and Improved Image Quality** Revit now allows for the insertion of PDF files as 2D objects. If the PDF is vector based, it allows for snapping. In addition, you can use pick lines to select vector elements to generate native Revit elements such as walls and linework. Now you can copy images as instances and do not need to load duplicate copies.

**Elliptical Walls** The wall tool now allows for the generation of both elliptical walls and curtain walls. You'll see an ellipse option available in the draw panel.

**Path of Travel** New functionality in Revit allows for the picking of two points; then Revit will calculate the shortest distance between them, taking into account the geometry (i.e., walls, doors, openings, and furniture) that may impede the path of travel.

**Improvement in Filters** Improvements to the filter functionality include the addition of "OR" logic, and general UI enhancements.

**Scope Boxes** You can now edit and manage scope boxes in a view list, eliminating the need to manually search and manipulate them in individual views.

**Better Model Graphic Fidelity** The error message, "Element is too small to be viewed on screen," has been removed. This allows for a tighter granularity when detailing.

## What to Expect

*Mastering Autodesk® Revit® 2020* is divided into several parts, each representing a milestone in your progress toward becoming an expert Revit user. Here is a description of those parts and what they will show you.

## **Part 1: Fundamentals**

This book is not intended for novices, but we recognize that not everyone will know how to find every tool or have a complete understanding of the workflow. The chapters in Part 1 help you build a foundation of essential tools and knowledge.

Chapter 1, “Understanding the Principles of BIM,” covers principles in building information modeling within your office or project environment.

Chapter 2, “Exploring the UI and Organizing Projects,” details the Revit interface and general organization.

Chapter 3, “The Basics of the Toolbox,” explores the commands and tools within Revit. It gives you an overview of where to find them and prepares the deep dive into their use for the chapters ahead.

Chapter 4, “Configuring Templates and Standards,” discusses the tools you’ll need to develop and manage graphic standards in a project template.

## **Part 2: Collaboration and Teamwork**

Part 2 sets you on the path toward using Revit on a team or throughout your firm and takes a deep dive into a successful BIM workflow.

Chapter 5, “Collaborating with a Team,” discusses the critical tools for working with Revit on any project team.

Chapter 6, “Working with Consultants,” covers the basics of working with team members outside your office.

Chapter 7, “Interoperability: Working Multiplatform,” details the tools you’ll need to share your Revit files with other team members who don’t use Revit as a design tool.

Chapter 8, “Managing Revit Projects,” covers how to manage the Revit model to keep the file running smoothly and efficiently.

## **Part 3: Modeling and Massing for Design**

In this part, you’ll delve into the use of Revit starting from the early stages of design through analysis, iteration, and visualization.

Chapter 9, “Advanced Modeling and Massing,” details the creation of forms and shapes with the conceptual Revit toolkit.

Chapter 10, “Conceptual Design,” gives you an overview of conceptual design tools including Dynamo and FormIt.

Chapter 11, “Working with Phasing, Groups, and Design Options,” takes the next step after the initial design and analysis: iteration.

Chapter 12, “Visualization,” takes the design work you’ve created and shows you how to create stunning renderings and imagery of your design.

## **Part 4: Extended Modeling Techniques**

Part 4 takes the conceptual forms you create in Part 3 and expands them to the real world using walls, floors, roofs, and other building components to create the elements behind a building.

Chapter 13, “Creating Walls and Curtain Walls,” delves into the use of the Wall and Curtain Wall tools.

Chapter 14, “Modeling Floors, Ceilings, and Roofs,” demonstrates a variety of ways to work with the horizontal components of a building: floors, ceilings, and roofs.

Chapter 15, “Designing with the Family Editor,” shows you how to work with parametric families to create a host of content for the building design.

Chapter 16, “Creating Stairs and Railings,” demonstrates a variety of ways and techniques to use the Stair and Railing tools—for their intended purpose and for others.

## **Part 5: Documentation**

Once the building is designed, it becomes necessary to create the views and documents needed to build the project. This section shows you how to detail, document, and annotate the design.

Chapter 17, “Detailing Your Design,” works with the building design you created in previous chapters to add 2D components for documentation.

Chapter 18, “Documenting Your Design,” works with the newly created views and helps you organize them on sheets.

Chapter 19, “Annotating Your Design,” takes the next step in the documentation process and works with keynoting and dimensioning.

## **Part 6: Construction and Beyond**

This section focuses on what to do once the design is resolved, taking it into the construction process and working with presentation tools.

Chapter 20, “Working in the Construction Phase,” focuses on the tools Revit has to keep track of changes during construction.

Chapter 21, “Presenting Your Design,” shows you how to take the completed design and display the results in a variety of 2D and 3D methods.

Chapter 22, “Design Analysis,” teaches you how to use new tools that analyze the energy consumption of your proposed design and help optimize the building’s energy footprint.

## **Appendixes**

Three appendixes supplement the chapters’ coverage of Revit software features.

Appendix A, “The Bottom Line,” offers solutions to the “Master It” questions in each chapter’s “Bottom Line” section.



Appendix B, “Tips, Tricks, and Troubleshooting,” is just what the title describes—a collection of tips and tricks for troubleshooting and working effectively with Revit.

Appendix C, “Autodesk Revit Architecture Certification,” describes Autodesk’s certification exam for Revit Architecture and how this book can be used as a supplementary tool for test preparation. Throughout the book, the icon shown here marks significant coverage of exam objectives.

## **Contacting the Authors**

We welcome your feedback and comments. You can find the authors on Facebook at Mastering Revit and on Twitter @MasteringRevit.

*We hope you enjoy the book.*



## Part 1

# Fundamentals

Although this book is focused on helping you master Revit, we recognize that not everyone will know how to find every tool or have a complete understanding of workflows. The chapters in Part 1 will help you build a foundation of essential knowledge and may even give veteran Revit users some additional insight into the basic tools and concepts of building information modeling (BIM).

- ◆ **Chapter 1: Understanding the Principles of BIM**
- ◆ **Chapter 2: Exploring the UI and Organizing Projects**
- ◆ **Chapter 3: The Basics of the Toolbox**
- ◆ **Chapter 4: Configuring Templates and Standards**





## Chapter 1

# Understanding the Principles of BIM

In this chapter, we cover the principles of a building information modeling (BIM) approach within most office environments and summarize some of the many practices used in today's architectural workflows. We explain how you and your organization can achieve some of the many possible benefits from BIM by sharing the processes that these technologies support. As you will see, these practices are oriented to industry BIM uses that provide advantages such as more thoroughly explored design concepts, better coordinated documentation, and better executed construction methods.

### IN THIS CHAPTER, YOU'LL LEARN TO

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- ◆ Focus your investment in BIM
- ◆ Understand a BIM workflow
- ◆ Leverage BIM processes

## The Fundamentals of a BIM Approach

Building information modeling is an integrated model-centric methodology that delivers validated and coordinated knowledge about a building project throughout planning, design, construction, and operation. When this collaborative, interdisciplinary approach is optimized, it can improve an organization's operations. BIM provides designers, contractors, and owners with a process to improve decision-making, quality, and timeliness. At the core of this BIM approach are model-centric workflows (geometric and data models) that support project execution and asset lifecycle management. These workflows determine the methodology for creating data-rich geometries, integrated deliverables, and a model-based process to develop projects from planning through the operation and management lifecycle phases. BIM can be defined through technology, processes (its governance through standardization), and people. The technology system is central to the processes of creating, storing, and using models. With processes, the success of BIM requires all stakeholders in the project ecosystem to follow a series of steps, both as individuals and as a team. Ultimately, the users of these techniques and technologies are committed to improving their design process by successfully integrating both geometry and data.



If you are investing in BIM today, understand that BIM has been adopted by many in the AEC (architecture, engineering, and construction) industry. To succeed with these practices in the current environment, a business must make fundamental changes in the way it operates, whether by moving into a new market or by changing its methods of operation. It requires an alignment of the organization's activities relating to its people, processes, and technology with its business strategy and vision. Through collaboration and data management during an asset's lifecycle, sharing information efficiently and effectively can support better integration and interoperability among all project stakeholders. Along with this data comes the possibility of integrated analysis. By making these analyses easily accessible, derivatives of this model-centric workflow can provide a better understanding of design opportunities and decisions' consequences. With the availability of valid geometry-based data, 2D, 3D (visualization, clash detection), 4D (time), 5D (cost), and beyond are possible. Taking advantage of these capabilities is a must in keeping architecture firms relevant in today's market. Transforming your organization's business quickly and efficiently will be the difference between maintaining your market share and taking that next evolutionary step forward.

## **The Management People inside a BIM Project Team**

The architectural marketplace has changed, and it influences staffing decisions as skills needed for BIM projects can be different than traditional CAD skill sets. Some of your organization's leadership may be aware of this change and are organizing BIM teams and resources to better anticipate new processes. Others are unsure of how BIM may change how they plan projects, from staffing to hiring. When looking to acquire BIM-skilled staff, savvy firms look for process experience in their new hires and no longer solely focus on hiring those with tool expertise. The primary factor is always professional experience, but having knowledge of BIM workflows complements these professional skills.

When planning project staffing, architecture firms generally focus on deliverables produced by a project hierarchy of managers, designers, engineers, drafters, and interns. BIM roles and responsibilities are based on availability within the project team, rather than composing the best fit based on model-based workflows. This does not constitute a project problem as much as it decreases efficiency in two ways:

- ◆ Roles/responsibilities are not clearly defined, and team members must adjust to BIM project needs during the project. Managers, who are making staffing decisions, may not have the resources to judge BIM experience level or tool/process skill sets, other than hearsay or previous project experience with similar circumstances.
- ◆ Though BIM managers have a better understanding of project workflows and needed capabilities, they do not generally make staffing decisions for projects. There may be project managers who know to confer with BIM managers at project startup; however, in many cases the BIM manager is brought in after project requirements and commitments are made.

Typically, professionals are hired based on project experience, education, and certifications. Historically for architecture firms, BIM experience was considered as nice to have but not required. In today's market as BIM and BIM skills have become commoditized and in high demand, an increasing number of professionals have BIM experience on their résumés in the

form of project experience and trained tools. Not having these skill sets does not preclude staff from being successful BIM project team members; it does impede the ability of managers with BIM experience to staff projects appropriately. It hinders their ability to develop a plan in accordance with project requirements.

BIM project execution is fast becoming the standard project methodology. Regardless of your role, whether you are making staffing decisions or are a hardworking BIM project team member, understanding how BIM workflows are changing the planning and execution of projects is important. We must accept that BIM is now essential, and we must be prepared to address the roles, processes, and technology.

## Staffing for BIM

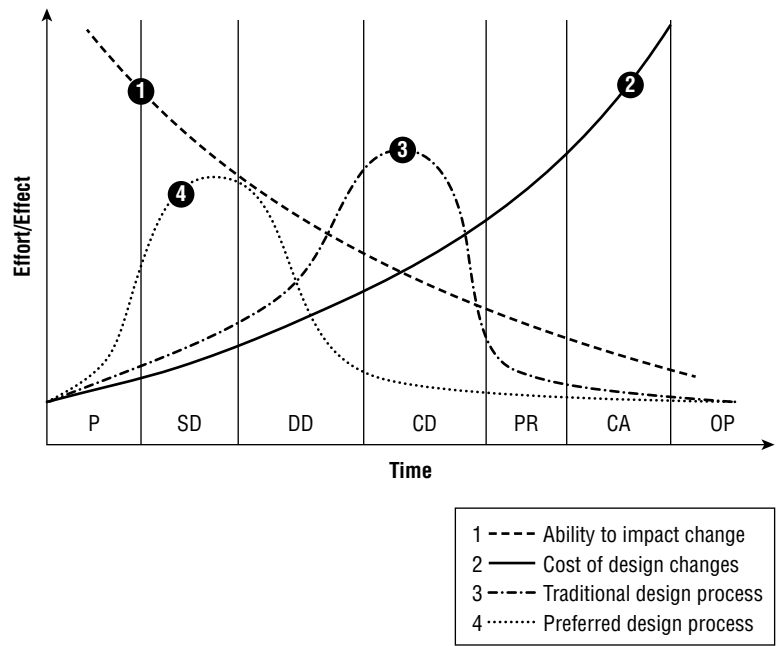
As the building industry's process of design and documentation is transforming, one of the fundamental changes that teams need to address is staff planning in a BIM process. A common misconception of project management is that staffing the BIM project will be the same as it has been in CAD workflows. Unfortunately, this is not the case. Because a BIM-based project can significantly alter the project workflow, which now includes BIM-focused goals that are beyond simple documentation, many of the standard timetables for task completion are no longer valid. (See Chapter 8, "Managing Revit Projects," for further details.) Although fundamental deliverables remain the same (drawings, schedules, etc.), the processes to reach these outputs are different. For example, in a CAD workflow, a user can create a plan as a single one-off entity. In a BIM workflow, the same user must develop a model before a floor plan can be produced. The investment in the 3D model requires more time upfront, and therefore the floor plan to be produced necessitates a longer schedule. However, once the model has been developed, many other derivatives become expedient, such as other drawing types (i.e., sections, elevations, callouts), schedules, analysis, and 3D renderings. To leverage this workflow, the staff and processes must consider the gathering of momentum early in the cadence of execution to accommodate all phases.

Years ago, Patrick MacLeamy, who was then CEO of Hellmuth, Obata, + Kassabaum, explained this workflow movement with a diagrammatical description of the shift of workload and the ease of affecting change in the construction process forward. The graph, which has come to be known as the MacLeamy curve (Figure 1.1), is not simply intended to imply a shift in labor earlier in the design process; rather, it stresses the importance of being able to make higher-value decisions earlier, before changes become too difficult or costly to implement. The x-axis of the chart represents project phases from conceptual design through occupancy, whereas the y-axis represents the amount of effort in each phase.

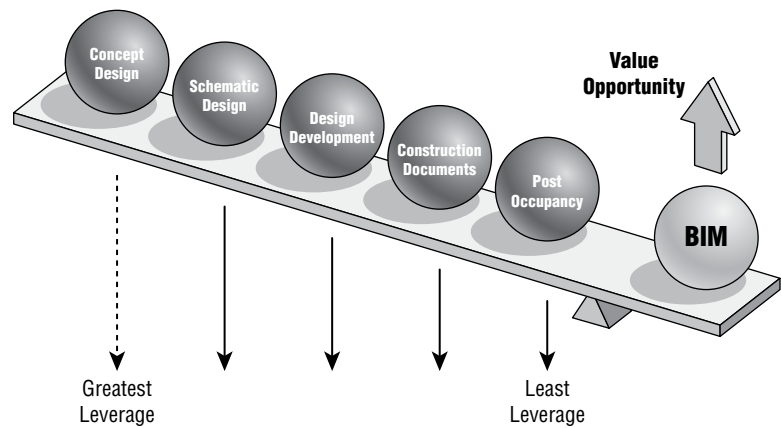
Another important aspect of a BIM workflow is its ability to leverage decisions earlier in the process. As shown in Figure 1.2, implementing BIM in initial project phases allows teams to make and share better information earlier so that the entire project team can benefit. Based on *BIM uses*, a common industry term that we will refer to later in this chapter, project teams may need to adjust labor in the planning and design stages to support the development of the geometric and data model. In a CAD workflow, different project roles are assigned separate tasks to move the design forward. A planner may be developing a program, just as a designer may be producing massing studies. In a BIM workflow, these roles may be continuing the same task, but instead of working independently, they are working in the context of a single model, allowing them to interact through geometry and information. Because of this interaction and its ability to

allow better decision making, project teams may be deploying additional staff to help support this collaboration in BIM. Depending on the BIM uses, teams might increase staff to build a model or to perform energy analysis; however, deploying a BIM workflow will not necessarily provide more proficiency or quality than a CAD-based project without proper planning and governance.

**FIGURE 1.1**  
The effort curves in the design and construction industry



**FIGURE 1.2**  
BIM provides more leverage when it is implemented earlier in the design.



## Understanding Project Roles

It's also important to understand how the significant changes to tools and processes provided by BIM affect the roles and responsibilities of the project team. Project managers need to plan staffing and labor required to complete tasks in every project phase. BIM projects are supported by a few primary roles that will allow the team a level of predictability, although the specific effort and staffing will vary between offices (and even projects). Here are the primary roles that should be considered on every BIM project:

**Design Architect** Generates design intent from the planning stage through early design

**Technical Architect** Produces the deliverables, ensuring the design intent is achieved

**BIM Coordinator** Directs the BIM workflow between design and production

These roles represent efforts and general tasks that you need to take into account on any BIM project. For larger projects, these roles could represent multiple people, whereas smaller projects might constitute the same person filling multiple roles. For many architecture firms, designers and production staff may be tightly integrated and have few differences in responsibilities. For other firms, there may be a clear demarcation between the first two roles. Regardless of the interaction between designers and production roles, every BIM project has some coordination responsibilities. We will next explore each of these in more detail and discuss how these roles affect the project workflow.

## THE ROLE OF THE DESIGN ARCHITECT

The role of the design architect is to generate the design intent, typically focused on the project from pursuit through planning to design development. These staff may include licensed architects and interns. Designers typically interact with the BIM process by first transferring their conceptual ideas into digital form. For many planners, this is going from 2D layouts to a 3D model. For more sophisticated designers, it might be to create a conceptual massing model based on sketched geometry or something as sophisticated as iterative design calculations. Whatever the case, designers start the modeling process on a project.

For some workflows, designers may stay in a more traditional process, and technical architects begin the BIM process based on their designs. As creative processes and digital capabilities align, designers moving forward are more likely to use digital authoring tools for their work rather than traditional ones, such as hand sketching and physical modeling. With this, the BIM process will start earlier in the project time line. Following this workflow, designers have the capability to make better decisions for the project team earlier based on the intelligence they provide to their geometric-based designs. What becomes most important at this stage is having a workflow specific to design work in BIM projects that allows creativity but properly sets the stage for production staff to develop the designs into buildable instructions. With this in mind, the typical responsibilities for a design architect include:

- ◆ Create initial design intent models through 3D geometry *using* conceptual massing or iterative design processes
- ◆ Lead the creation of architectural elements and building from within the model
- ◆ Design around code requirements and other building logistics

## THE ROLE OF THE TECHNICAL ARCHITECT

The role of the technical architect is to ensure that the project is buildable. These staff can be a wide-ranging group from experienced licensed architects and architectural technologists to interns who are learning how buildings go together. As with design architects, technical architects have a role in the BIM process not because of their professional skill sets but because of their responsibilities to the project workflow. As models are developed, technical architects solve issues such as constructability, wall types, and managing the program of spatial and equipment requirements, as well as other issues involving code compliance and client relationships.

Primarily concerned with deliverables, production staff manipulates models to create the needed outputs, such as drawings and schedules. The role of these staff is to create sheets and embellish associated views with annotations or other details. This role applies standards to the project (as in wall types, keynotes, and so on) and organizes the document set. Technical architects are responsible for the bulk of the work needed to document the project. In earlier stages of the project, this role is typically assumed by either the architect or the modeler, but as documentation progresses into later phases of design, this can quickly become the role of multiple people on a larger project. This role includes the following tasks:

- ◆ Validate the constructability and detailing aspects of the design
- ◆ Produce project deliverables from well-coordinated models
- ◆ Follow the established Level of Development (LOD) or Model Development Specification (MDS) to ensure models comply with requirements of the stated BIM uses
- ◆ Ensure the models and valid data are passed to construction and operation phases of the project lifecycle

## THE ROLE OF THE BIM COORDINATOR

BIM coordinators supervise the overall project modeling techniques and discipline-specific BIM output through all project phases. They are responsible for checking that all models produced by design and production staff comply with the standards set out by the *BIM execution plan (BxP)*. They check that models are correctly named and are the current version and that all relevant asset metadata has been completed with appropriate values. They coordinate requests for supplier information from the design teams and determine whether model details already exist in the library of design objects. Where model components do not already exist, they create or delegate their creation in the context of standards and set responsibilities. Their BIM duties are to:

- ◆ Author and maintain the technical sections of the BxP
- ◆ Determine project file organization and model splitting strategy
- ◆ Define file sharing protocols for the project
- ◆ Determine team training needs and organize training if needed
- ◆ Assemble and maintain any multidiscipline models
- ◆ Manage publication of files

- ◆ Create project delivery output from assembled files matching all the firm's BIM standards
- ◆ Review models for adherence to project standards
- ◆ Maintain the team's access to the correct tools for BIM authoring, aggregation, and analysis
- ◆ Oversee the application of BIM technologies and ensure that the model adheres to all internal and client-specific goals and standards
- ◆ Oversee the development of the content of a specific model element to the LOD/MDS listed for specified phases of the project
- ◆ Assist all team members in BIM processes at all stages of the project
- ◆ Lead 3D coordination meetings

These BIM roles for architectural project teams generally work for most firms and building types; however, it is ultimately up to each organization and its management to decide how team members share in the responsibilities of managing geometry and connected data specifically for its needs. As long as there is an expectation set at the beginning of the project and a workflow defined during its phases, any number of roles and responsibilities should help ensure that the project is completed successfully. In support of that, project managers have a responsibility to help maintain the integrity of this workflow. Although they may not be directly developing models, they are making important staffing decisions based on this workflow and have the responsibility to ensure that the deliverables from this process meet contractual obligations. With that, we suggest that project managers have enough knowledge of BIM people, processes, and tools to do the following:

- ◆ Understand the impact BIM has on a project delivery schedule
- ◆ Allocate time as planned for BIM management activities for the BIM coordinator and any BIM administration and support requirements
- ◆ Be familiar with BIM concepts and uses on a project so that they are able to effectively manage the project team and communicate progress and requirements to the client
- ◆ Oversee the administrative and contract sections of the BIM project execution plan

## Establishing a BIM Execution Plan

To optimize your results with BIM, you need to start with the end in mind. Although a lot of tasks are possible with BIM, before you draw your first wall, you will want to create a BxP. We go into more detail about creating these plans and some resources for them in Chapter 6, "Working with Consultants," but essentially a BxP helps to drive the direction of the modeling effort and modeling outcomes. How will your consulting team share models? Will your project need to provide BIM deliverables such as a reference model or databases in the *Construction Operations Building Information Exchange (COBie)* format? Does the owner have expectations for a model deliverable for operations and management? All those possibilities and more are explored and documented in a BxP. It gives the project team a definitive outcome to develop and enrich the models.

