ISBN: 978-1-119-57012-7
ISBN: 978-1-119-57023-3 (ebk.)
ISBN: 978-1-119-57022-6 (ebk.)

Library of Congress Control Number: 2019950198

C10015258_110119

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

Acknowledgments

Just like building design, the process of writing and publishing a book is truly a team sport—and without the hard work, dedication, and willingness to put up with the authoring team, this book would never have happened. Of all the people to thank, first we'd like to thank the staff at the Revit Factory. Without their fine work, this would be a very empty book. A special thanks to the two product managers, Harlan Brumm and Sasha Crotty. And a huge thank you to the rest of the Factory: thank you gang, for your hard work, innovative ideas, and desire to stay in touch with current design and construction issues.

Also, a big thanks to our technical team. They dot our i's, cross our t's, and chide us every time we turn in something late. Their work and effort ensure that we as authors can produce something that you the reader can actually follow. So a thank you to our amazing and patient developmental editor, Mary Ellen Schutz, for putting up with our excuses and typos; to copyeditor Kim Cofer, indexer Johnna VanHoose Dinse, and proofreader Kathryn Duggan for taking our slang and making it readable; and to production editor Barath Kumar Rajasekaran for putting all the pieces together and getting it ready for print. A thank you to Eric Stimmel, technical editor, who has given a careful and detailed eye to all of our Revit workflows, and to our excellent support team at Sybex, who helped us develop all this foxy content. As we continue our book writing journey, we are encouraged by Eddy Krygiel's last words to the authoring team, "You got this!"

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

Robert Yori is a Senior Product Strategist in CRH Americas' Technology Studio. He explores innovative uses of technology to improve businesses and their design and delivery of projects and products. His role includes work with EDSL, makers of building energy modeling software. Prior to CRH, he served as Senior Digital Design Manager at Skidmore, Owings and Merrill, where he focused on BIM implementation, big data analysis, knowledge and change management, and learning initiatives. In addition, he has also provided consulting services for AEC firms and developers, and has taught and used Revit since 2000.

Robert is past chair of the AIA's Technology in Architectural Practice (TAP) Knowledge Community, serves in the planning group of the AIA NY Technology Committee, and co-leads the BiLT Design Technology Summit. Most recently, he has also served on the review panel for the AIA Energy Modeling Design Guide.

Marcus Kim is the Architecture and Engineering Consulting Manager at Autodesk. He provides leadership and technical direction for Autodesk's Americas consulting division, who are engaged in supporting enterprise adoption of Revit and BIM for AEC customers. Marcus received his bachelor's degree in architectural studies from the University of Illinois at Chicago and has an associate of arts in digital media from the American Academy of Art. Prior to his transition to Autodesk, Marcus managed the BIM on complex and high-profile projects, developing new workflows and implementing standards during a time when BIM was in its infancy. At Autodesk, Marcus continues to lead the direction of BIM for his customers as they strive to reach higher BIM maturity levels, connecting them to new technologies such as smart buildings, generative design, and data analytics.

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.

Lance Kirby is the Director of Customer Success at Building Systems Design, Inc. He received his bachelor's degree in architecture from Mississippi State University's College of Architecture, Art, and Design and also studied at the Budapest University of Technology and Economics, coincidentally alongside the creators of Graphisoft's ARCHICAD. He spent six years in various architecture offices helping to produce everything from 400-square-foot fast-food kiosks in shopping malls to 7,000,000-square-foot federal prisons.

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.

When he is not traveling in support of his customers, he may be traveling with his flight attendant wife, Scarlett. He enjoys fiction, analog/digital gaming, gastronomy of the smoked-meat variety, and heavy down-tuned music.

Contents at a Glance

Contents

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:

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www.wiley.com/go/masteringrevit2020
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Don't have a copy of Revit 2020? Download the trial version of Revit from:

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

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

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https://accounts.autodesk.com
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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`

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.

CERT OBJECTIVE

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

- 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.

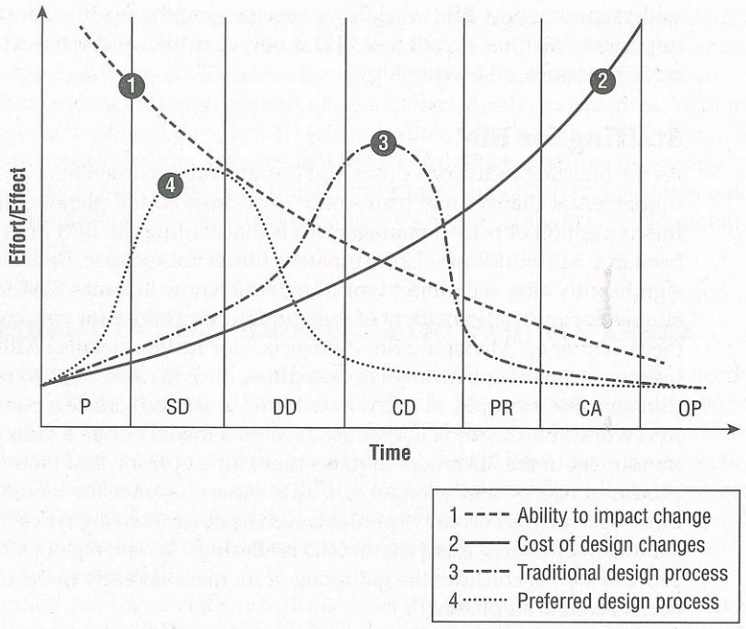


FIGURE 1.1
The effort curves in the design and construction industry

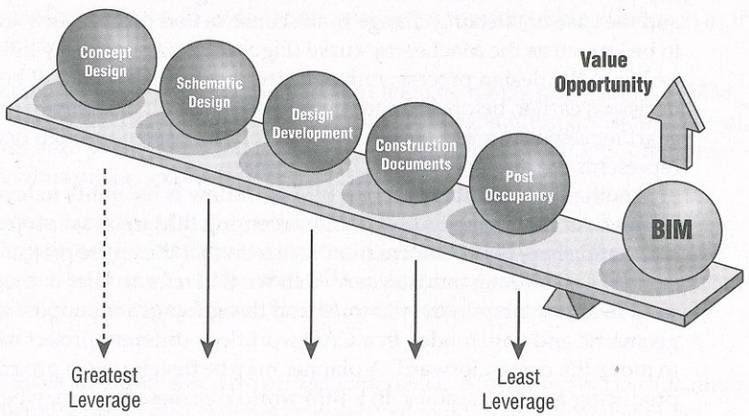


FIGURE 1.2
BIM provides more leverage when it is implemented earlier in the design.

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.

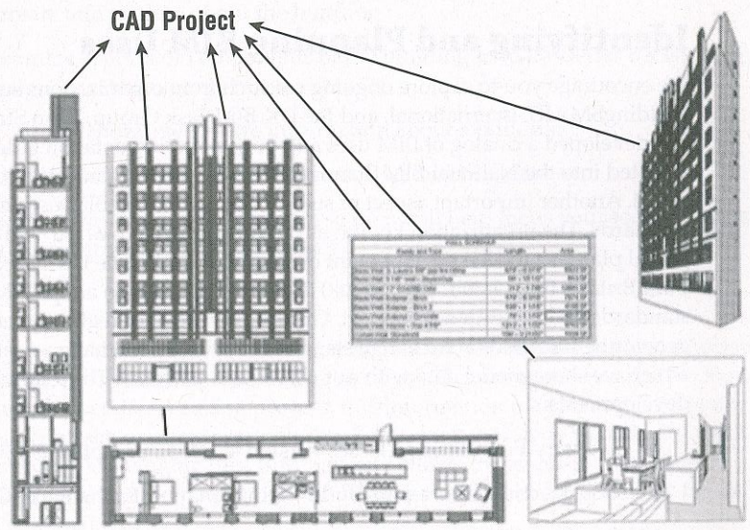
Optimizing BIM Processes

According to the National Institute of Building Sciences (`www.nibs.org`), 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.

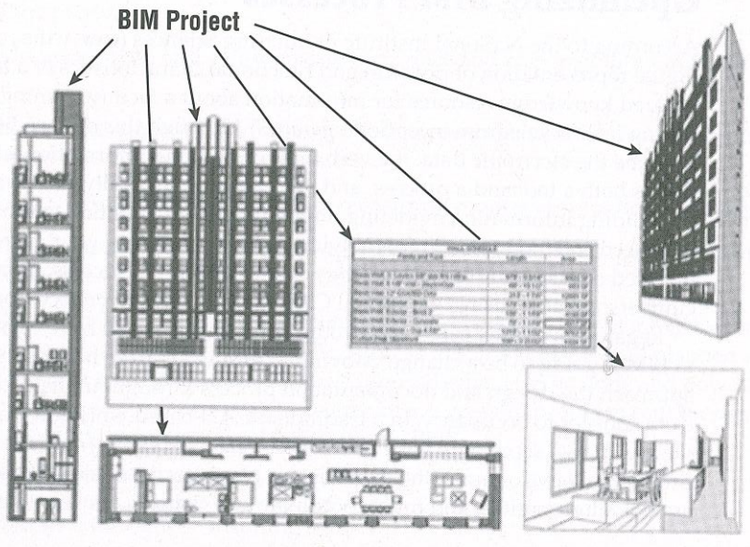
FIGURE 1.3
A CAD-based workflow



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

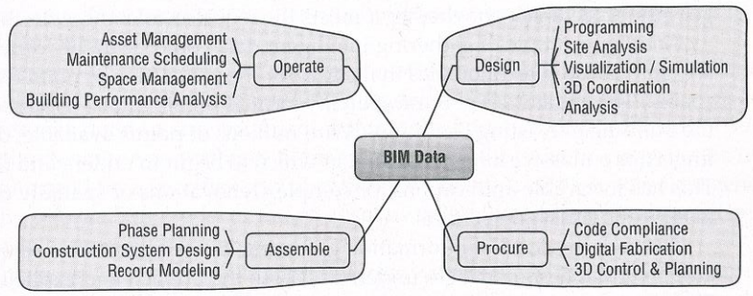
We encourage you to explore ongoing research from organizations such as Penn State University, buildingSMART International, and the UK BIM Task Group. Penn State (`http://bim.psu.edu`) has developed a catalog of BIM uses and project implementation guidelines that have been adopted into the National BIM 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`) provides a global platform for the development of such standards. The UK-based CDBB (Centre for Digital Built Britain) (`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.

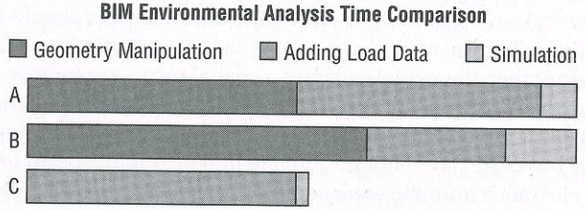


FIGURE 1.6
BIM environmental analysis-time comparison

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.