Creating a standard BIM execution planning process for every project will help teams plan and carry out the required processes to achieve the anticipated goals. By using a BxP template and a planned methodology, the project team members should actively pursue these concepts:

- ◆ All parties should clearly understand and communicate the strategic goals for implementing BIM on the project.
- ◆ Teams should understand and communicate their roles and responsibilities in the project execution.
- ◆ The plan should outline resources, training, or other competencies necessary to successfully implement BIM for the intended uses.
- ◆ The baseline plan should provide a goal for measuring progress throughout the project.
- ◆ The plan should provide a benchmark for describing the process to future participants who join the project.

Inexperienced teams trying to implement unfamiliar BIM processes without a BxP can carry risk such as impact to project cost and schedule. To address this, if the BxP is well planned and communicated, the project team will have set expectations of what is to be done and how, thereby reducing the overall risk to the project. To ensure a successful project execution planning process, the team should do the following things with the BxP:

- ◆ Modify the plan to meet the project's needs.
- ◆ Build the plan with the entire consulting team.
- ◆ Create a *MDS* and supporting *LOD* for model elements with the entire project team to include consultants. This will facilitate model and staff planning.
- ◆ Review the plan early and often, making needed changes as project experience grows.

For those who are responsible for developing the BxP for a team, begin the plan by referencing industry-based templates, such as the Penn State Project Execution Plan or the Autodesk BIM Deployment Workbook, that can provide you with shortcuts to a well-organized and consistent BxP process. Determine what is needed by your project teams and then modify the plan to match your requirements. Additional language specific to the type of facility and construction should be added to the plan to make it more appropriate. A comprehensive BxP should include these sections:

- ◆ Statement of project goals and objectives
- ◆ Intended BIM uses
- ◆ Team structure and deliverables
- ◆ Roles and responsibilities
- ◆ Data transfers
- ◆ Phase-based data requirements
- ◆ Intended authoring, analysis, and aggregation tools
- ◆ Governance information

By doing these things, project teams should have no problem developing a comprehensive BIM execution plan that will benefit them on a daily basis.

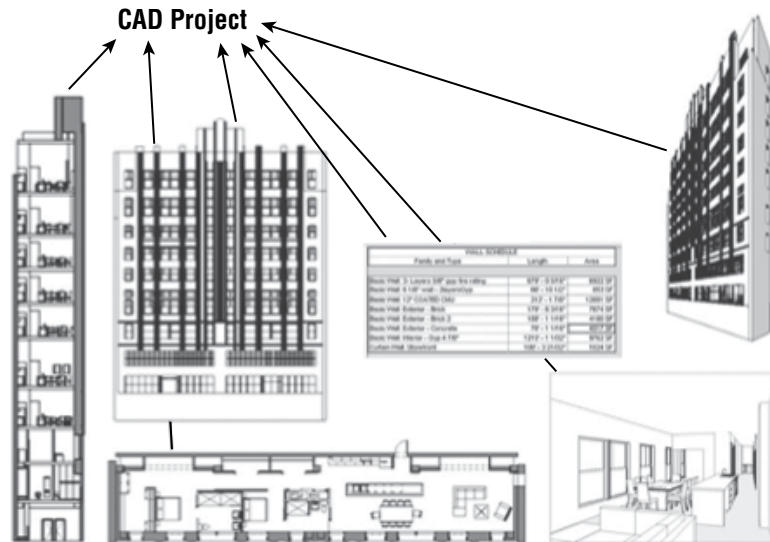
## Optimizing BIM Processes

According to the National Institute of Building Sciences ([www.nibs.org](http://www.nibs.org)), BIM is defined as “a digital representation of physical and functional characteristics of a facility” that serves as a “shared knowledge resource for information about a facility forming a reliable basis for decisions during its lifecycle from inception onward.” Although this defines BIM as a noun used to describe the electronic data, the verb form of building information *modeling* is equally important. BIM is both a tool and a process, and one cannot realistically exist without the other.

Building information modeling implies increased attention to more informed design and enhanced collaboration. Simply relying on tools to replace your current processes without an updated corresponding methodology will yield limited success. In fact, it may even be more cumbersome than using traditional CAD tools to execute project work.

Regardless of the design and production workflow you have established in the past, moving to BIM is going to be a change. Moving to BIM is a shift in how designers and contractors approach the design and documentation process throughout the entire lifecycle of the project, from concept to occupancy. In a traditional CAD-based workflow, represented in Figure 1.3, each view is drawn separately with no inherent relationship between drawings. In this type of production environment, the team creates plans, sections, elevations, schedules, and perspectives as standalone entities and must coordinate any changes between these views manually.

**FIGURE 1.3**  
A CAD-based workflow

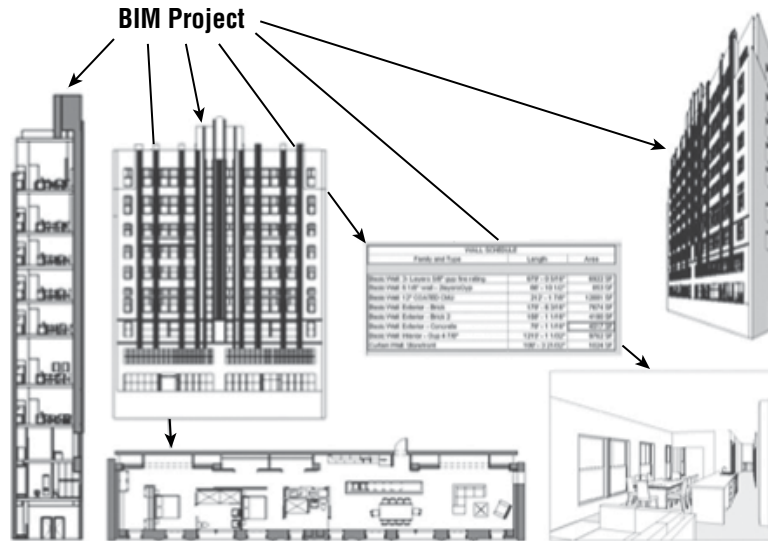


In a BIM-based workflow, the team creates 3D parametric models to generate the drawings necessary for documentation and analysis. Plans, sections, elevations, schedules, and perspectives are all by-products of creating a building information model, as shown in Figure 1.4. This



enhanced representation methodology not only allows for highly coordinated documentation but also provides the basic model geometry necessary for analysis, such as daylighting studies, energy usage simulation, material takeoffs, and so on.

**FIGURE 1.4**  
A BIM-based workflow



## Identifying and Planning BIM Uses

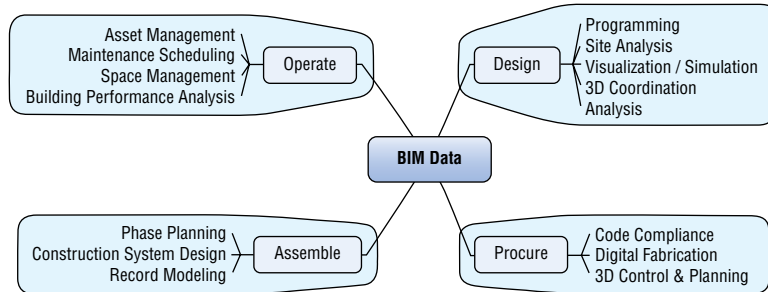
We encourage you to explore ongoing research from organizations such as Penn State University, buildingSMART International, and the UK BIM Task Group. Penn State (<http://bim.psu.edu>) has developed a catalog of BIM uses and project implementation guidelines that have been adopted into the National BIM Standard-United States Version 3 (<http://nationalbimstandard.org>). Another important aspect of supporting numerous BIM uses is the development of open standards. The organization known as buildingSMART ([www.buildingsmart.org](http://www.buildingsmart.org)) provides a global platform for the development of such standards. The UK-based CDBB (Centre for Digital Built Britain) ([www.cdbb.cam.ac.uk](http://www.cdbb.cam.ac.uk)) is helping that region adopt BIM practices through building standards and educational support. Groups from several regional chapters around the world are generating information exchange standards that will soon have a profound impact on the ways in which we share model data with our clients and partners. The following are some of the developments:

- ◆ Industry Foundation Classes version 4 (IFC4), accepted as ISO 16739
- ◆ Construction Operations Building Information Exchange (COBie)
- ◆ Specifiers' Properties Information Exchange (SPie)
- ◆ BIM Collaboration Format (BCF)

For a general overview of the approach to standardizing exchanges with information delivery manuals (IDMs) and model view definitions (MVDs), visit <https://technical.buildingsmart.org/standards/ifc/ifc-schema-specifications>.

As the industry continues to build processes around the technology behind BIM, its potential continues to grow. Many applications are possible using building information modeling. As more and more benefits are achievable through BIM, teams find new uses to explore and develop. Figure 1.5 shows some of the potential opportunities that have been identified by the AEC industry and clearly organized by Penn State.

**FIGURE 1.5**  
Service opportunities  
that BIM supports



When you are trying to plan and manage your organization's BIM and methodology, it's important to think about the use of these processes and technology to achieve your project goals. One of the primary ways of understanding this is through BIM uses. These many uses can be organized into five basic activities: gather, generate, analyze, communicate, and realize.

**Gather** To collect and manage building information

**Generate** To create information about the building

**Analyze** To examine aspects or components of the building to make better decisions about how to plan, design, construct, or operate it

**Communicate** To collaboratively share information about a building

**Realize** To build or manage a physical element using building data

Understanding how benefits are derived from these uses will help focus your teams' efforts in planning, managing, and governing BIM processes.

## Gather

As architects pursue work and plan awarded projects, they gather information about budgets, required functionality, site context, and anything else of significance that is required to make the best decisions for the project. In an analog process, this information may be gathered in the building program, a contract, or even a cartoon set of drawings required. The advent of BIM processes and technology is changing this. BIM not only allows the acquisition of smartly acquired contextual data about the project but also becomes an improved repository for information gathered in traditional ways.

One example of these traditional processes is the creation of the space program. Space programs are usually developed by interviewing user groups that are to occupy the building and gathering information about the things that they do and the equipment they need in the adjacencies of the spaces they occupy. These processes are collected in a spreadsheet or in graphical

layouts that explain their qualities. This type of data is typically used in parallel with the design process, with many planners manually pulling information into computer-aided drawing (CAD) layouts. With BIM, this process takes on a more evolved approach to connecting design data to programmatic requirements. Using a BIM process, a designer can input spatial information directly into the model database even before conceptual massing or area plans are generated. This allows the designer to take directly from the program information to lay out a design and get instant feedback on whether it meets the required tolerances for these requirements.

Another example of gathering intelligent data could be in the form of laser scanning. There are sophisticated technologies that allow for the generation of point clouds for preexisting spaces. The generation of these spatially located points can be used as an accurate underlay in the building of existing conditions. With millions of points available, designers have at their fingertips a massive amount of data in which to begin to understand the context of their designs. This has incredible applications for complex renovations or spatially challenged sites or even historical preservation efforts.

Through this kind of information gathering, the qualification and quantification of data can empower the design team to understand both the implicit and explicit attributes of its projects. These processes can also help support estimating and cost-forecasting efforts. During the early design phases of a building, quantities may be generally estimated but become more certain as the contract documents are created and construction processes proceed. All along, the stored information becomes more and more accurate with respect to design intent.

Toward the later part of the construction process and into operations and maintenance, processes can help establish real-time performance measurements within facilities to help owners understand energy usage, operation costs, and many other metrics. For example, an integrated operations and maintenance (O&M) system may be tracking electrical costs on an hourly, daily, weekly, monthly, and yearly basis to help owners understand where they're maximizing their energy investments and where there is waste that can be reduced.

As illustrated in this section, we hope that you see how information gathering can be important throughout the entire lifecycle of a BIM project.

## **Generate**

One of the most common aspects of building information modeling, and the one most accessible to new users, is the creation of intelligent geometry. As users draw a wall, a mass, or a new level, they are generating not only form but also data that helps them make informed design decisions. For example, when a wall is drawn in an authoring tool, that object can immediately have attributes such as length, width, and height. It may also have multiple materials, structural and finish, as well as cost and a fire rating. In a CAD process, the users must maintain the intelligence that they attribute to the objects they are drawing. They may be able to quickly generate four lines to represent a wall that could understand length and width, but that's where the distinction stops. These CAD drawings, although they can contain additional information, are inherently focused on the output, whereas building information models inform the outputs. A wall in a model database is the design. In CAD, the outputs represent what the users conceptually maintain in their mind. As smart as we are as architects, we can't maintain all the information needed to be communicated to the contractor in building our designs. That's where BIM can begin to support us by maintaining the information for us.

When users generate information about the project through both geometry and integrated data, they are prescribing attributes, arranging elements, and determining real-world

dimensions. Within the context of the lifecycle of the building, the designers during the planning and design phases are the primary generators of geometry and data. During the construction phase of the project, the subcontractors will manage most of the data in the models. For sophisticated BIM projects, the construction phase management of as-built data can be created to build a foundation for the operations phase where that information could be used to operate and maintain the building. This database that they might maintain could be updated with new information throughout its entire lifecycle. This might include new equipment installed or renovations made to existing structures.

As experts generate both geometry and data for the project, they are specifying qualities and generating design data. The planner of a building may define spaces in the building, just as a structural engineer may define a structural grid. Later in the project, a contractor might define a specific construction sequence as attributes of materials, just as the owner's construction manager may define the need for a specific piece of equipment. Because all these ideas are generated inside the building information model or linked systems that influence this database, generation of building data can happen in every phase.

As designers make decisions about the spatial configurations of the building, they have a range of elements in three dimensions. This is the beginning of 3D coordination processes, which is a major asset to BIM practices in terms of collaboration and problem solving. This can begin with the arrangement of spaces; move to an arrangement of structural systems, through mechanical, electrical, and plumbing systems; and end with coordination of trades that are constructing the building. Because of all these aspects that occupy space and therefore have some relationship with one another, the model becomes a spatial organizer for this arrangement.

Before the opportunities that BIM provides, subcontractors could only determine technical issues with installations as services were being installed. This might include a piece of ductwork that does not quite have enough room to move around a beam or a doorway that does not have enough clearance from the edge of the stair riser. Because BIM provides the ability to simulate design conditions, the spatial coordination between designers, engineers, and consultants can be addressed prior to construction and installation. We now have the ability to find mistakes within a simulated environment and provide corrective actions during the design phase of the project. This ability to solve problems earlier in the arrangement of these three-dimensional objects affords designers and builders a terrific opportunity of designing better outcomes with much more cost-effective and timely solutions. In the end, it's much cheaper to fix it in the computer than in the field.

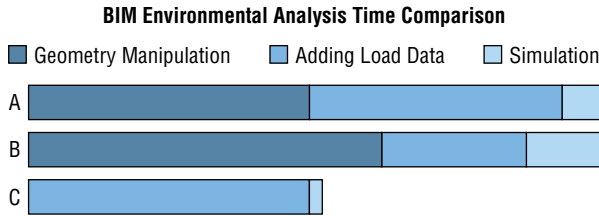
The sizing of geometry is also an important aspect to the generation of information in these models. Just as spatial organization is important, the ability to estimate the correct dimensional aspects of building systems in the specification of equipment is important. Generating sizing information in a 3D model might take the form of creating types based on standard industry specifications. Being able to specifically model objects that have real sizes and tolerances helps designers make the right decisions about specifying common building elements and complex building systems. Typical authoring programs have tolerances built in for the level of detail that's required to have buildings constructed accurately. Users have the capability of modeling much more accurately than they ever could in the field. Of course, the caution here is that teams need to realize that though they can be more accurate in the model, the ultimate purpose of the model is to get the building built and into operation efficiently and effectively. This means sizes should be based on the requirements of the construction trades; any more information or accuracy beyond that is not needed. However, where BIM shines above typical CAD processes is its ability to share truth. It is much more work to hide the true sizes than it is to display them accurately.

This may frustrate some users who are used to applying their own dimensions, until they realize that the models represent what they designed, whether it is to a standard dimension or not.

Analyze

The primary purpose for the authoring environment is creation and not analysis. Because geometry and data are combined in a single database, confidence in that interaction allows us to begin to understand what it is and what it will create. This first step into analysis begins at the planning stages. However, it's common to pull information from the authoring environment into one specifically built for analysis. You'll find that many processes and tools specifically built for analysis work in parallel, and sometimes perpendicular, to model authoring. The real value in BIM beyond design documentation is the interoperability of model geometry and metadata between applications. Consider energy modeling as an example. In Figure 1.6, we're comparing three energy-modeling applications: A, B, and C. In the figure, the darkest blue (gray) bar reflects the time it takes to either import model geometry into the analysis package or redraw the design with the analysis package. The lighter blue bar (gray) reflects the amount of time needed to add data not within the authoring environment, such as loads, zoning, and so on. The lightest bar represents the time it takes to perform the analysis once all the information is in place.

**FIGURE 1.6**  
BIM environmental  
analysis-time  
comparison



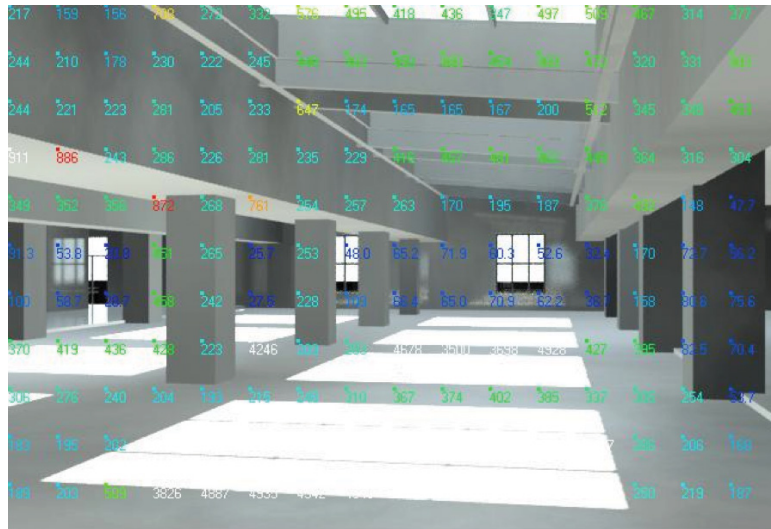
In some instances, models authored in one platform may not work directly with analysis platforms, such as the example in A and B. This caused the re-creation of the geometry directly in the analysis tool and also required time to coordinate and maintain the design and its iterations between the two models. The trend of these tools is moving toward better integration or additional analysis tools embedded inside the authoring applications. In application C, model geometry was directly imported into the analysis package, saving nearly 50 percent of the time needed to create and run the full analysis. Using this workflow, you can bring analysis to more projects, perform more iterations, or do the analysis in half the time.

The same workflow is true for daylighting (Figure 1.7) and other types of building performance analysis. By designing directly in the authoring tool, designers are able to move away from anecdotal or prescriptive design solutions and begin to rely on calculated results.

Building analysis can reach beyond just the design phase and into the whole building lifecycle. Once the building has been occupied, the use of BIM does not need to end. More advanced facilities management systems support tracking—and thereby trending—building use over time. By trending building use, you can begin to predict usage patterns and help anticipate future uses such as energy consumption or expansion. This strategy can help you become more proactive with maintenance and equipment replacement because you will be able to perceive how equipment performance begins to degrade over time. Trending will also aid you in providing a more comfortable environment for building occupants by understanding historic use

patterns and allowing you to keep the building tuned for optimized energy performance. The application of this analysis comes in the Realize stage of BIM uses covered later in this chapter.

**FIGURE 1.7**  
Daylighting overlay from  
Autodesk® 3ds Max®



## Communicate

Using BIM to better visualize a building is a powerful way to communicate design intent. Creating documentation and visualization using BIM gives teams the added advantage of being able to communicate the design of the project in 3D, where it is more accessible to project participants. It is especially persuasive for those who are involved directly with the construction process but are still important decision-makers. Owners can benefit greatly from this type of communication. In this, visualization is a valuable tool for making design or construction decisions.

Although 3D visualization was initially conceived as one of the “low-hanging fruits” of a BIM workflow, this benefit has led to an explosion of additional perceptions of the design, including isometric details, renderings, animations, clash detection reports, and so on. This provides a much better way to communicate design opportunities and decisions between project stakeholders.

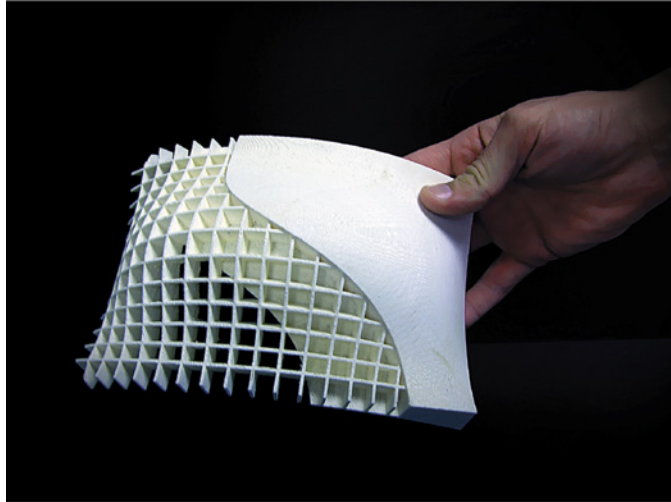
In the 1990s, if you wanted to create a rendering, a physical model, a daylighting model, an energy model, and an animation, you would have had to create five separate models and use five different pieces of software. There was limited ability to reuse model geometry and data between model uses. One of the key uses of BIM is the opportunity to repurpose the model for a variety of visualizations; you never have to re-create geometry between uses. Reuse also ensures that you’re using the most current information in each visualization because it comes from the same source. As the capacity of cloud rendering and analysis grows, the feedback will no longer need to process locally, and you’ll be able to receive feedback faster.