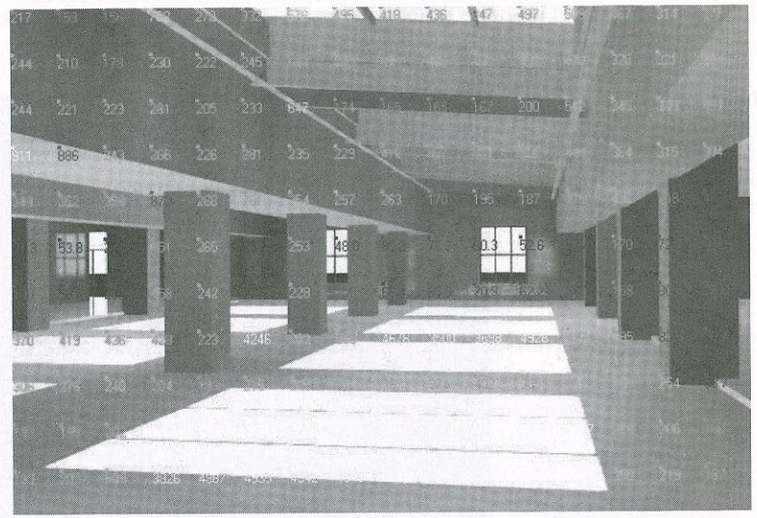


FIGURE 1.7
Daylighting overlay from Autodesk® 3ds Max®

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.

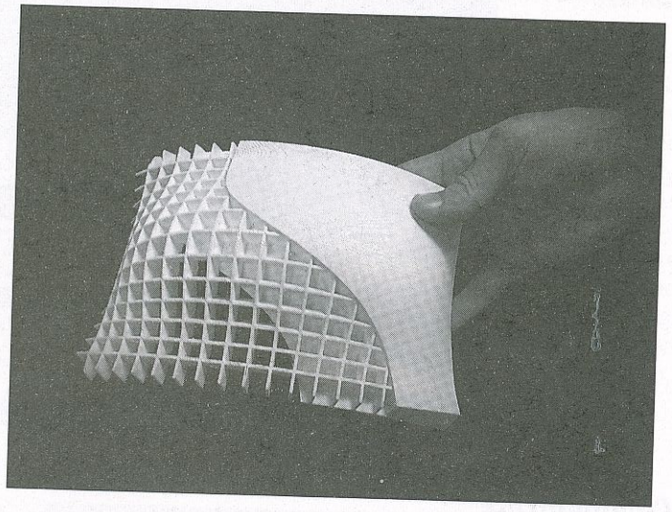


FIGURE 1.8
An example of rapid prototyping using BIM data
Source: HOK

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.

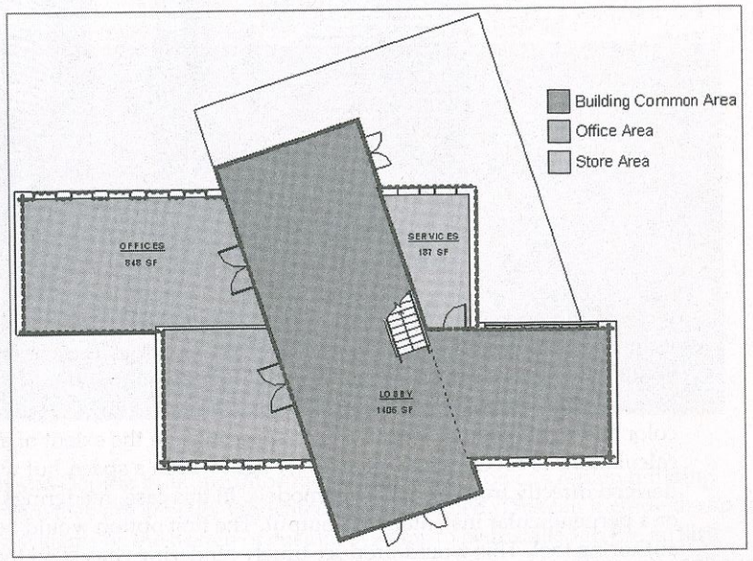


FIGURE 1.9
Even 2D views can evolve to illustrate and analyze spatial properties.

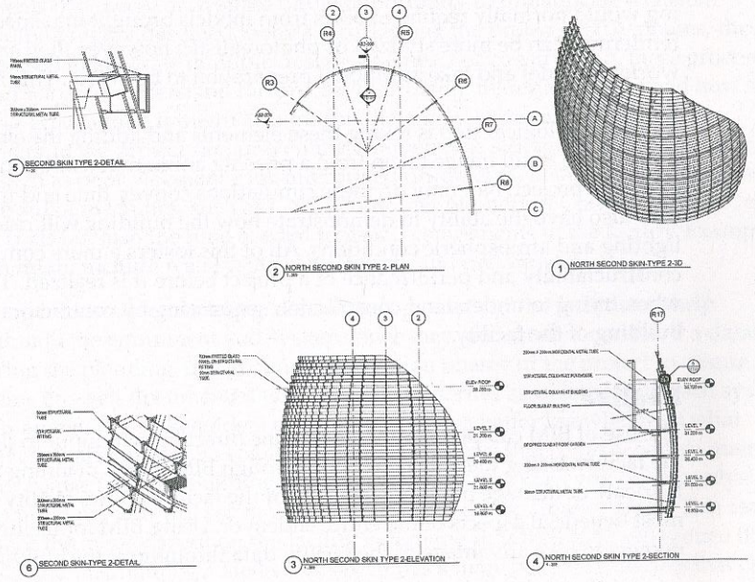


FIGURE 1.10
Construction documentation can begin to transform from 2D to 3D.
Source: HOK

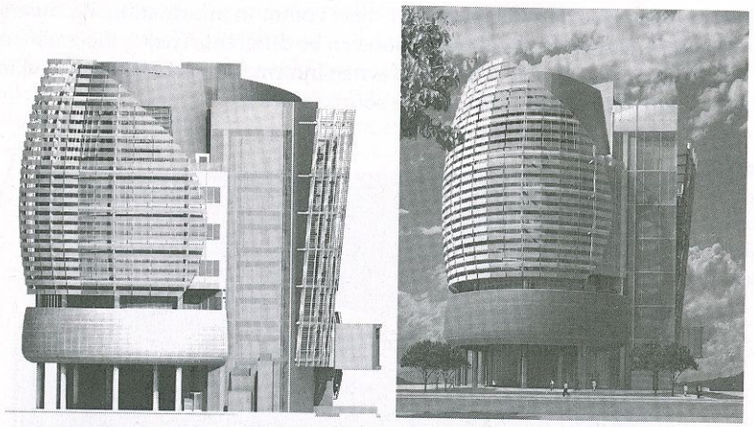


FIGURE 1.11
Two different methods of using 3D presentation views
Source: HOK

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.

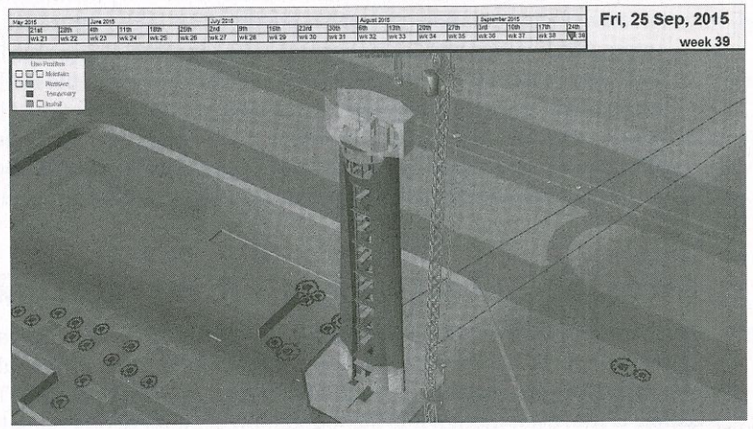


FIGURE 1.12
A still from an animation showing accurate physical conditions for the project
Source: HOK

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.

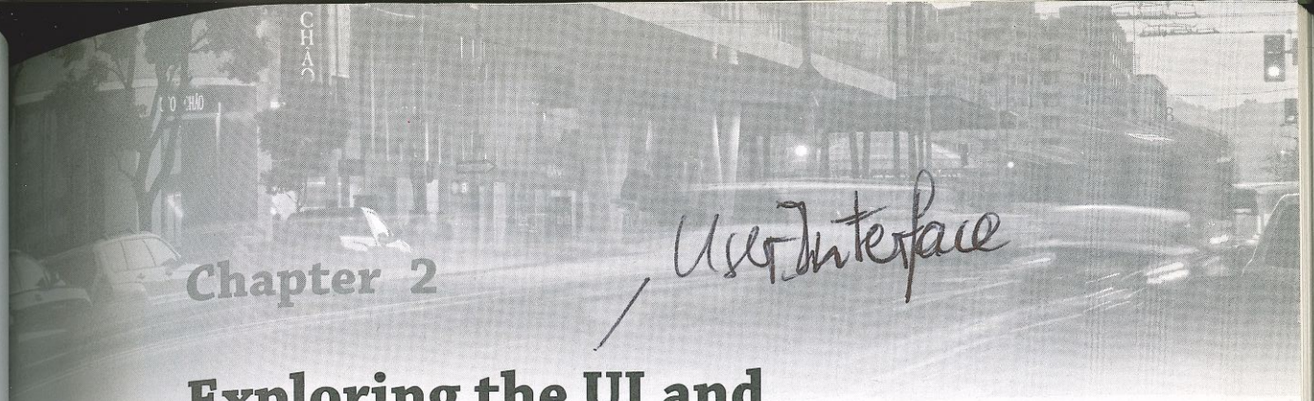
> **Master It** What are the three primary roles in a Revit project, and what are the responsibilities of those roles?

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

User Interface

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

- Understand the user interface
- Understand project organization

Understanding the User Interface

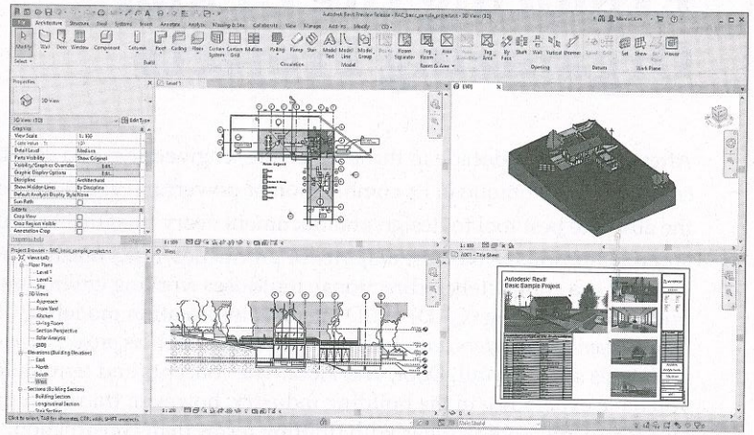
The UI is based on the Windows ribbon framework that is also found in software applications such as Microsoft Office. Within Revit, you will find many commands and tools that use similar dialog boxes and workflows. For example, you will not find disparate dialog boxes for door properties versus window 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

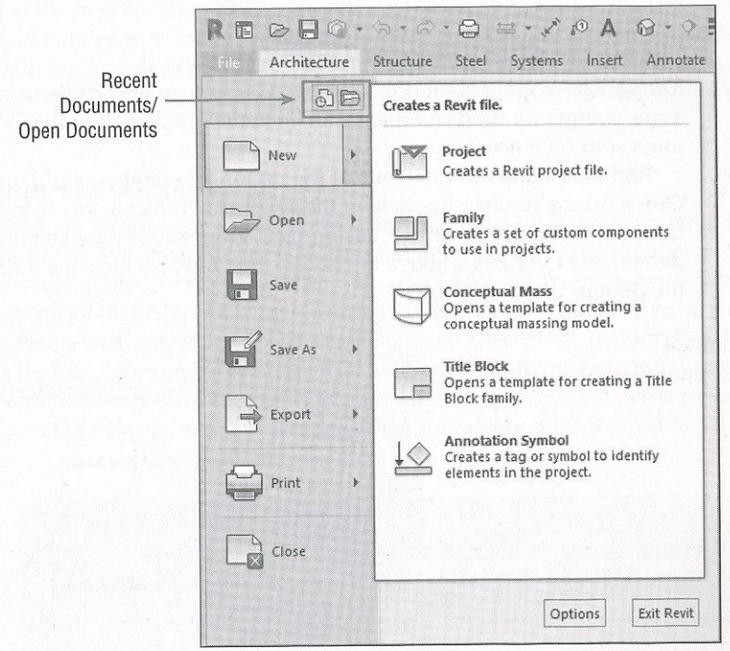
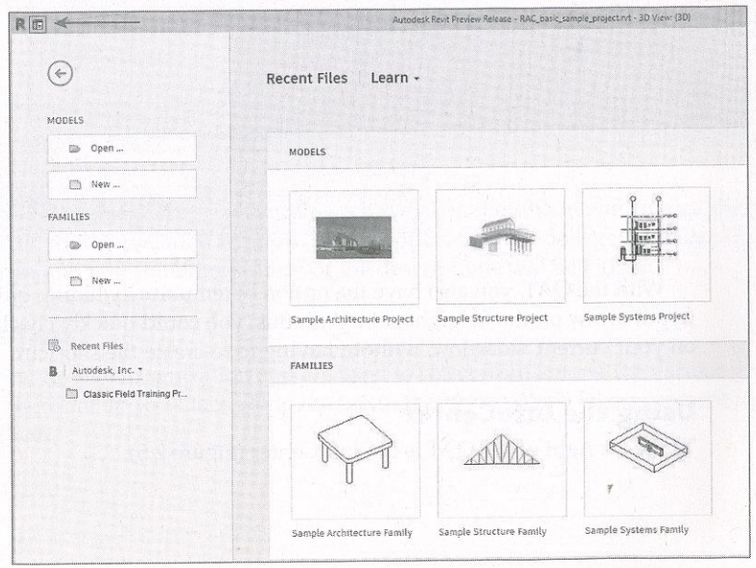


FIGURE 2.3
The Home view



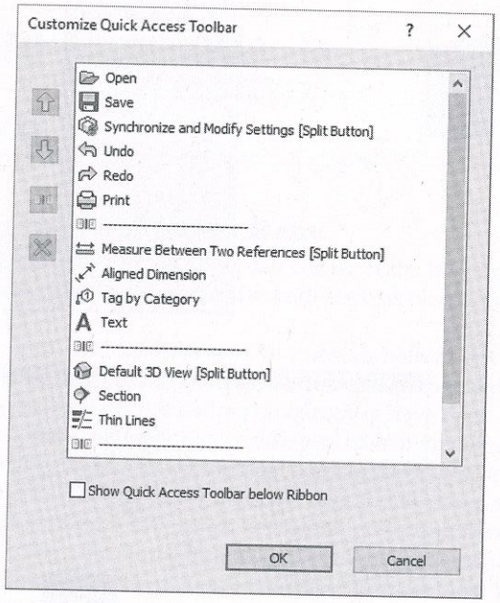
When accessing some of the flyout commands in the Application menu, be aware that there may be additional commands or options on the flyout that are hidden. This is most evident on the Export command flyout, in which you must scroll to the bottom of the flyout to access exporting options for Industry 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

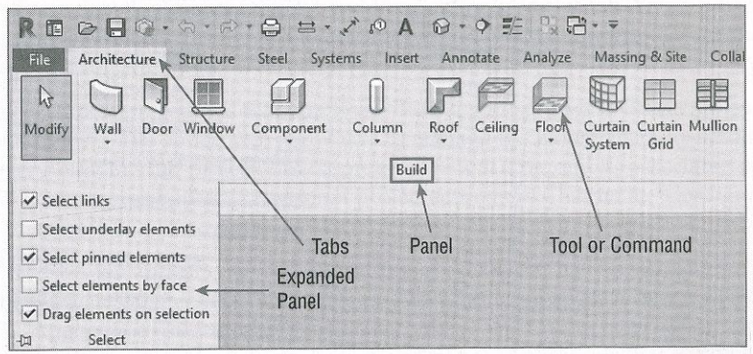
From left to right, you have the ability to search for help solutions, sign in to Autodesk A360 to access online services that integrate with Revit, open a website to the Autodesk App Store ➢ Revit and then open the help content.

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.

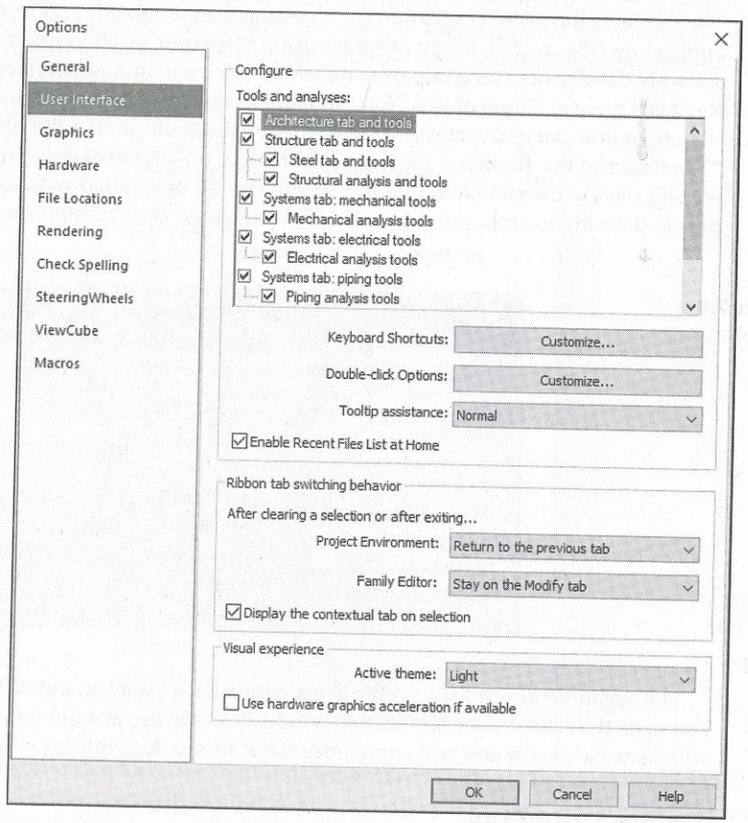
TOURING THE TABS

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.

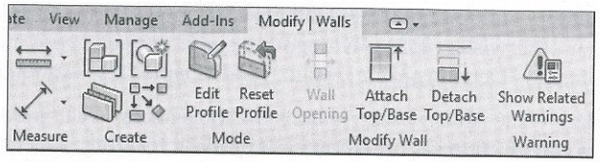
One of the most important settings that you'll use during your project is Object Styles on the Manage tab. Selecting this option will allow you to manage the global visibility settings for just about everything in your project: how it projects, how it cuts, and its associated color and pen weight. Learn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

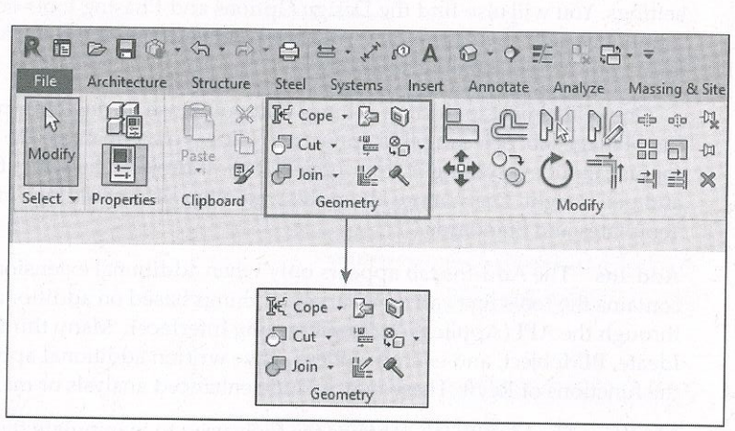


A simple, yet important, setting that may be exposed on the contextual tab when placing model content is Tag On Placement. Modeling commands such as Door, Window, and Component allow you to enable automatic tagging to reduce overall documentation time. If you are working in an early design phase, you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

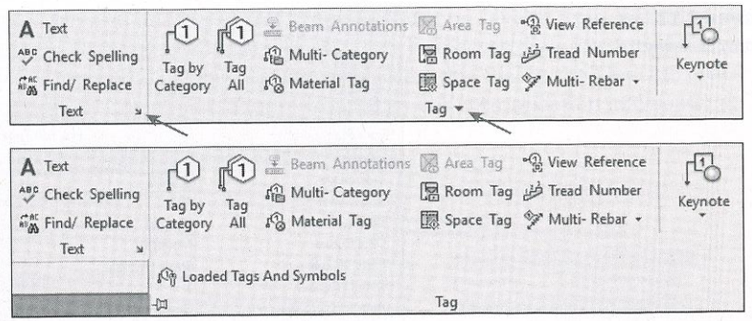
FIGURE 2.9
Panels can be relocated anywhere in the UI.