This digital creation of the project has given us a variety of tools to communicate its aspects. Because the model is a single source of truth, it can be used in many different applications for communicating. Models may be imported into a gaming engine for an interactive virtual

experience, allowing clients to virtually tour the building at their own pace, to help understand how this building will accommodate their functional and aesthetic needs. These same virtual models can be physically printed through rapid prototyping methods such as 3D printing, creating small models (Figure 1.8) in a fraction of the time it would take to build one by hand. Many other forms of communicating through BIM are emerging as you read this book.

**FIGURE 1.8**

An example of rapid prototyping using BIM data  
Source: HOK



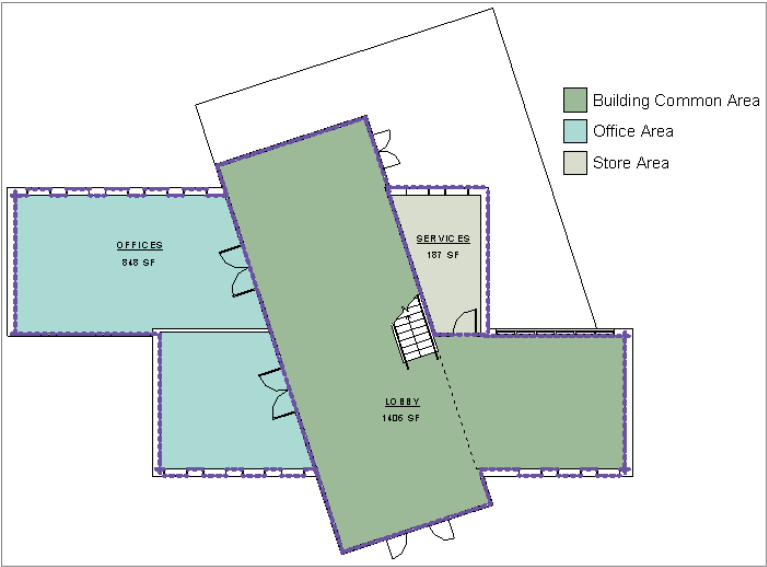
If we consider a broad spectrum of representations, from tabular data to intelligently generated 2D documentation and 3D visualization, our traditional design deliverables become transformed. Schedules give you instantaneous reports on component quantities and space usage, whereas plans, sections, and elevations afford you the flexibility to customize their display using the information embedded in the modeled elements. For example, the plan in Figure 1.9 shows how color fills can be automatically applied to illustrate space usage by function. Because this is live in the model, changes can be made easily, providing confidence to the communicators and the receivers of this information that what they are seeing is accurate and can be the basis of valid decision-making.

Expanding 2D documentation to include 3D imagery also gives project teams the ability to clearly share the intent of more complex designs. It also has a positive effect on construction by reducing translation errors with illustrative documentation, rather than cryptic details and notations. Figure 1.10 shows a basic example of a drawing sheet composed of both 2D and 3D views generated directly from the project model.

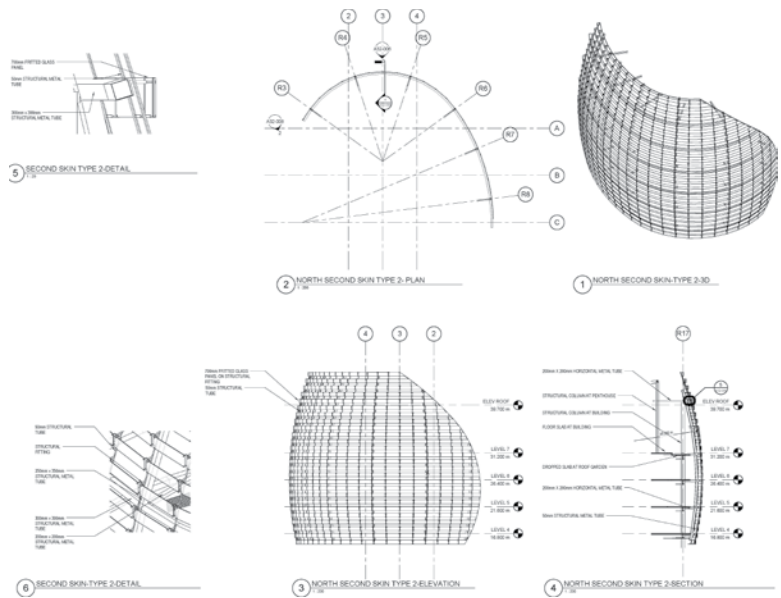
Another obvious benefit to creating a complete model of the building is the ability to generate a wide variety of 3D images for presentation. These images are used not only to describe design intent but also to illustrate ideas about proportion, form, space, and functional relationships. The ease with which these kinds of views can be produced makes the rendered perspective more of a commodity. As shown in the left side of Figure 1.11, materiality may be removed to focus on the building form and element adjacencies. The same model is used again for a final photorealistic rendering, as shown in the right side of Figure 1.11. As the model contains information of both form and function, it's up to the communicator to decide what information is shared. A plan,

perspective, and schedule can share common information. Because they come in different forms, the intent of the communication can be different. That is the great boon of having an intelligent model; you decide where and when information is communicated in any of the outputs with the confidence that it is the single source of truth.

**FIGURE 1.9**  
Even 2D views can evolve to illustrate and analyze spatial properties.



**FIGURE 1.10**  
Construction documentation can begin to transform from 2D to 3D.  
Source: HOK





**FIGURE 1.11**

Two different methods  
of using 3D presentation  
views

Source: HOK



By adding materials to the BIM elements, you can begin to explore the space in color and light, creating photorealistic renderings of the building. These images can convey information about both the intent and context of the design. Iterations at this level are limited only by processing power and user intent. The photorealism allows for an almost lifelike exploration of color and light qualities within a built space even to the extent of allowing analytic brightness calculations to reveal the exact levels of light within a space, but with the added benefit of being derived directly from the working models. In this case, renderings can be an embedded process or a perpendicular instantaneous output. The first option would be rendering within the authoring tool. This would produce timely renderings based on the current models but may not be of the quality needed for presentation purposes. More high-end renderings used for marketing would normally require exports from models brought into specific rendering tools. These renderings can be more stylized or photorealistic; however, they are a snapshot in time of the working model and take additional preparation to be useful. This in effect ends their BIM connectivity.

The next logical step is taking these elements and adding the element of time. In Figure 1.12, you can see a still image taken from a phasing animation (commonly referred to as a 4D simulation) of a project. Not only do these simulations convey time and movement through space, but they also have the ability to demonstrate how the building will react or perform under real lighting and atmospheric conditions. All of this fosters a more complete understanding of the constructability and performance of a project before it is realized. This is also a common method when trying to understand construction sequencing by contractors as they are planning the building of the facility.

## Realize

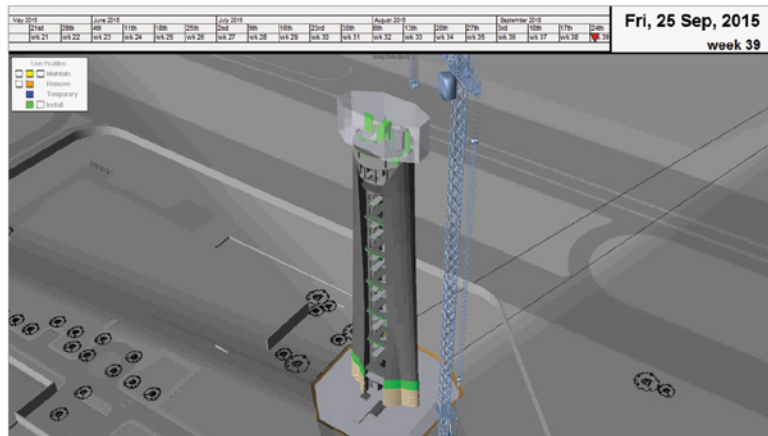
The use of BIM can potentially remove the direct human input to develop specific elements of the facility. Using the data generated through BIM-based planning and design processes to fabricate or manage building elements of the facility allows facility owners to realize some of the most beneficial aspects of the entire endeavor. Using BIM for facility management can enable owners to take advantage of the facility data throughout the building's lifecycle to support safe,

effective, and efficient environments. The maintenance of this data can improve efficiencies through having accurate as-builts. It can promote the optimization of operation and maintenance of the facility's systems to reduce energy usage. Let's explore two main concepts of BIM realization: assemblage and control.

**FIGURE 1.12**

A still from an animation showing accurate physical conditions for the project

Source: HOK



**Assemblage** By developing building information modeling, you can replan building elements way before they are actually fabricated and assembled. This can include the specification of existing systems or the design of custom systems to be installed in the facility. Examples include picking a water pump that fits both the functional requirements and the spatial requirements of a mechanical space or the opportunity to prefabricate a custom receptionist desk for a highly designed lobby space. During the projects' early phases, these processes can be used to generate multiple design schemes. For construction, these processes can help the contractors to understand the process of bringing materials on-site and how and when they should go together. It might also inform them how to pre-assemble custom systems for delivery to the project site, preventing cumbersome storage or barriers to successful assemblage such as poor weather or misinterpreted documents. Being able to assemble systems with the aid of machines, such as CNC (Computer Numerical Control) systems, can reduce not only costs but also the time needed to install components in the facility. Examples of prefabrication might include wall systems, ductwork, and curtainwall.

**Control** Building information modeling also allows operators of the facilities to help manage and maintain the equipment and systems once they are installed on-site. If a database was created during the planning, design, and construction phases of the project to ensure that all as-built systems are well documented with specific properties associated with each system, operations and maintenance stakeholders not only will have a better knowledge of what systems they have but also may have some automated processes that could schedule maintenance requests or connect in with building system analysis tools. When you do an analysis of the life span of a building, you will see most of the time is in the occupancy stage. This really means that most of the money spent on the facility is running it. If BIM can help reduce the costs of operating and maintaining a facility, this becomes a huge benefit to owners that can

be realized through a building information modeling process. Architects are the primary origin of this information that can help owners achieve these benefits. A good model-based database can help an owner solve maintenance issues more quickly, may be able to find potential issues more readily, and can help with planning future construction much more easily. The use of this data to regulate facility systems potentially allows facility operators to optimize their operations. It is even possible that in the future, building systems could be automated because of information generated by BIM. Being able to plan the system integrations ahead of time allows for more intelligence built into the facility. An example of this is when a thermostat is programmed to modify the settings of the HVAC system in response to preprogrammed rules by its connection to an intelligent monitoring system, enabled by the BIM. Benefits such as these can really help owners optimize the operations and maintenance of the facilities and demand more services from its designers, such as yourself.

## **Integrating Tools inside a BIM Workflow**

As you have read with the explanations of people and processes involved with BIM, the last aspect to discuss is the technology. Without the technology, you would not be here; it supports all the other things that make building information modeling possible. The thing you may not realize is that even though it is the foundation of all these other great opportunities and benefits, it is still a lesser aspect of the entire BIM ecosystem. This may confuse some readers, but in our experience, we find that the most meaningful changes happen with the people deploying these processes and the methodology they take in transforming their work. The tools that people use in their workflows to generate geometry and data change only slightly from year to year. Technology is constantly being improved, made more efficient, and better integrated with other tools in the market. You as an individual user have little influence over this. Understanding the existing capabilities of tools is important; however, change in the technology sense is much more limited than improvements to your process and skill sets.

The purpose of this book is to connect your knowledge as a person with the best understanding of an authoring tool's capabilities. That specific authoring tool, of course, is Autodesk® Revit®. Coming to this realization, the user must understand that an expert of the software is not an expert in BIM. Many people know the functions of the tool based on learning or experience but still do not have a grasp on why they should do something and when they should do it. That comes with having a better understanding of not only why BIM is beneficial but also how all these things come together to create an architectural zeitgeist. Throughout this volume we hope to make contributions to your understanding of all three and to help you make the connection between opportunities in the application and a methodology to deploy them, with the overall sense of what it means to your project and to your organization.

## **What Is Revit?**

Revit is a BIM application for authoring parametric 3D models that generate geometry with embedded information for the design and construction of buildings and infrastructure. It is from these intelligent models that plans, sections, elevations, perspectives, details, and schedules—all the necessary instruments to document the design of a building—can be derived. Drawings created using Revit are not a collection of 2D lines and shapes that are interpreted to represent a building, but live views extracted from virtual building models. These models are a compilation

of intelligent components that contain not only geometric attributes but also data informing decisions about the building at every stage of the process, including occupancy.

Elements in Revit models are managed and manipulated through a series of parameters that we will discuss in greater detail throughout this book. These elements have bidirectional associativity, allowing the user to change the 2D views to change the 3D model or to change the 3D model to change the 2D views. If you move a door in a plan, that door is moved in all the elevations, sections, perspectives, and so on, in which that object appears. In addition, all the element's properties contain information internally, which means that intelligent annotations are directly linked to the objects. These tags display the object's data directly, rather than a manual entry interpreted by the user. When contrasted with traditional CAD tools that store element information only in the annotation, Revit gives you the opportunity to more easily input, manage, and export your project data for project coordination and execution.

## The Bottom Line

**Focus your investment in BIM.** Since using Revit is a change in workflow, it is also important to understand the change in staffing and who is needed to perform what roles on a project.

**Master It** What are the three primary roles in a Revit project, and what are the responsibilities of those roles?

**Understand a BIM workflow.** Understand how projects are completed in BIM and how the use of Revit on a project can change how information within a project is created.

**Master It** Explain one of the primary differences between a more traditional 2D CAD-based workflow and producing documents using Revit.

**Leverage BIM processes.** Understanding the level of risk your firm is willing to take in new technologies will help you establish goals for your future use of BIM.

**Master It** Using the three areas of firm integration (visualization, analysis, and strategy), define how those areas overlap for your firm or project.





## Chapter 2

# Exploring the UI and Organizing Projects

After more than a decade in the architecture, engineering, and construction (AEC) industry, Revit continues to be unique in its combination of powerful features and ease of use. Revit may not be the absolute best tool to design and document every imaginable building type, but its features and functions make the vast majority of production tasks much more efficient and accurate.

Revit is a completely bidirectional, multiuser working environment, unlike other 2D computer-aided drafting (CAD) or 3D building information modeling (BIM) tools. Instead of talking about *layers* and *vectors*, you will be using terms such as *projects*, *components*, and *parameters* along with tools such as Wall, Door, and Floor. The concepts and terminology should seem familiar if you have experience in the building industry; however, transitioning to them can be a daunting task if you are more familiar with drafting terms than construction. This chapter provides an overview of the Revit user interface (UI) as well as the key aspects of data organization within a project.

### IN THIS CHAPTER, YOU'LL LEARN TO

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- ◆ Understand the user interface
- ◆ Understand project organization

## Understanding the User Interface

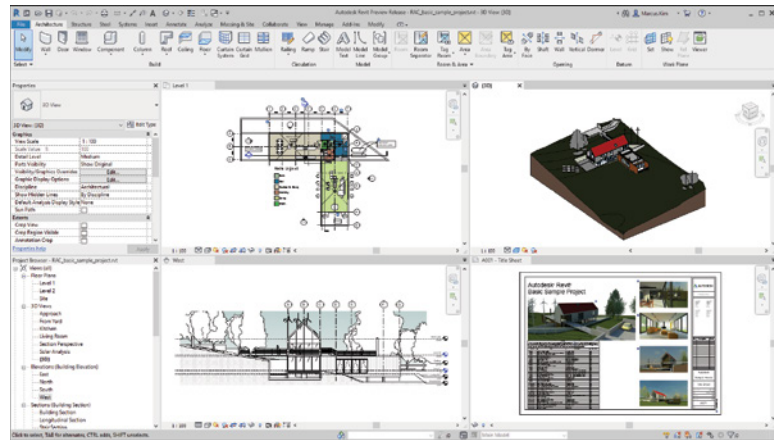
The UI is based on the Windows ribbon framework that is also found in software applications such as Microsoft Office. Within Revit, you will find many commands and tools that use similar dialog boxes and workflows. For example, you will not find disparate dialog boxes for door properties versus window properties. Persistence of tool location is another key to increased usability. Even though tools remain contextually exposed or hidden, the majority of them can be found in the same place relative to the overall UI.

As you're learning the interface, keep in mind that the interface presents a tooltip for every element. This tooltip has two stages. The first stage, which appears when you first mouse over the tool, provides the name as well as an option to find out more information from the Help menu by pressing the F1 key. Most tooltips provide a second stage that gives you an additional description about what the tool is typically used for. A new user can learn a lot just by mousing over various parts of the interface.

You have the ability to access all three disciplines of the Revit suite—Architecture, Structure, and MEP. This functionality is addressed in the “Getting to Know the Ribbon” section of this chapter.

Figure 2.1 shows the Revit UI. To illustrate some different project views, we’ve tiled four view types: plan, elevation, 3D, and sheet. In the following sections of this chapter, we will review the major components of the UI.

**FIGURE 2.1**  
The Revit UI



## Accessing and Using the Application Menu

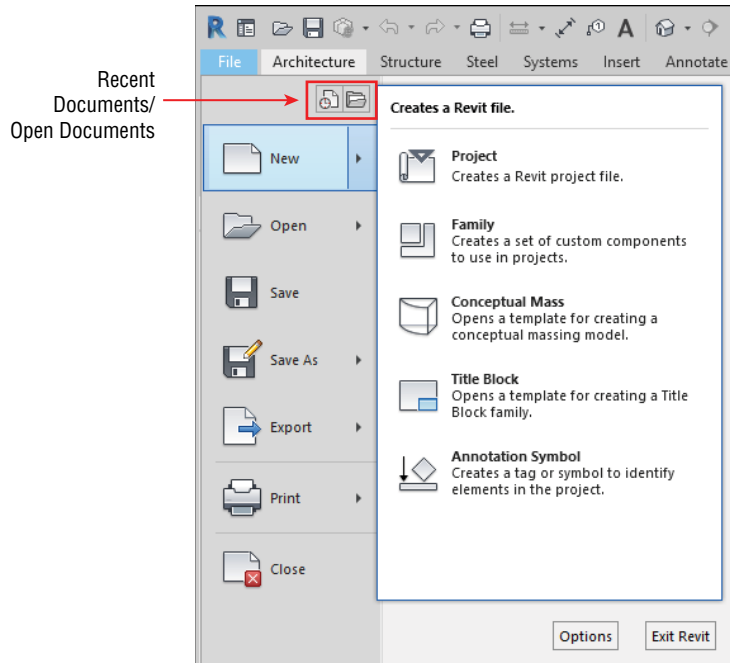
Click the File tab just under the big *R* in the upper-left corner of the UI (Figure 2.2) to open the Application menu and access commonly used commands such as New, Open, Save, Print, and so on.

In the upper-left corner of the dialog, there are two icons for both recent documents and open documents. Recent Documents lists the last several files that you’ve opened, no matter the location. Open Documents shows you all the files you currently have open, as Revit allows you to load multiple files at once. This is a great tool in case you have many views open and you want to quickly go to a specific file you’re working on. New to Revit 2020 is the Home button, located to the right of the big *R*. Clicking this will toggle over to the Home screen that appears at the start of Revit 2020’s launch (Figure 2.3). It will list recent model and family files as well as common file commands. Clicking the Home button again will toggle back to the ribbon UI.

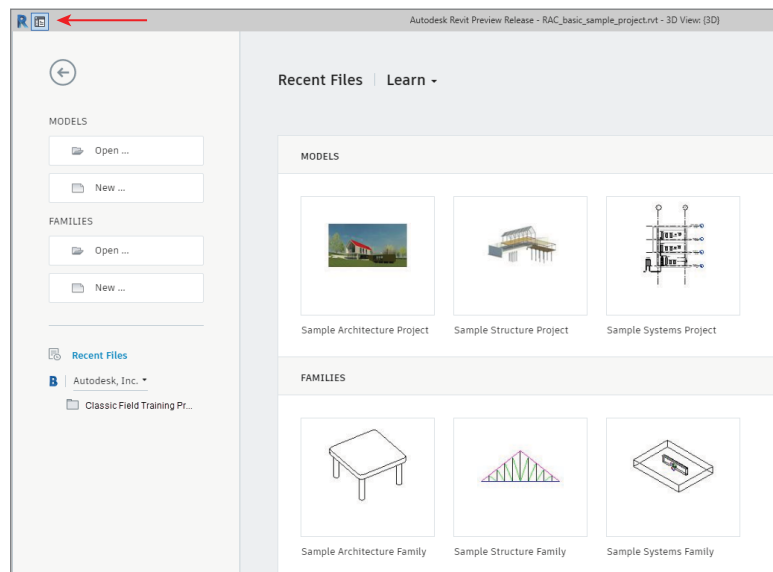
Many of the tools that allow you to open or save multiple formats include flyout menus that help you specify different options. For example, when you have a project open and you choose Save As, you can save your project as a typical Revit file or as a template to be used as a basis for future projects. Dialogs like this will also limit you to the operations that you can do currently. If you have a project file open, you cannot save it as a family file; Revit will gray that option out, visually informing you that this is not a valid operation. These dialogs are nice in that you can customize locations for opening and saving certain file types. When you open the Open dialog, you’ll see a list of shortcuts to the left that give you quick access to your desktop, favorites, and even the history of your most recent navigation. What’s nice about this dialog is that you can also create additional locations based on your current workflow. Creating a shortcut to a library of

components or to your project folder will help save you time when you're navigating between files. The Export option allows you to take your existing model and convert to a new format (CAD formats, DWF/DWFX, FBX, gbXML, IFC, and ODBC database). Use the Close command to quickly close a project or family without closing every open view.