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



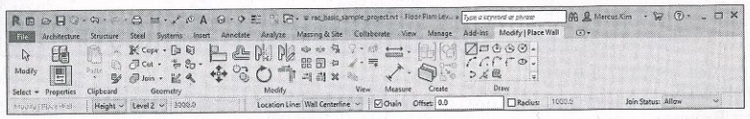
Using Other Aspects of the UI

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

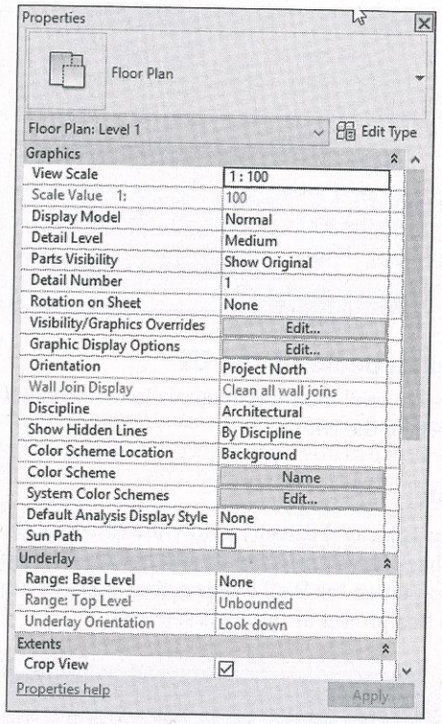
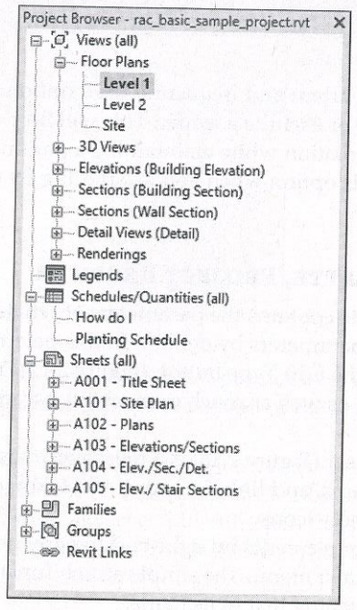
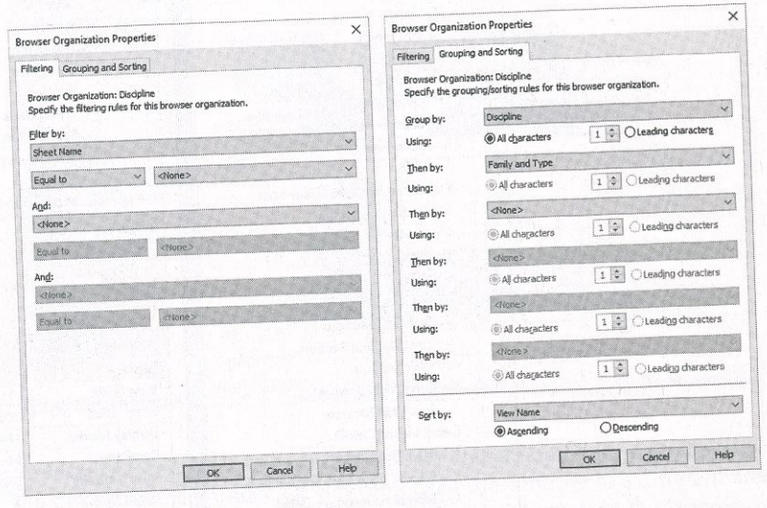


FIGURE 2.13
Project Browser



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.

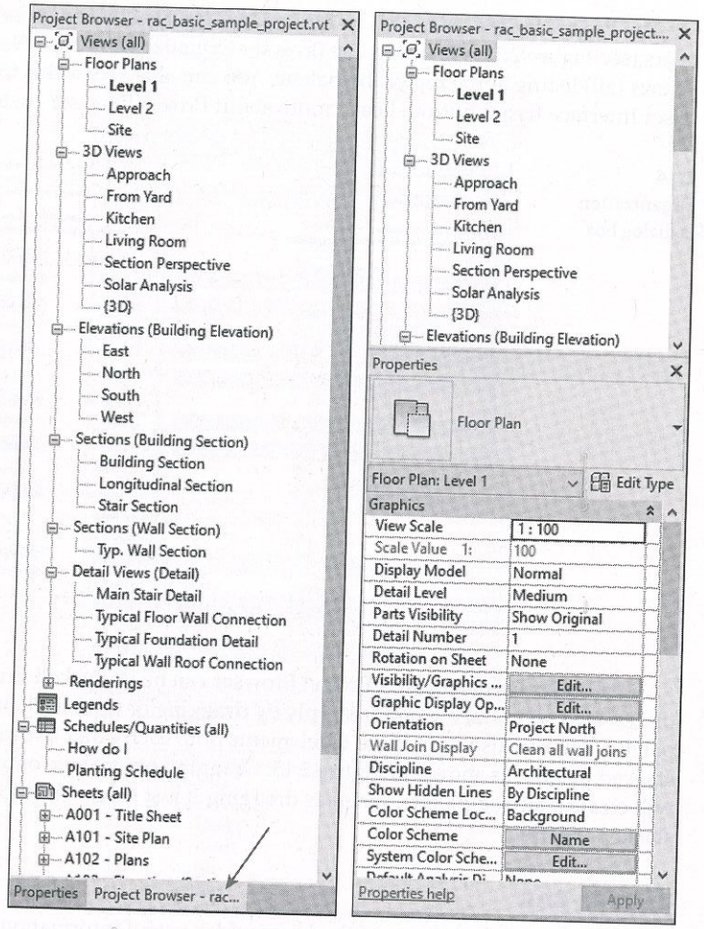
Status Bar

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



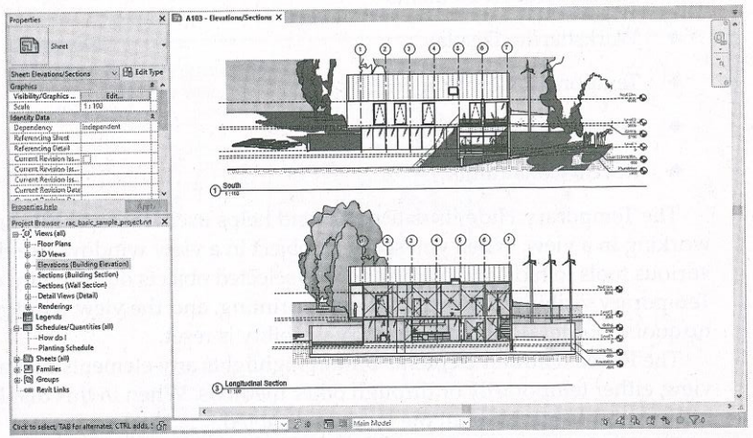
DRAWING AREA

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

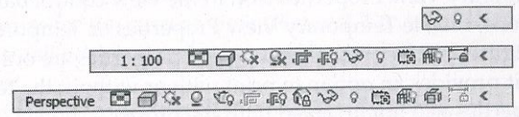


As of the last release of Revit 2019, views are no longer constrained within the boundaries of the Revit (UI). You can completely undock a view and drag the window to a different area of your monitor or to a second monitor. Prior to this, the only way to work on Revit across multiple monitors was to 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.

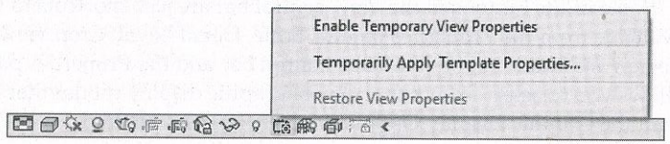
The Temporary View Properties command when invoked is intended to allow a user to make temporary graphic changes to a view such as visibility graphics, scale, and view templates. When in this display mode, the view window will have a purple border until the mode is disabled. See the next section for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

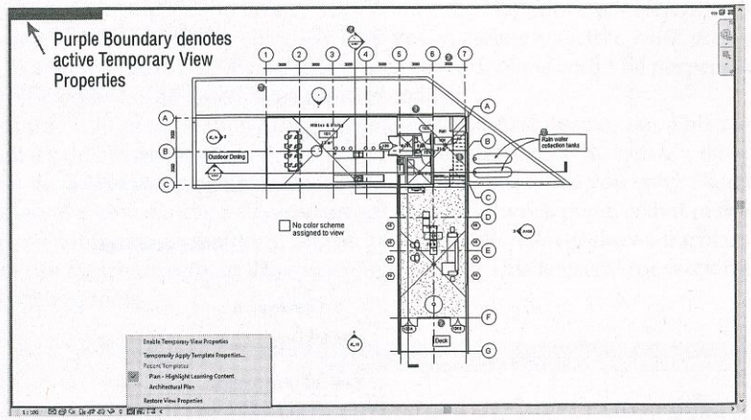
You may also temporarily modify view properties or apply a view template. When you click the Temporary View Properties icon in the view control bar, you will have a choice between two key options, Enable Temporary View Properties or Temporarily Apply Template Properties, as shown in Figure 2.18. Because 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.

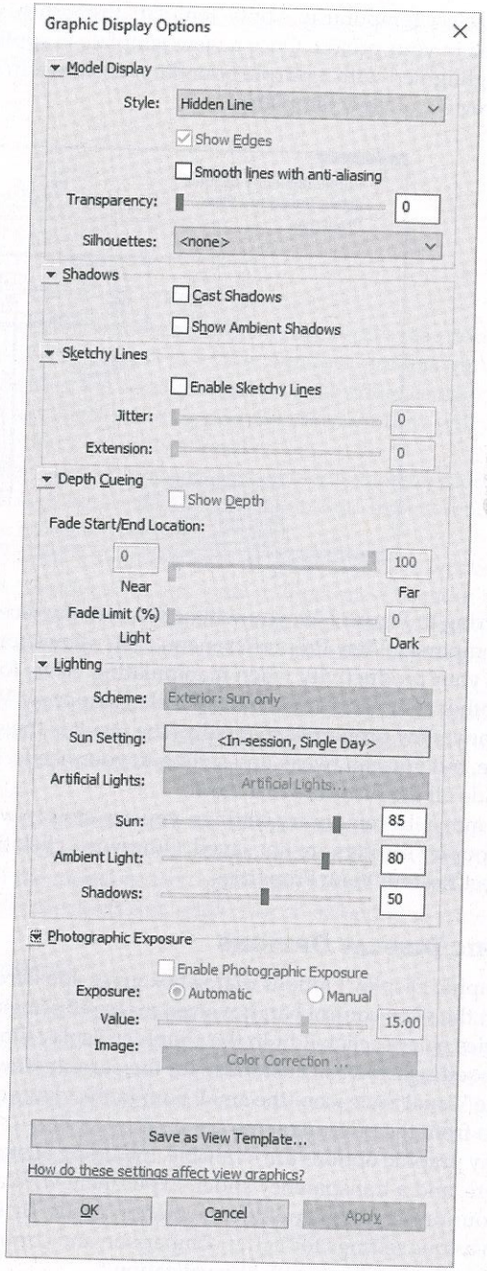
To remove the temporary settings, you can simply wait until you close the project file because the temporary settings are not saved. Otherwise, click the Temporary View Properties icon again and select Restore View Properties.

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

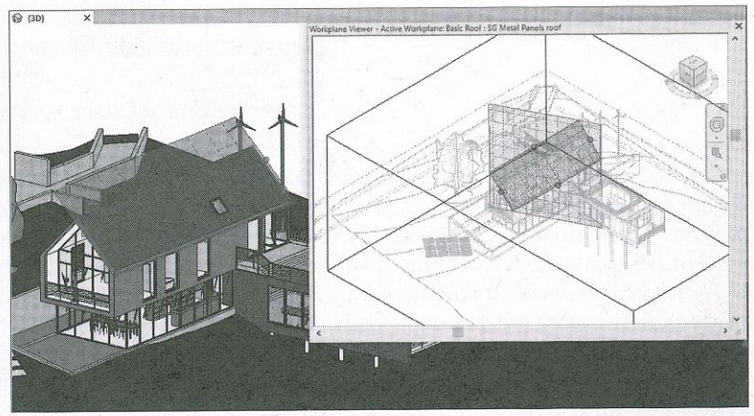


WORK PLANE VIEWER

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.

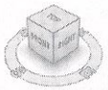
The Viewer option is located on the Work Plane panel of the Architecture tab. This viewer is available from all model views when you're in the project environment. By default, the work plane is based on the active work plane of the last active view. But when you enter Sketch mode (for example, when you 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.



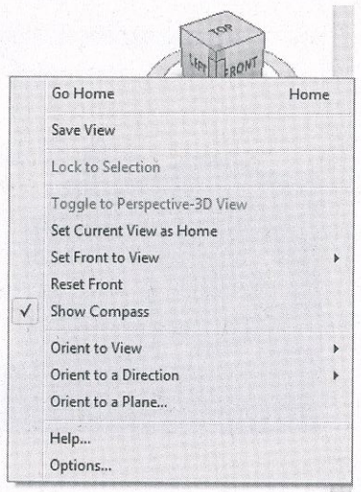
ViewCube

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

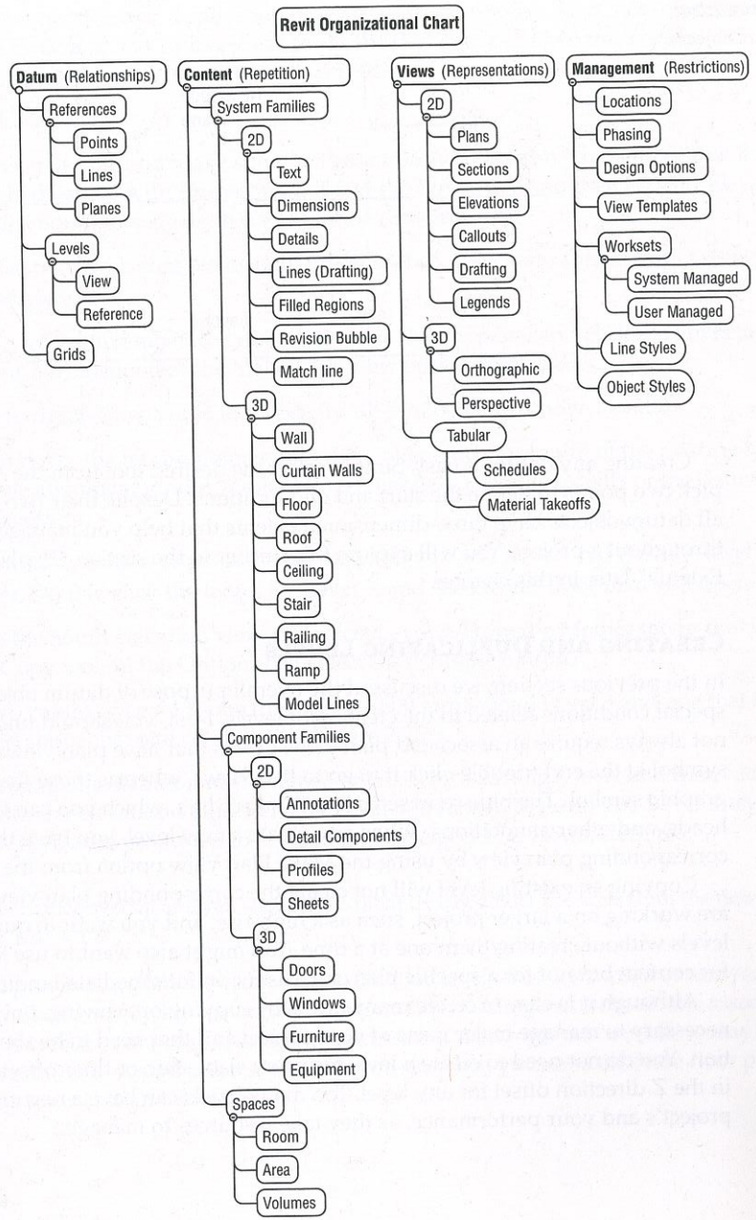
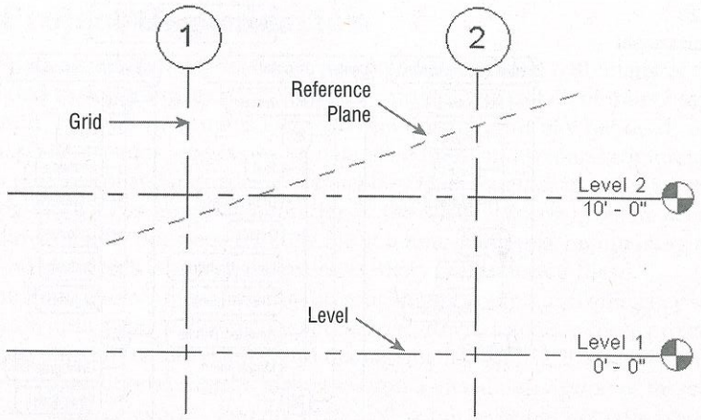


FIGURE 2.24
Datum objects



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.

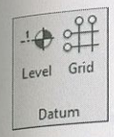
Although it is easy to create many levels by copying or arraying, only create the levels that are necessary to manage major parts of your project and that need to be shown in your documentation. You do not need to create a level for every slab, stair, or floor offset, as objects can be shifted in the 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`.

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.

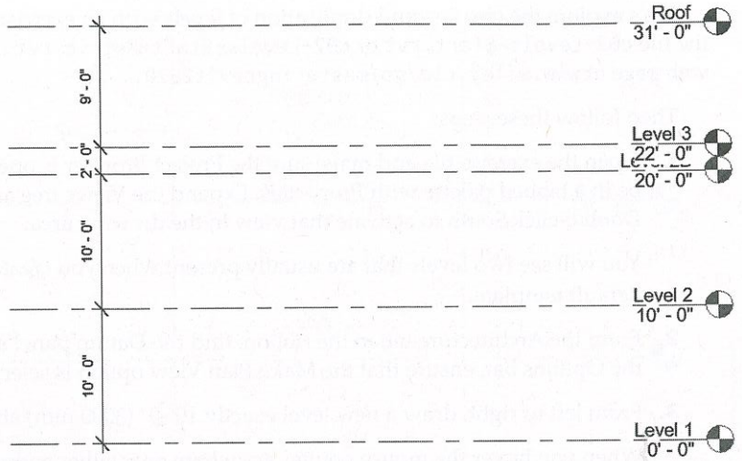
   When you hover the mouse pointer anywhere near either endpoint of the existing levels, you will see alignment guides (dashed lines) that help keep the extents of the datum objects consistent.
4. Click the Modify button or press the Esc key, and you will notice that the new level has a blue target. Double-click 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″.

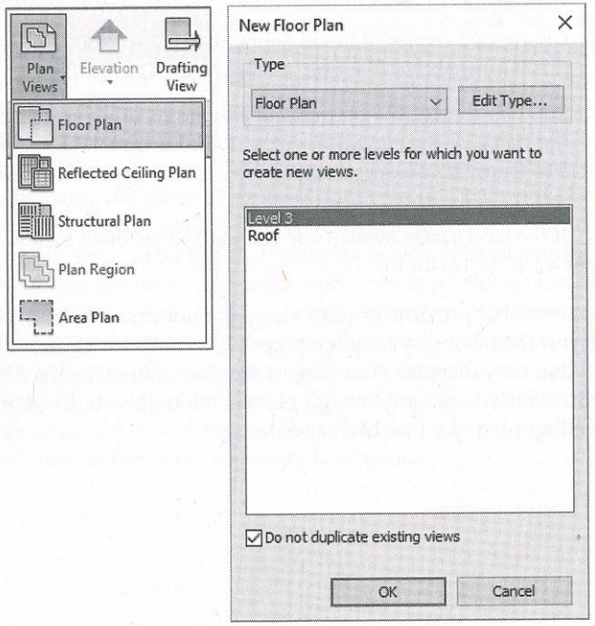
As we stated previously, plan views are not created for levels that are copied or arrayed. This gives you the flexibility to quickly generate levels for taller buildings without all the associated views that may increase your project file size unnecessarily. Although this workflow may be beneficial for 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



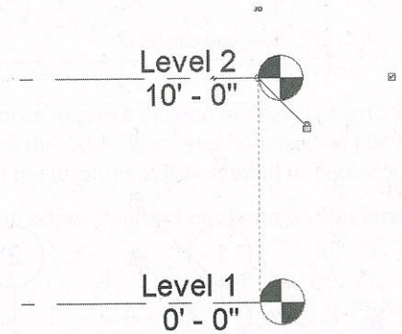
You can also use this command to create duplicate views of existing levels. Clear the Do Not Duplicate Existing Views option at the bottom of the dialog box to see all the levels in your project.

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.

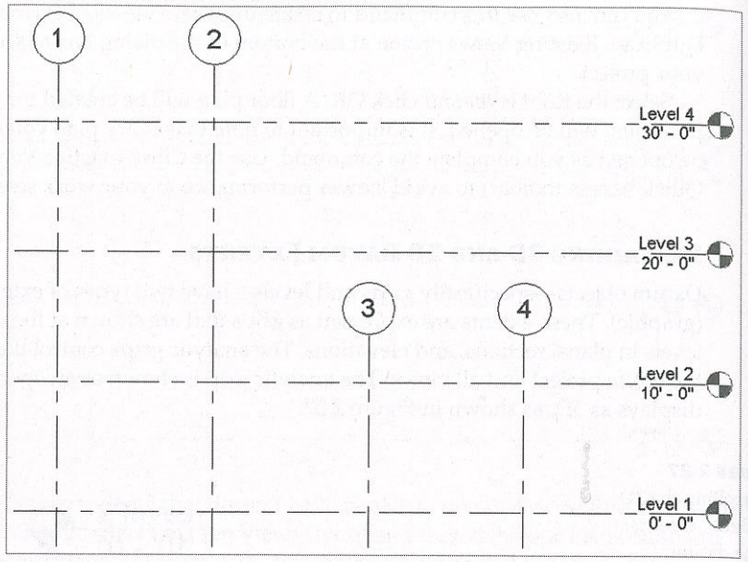


FIGURE 2.28
3D (analytic) extents affect the visibility of datum objects.

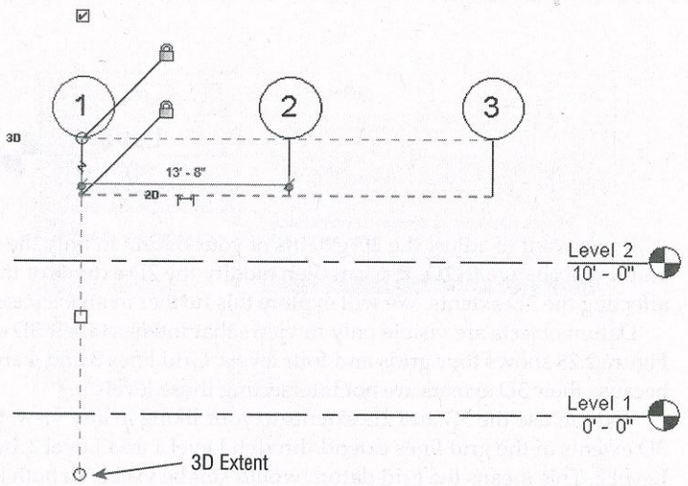


FIGURE 2.29
Customizing 3D and 2D extents of datum objects

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.