**FIGURE 2.2**  
The Application menu



**FIGURE 2.3**  
The Home view





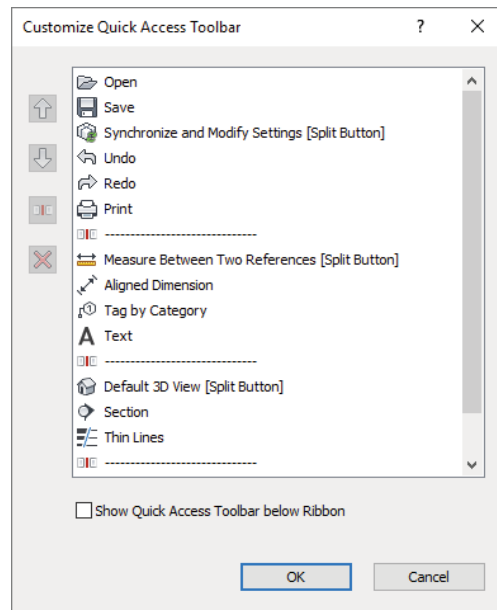
When accessing some of the flyout commands in the Application menu, be aware that there may be additional commands or options on the flyout that are hidden. This is most evident on the Export command flyout, in which you must scroll to the bottom of the flyout to access exporting options for Industry Foundation Classes (IFC) and others. If you click the button without choosing the flyout, you are choosing the default option.

## Using the Quick Access Toolbar

The Quick Access toolbar (QAT) allows you to keep frequently used tools at your fingertips. Some commonly used commands are included by default in the QAT, but you can customize it to meet your own needs.

Right-click any button in one of the ribbon tabs, and you will find the command Add To Quick Access Toolbar. By clicking the small, down-facing arrow to the far right of the QAT, you'll find that tools may be further customized, grouped, or removed from the toolbar (Figure 2.4). By default, the QAT bar is above the ribbon, but you also have the option to show the QAT below the ribbon.

**FIGURE 2.4**  
Customizing the QAT



With the QAT, you also have the option of temporarily hiding quick access tools based on the flyout arrow on the far-right side. With this, you could quickly check or uncheck QAT tools based on your current workflow, without having to re-create the shortcut.

## Using the InfoCenter

To the far right of the QAT is the InfoCenter (Figure 2.5).

**FIGURE 2.5**  
The InfoCenter



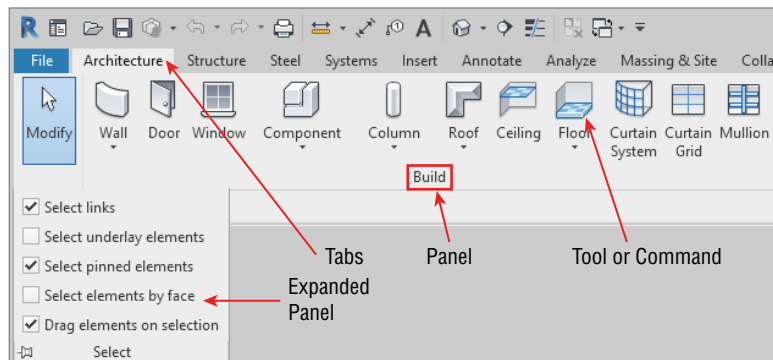
From left to right, you have the ability to search for help solutions, sign in to Autodesk A360 to access online services that integrate with Revit, open a website to the Autodesk App Store > Revit and then open the help content.

Because Autodesk continues to move toward more cloud services, we recommend making sure you have a login for your system. This helps with other things such as collaboration, and it is going to make it easier for you to take advantage of all the capabilities that the software has to offer.

## Getting to Know the Ribbon

The ribbon is the primary location for accessing the commands and tools you will use in the application (Figure 2.6). Every program using Microsoft's ribbon interface is different, and some software developers and companies develop their own unique interfaces and ways of working. Revit is a great example of this. You can launch commands and tools by selecting icons in the ribbon, or you can create customized keyboard shortcuts as an alternative. Refer to Chapter 3, "The Basics of the Toolbox," for more information on keyboard shortcuts. Throughout this book, we will refer to the ribbon frequently, so you should be familiar with its basic parts: tabs and panels. Tabs are the categories of tools, and panels are the subcategories organized into icons.

**FIGURE 2.6**  
The ribbon



The organization and size of the icons within each panel on the ribbon will change slightly as you scale the size of your application window. As the application window gets smaller, the icons will decrease in size and will sometimes stack, or the descriptions will be hidden.

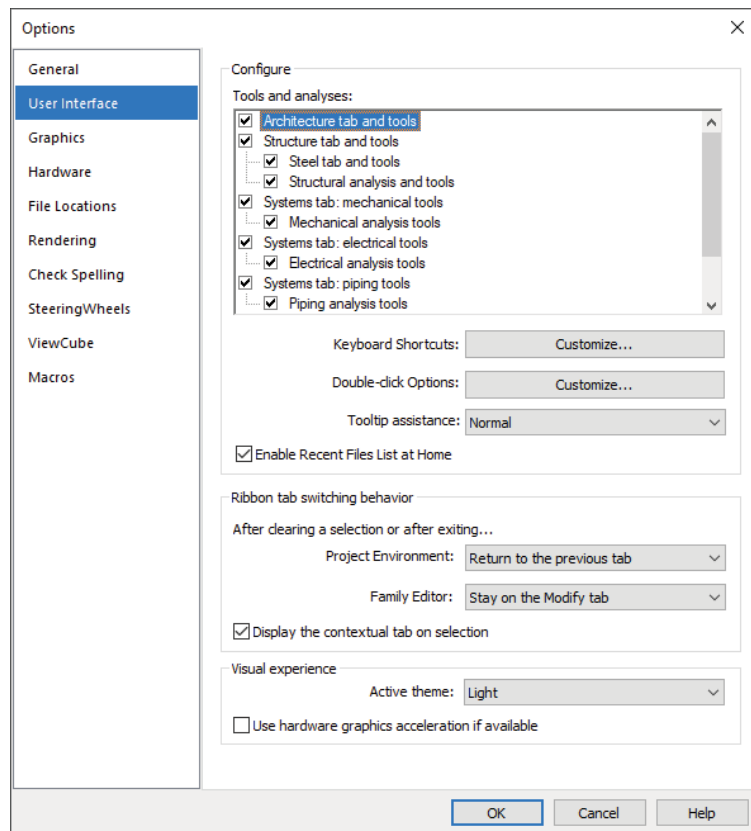
## TOURING THE TABS

Tabs are the highest level of organization and are used to select from among the various groups of functionality. There are up to 14 tabs along the top of the ribbon. We'll take a moment to briefly describe them.

**File** The Revit File tab contains all the features for the Application menu, as previously discussed. (See “Accessing and Using the Application Menu.”)

**Architecture, Structure, or Systems** When you install Revit, you will have access to the tools for all three design disciplines, and you can control the visibility of these tabs (Architecture, Structure, and Systems) from the Options dialog box (accessed from the Application menu), as shown in Figure 2.7. It has become common for architects to have all three disciplines visible to improve collaboration. Note, as of Revit 2019, the Structures tab and tools include a Steel tab option. These tabs contain tools you will use to create or place content specific to each design discipline. At the end of the tabs bar, there is a tool that allows you to cycle through variations of displaying tabs and panels. This is really useful only if you are trying to increase the real estate that is available to your working views.

**FIGURE 2.7**  
Setting the UI options



**Insert** The Insert tab is used to link or import external files (2D, 3D, image, PDF, and other Revit files with the file extension RVT). To insert content from family files, you can use the Load Family command from this tab; however, this same command is available with most modeling commands in the contextual tab of the ribbon. Learn more about linking Revit files in Chapter 6, “Working with Consultants,” and using other file formats in Chapter 7, “Interoperability: Working Multiplatform.”

**Annotate** The Annotate tab contains many of the tools necessary to annotate, tag, dimension, or otherwise graphically document your project. Learn more about these tools in Chapter 17, “Detailing Your Design,” and Chapter 19, “Annotating Your Design.”

**Analyze** The Analyze tab contains the tools necessary to modify energy analysis settings and to run an energy simulation via Autodesk Insight®. This feature requires an Autodesk Subscription account to access the online analysis engine. Learn more about conceptual energy analysis in Chapter 22, “Conceptual Design and Design Analysis.”

**Massing & Site** The Massing & Site tab contains the tools necessary to add massing and site-related elements such as toposurfaces and property lines. Learn more about modeling site context in Chapter 3 and in Chapter 9, “Advanced Modeling and Massing.”

**Collaborate** The Collaborate tab contains the tools that you’ll use to coordinate and manage the project within your own team as well as across other teams and their linked files. Learn more about worksharing in Chapter 5, “Collaborating with a Team,” and interdisciplinary coordination in Chapter 6.

**View** The View tab contains the tools that you’ll use to create all your project views, 2D and 3D, as well as schedules, legends, and sheets. You can also modify your UI from this tab, including your keyboard shortcuts. Learn more about creating multiple project views and sheets in Chapter 18, “Documenting Your Design.”

**Manage** The Manage tab contains tools to access all your project standards and other settings. You will also find the Design Options and Phasing tools on this tab. You can find additional tools such as Review Warnings and Select by ID on the Manage tab that will help keep your project running smoothly.

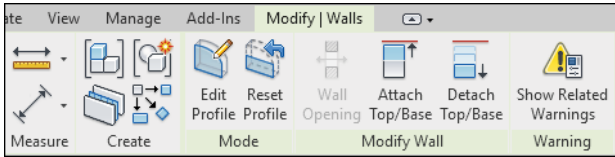
One of the most important settings that you’ll use during your project is Object Styles on the Manage tab. Selecting this option will allow you to manage the global visibility settings for just about everything in your project: how it projects, how it cuts, and its associated color and pen weight. Learn more about this and other project settings in Chapter 4, “Configuring Templates and Standards.”

**Add-Ins** The Add-Ins tab appears only when additional extensions have been installed. It contains the tools that can do a variety of things based on additional applications created through the API (Application Programming Interface). Many third-party companies, such as Ideate, BIMobject, and even Autodesk, have written additional applications that supplement the functions of Revit. These may include enhanced analysis or management processes.

**Modify** The Modify tab contains the tools used to manipulate the content you’re creating in your project. You’ll find tools such as Cut, Join, Move, Copy, and Rotate, among many others. Learn more about common editing tools in Chapter 3.

**Contextual Tabs** Contextual tabs are revealed when specific elements are selected or element creation commands are launched. For example, the Modify | Walls contextual tab (Figure 2.8) is displayed when a wall is selected. These unique tabs are usually colored green to help you distinguish them from other static tabs in the ribbon.

**FIGURE 2.8**  
Example of a contextual tab

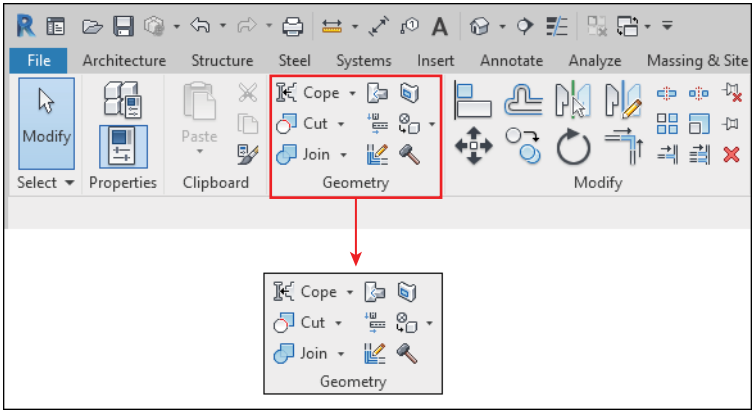


A simple, yet important, setting that may be exposed on the contextual tab when placing model content is Tag On Placement. Modeling commands such as Door, Window, and Component allow you to enable automatic tagging to reduce overall documentation time. If you are working in an early design phase, you may want to disable the Tag On Placement setting, unless you have separate presentation views created.

**PLACING PANELS**

Within each tab in the ribbon are groups of tools and commands referred to as *panels*. If you want to make any panel consistently available for easy access, you can pull it out of its tab and arrange it anywhere on your computer screen. To relocate a panel, drag the panel out of the ribbon using your mouse pointer on the panel title bar (Figure 2.9). The panel will snap to alignment with other panels you have previously dragged from the ribbon if you hover over other floating panels while dragging. These changes are persistent beyond a session of the software and will retain their new position every time you restart Revit until you choose to change them again.

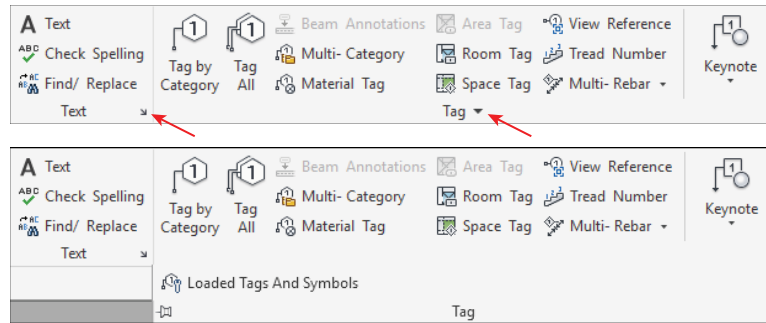
**FIGURE 2.9**  
Panels can be relocated anywhere in the UI.



To return a panel to the ribbon, hover the mouse pointer over a floating panel and the panel's border will appear. Click the arrow in the upper portion of the gray bar at the right of the floating panel.

On some panels, you will find that settings can be accessed from the panel's title bar. You can see an example of these features on the Annotate tab of the ribbon. In Figure 2.10, the small arrow on the Text panel is known as a *dialog launcher* and will open the Type Properties dialog box for Text (not shown in Figure 2.10). Clicking the down arrow on the Tag panel exposes an *expanded panel* that displays the Loaded Tags And Symbols command.

**FIGURE 2.10**  
Special panel features



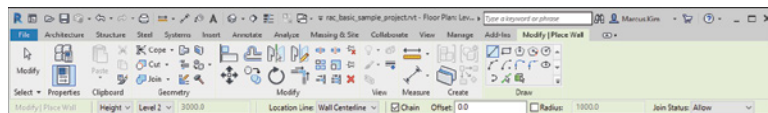
## Using Other Aspects of the UI

Now that we've covered the fundamental elements contained in the ribbon, let's look at other important aspects of the UI.

### OPTIONS BAR

The Options bar is located directly below the ribbon and is a contextually sensitive area that gives you feedback as you select tools and objects. In Figure 2.11, you see the options available below the ribbon when the Wall tool is active. You can also use the Options bar when an object already placed in a project or family is selected.

**FIGURE 2.11**  
Options appear in a bar below the ribbon.



An especially important and frequently used option is included with any annotation symbol: the ability to include or exclude a leader. This will help you place tags in the clearest location within your documentation while maintaining a parametric relationship to the associated model element. Look for this option when you use the Tag By Category command from the Annotate tab in the ribbon.

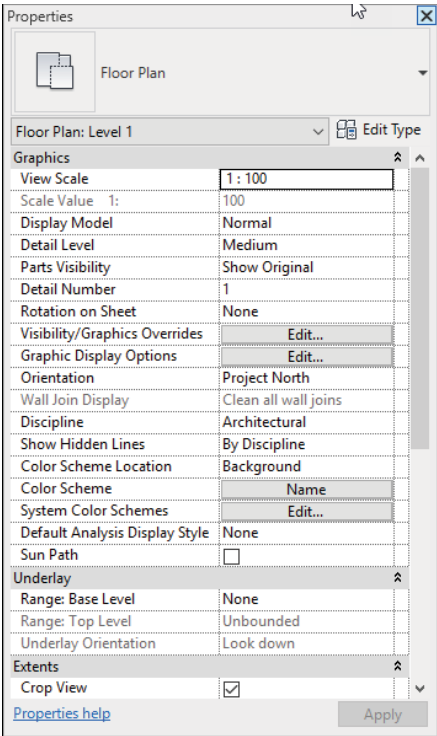
### PROPERTIES PALETTE, PROJECT BROWSER

The Properties palette contains the parameters of whatever you're currently working on and shows the instance parameters by default. In this palette, you will find the Type Selector, a selection filter, and the Edit Type button (Figure 2.12). You'll learn more about filtering selected objects in Chapter 3, as well as much more about parameters in Chapter 15, "Designing with the Family Editor."

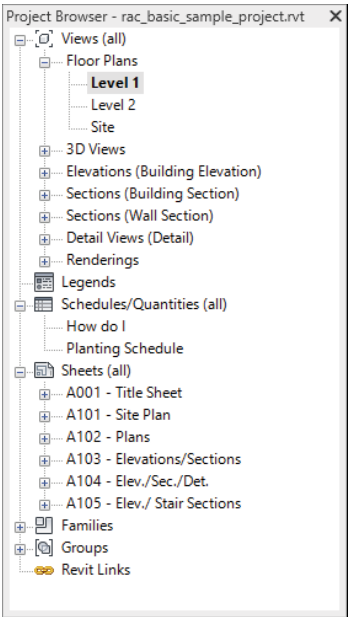
The Project Browser (Figure 2.13) is a hierarchical listing of all the views, legends, schedules, sheets, families, groups, and links in your project. You can expand and collapse the project tree by selecting the + and – icons.

You can search for elements by right-clicking any item in the Project Browser and selecting Search from the context menu. The simple search function will highlight any view, sheet, family, or type with the matching text in its name.

**FIGURE 2.12**  
Properties palette

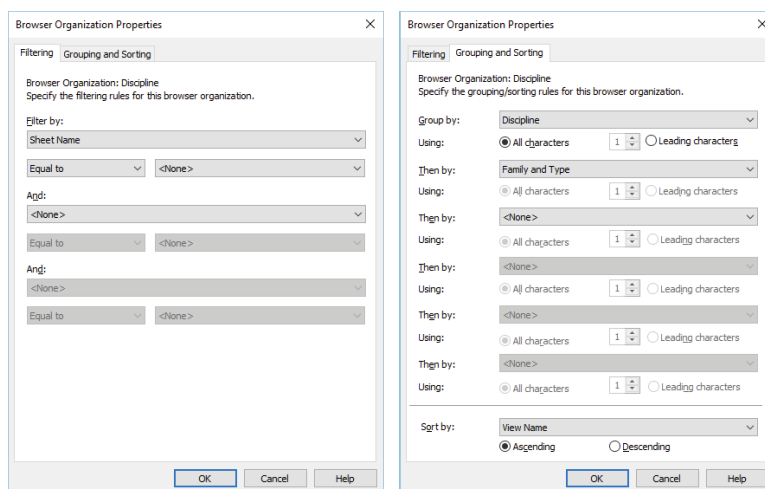


**FIGURE 2.13**  
Project Browser



The Project Browser can also be filtered and grouped based on several user-defined parameters (see Figure 2.14). To access the Browser Organization Properties dialog box, right-click the Views (all) listing at the top of the palette. You can also access this tool in the View tab under the User Interface flyout button. Learn more about Project Browser customization in Chapter 4.

**FIGURE 2.14**  
Browser Organization  
Properties dialog box



The Properties palette and Project Browser can be undocked from the main UI and can also be placed on a secondary monitor simply by dragging or double-clicking the top border of either palette. You can also drag these UI elements onto each other to use them in a unified tabbed or stacked palette, as shown in Figure 2.15. Dragging one palette onto the top border of the other will create a tabbed palette, whereas dragging it just below the top border will result in a stacked palette.

## STATUS BAR

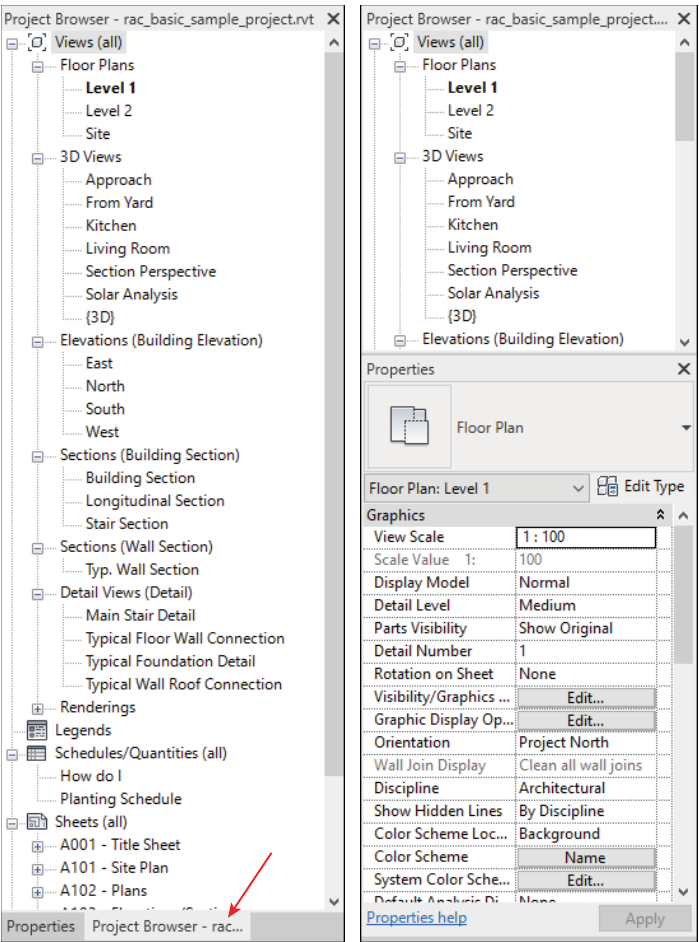
The status bar at the bottom of the UI provides useful information about selected objects and active tools. When you start a tool, the status bar will display prompts about the next step required of the tool. For example, select an object and start the Rotate command; the status bar will read “Click to enter rotate start ray or drag or click the rotation center control.” It is also useful when you are using the Tab key to toggle between object snap points or when selecting chains of elements.

Toward the middle of the status bar, you will find toolbars for worksets and design options. Showing the current worksets during a collaborative project will help ensure you are placing elements on the correct workset. Worksharing will be covered in Chapter 5. If you’re using design options (covered more in Chapter 11, “Working with Phasing, Groups, and Design Options”), the status bar can also show you which option you’re currently exploring.

At the far right end, you will see a filter icon next to a number. When you select objects in a view window, the number of selected objects will be displayed here. Click the Filter icon to open the Filter dialog box and refine the selection set. The five icons next to the Filter icon determine which objects in your model are eligible for selection. We will discuss selecting elements in greater detail in Chapter 3.



**FIGURE 2.15**  
Properties palette and  
Project Browser  
combined in a tabbed or  
stacked palette



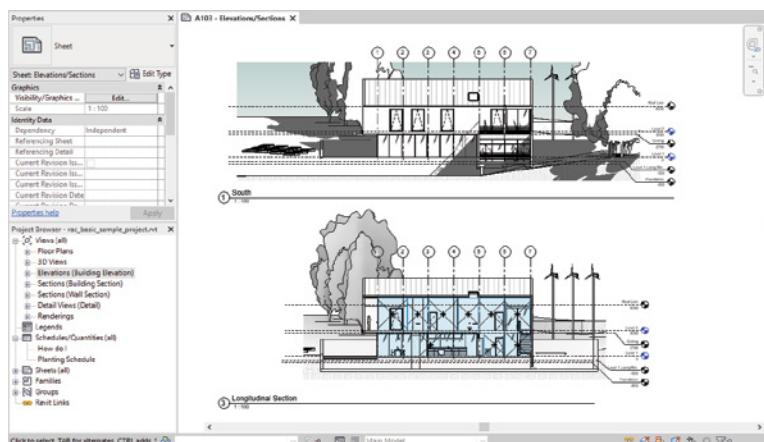
**DRAWING AREA**

The drawing area is the window into your design space. As shown previously in Figure 2.1, you can tile several views from any number of open files or you can maximize the view window and have all open views listed as Tabs. When the view windows in the drawing area are maximized, press Ctrl+Tab on the keyboard to cycle through the open views. To reverse the cycling, press Ctrl+Shift+Tab. Alternatively, you can click a tab to make that view current or utilize the Switch Windows functionality located in the Windows panel of the View tab. To go directly to the view you want to see, choose the view from your Project Browser.

If you decide to use tiled views when you work in Revit, you should be aware of a subtle limitation. You'll be able to zoom into only the extents that are defined by the drawing area. If you want to get around this limitation, here's a helpful tip: create a new sheet, but then delete the sheet border. This is now a workspace for any view of the project. Just be sure to label it as a working sheet apart from your documentation set. Now you can create duplicate views of any of

your project views and assemble them in this working space (Figure 2.16). Zooming in and out is much more fluid, and you're not limited to the extents of one drawing area.

**FIGURE 2.16**  
Working sheet view



As of the last release of Revit 2019, views are no longer constrained within the boundaries of the Revit (UI). You can completely undock a view and drag the window to a different area of your monitor or to a second monitor. Prior to this, the only way to work on Revit across multiple monitors was to stretch the UI. To undock a view, click the appropriate view tab, and drag away from the UI. To redock the view, click the appropriate view tab and drag back within the constraints of the UI; you will see a highlighted blue boundary notifying you that it is going to re-dock.

## VIEW CONTROL BAR

The view control bar is at the bottom of every view and changes slightly depending on the type of view (Figure 2.17). For example, sheet views have only two buttons, and perspective views do not have a scale option. Figure 2.17 shows three view windows tiled to illustrate some of the differences in the view control bar. From top to bottom, you can see the view control bar for a sheet view, a plan view, and a 3D perspective view.

**FIGURE 2.17**  
View control  
bar examples



Some of the buttons in the view control bar are just shortcuts to view parameters that are also available from the Properties palette. Scale, Detail Level, Crop View, and Show/Hide Crop Region are found in both the view control bar and the Properties palette. The Visual Style button allows you to select from a short list of graphic display modes that can be customized in detail with the Graphic Display Options in the Properties palette.

Other buttons in the view control bar are unique commands and sequenced from left to right:

- ◆ Temporary Hide/Isolate
- ◆ Reveal Hidden Elements
- ◆ Worksharing Display
- ◆ Temporary View Properties
- ◆ Show/Hide Analytical Model
- ◆ Reveal Constraints

The Temporary Hide/Isolate command helps users more readily see specific elements while working in a view. When you select an object in a view window, use this button to select from various tools to hide or isolate either the selected objects or the entire category of objects. Temporary visibility states do not affect printing, and the view window will display with a turquoise border until the temporary visibility is reset.

The Reveal Hidden Elements button highlights any elements that are hidden in the current view, either temporarily or through other methods. When in this display mode, the view window has a magenta border until the mode is disabled.

The Worksharing Display button is available only on projects where worksharing is enabled. This mode can be enabled and configured in any view to illustrate Checkout Status, Owners, Model Updates, and Worksets. When in this display mode, the view window will have an orange border until the mode is disabled. Refer to Chapter 5 for a detailed explanation of these visibility features.

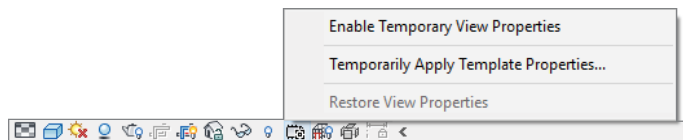
The Temporary View Properties command when invoked is intended to allow a user to make temporary graphic changes to a view such as visibility graphics, scale, and view templates. When in this display mode, the view window will have a purple border until the mode is disabled. See the next section for more details.

The Show/Hide Analytical Model button allows you to quickly display analytical graphics that are commonly used by the Structural or MEP tools in Revit. Finally, the Reveal Constraints button temporarily displays all the model-based constraints visible in the current view. This is useful for troubleshooting model elements that might not be behaving as expected.

## TEMPORARY VIEW PROPERTIES

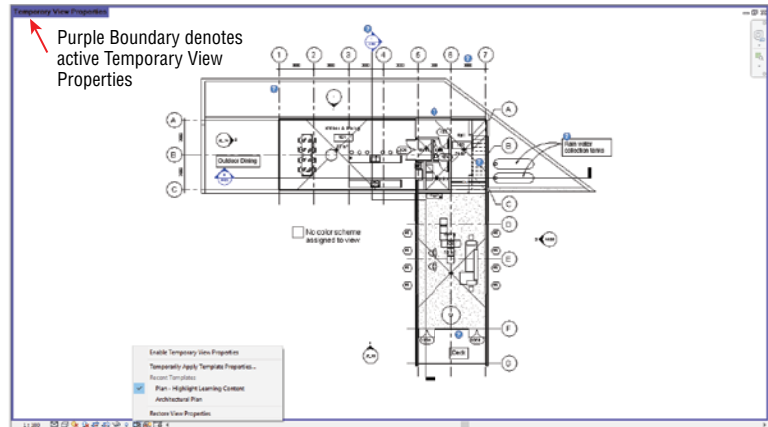
You may also temporarily modify view properties or apply a view template. When you click the Temporary View Properties icon in the view control bar, you will have a choice between two key options, Enable Temporary View Properties or Temporarily Apply Template Properties, as shown in Figure 2.18. Because these applied properties are only temporary, when printing the view, Revit provides an option to print with or without the temporary settings. The Temporary View Properties will not be saved with the project.

**FIGURE 2.18**  
Temporary View  
Properties command



If you select **Temporarily Apply Template Properties**, you can select from any view template established in your project. Once a view template is applied to the view with this tool, the view will be highlighted with a purple boundary, as shown in Figure 2.19. Refer to Chapter 4 for a detailed review of view templates.

**FIGURE 2.19**  
Active view with  
Temporary View  
Properties applied



Referring to Figure 2.19, you will notice that any recently applied view templates will appear in the **Temporary View Properties** menu. This allows for rapid application of templates to increase your productivity when manipulating views for various working scenarios.

The other command selection is **Enable Temporary View Properties**. This mode allows you to change any view properties manually. The result is the same as temporarily applying a view template, but you can tweak any setting to your needs. For example, you might want to temporarily hide all the furniture in a view.

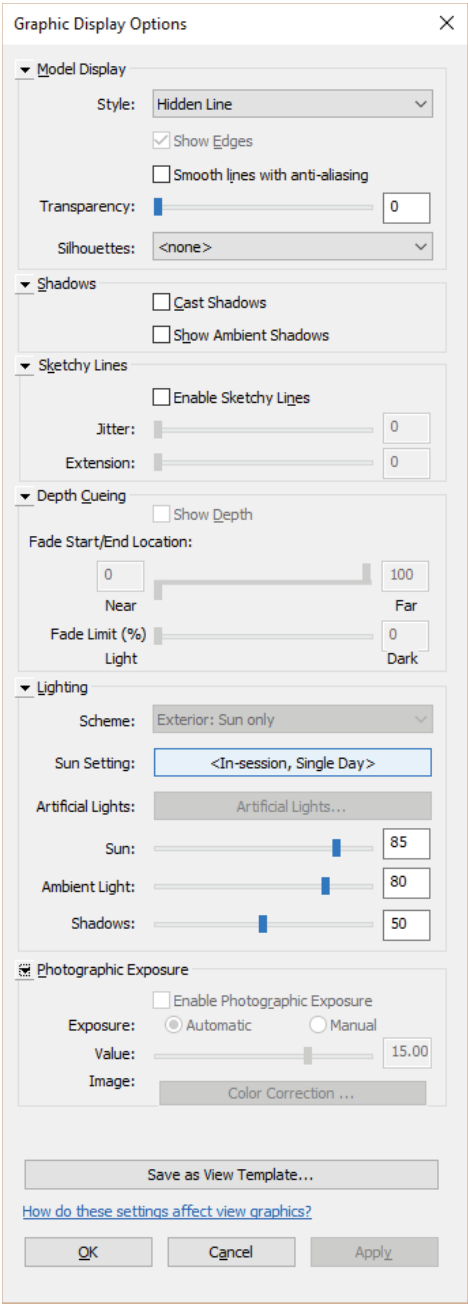
To remove the temporary settings, you can simply wait until you close the project file because the temporary settings are not saved. Otherwise, click the **Temporary View Properties** icon again and select **Restore View Properties**.

## GRAPHIC DISPLAY OPTIONS

The **Graphic Display Options** dialog box gives you access to some of the same settings you can select in the view control bar; however, more refinement options are available. From the Properties palette, click **Edit** in the **Graphic Display Options** property field, and explore the graphic settings you can customize for the current view (Figure 2.20). As an alternative, you can click the **Visual Style** icon (the small box) in the view control bar and choose **Graphic Display Options** from the pop-up menu.

Many graphic options are available, including customized backgrounds, photographic exposure, and a transparency slider. Experiment with a variety of the settings to see which ones meet your presentation and documentation needs. By saving them as view templates, you can group various settings for better comparison and contrast. You will learn much more about graphic styles in Chapter 12, “Visualization.”

**FIGURE 2.20**  
Graphic Display Options  
dialog box

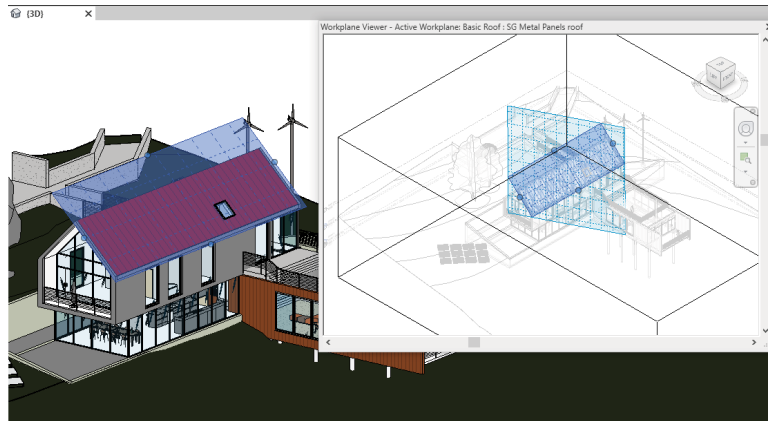


## WORK PLANE VIEWER

Most modeling tools and commands require an active work plane on which to place geometry. When you are working in a plan view, the work plane is usually set to the current level associated with the view. In a 3D, section, or elevation view, the definition of an active work plane may be a bit more confusing. In addition to levels, work planes can be defined as reference planes, a structural grid, or a surface of another object. To help you visualize an active work plane, a work plane viewer is available in Revit. Be aware that an active work plane could be perpendicular to your orientation if the view is adjusted three dimensionally.

The Viewer option is located on the Work Plane panel of the Architecture tab. This viewer is available from all model views when you're in the project environment. By default, the work plane is based on the active work plane of the last active view. But when you enter Sketch mode (for example, when you are creating a floor or a roof), the active work plane is that of the sketch (Figure 2.21). So even if the project window shows a 3D view, the viewer shows the plane of the sketch—and you can sketch directly in the work plane viewer! This is useful for working on sloped surfaces such as roofs.

**FIGURE 2.21**  
Sketch mode with active  
work plane



## Navigation Methods

One of the challenges of any 3D modeling software is creating methods of navigation that are intuitive. If you have used more than one modeling application, such as Rhino, SketchUp, or Digital Project, you will know that there is no standard 3D navigation functionality. As is the case with Revit, Autodesk has consistent navigation tools across most of its industry-based applications such as AutoCAD® and Navisworks®. These include the ViewCube® tool, the SteeringWheels® tool, and basic mouse controls.



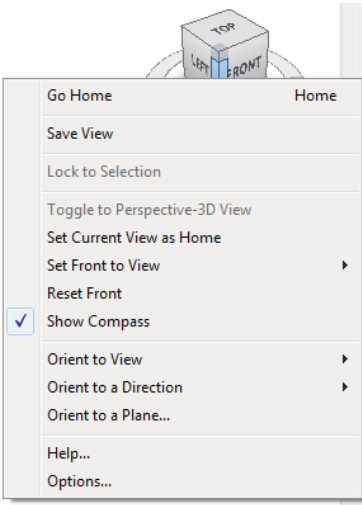
**VIEWCUBE**

A 3D navigation tool known as the ViewCube is available in most Autodesk design software.

This tool will appear by default in the upper-right corner of any 3D view. Click any face of the cube to orient the view to that face or click a corner of the cube to orient to an axonometric angle. Press and hold the left mouse button while moving the mouse pointer over the ViewCube to orbit the view freely. Press and hold the left mouse button while hovering over the compass, and the view will rotate as if it were on a turntable. The selected tool, the cube or compass, will highlight with a shade of blue when active.

Hovering over the ViewCube with your mouse pointer reveals the Home option (the little house above and left of the ViewCube) that you click to return to your home view. Right-clicking the ViewCube opens a menu that allows you to set, save, and orient your view (see Figure 2.22). Selecting Options from the context menu takes you directly to the ViewCube options in the Options dialog box, which you can also access from the Application menu. The ViewCube options allow you to customize the placement, transparency, and functional behavior of the tool.

**FIGURE 2.22**  
ViewCube context menu



**STEERINGWHEELS**

Another method of navigation that is unique to Autodesk software is the SteeringWheels tool. This tool can be activated by pressing the F8 key, by pressing Shift+W, or by using the Navigation bar. The SteeringWheels will follow your mouse pointer as you move around a view and will stop when the mouse movement slows, allowing you to hover the mouse pointer over one of the

command areas on the wheel. As you hover the mouse pointer over a navigation command, press and hold the left mouse button while moving the mouse to activate the corresponding navigation method. There are many ways to customize the SteeringWheels, all accessible through the Wheel menu in the lower-left side of the tool. This is easier to demonstrate than explain in text, so feel free to try the various modes of the SteeringWheels tool as you continue through this book.

If you use a laptop or mobile workstation without the benefit of a mouse, the SteeringWheels tool can be a welcome substitute for traditional pointer-based navigation. The touchpads or pointing sticks on most laptops do a poor job of emulating the press-and-drag motions of a mouse along with simultaneous keyboard button combinations that drive native navigation in Revit. If you're struggling without a mouse connected to your laptop, try the SteeringWheels tool and you might thank us!



## NAVIGATION BAR

Access to the most common navigating tools is also provided in the Navigation bar located at the right side of the drawing area. From here you can launch any of the SteeringWheels and all the zoom/pan commands from the flyout buttons.

## NAVIGATING WITH THE MOUSE

As with most modern design applications, the mouse can also be used to navigate in any view. You are not constrained to using the ViewCube, SteeringWheels, or Navigation bar. You might have already figured out that pressing the left mouse button selects objects and pressing the right mouse button accesses context menus. We discuss selection methods with greater detail in Chapter 3. For now, let's review how you can use the mouse to navigate the views in Revit.

To pan in any view, press and hold the wheel button on your mouse while moving it around your mouse pad. Hold the Shift key and use the wheel button on the mouse to orbit a 3D view.

The mouse wheel can be used to zoom in and zoom out of any view, but the zooming may be somewhat choppy. Hold the Ctrl key and press the wheel button while moving the mouse forward to zoom out (pushing the model away) or backward to zoom in (pulling the model toward you). You will also notice that the views will zoom in and out with a focal point based on the location of the mouse pointer.

In camera views, zooming works a bit differently. Scrolling the mouse wheel zooms in and out but includes the view's crop region. To adjust the view within the crop region, only the SteeringWheels and the ViewCube can be used.



## Defining Project Organization

If you have experience with 2D CAD software, you are likely familiar with many of the terms and concepts related to designing and documenting a project, but not all of them have exact equivalents in Revit. You may be comfortable with thinking in terms of what needs to be drawn and coordinated: plans, sections, elevations, details, schedules, and so on. Such information is likely stored in a plethora of separate files that must be linked together in order to reference other parts of a building design. For teams collaborating in the design process, you are also likely accustomed to allowing only one person in one file at a time. With this, maintaining all your project settings and standards is a struggle across so many disconnected files.

Working in the Revit environment affords you much more control and efficiency in managing these issues. From within a single, bidirectional database, Revit organizes these project organization aspects: datum objects, content, views, and management. Figure 2.23 shows what we like to think of as a Revit organizational chart, which gives you a visual description of these four categories and what these categories contain. In the following sections, we'll discuss each of these categories and describe its particular role in your Revit project environment.

### Introducing Datum Objects

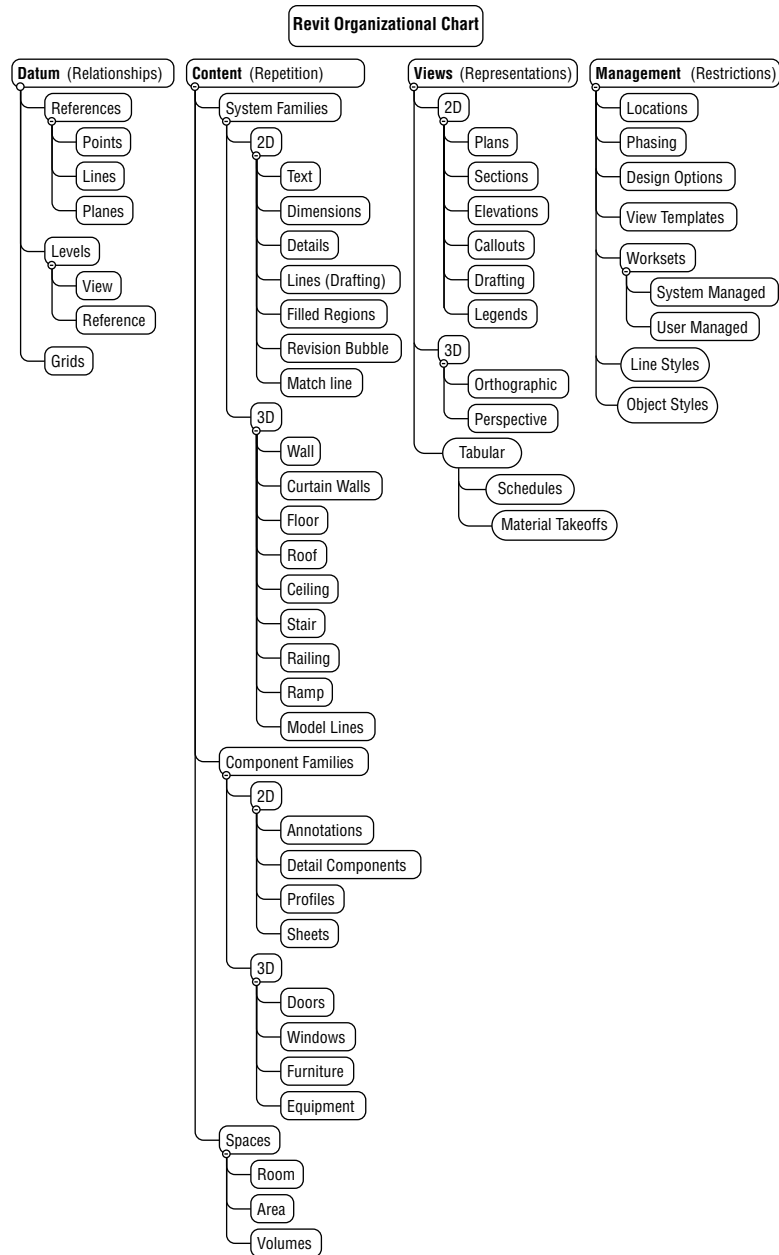
Data (plural) are sometimes referred to in Revit as *datum objects* and consist of references, grids, and levels (Figure 2.24). Datum objects establish geometric behavior by controlling the location and extents of your content (the building, the stuff that goes in a building, and the stuff you need to document your building).