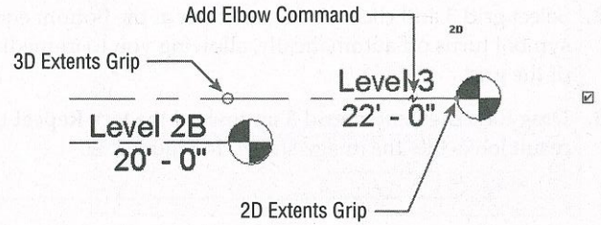


FIGURE 2.30
Adjusting the graphic extents of a level

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.

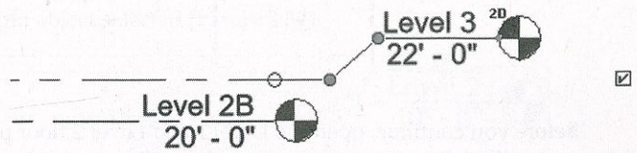


FIGURE 2.31
Adding an elbow to a level

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:

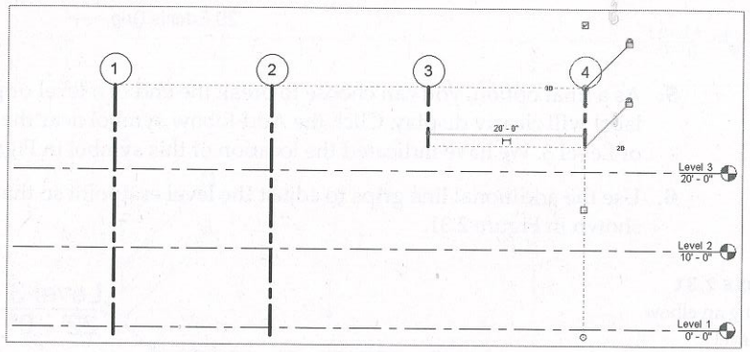
1. Download and open the `c02-Grids-Start.rvt` file from this book's web page and then activate the South elevation.

   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.

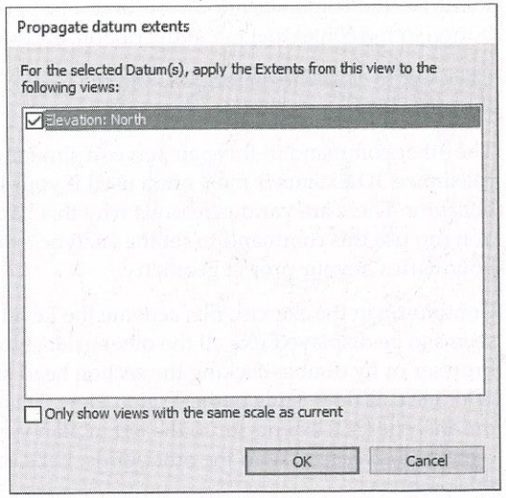
FIGURE 2.32
Adjusting the 2D extents of grids



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

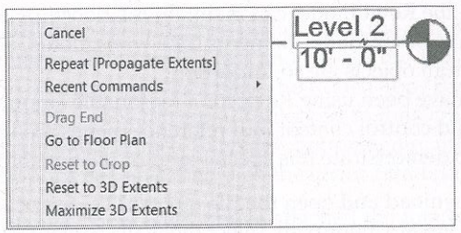


You can use the Propagate Extents command to easily copy datum settings to any parallel views in your project. This is especially effective for propagating grid extents to many plan views in high-rise buildings.

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

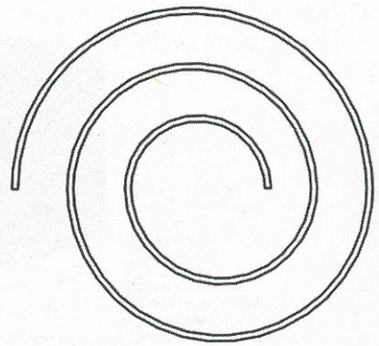
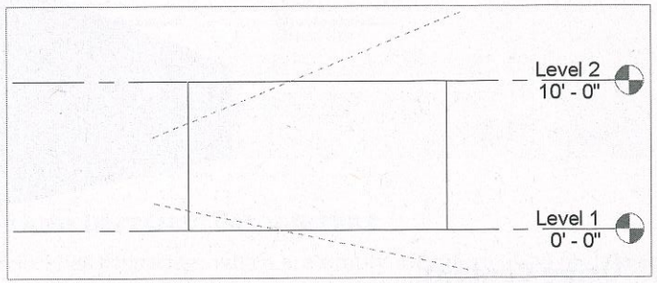


Figure 2.36
Reference planes and levels shown in elevation



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

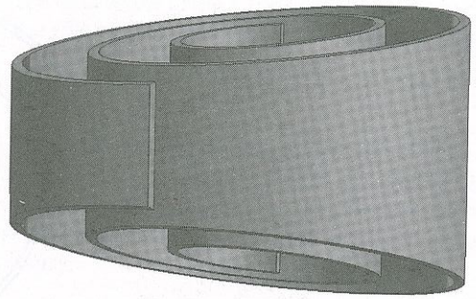
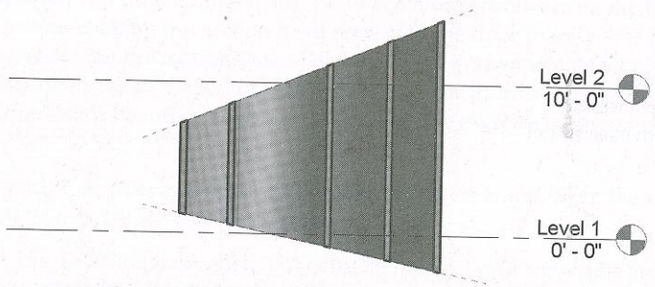


FIGURE 2.38
Section view



Using Content

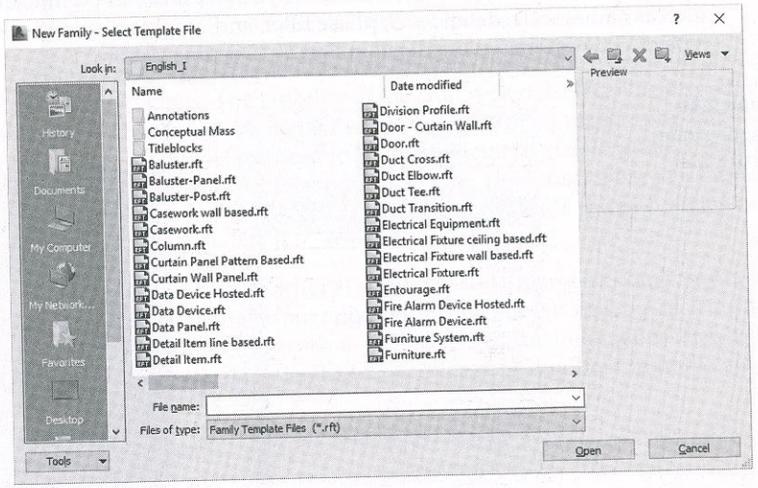
Effective use of content is all about repeated elements in a hierarchy (project, family, type, instance) that you put in your Revit project to develop and document your design. Content can often maintain relationships with other content, but more important, they maintain relationships to datum objects. 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."

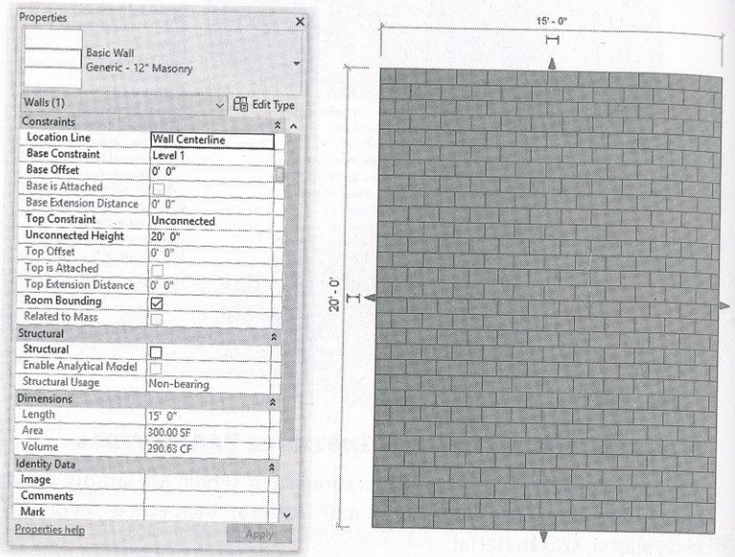


FIGURE 2.40
Instance parameters of a wall

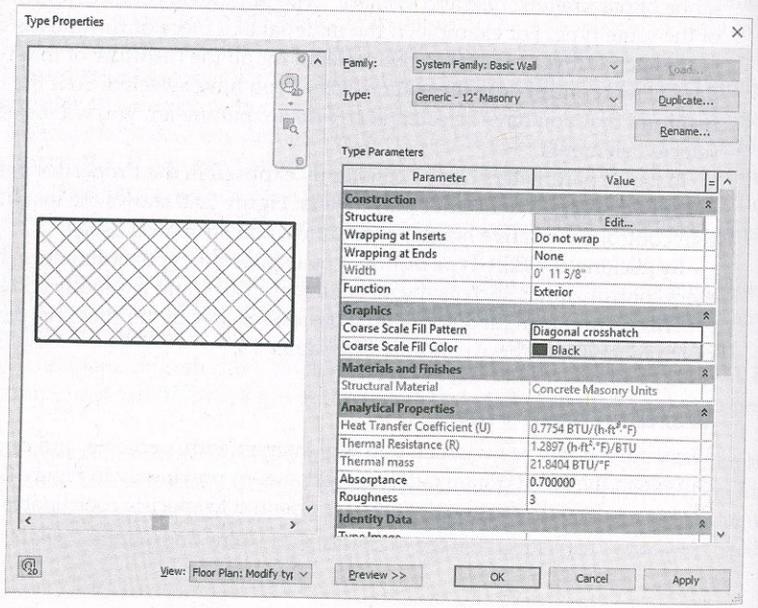


FIGURE 2.41
Type parameters of a wall

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).