Reference planes can be created in any 2D view from the main ribbon tabs (Architecture, Structure, or Systems), but once created, they may not be visible in 3D. After you add reference planes to your project, they can be set and seen from the Work Plane panel. This will allow you to work with respect to the desired work plane.

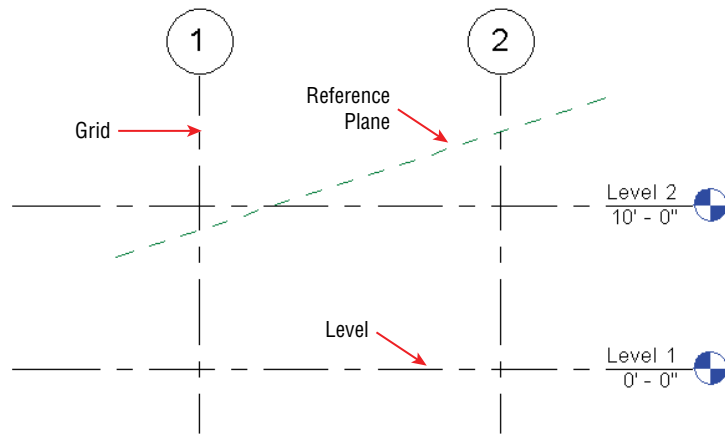
Grids are used to locate structural elements in your project. You are not required to include grids in your project, but they are quite useful in managing structural walls and columns. Like reference planes, grid lines can be added to any 2D view. Keep in mind that grids can be perpendicular only to levels. Furthermore, grids are visible only in views that are perpendicular to the grid. So, if the grid is in a north-south orientation, you'll be able to see it only in plan and from the east-west orientation.

Levels are datum objects that are parallel to the ground plane. They serve several purposes. First, they are the main method for placing and managing the elevation (or Z-location) of content. Virtually all content placed in a Revit model has a Level parameter. You can even move objects from one level to another simply by changing this property in the Properties palette. Levels also function as constraints for objects such as walls and columns. These objects have top and bottom constraints that can be set to levels so that they will automatically update if the levels are adjusted. Levels may be seen and created only in elevation and section views; therefore, you can't create levels in plan view, and they can't be diagonal to the ground plane.

**FIGURE 2.23**  
Revit organizational  
chart



**FIGURE 2.24**  
Datum objects



Creating any datum is easy. Simply select the desired tool from the Architecture tab and then pick two points to define the start and end locations. Despite their two-dimensional appearance, all datum objects have three-dimensional extents that help you manage their appearance throughout a project. You will explore this further in the section “Explaining 3D and 2D Datum Extents” later in this chapter.

## CREATING AND DUPLICATING LEVELS

In the previous section, we discussed the overall purpose of datum objects; however, there are special conditions related to the creation of levels. First, you should understand that a level does not always require an associated plan view. Levels that have plan views will have a blue graphic symbol at the end (double-click it to go to that view), whereas those that don’t will have a black graphic symbol. The blue represents hyperlinked data, which you can find on levels, section heads, and other annotations. When you create a new level, you have the option to create a corresponding plan view by using the Make Plan View option from the Options bar.

Copying an existing level will not create the corresponding plan views. This is useful if you are working on a larger project, such as a high-rise, and you want to quickly configure multiple levels without creating them one at a time. You might also want to use levels just as a reference for content but not for a specific plan, such as for an intermediate landing or mezzanine.

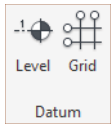
Although it is easy to create many levels by copying or arraying, only create the levels that are necessary to manage major parts of your project and that need to be shown in your documentation. You do not need to create a level for every slab, stair, or floor offset, as objects can be shifted in the Z direction offset for any level. Too many levels can have a negative impact on your project’s and your performance, as they take resources to manage.

Let's explore the creation and duplication of levels with an exercise. First, download and open the file `c02-Levels-Start.rvt` or `c02-Levels-Start-Metric.rvt` from this book's web page at [www.wiley.com/go/masteringrevit2020](http://www.wiley.com/go/masteringrevit2020).

Then follow these steps:

1. Open the exercise file and make sure the Project Browser is open—remember that it may be in a tabbed palette with Properties. Expand the Views tree and then expand Elevations. Double-click South to activate that view in the drawing area.

You will see two levels that are usually present when you create a new project using the default template.



2. From the Architecture tab in the ribbon, find the Datum panel and click the Level tool. In the Options bar, ensure that the Make Plan View option is selected.
3. From left to right, draw a new level exactly 10'-0" (3000 mm) above Level 2.

When you hover the mouse pointer anywhere near either endpoint of the existing levels, you will see alignment guides (dashed lines) that help keep the extents of the datum objects consistent.

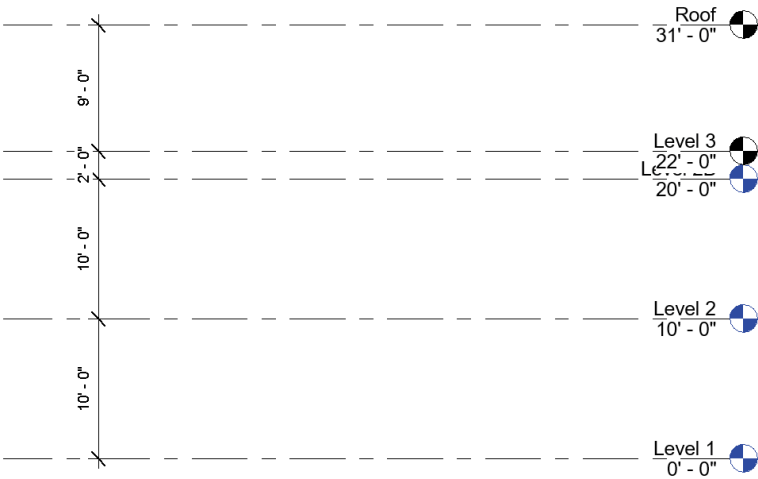
4. Click the Modify button or press the Esc key, and you will notice that the new level has a blue target. Double-click the target for Level 3, and the Level 3 floor plan will open.
5. Return to the South elevation view and select Level 3. From the Modify tab in the ribbon, click the Copy tool. In the Options bar, select the Multiple option.
6. Create two copies of Level 3: one that is 2'-0" (600 mm) above Level 3 and one that is 9'-0" (2700 mm) above that one, as shown in Figure 2.25.
7. You can change the names and elevations of levels by selecting a level and then clicking the name or the elevation value. Rename Level 3 to **Level 2B**, Level 4 to **Level 3**, and Level 5 to **Roof**. If you are prompted to rename the corresponding views, click Yes.



**TIP** If the level names overlap and you want to see them clearly, adjust the scale from the default 1/8" = 1'0" to 1/4" = 1'0".

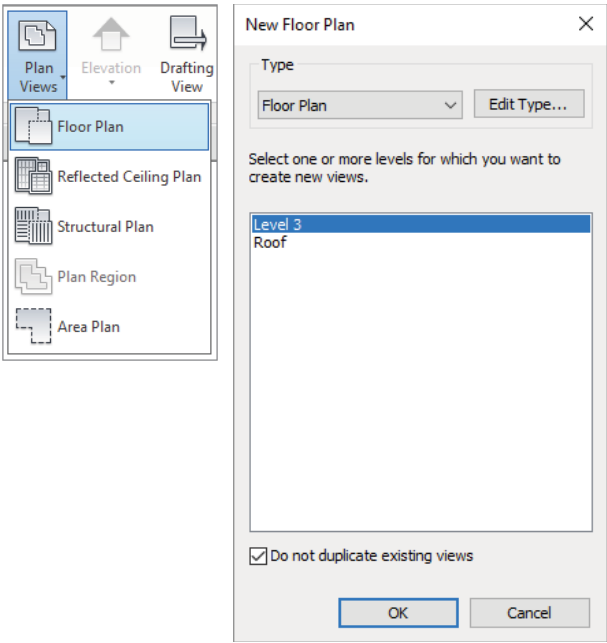
As we stated previously, plan views are not created for levels that are copied or arrayed. This gives you the flexibility to quickly generate levels for taller buildings without all the associated views that may increase your project file size unnecessarily. Although this workflow may be beneficial for you in early design phases, what do you do when you need all those floor plans and ceiling plans for that high-rise design?

**FIGURE 2.25**  
Create multiple copies  
of levels.



If you want to convert a level that doesn't have a view to one that does, find the Create panel on the View tab and then select the Plan Views flyout and then the Floor Plan command. This opens the dialog box shown in Figure 2.26. You can select among all the levels without corresponding views in your project. Only the levels you copied in the previous exercise are listed in the dialog box.

**FIGURE 2.26**  
Adding views to levels



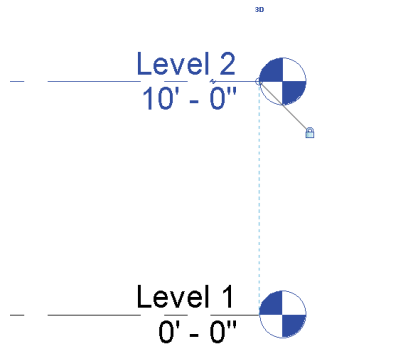
You can also use this command to create duplicate views of existing levels. Clear the Do Not Duplicate Existing Views option at the bottom of the dialog box to see all the levels in your project.

Select the Roof level and click OK. A floor plan will be created for the Roof level, and that floor plan will be opened. It is important to note that every plan you create with this method will be opened as you complete the command. Use the Close Inactive Views tool (available in the Quick Access toolbar) to avoid slower performance in your work session.

## EXPLAINING 3D AND 2D DATUM EXTENTS

Datum objects—specifically grids and levels—have two types of extents: 3D (analytic) and 2D (graphic). These extents are expressed as grips that are shown at the endpoints of the grids and levels in plans, sections, and elevations. The analytic grips control the extents of the datum across the entire project and all views. The analytic grip is shown as an open circle, and the indicator displays as 3D, as shown in Figure 2.27.

**FIGURE 2.27**  
Controlling the 3D  
(analytic) extents  
of the datum



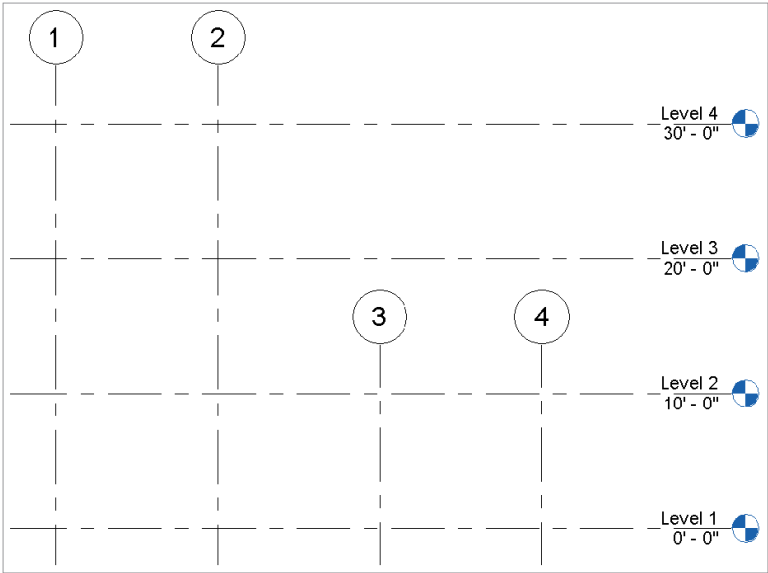
If you want to adjust the 2D extents of your datum in only the current view, click the 3D icon, and it will change to 2D. You can then modify the 2D extents of the datum object without affecting the 3D extents. We will explore this further in an exercise later in this section.

Datum objects are visible only in views that intersect their 3D extents. The elevation in Figure 2.28 shows four grids and four levels. Grid lines 3 and 4 are not visible on Levels 3 and 4 because their 3D extents are not intersecting those levels.

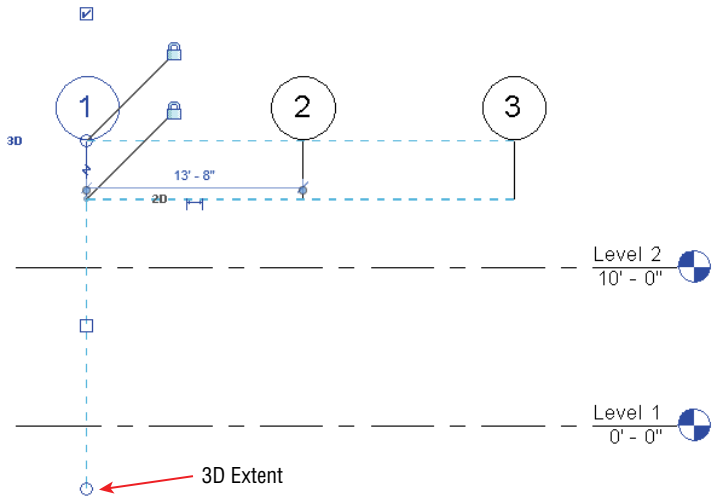
You can use the 3D and 2D extents to your liking in any view. In Figure 2.29, for example, the 3D extents of the grid lines extend through Level 1 and Level 2, but the 2D extents are set above Level 2. This means the grid datum would still be visible in both levels, even though it looks like they do not intersect the levels.

When you move a datum object, one way or another, content is going to respond. If you move a level, walls and furniture are going to move accordingly. If you move a grid, structural elements associated with the grid will relocate. And if you move references, the elements associated with them will update. Therefore, you will often constrain or pin datum objects in order to restrict their movement as your project is starting to develop.

**FIGURE 2.28**  
3D (analytic) extents affect the visibility of datum objects.



**FIGURE 2.29**  
Customizing 3D and 2D extents of datum objects



Let's continue with the exercise from the section "Creating and Duplicating Levels" and edit the 2D extents for one of the levels you copied. Remember that although this exercise uses levels, these methods can be applied to grids as well. Here are the steps:

1. Open the South elevation view again, and you'll notice that the label for Level 3 is slightly overlapping the label for Level 2B because they are relatively close. You'll need to adjust the 2D extent of Level 3.

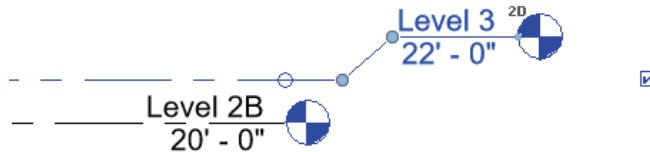
2. Select Level 3, and you'll see two items at the right endpoint with which you'll need to interact: the 3D indicator and the lock symbol. First, click the lock symbol to unlock the right endpoint. This will allow you to move the endpoint for the selected level without affecting all the other levels.
3. Click the 3D indicator so that it changes to 2D. Now you are ready to modify the 2D extents of the level.
4. Drag the 2D extents grip (the solid circle) to the right. The result should look like the image shown in Figure 2.30.

**FIGURE 2.30**  
Adjusting the graphic extents of a level



5. As a final option, you can choose to break the end of a level or grid line so that the tag or label will clearly display. Click the Add Elbow symbol near the label at the right endpoint of Level 3. We have indicated the location of this symbol in Figure 2.30.
6. Use the additional line grips to adjust the level endpoint so that it resembles the image shown in Figure 2.31.

**FIGURE 2.31**  
Adding an elbow to a level



## PROPAGATING EXTENTS

Quite often you will adjust the extents of datum objects that need to be replicated in several other views. Fortunately, there is a tool to help you accomplish this—Propagate Extents. The premise of this tool is simple, but you must be aware of the subtleties in applying it to a three-dimensional model.

The Propagate Extents tool pushes any modifications you apply to a datum object from one view to other parallel views of your choosing. This tool does not work well on levels because the parallel views are essentially mirrored views of each other. For example, the orientation of the South elevation is the opposite of the North elevation; therefore, if you make a change to the extents at the right end of a level in the South elevation, those changes would be propagated to the left end in the North elevation.



The best use for the Propagate Extents tool is to adjust the 2D extents of grids. Why only the 2D extents? Because changing the 3D extents affects the datum object throughout the project, independent of any specific view. Let's examine this behavior with a quick exercise:

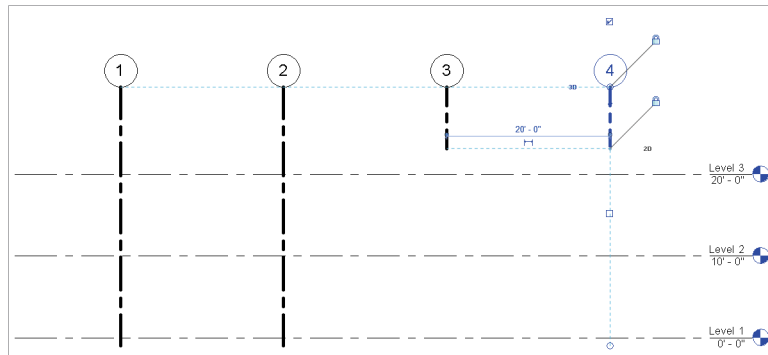
1. Download and open the `c02-Grids-Start.rvt` file from this book's web page and then activate the South elevation.

You will see three levels and four grids.

**NOTE** The line weight of the grid lines has been increased for clarity.

2. Select grid 3 and click the 3D indicator at the bottom endpoint. Notice that the lock symbol turns off automatically, allowing you to immediately adjust the graphic extents of the grid.
3. Drag the 2D extent of grid 3 up toward the top. Repeat this process for grid 4 so that the result looks like the image shown in Figure 2.32.

**FIGURE 2.32**  
Adjusting the 2D  
extents of grids

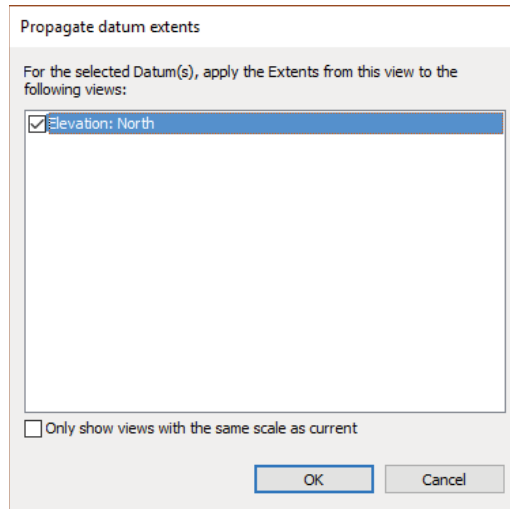


Before you continue, open the Level 1 and Level 2 floor plans and observe that grids 3 and 4 are still visible. If you had adjusted the 3D extents of the grids in the South elevation view, those changes would already be reflected in the other views. We're using this method because we want to maintain the 3D extents but modify the 2D extents only in the South elevation view.

4. Return to the South elevation view and select grids 3 and 4 while pressing the Ctrl key. From the contextual tab in the ribbon, click the Propagate Extents button, and the dialog box will appear as shown in Figure 2.33.
5. In the Propagate Datum Extents dialog box, select the North elevation view.
6. Click OK to complete the command and then activate the North elevation view. Observe that the 2D extents of grids 3 and 4 now match the modifications you applied in the South elevation view.

**FIGURE 2.33**

Propagating extents to other views



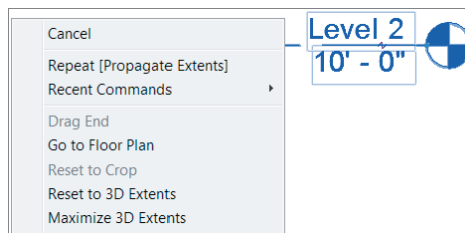
You can use the Propagate Extents command to easily copy datum settings to any parallel views in your project. This is especially effective for propagating grid extents to many plan views in high-rise buildings.

### RESETTING OR MAXIMIZING 3D EXTENTS

Two commands you might need when adjusting datum object extents are ones that give you the ability to reset or maximize the 3D extents. These commands are available in the context menu when you have a datum object selected (Figure 2.34).

**FIGURE 2.34**

Extent commands in the context menu



The Reset To 3D Extents command allows you to reset any graphic extent modifications back to the analytic extents. Let's apply this command in the continued exercise file:

1. In the c02-Grids-Start file, return to the South elevation view. Right-click grid 3, and select Reset To 3D Extents from the context menu. Repeat this step for grid 4.
2. You will see the grid lines return to their original condition; however, this has been changed only in the current view (South elevation). Activate the North elevation view to observe this behavior.

3. Return to the South elevation view and select grids 3 and 4; click the Propagate Extents button in the contextual tab in the ribbon, and select the North elevation view.
4. Click OK to close the dialog box, and the reset 2D extents will be applied to the grids in the other views.

The other command in this pair serves a similar purpose in dealing with datum objects. Maximize 3D Extents is most often used if your levels or grids are exhibiting strange behavior. There are various reasons why this happens, but you'll realize it when it does. You can use this command to set the analytic extents of a datum object to the outer boundaries of your project geometry.

Continuing in the exercise file, activate the Level 1 floor plan and notice that grid line C seems to be displayed like all the other grids. Now activate Section 1 from the Project Browser or by double-clicking the section head shown in the floor plan. You'll notice that grid line C is not visible in the section view. This is because someone mistakenly pulled the analytic (3D) extents far to the left in plan view while the graphic (2D) extents remained consistent with the other grids. Let's continue the exercise and repair this problem.

5. Activate the Level 1 floor plan and select grid line C. Right-click and, from the context menu, choose the Maximize 3D Extents command.
6. It may not seem like anything happened, but activate the Section 1 view and you'll now see that grid line C is visible.
7. Return to the Level 1 floor plan, select grid line C again, and then click the 2D indicator at the right endpoint so that it indicates 3D.

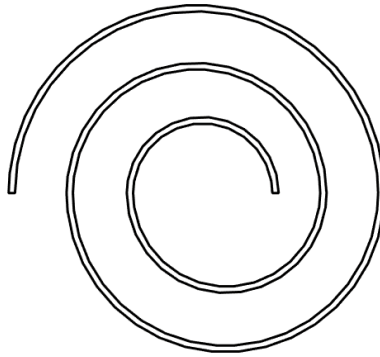
## USING REFERENCE PLANES

Objects in the Revit model can maintain relationships with other objects; however, you may not always have other model elements (like walls, floors, and roofs) to relate to other geometry. This is why datum objects are so important.

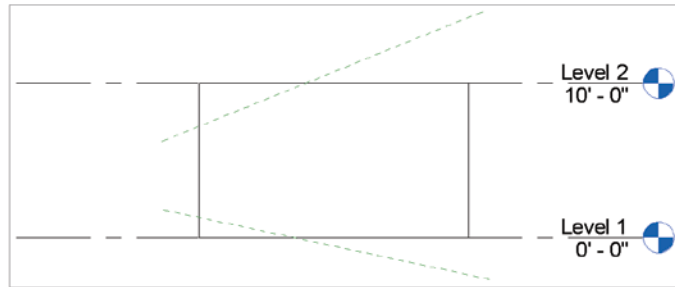
If you have been using Revit for a reasonable amount of time, it seems obvious that levels and grids would control content, but reference planes aren't often appreciated. Here's a simple exercise to demonstrate this special kind of relationship between reference planes and walls:

1. Download and open the file `c02-Walls-Start.rvt` from this book's web page. Activate the Level 1 floor plan, select the wall segment, right-click, and then choose Create Similar from the context menu. Use the Tangent End Arc option from the Draw panel in the contextual tab of the ribbon to create a series of concentric walls starting from the left endpoint of the provided wall, as shown in Figure 2.35.
2. Go to the South elevation view. From the Architecture tab in the ribbon, click the Reference Plane tool and add two angled planes (dashed lines), as shown in Figure 2.36.

**FIGURE 2.35**  
Concentric walls



**FIGURE 2.36**  
Reference planes and  
levels shown in elevation



3. If you move Level 1, you'll notice that the walls all move with it. You don't have to select the walls; it's in the properties of the walls to maintain a relationship to the Level 1 datum. You could make the top of the walls maintain this same kind of relationship to Level 2.

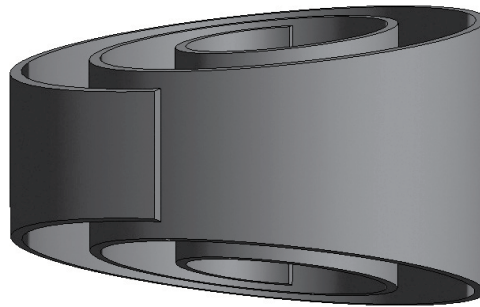
You can also create a relationship to the reference planes. To do so, simply select all the walls (just hover your mouse over one wall, press and release the Tab key, and then left-click to select the chain of walls) and then click the Attach Top/Base button in the ribbon. Note that Attach Wall > Top is the default selection in the Options bar, so first pick the upper reference plane. Click the Attach Top/Base button again, make sure Attach Wall > Base is selected in the Options bar, and then pick the lower reference plane.

Figure 2.37 shows the results in a 3D view after you've attached the top and bottom of the walls to the upper and lower reference planes.

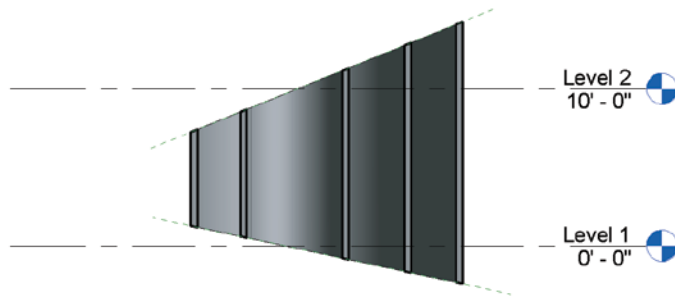
Try moving and rotating the reference planes, and notice that the walls will maintain their relationships to the planes. This is shown in a section view of the walls in Figure 2.38.

Although you can use levels, grids, and reference planes to customize model elements, there may be situations where you need to establish relationships with nonplanar geometry.

**FIGURE 2.37**  
Finished walls



**FIGURE 2.38**  
Section view



## Using Content

Effective use of content is all about repeated elements in a hierarchy (project, family, type, instance) that you put in your Revit project to develop and document your design. Content can often maintain relationships with other content, but more important, they maintain relationships to datum objects. As you can see from the Revit organizational chart shown previously in Figure 2.23, content includes system families, component families, and spaces.

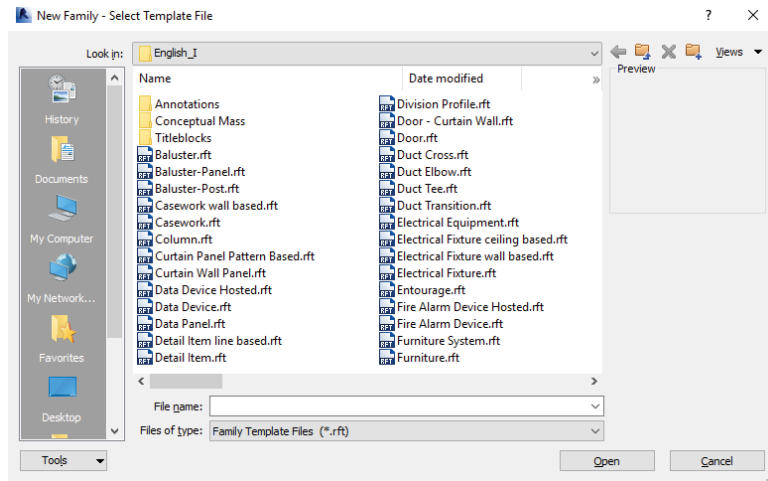
*System families* (also called *host families*) are content that is part of the Revit project environment and are more akin to rule sets rather than physically constructed components. These families are not created and stored in external files with the file extension RFA—they're found only in the RVT project file. If you need another type of a system family, you will duplicate an existing type from within the project. System families can be 3D elements such as walls, floors, roofs, ceilings, stairs, and railings or 2D elements such as text, dimensions, revision clouds, and insulation.

*Component families* are created in the Family Editor and are either 2D or 3D content. This means you will have to create and load these kinds of families outside the Revit project environment as RFA files. When you start to create a component family, you'll need to select an appropriate family template (Figure 2.39). By selecting the right family template, you will be certain that the component you're creating is going to behave, view, schedule, and (if necessary) export properly.

Although most system families help shape the physical aspects of a building, the occupied voids within are critical to a successful design. These elements are *spaces*, which take the form of rooms and areas. Spaces maintain relationships to datum objects but also to model elements including floors, walls, ceilings, and roofs. In addition to spatial properties, rooms are used to

store information about finishes within a project. Take a look at the properties of a room, and you will find Floor Finish, Base Finish, Wall Finish, and Ceiling Finish.

**FIGURE 2.39**  
Selecting a family template



## WORKING WITH TYPE AND INSTANCE PARAMETERS

All content in an Revit project has *parameters*, which are simply the information or data about something. Parameters can affect many different aspects of an object, such as visibility, behavior, size, shape, and material.

To develop a fundamental understanding of parameters, you must note that there are two kinds of parameters: *type* and *instance*. Type parameters control information about every element of the same type. For example, if the material of a piece of furniture is designated as a type parameter and you change it, the material for all the furniture of that type will change. Instance parameters control only the instances that you have selected. So if the material of the piece of furniture that you have selected is an *instance* parameter, you will be editing only the selected elements.

Instance parameters can be constantly exposed in the Properties palette. Selecting something initially displays the instance parameters. Figure 2.40 shows the instance parameters of a wall that control the relative height, constraints, and structural usage.

By clicking the Edit Type button, you expose the type parameters (Figure 2.41). These parameters control values such as the structure, graphics, and assembly code.

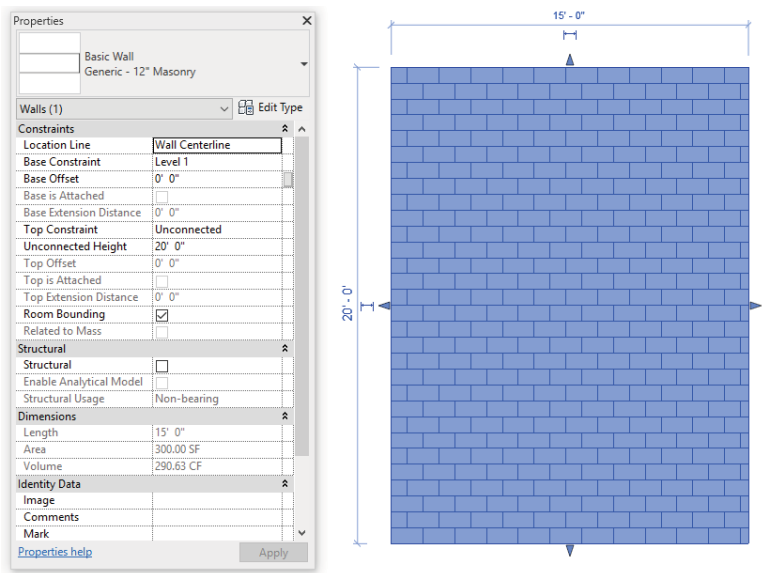
This section provided you with a basic overview of families and parameters; you will learn much more about these concepts in Chapter 15.

## Working with Views

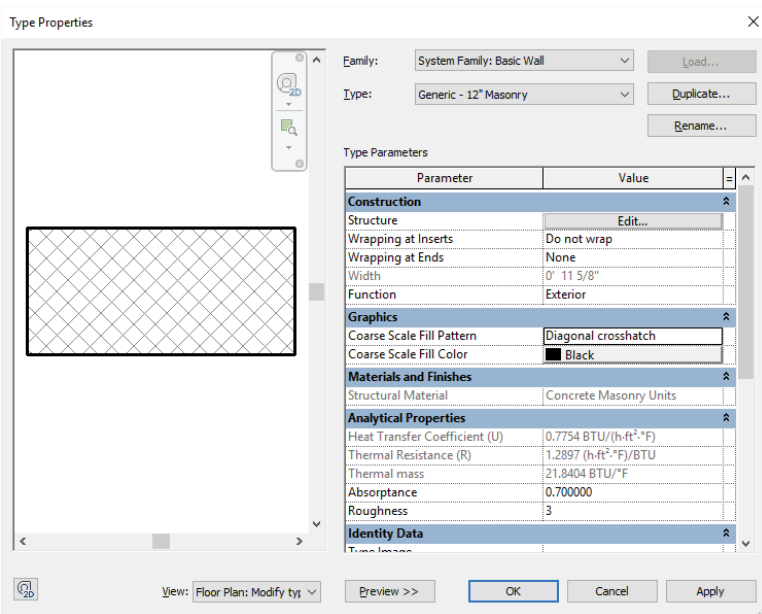
*Views* are the means by which you will interact with, perceive, and document the project. As you can see in the Revit organizational chart shown previously in Figure 2.23, there are both 2D and 3D views. Two-dimensional views are oriented to specific coordinates such as plan, elevation,

and section. Schedules and material takeoffs are yet another way of viewing information in a project that is neither 2D nor 3D. Three-dimensional views are either orthographic or perspective (camera view) in nature. Views also have type and instance parameters that control properties such as name, scale, detail level, phase filter, and graphic display options. We will review each type of view again in more detail in Part 5, “Documentation.”

**FIGURE 2.40**  
Instance parameters of a wall



**FIGURE 2.41**  
Type parameters of a wall



## REVIEWING THE COMMON PROPERTIES OF VIEWS

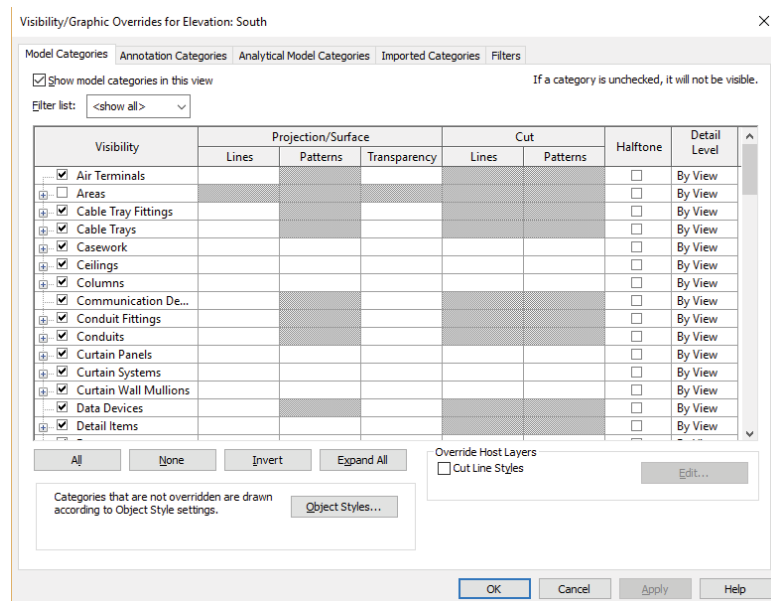
Let's first review, in detail, some of the properties that apply to most views. All of these are found in the Properties palette when no objects are selected; however, some properties may also be accessed in the view control bar. The most common view properties are as follows:

**Crop Region** With the exception of schedules and drafting views, the extents of all views can be limited using crop regions. The visibility of the crop region itself can be turned off, but you can choose to hide all crop regions in the Print Setup dialog box when using the Print command. Although you might feel the need to keep crop regions visible to allow easier editing, you can use the Reveal Hidden Elements tool in the view control bar to temporarily show hidden crop regions. Buttons to enable/disable and show/hide the crop region are available on the view control bar.

**View Scale** The view scale is the proportional system used to represent components of measured drawings. The scale of a view not only controls its printed size, but also automatically controls the relative weight of line work as well as the size of annotations such as text, dimensions, and tags. The view scale is displayed on and can be modified from the view control bar.

**Visibility/Graphics** The Visibility/Graphic Overrides dialog box (Figure 2.42) allows overrides of a view's elements in two essential ways: visibility (turn object categories on/off) and graphics (customize line thickness, color, and fill pattern).

**FIGURE 2.42**  
Visibility and graphic  
overrides for  
an elevation



**Detail Level** The Detail Level parameter can be set to one of three predefined choices: Coarse, Medium, or Fine. A representation for each setting is defined during the component's



construction and sets the level of detail in each view level. It can help improve model performance and avoid cluttered views by limiting the visibility of smaller model elements. Detail Level can be set with a button on the view control bar.

**View Template** View templates are a selection of view properties, which can include properties that change the scale, detail level, and visibility of objects in the view. As an aid to standardization, view templates can help you organize common view settings and apply them to groups of views throughout your project and other projects within your office or firm. View templates are covered in detail in Chapter 4.

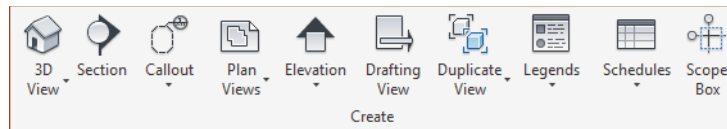
## CREATING AND DUPLICATING VIEWS

You can create views in various ways in order to work with your project in a manner that meets your needs. Although creating views is quick and easy, you should avoid populating your project file with too many unnecessary views. An overabundance of unused views will increase the amount of management your team will need for the project's organization. Views that do not have a specific purpose are just another object to maintain, search through, and store. Keep it simple, and routinely purge valueless views. Let's review the procedures to create different view types and see how to control their extents after they're created.

New views can be generated from the Create panel on the View tab of the ribbon (Figure 2.43), and the process is quite simple. Click one of the buttons, and a new view is activated and stored in the Project Browser.

**FIGURE 2.43**

Creating new views from the ribbon



Another quick way to create new views is to right-click a view name in the Project Browser and select one of the Duplicate View commands (Figure 2.44). You can also duplicate the current view by using the Duplicate View button in the Create panel of the ribbon.

As you can see in Figure 2.44, there are three choices in the Duplicate View flyout command: Duplicate, Duplicate With Detailing, and Duplicate As A Dependent. Let's take a quick look at what each of these options means.

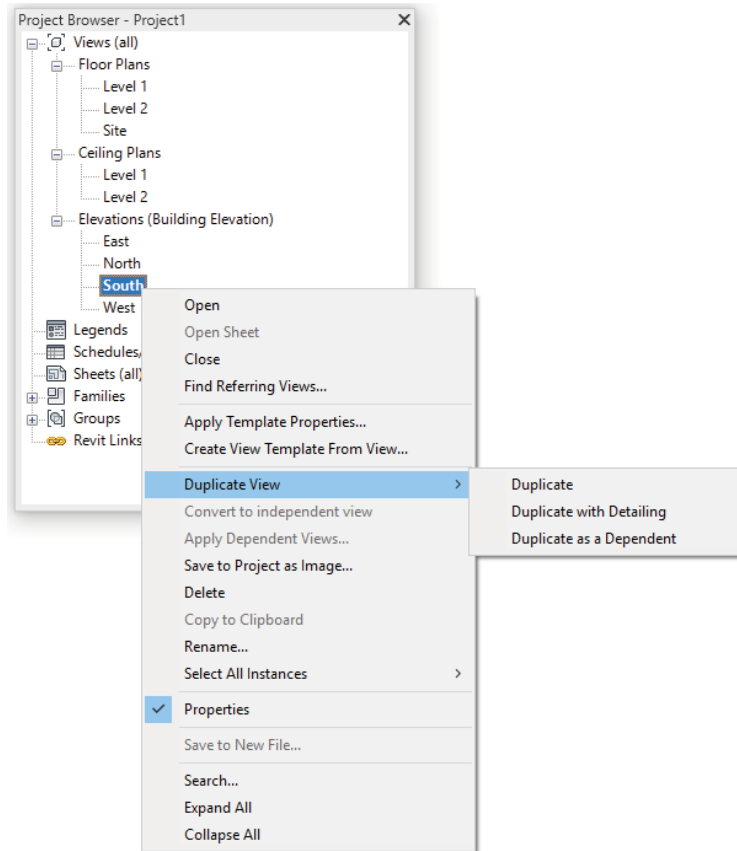
**Duplicate** This command will create a copy of the selected view but will not replicate any of the annotations in the view. Use this command when you need a fresh copy of a view in which you will create a new annotation for a different documentation purpose or even a working view without clutter.

**Duplicate With Detailing** As its name suggests, this command will create a copy of the selected view with all the annotation in the view. We don't recommend using this command too often because replicated annotation is often a sign of an inefficient production process.

**Duplicate As A Dependent** This command allows you to create a series of partial views that assume the properties of one parent view. Using dependent views does not mean you can have a parent view with a larger scale like 1:100 and then create dependent views at larger

scales such as 1:50. The parent view has all the same properties as the dependents, but you can manage the crop regions and settings from the parent view. This is used most commonly with large plans and elevations that cannot fit on the project's standard sheet size.

**FIGURE 2.44**  
Duplicating views from  
the Project Browser



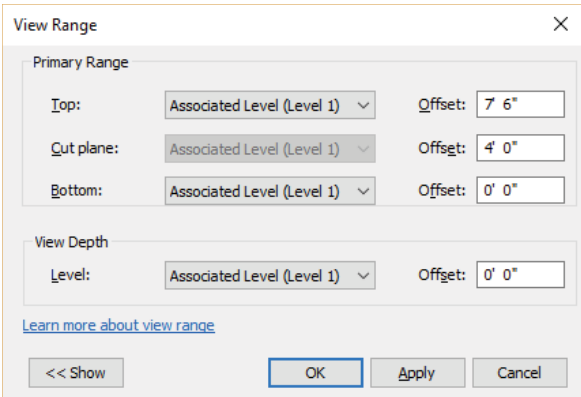
## CREATING FLOOR PLANS AND CEILING PLANS

As you learned in the section “Creating and Duplicating Levels” earlier in this chapter, when you create a level in an elevation or section view, you have the option to create a plan view for that level in the Options bar. If you have levels without corresponding plan views, you can also use the Plan Views tool from the ribbon to create a plan view.

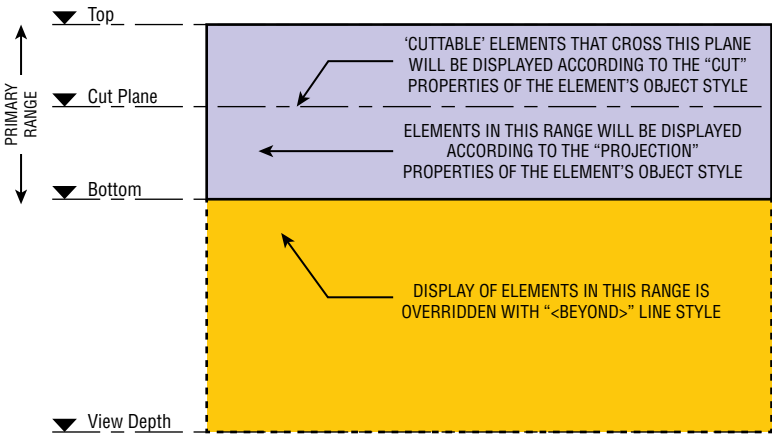
The vertical extents of plans and ceiling plans are controlled by the View Range settings. The View Range settings, as shown in Figure 2.45, define the vertical range of the view.

The view range properties can be difficult to understand, so we created a diagram to illustrate the principles. In Figure 2.46, you will see that the primary range is the zone you usually see in a default floor or ceiling plan. If an object crosses the cut plane, the object's Cut values are used. If the object is below the cut plane but above the bottom, the object's Projection values are used. Cut and Projection values can be found in Visibility/Graphics.