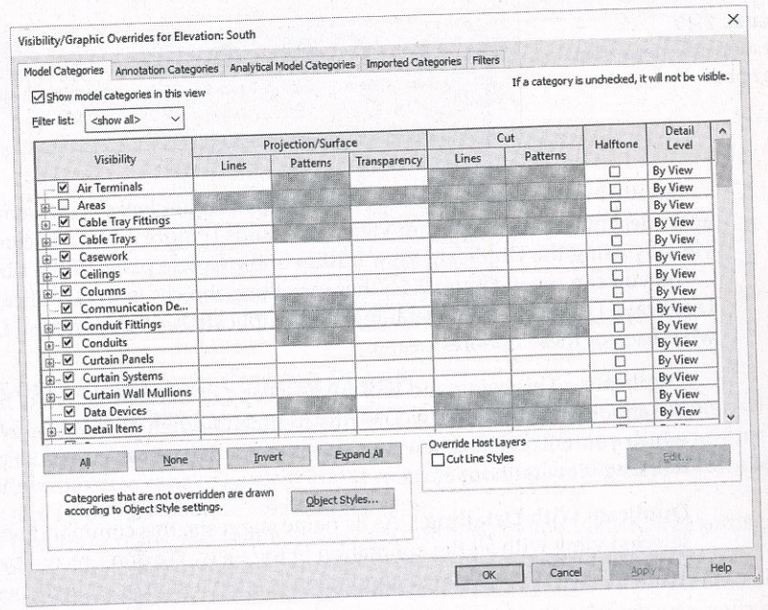


FIGURE 2.42
Visibility and graphic overrides for an elevation

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.

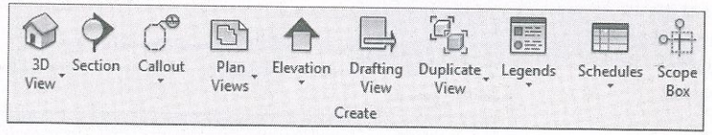
View Template View templates are a selection of view properties, which can include properties that change the scale, detail level, and visibility of objects in the view. As an aid to standardization, view templates can help you organize common view settings and apply them to groups of views throughout 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.

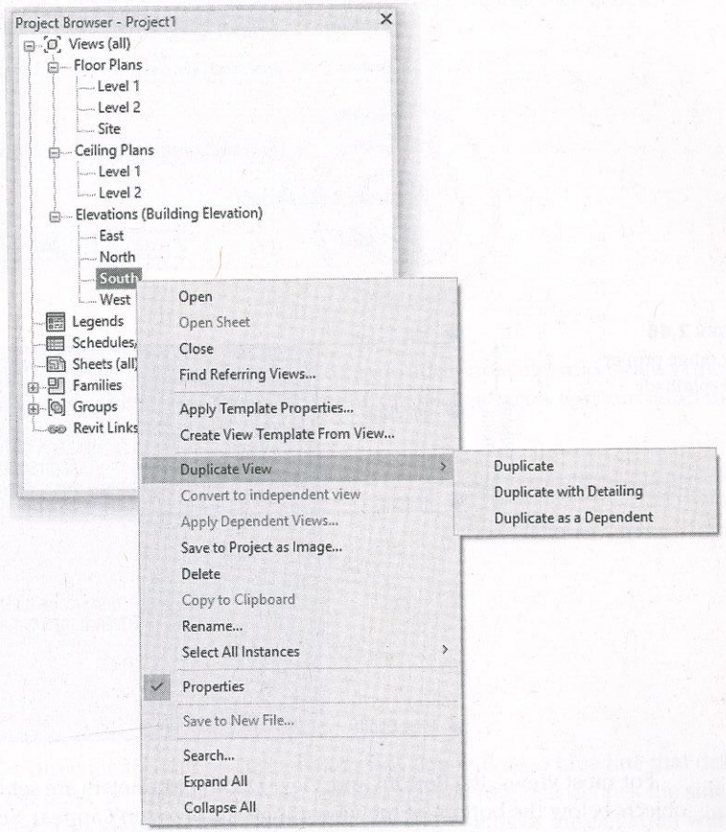
As you can see in Figure 2.44, there are three choices in the Duplicate View flyout command: Duplicate, Duplicate With Detailing, and Duplicate As A Dependent. Let's take a quick look at what each of these options means.

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

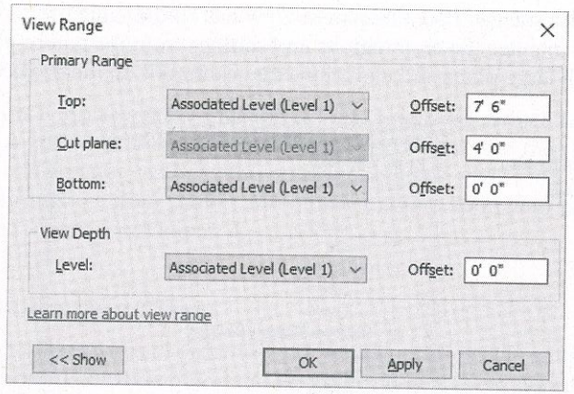
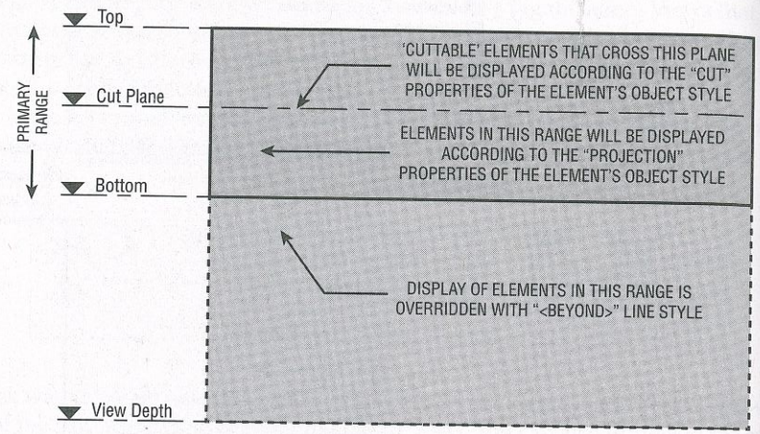


FIGURE 2.46
View range properties explained



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.

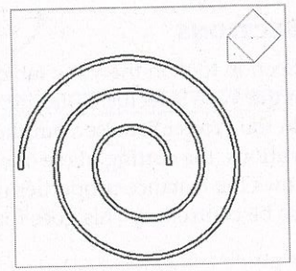
Perhaps you only need to apply a different view range setting to isolated areas of a view. This can be accomplished with the use of the Plan Region tool. You can find this tool in the Create panel of the View tab along with the other Plan View tools. The Plan Region tool allows you to sketch a boundary 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

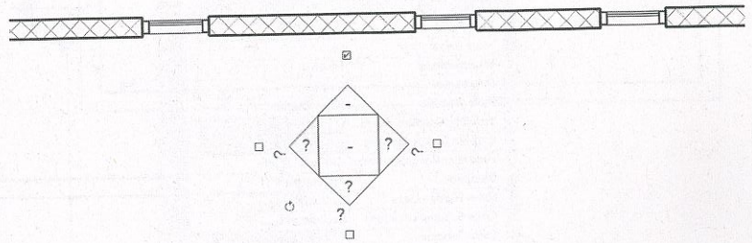
Selecting the Elevation tool on the View tab creates elevations of various types. You'll also notice that as you place an elevation tag, the elevations automatically orient to walls (Figure 2.47). If there's no host element nearby to reference, they'll automatically orient to the left.

FIGURE 2.47
Elevation tag orientation



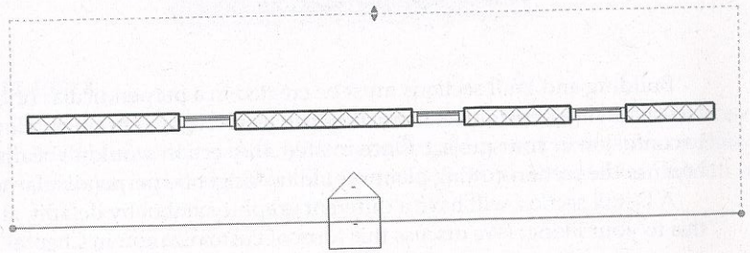
Selecting the center of the tag will allow you to create additional elevation views (more typically done for interior elevations) by selecting the unchecked boxes that surround the elevation tag (Figure 2.48).

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



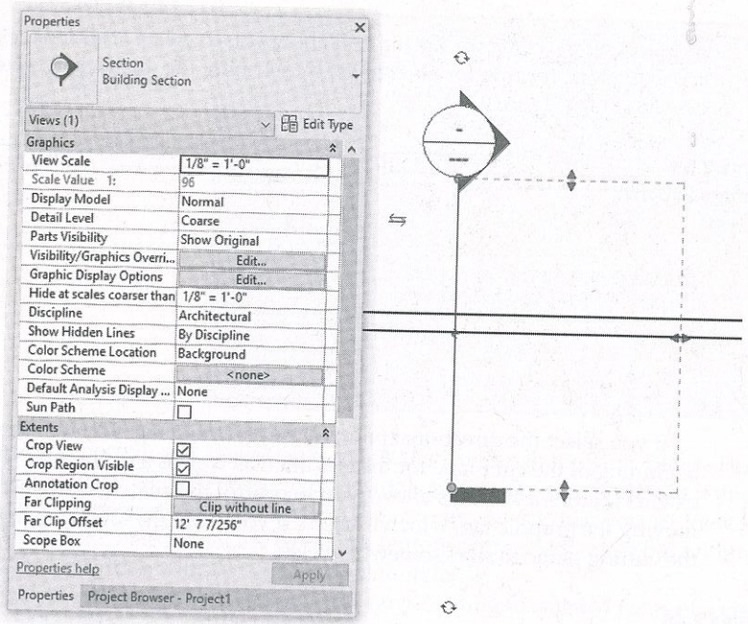
Finally, there are three types of elevations in Revit project: exterior, interior, and framing. Their differences are more than graphic. *Exterior elevations*, by default, do not have an active crop boundary, only a starting cut plane. *Interior elevations* have their crop boundary on by default and 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

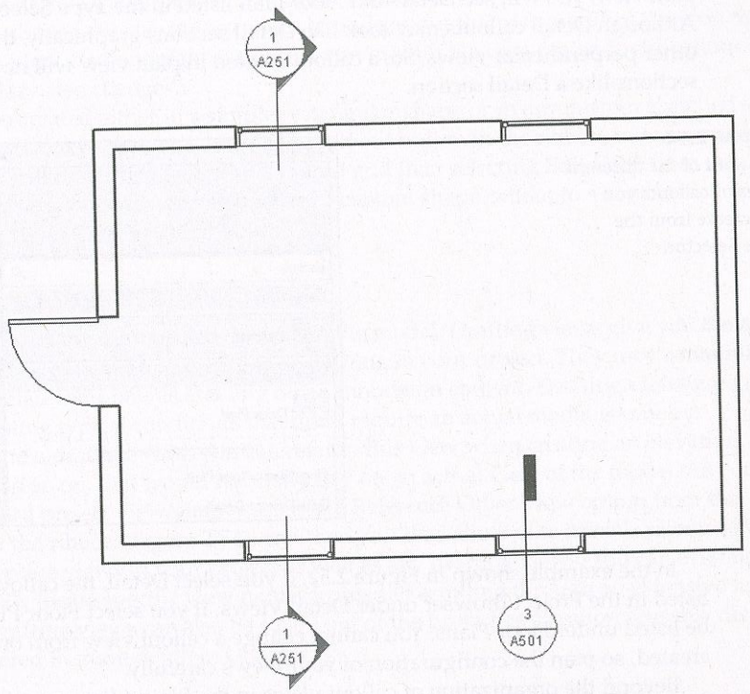


Building and Wall sections must be created in a perpendicular orientation with respect to levels. But after you create them, they can be rotated in elevation. However, doing so could lead to confusion in your project. Once rotated, the section wouldn't be displayed in plan view because the section cutting 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

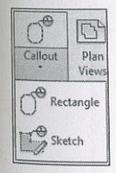
graphic symbol, Detail sections will have a smaller clipping region than a Building or Wall section. In Figure 2.51, a Building section is shown at the left of the image, and a Detail section is shown to the right.