**FIGURE 2.45**  
View Range dialog box



**FIGURE 2.46**  
View range properties explained



For most views, the Bottom and View Depth parameters are set to the same plane. Therefore, objects below the bottom of the view range simply won't appear. So, what happens if you need to show objects on a lower terrace for reference in the current view? When you set View Depth to Level Below or Unlimited, objects that are below the bottom of the view range but within the view depth will be overridden with the <Beyond> line style.

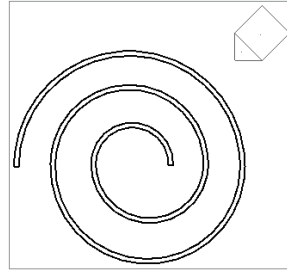
Perhaps you only need to apply a different view range setting to isolated areas of a view. This can be accomplished with the use of the Plan Region tool. You can find this tool in the Create panel of the View tab along with the other Plan View tools. The Plan Region tool allows you to sketch a boundary within which the View Range dialog box will be available to make specific changes. You can use this method for areas such as windows that might be placed in a wall above the cut plane but need to be shown on the plan for documentation.

Another useful property of plans is known as an *underlay*. Although this property may function more like a tool, it is found in the Properties palette along with the other view properties. An underlay allows you to use any other level as a reference in the current view. You can use the underlay to display ceiling soffits in a floor plan, to display furniture layouts in a ceiling plan, or to use another level as a reference for replicating partition layouts.

## CREATING ELEVATIONS

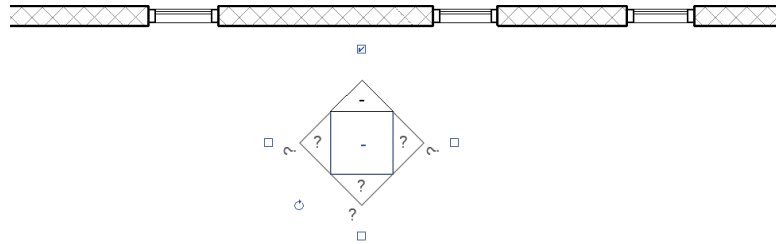
Selecting the Elevation tool on the View tab creates elevations of various types. You'll also notice that as you place an elevation tag, the elevations automatically orient to walls (Figure 2.47). If there's no host element nearby to reference, they'll automatically orient to the left.

**FIGURE 2.47**  
Elevation tag orientation



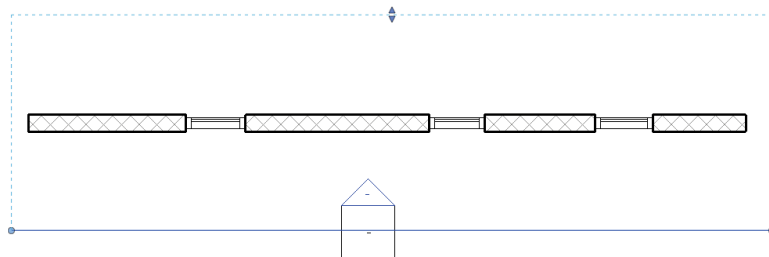
Selecting the center of the tag will allow you to create additional elevation views (more typically done for interior elevations) by selecting the unchecked boxes that surround the elevation tag (Figure 2.48).

**FIGURE 2.48**  
Creating additional elevations



If you select the directional point of the elevation tag, you will see a blue line that defines the beginning of the cut plane for the elevation as well as a dashed line that defines the side and rear extents (Figure 2.49). This allows you to control the analytic extents of the elevation without moving the graphic tag, which is useful if you want the tag in a particular location but you want the cutting plane to start somewhere else.

**FIGURE 2.49**  
Elevation extents



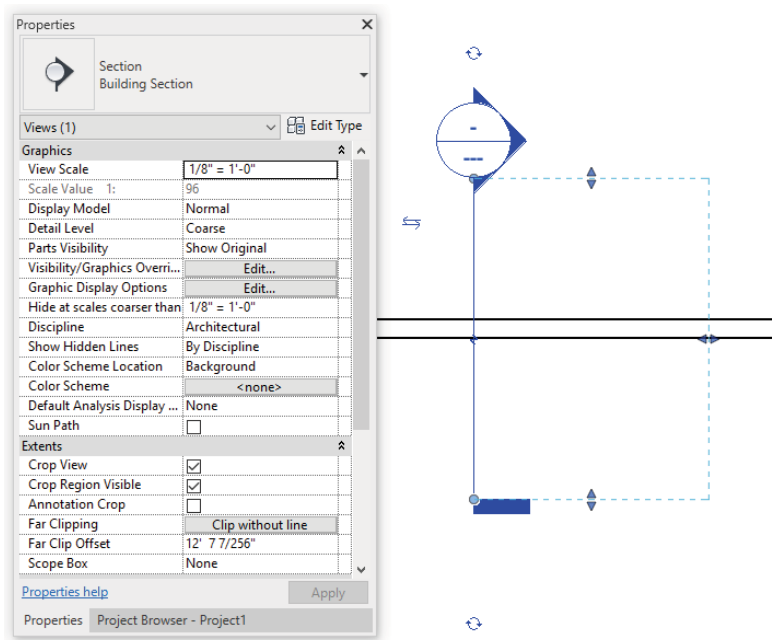
Finally, there are three types of elevations in Revit project: exterior, interior, and framing. Their differences are more than graphic. *Exterior elevations*, by default, do not have an active crop boundary, only a starting cut plane. *Interior elevations* have their crop boundary on by default and attempt to find boundaries of host elements, such as walls, floors, and ceilings. *Framing elevations* can be placed only along a grid line, and their cut plane corresponds to the respective grid.

CREATING SECTIONS

Selecting the Section tool on the View tab creates sections. By default, three types of sections are available from the Type Selector: Building, Wall, and Detail. This allows them to be grouped with better clarity in the Project Browser, but there are also other important properties.

Unlike elevations, the cutting plane of a section must correspond with its graphic line. Figure 2.50 shows the instance properties of a Building section. The far and side cut planes of a section can also be controlled. This goes for both Building and Wall sections.

FIGURE 2.50  
Section properties  
and extents

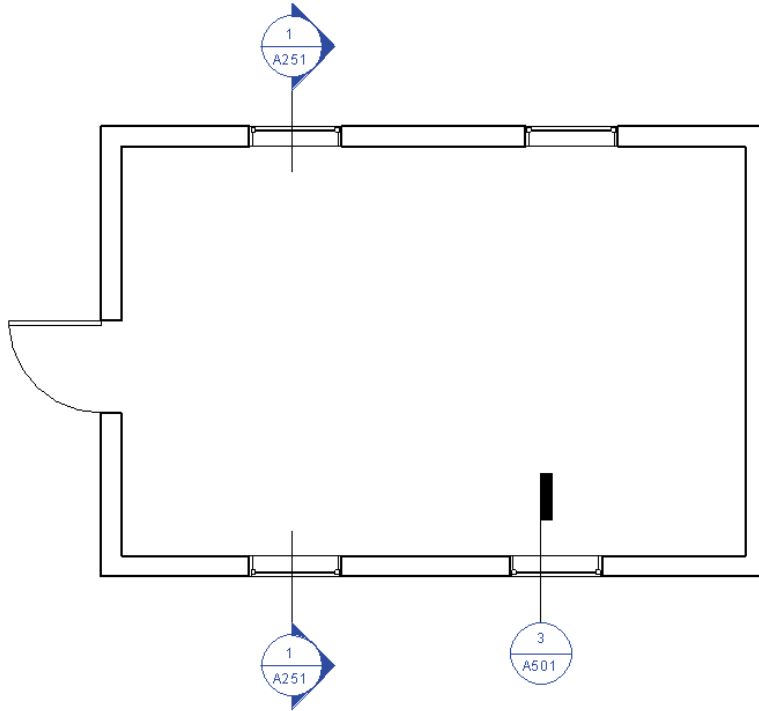


Building and Wall sections must be created in a perpendicular orientation with respect to levels. But after you create them, they can be rotated in elevation. However, doing so could lead to confusion in your project. Once rotated, the section wouldn't be displayed in plan view because the section cutting plane would no longer be perpendicular to the plan view.

A Detail section will have a different graphic symbol by default, although you can customize this to your liking. (We discuss this form of customization in Chapter 4.) Beyond the differing

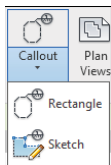
graphic symbol, Detail sections will have a smaller clipping region than a Building or Wall section. In Figure 2.51, a Building section is shown at the left of the image, and a Detail section is shown to the right.

**FIGURE 2.51**  
Building and Detail  
sections shown  
in plan view



It's important to know that a Detail section created in plan view will automatically display as a callout in any Building section or Wall section if the Detail section overlaps a larger section. Of course, this is not an ideal workflow for architectural documentation. We discuss the process of using callouts from larger sections in Chapter 17.

Also note the color of callout and section heads in Figure 2.51. These blue icons act as hyperlinks to the other views in your project. Double-click any of these blue heads to activate that view.

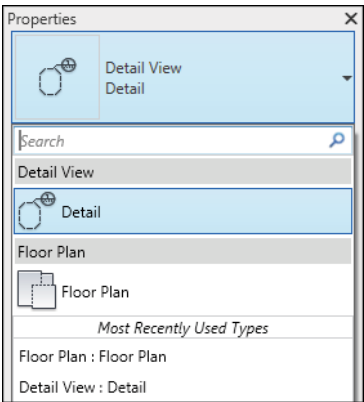


## CREATING CALLOUTS

The Callout tool allows you to create views that are intended to be enlarged from the scale of the parent view in which you create the callout. When you are in a parent view—a floor plan, section view, or elevation view—you can create a callout from the View tab in the ribbon within the Create panel.

The most important aspect of the Callout tool you need to understand is the difference between the types of callout views you can create. When you activate the Callout tool, click the Type Selector in the Properties palette. You will see several choices that depend on what kind of view you currently have activated. For example, if you are using the Callout tool in a floor plan view, you will see Detail and Floor Plan listed in the Type Selector, as shown in Figure 2.52. Although Detail callouts may look like Detail sections graphically, they are not visible inside other perpendicular views. So, a callout created in plan view will not be visible in elevations or sections like a Detail section.

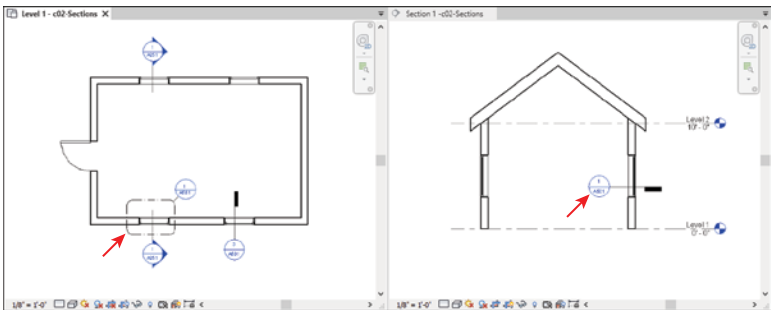
**FIGURE 2.52**  
Be aware of the different types of callouts you can create from the Type Selector.



In the example shown in Figure 2.52, if you select Detail, the callout view you create will be listed in the Project Browser under Detail Views. If you select Floor Plan, the callout view will be listed under Floor Plans. You cannot change a callout view from one type to another after it is created, so plan the configuration of your views carefully.

Beyond the organization of callout views in the Project Browser, choosing the right type for your callouts affects other functionality as well. The Detail callout has a unique property called Show In. This property can be set to either Parent View Only or Intersecting Views. If the callout is set to show in Intersecting Views, this type of callout in plan view would display as a section detail mark in an intersecting view such as a Building section. In Figure 2.53, you can see the callout added to the floor plan (left). When the Show In property of that callout is set to Intersecting Views, it displays as a detail section mark in the building section (right).

**FIGURE 2.53**  
Detail callouts can be set to show in intersecting views.



If you create a callout using the same type as the parent view, the callout view will also have all the same view controls as the parent view. In the floor plan example, you will still have view properties such as Depth Clipping and View Range. In a Detail callout, the property called Far Clip Settings can be set to either Independent or Same As Parent View.

Take a moment to note the grips on the boundary of a callout when one is selected. You can use these grips to change the size of the callout boundary, but this also modifies the crop region within the callout view. As you might assume, if you modify the crop region in the callout view, the callout boundary also changes.

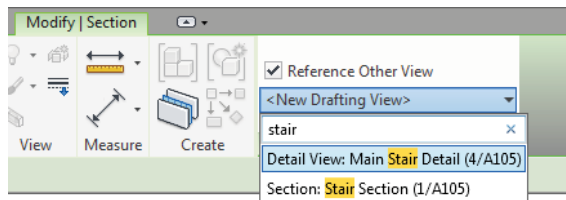
Callouts can be created either in a simple rectangular shape or in any custom sketched shape. You will see these two tool options in the Callout flyout button in the ribbon, but you can always edit a rectangular callout by first selecting a callout and then selecting Edit Crop from the contextual tab in the ribbon. You can also return a custom shape callout to a simple rectangular shape by clicking Reset Crop in the ribbon.

## USING DRAFTING VIEWS

Not every view needs to be connected directly to the model. Drafting views give you the ability to draw without first creating a reference to something in your project. They may contain Detail and Repeating Detail components and any other annotation content. Drafting views are great for quickly documenting typical conditions that don't require an actual model geometry.

Once you create a drafting view, you can refer to this view when creating an elevation, a section, detail, and so on, that would normally rely on an actual view of the model. As you start to create a standard project view, simply select the Reference Other View option from the contextual tab of the ribbon (Figure 2.54), and then you'll be allowed to select a reference view from all the other like views in your project as well as any drafting views. You can even use the search bar to easily locate specific view names instead of scrolling through an extensive list of all project views. Drafting views can also be saved out of the project as common reusable details. This will be covered in more depth in Chapter 17.

**FIGURE 2.54**  
Use the search bar with the Reference Other View option.



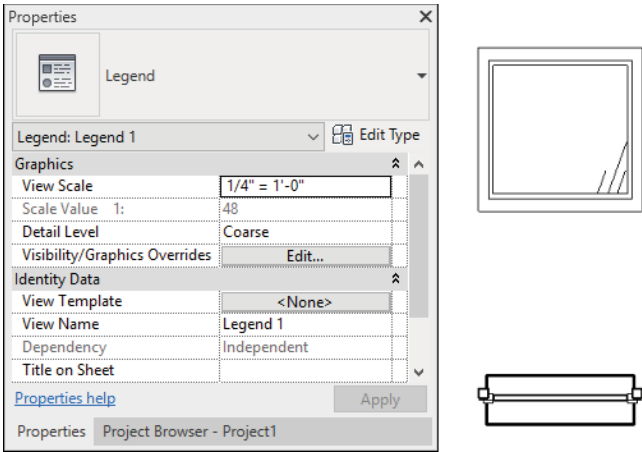
## USING LEGENDS

Legends are views in which you can display samples of model elements that will not affect schedules and quantity takeoffs. There are two types of legends: legends and keynote legends. Regular legends are used to assemble analytic views of content in your project, graphics, geometry, tags, and so on—anything that lives in your project. Legends may contain Detail, Repeating Detail, and Legend components, which are live representations of 3D model elements. Legends are unique in that they are the only graphical view that can be placed on more than one sheet.



A Legend component (Figure 2.55) is a special live representation of a system or component family that may appear only in legend views (not drafting views). If you make a change to an element in your project, the representation of that element in the legend will change as well. When you are creating a legend view, the Legend Component tool is located in the Component flyout button on the Detail panel of the Annotate tab in the ribbon.

**FIGURE 2.55**  
Legend components



Keynote legends are special schedules. When creating a keynote legend, you will be prompted much the same way as you are when creating a schedule (Figure 2.56). These types of legends are meant to be placed on either one sheet or multiple sheets. If the legend is placed on every sheet in which keynotes are used, the Filter By Sheet option should be selected on the Filter tab of the Keynote Legend Properties dialog box. With this option selected, only those keynotes that appear in views placed on a sheet will appear in the sheet's keynote legend.

**FIGURE 2.56**  
An example of a keynote  
legend placed  
on a sheet

KEYNOTE LEGEND	
061000.01	FRAME EXISTING OPENING TO MATCH.
061000.02	DOOR LANDING - TREATED WOOD STRUCTURE, TREX RAILS AND STEPPING SURFACES
061000.04	COMPOSITE RAILING SYSTEM, TIMBERTECH RADIANCE RAIL OR SIM.
074600.01	VINYL SIDING OVER 1/2" RIGID INSULATION
077200.02	BREAK-FORMED ALUMINUM FASCIA OR COMPOSITE TRIM (WHITE)
092100.01	1/2" GYPSUM BOARD, PAINT BY OWNER (TYP.)
096800.01	LAMINATED WOOD FLOORING (FURNISHED AND INSTALLED BY OWNER) OVER 3/4" PLYWOOD SUBFLOOR ALIGNED WITH EXIST. SUBFLOOR
096800.02	MARMOLEUM OR VINYL FLOORING (FURNISHED AND INSTALLED BY OWNER)
238100.01	DUCTLESS HEATING AND COOLING UNIT

## USING SCHEDULES

All model elements have information about their properties such as size, material, and cost. In Revit, a schedule is a list of any type of element in a project or linked models and the element attributes. You can report and interact with this information in tabular views known as schedules. There are six types of schedule views that can be accessed from the Create panel in the View tab of the ribbon: Schedule/Quantities, Graphical Column Schedule, Material Takeoff, Sheet List, Note Block, and View List.

**Schedule/Quantities** This is the most commonly used schedule type, allowing you to list and quantify all the element category types. You would use this type to make door schedules, wall schedules, window schedules, and so on. These schedule types are usually limited to scheduling properties within the same category; however, you can create a multi-category schedule or use some fields from other elements. For example, many model elements can refer to the properties of the room in which they are placed.

**Graphical Column Schedule** This schedule is different from the other schedule types and is commonly used by structural engineers. Structural columns are displayed according to their grid intersections, indicating top and bottom constraints as well as offsets.

**Material Takeoff** This type of schedule lists all the materials and subcomponents of any family category. You can use a material takeoff to measure any material that is used in a component or assembly. For example, you might want to know the volume of concrete within the model. Regardless of whether the concrete is in a wall or floor or column, you can tell the schedule to report the total amount of that material in the project. Material takeoffs will report material properties across multiple categories.

**Sheet List** This schedule allows you to create a list of all the sheets in the project.

**Note Block** This tool creates a unique schedule that lists the properties of a generic annotation symbol used in a project.

**View List** This schedule shows a list of all the views in the Project Browser and their properties. A view list can be a valuable tool to help you manage your project's views efficiently.

One important aspect that we want to reiterate is that schedules are derivatives of the model. Often, if the schedule is not accurate, the model is not accurate. A schedule can also deal with the tolerances the team has set in the units of the file and may be based on the template.

## USING SHEETS

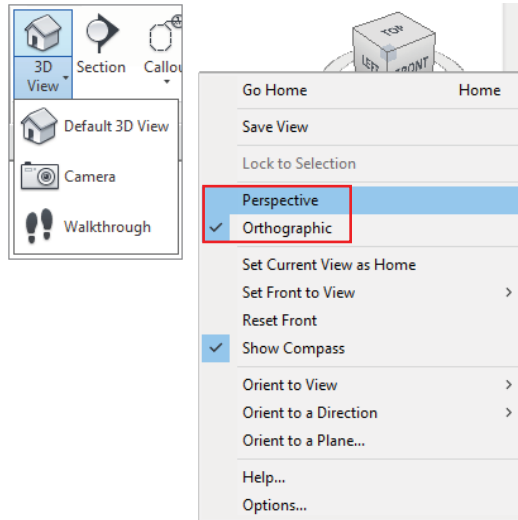
Printed contract documents are still a common deliverable that architects and engineers are paid to produce. You will use sheets to organize views and other annotation for the purpose of issuing printable (physical or digital) documents. Sheet borders can be customized, but the important fact to realize is that sheets are always scaled at 1:1. The important thing to remember is that you are not going to select a scale when you print a sheet; it's really more like printing than plotting. If you need your sheet to be smaller or fit on the desired page, these options are available, and using them is little different than printing from a word processing application.

You will learn more about creating sheets in Chapter 18.

## USING 3D VIEWS

Two kinds of 3D views are supported: orthographic and perspective. The Default 3D view is orthographic, whereas the Camera and Walkthrough views are in perspective (Figure 2.57). You can right-click the ViewCube and select the Perspective or Orthographic option to toggle between the 3D view types. We'll also cover 3D views in detail in Chapter 12.

**FIGURE 2.57**  
Creating 3D view types  
and toggling  
between them



Orthographic views will always show parallel edges along Cartesian x-, y-, and z-axes. Orthographic views are best if you need to show model information to scale. Many people do not realize that it is possible to dimension and detail in Revit inside a 3D orthographic view. For a more thorough explanation of annotating a 3D view, refer to Chapter 21, “Presenting Your Design.”

Create camera views by placing the starting point and endpoints of a camera (typically from a plan view). The first point you select in plan view is the point from which the view will be taken, but the second point is also the rotation origin for the view (Figure 2.58). This is important because if you select a second point that is far beyond your view, when you open the view and attempt to modify it, it will rotate around a target that doesn't seem to make sense. That's because the target location of the view is off in the distance.

A perspective view will not be to scale, but it can be made relatively larger or smaller by selecting the view's crop region and then selecting the Size Crop button from the Modify | Camera tab. Once you do this, you will have the option to change the view size and field of view, proportionally or not proportionally (Figure 2.59). You can also simply drag the nodes of the bounding box.

Camera extents are defined by the Far Clip Offset option, accessed in the Properties palette for the view. If the Far Clip Offset is too shallow, the view may resemble the image shown in Figure 2.60. Geometry that you'd expect to see will be “clipped” in the view.