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.

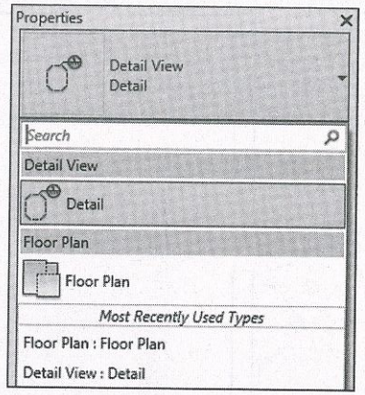


Creating Callouts

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.

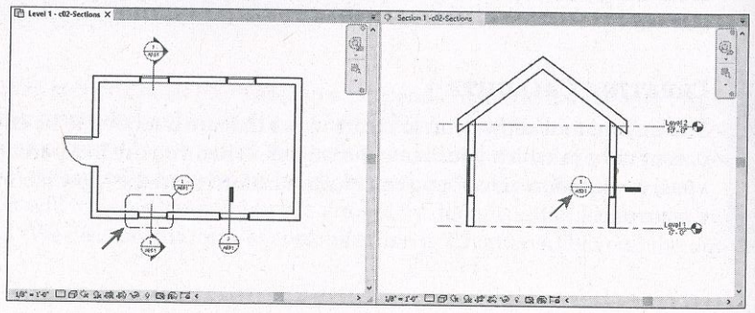
FIGURE 2.52
Be aware of the different types of callouts you can create from the Type Selector.



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.

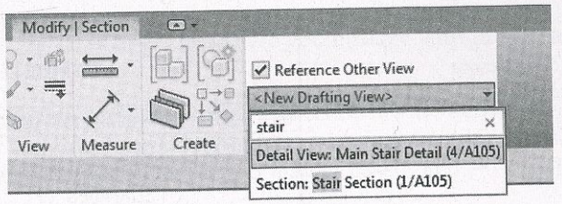
Callouts can be created either in a simple rectangular shape or in any custom sketched shape. You will see these two tool options in the Callout flyout button in the ribbon, but you can always edit a rectangular callout by first selecting a callout and then selecting Edit Crop from the contextual tab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

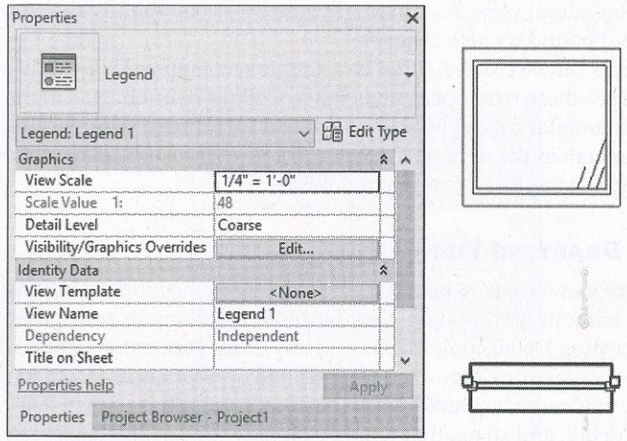


Using Legends

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 RADIANCERAIL 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

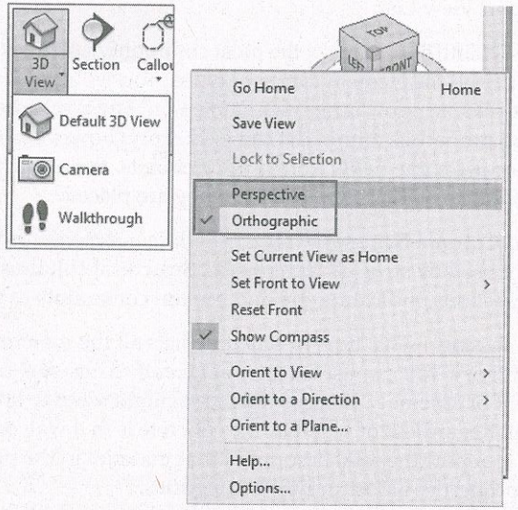
Printed contract documents are still a common deliverable that architects and engineers are paid to produce. You will use sheets to organize views and other annotation for the purpose of issuing printable (physical or digital) documents. Sheet borders can be customized, but the important fact to realize 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.

Figure 2.58
Setting camera and target origins

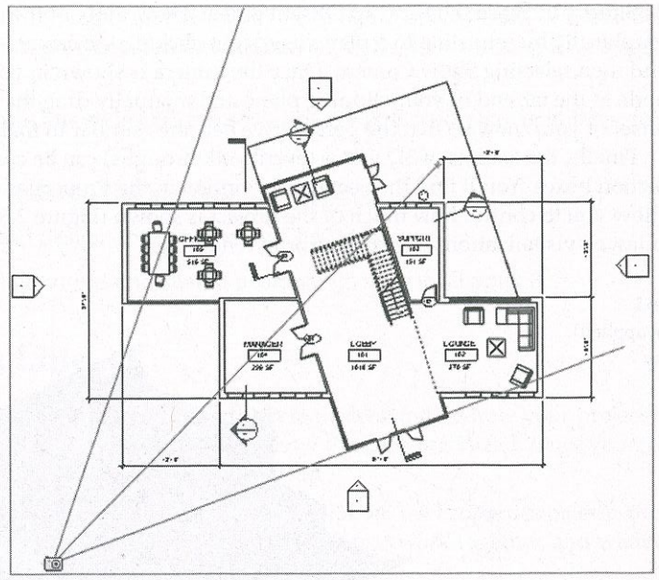


Figure 2.59
Modifying the view size and field of view

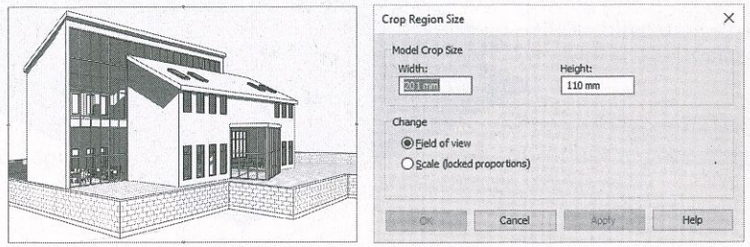
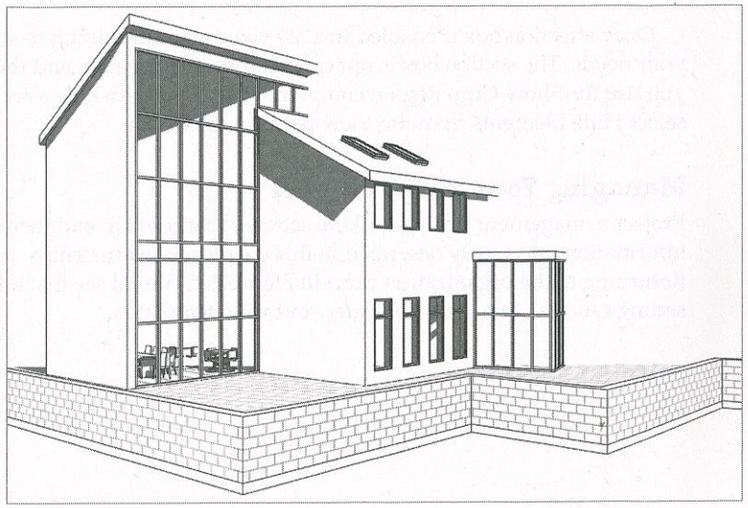


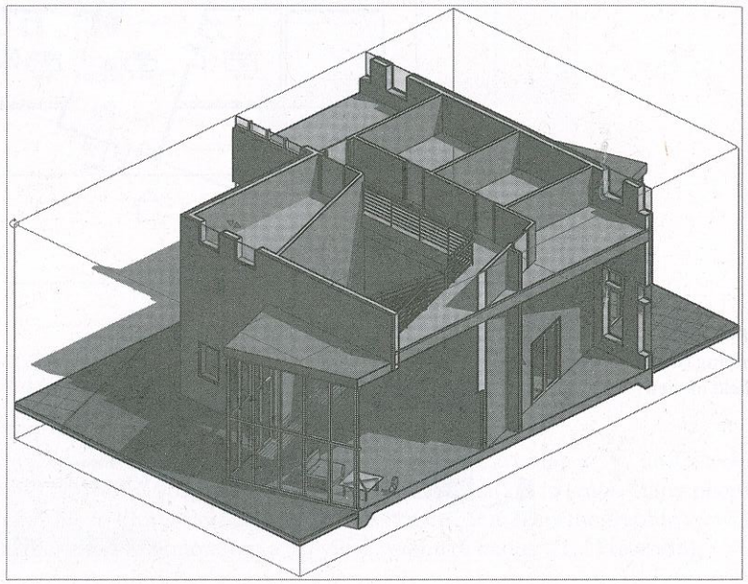
Figure 2.60
The Far Clip Offset is too shallow.



Simply increase the Far Clip Offset value to show more of the model. You may also do this graphically by returning to a plan view, right-clicking the camera view in the Project Browser, and then selecting Show Camera. Once the camera is shown in your plan view, you can select the node at the far end of your clipping plane and manually drag the node to extend the far clip offset of your view so that the perspective becomes similar to that shown in Figure 2.59.

Finally, the extents of 3D views (even walkthroughs) can be customized with the use of section boxes. You'll find the Section Box option in the Properties palette for a 3D view. This will allow you to control how much of the project is shown (Figure 2.61) and is helpful for creating cutaway visualizations in real time or in renderings.

FIGURE 2.61
Section box applied to a 3D view



Once a section box is enabled in a 3D view, you can select it to stretch or rotate it according to your needs. The section box is not considered a crop region, and therefore it is not affected when you use the Show Crop Region command. If you want to hide a section box, select it and then select Hide Elements from the View panel in the ribbon.

Managing Your Project Model

Project management involves all the settings that control (and therefore restrict) the graphic information previously described in this chapter as relationships, repetition, and representations. Returning to the organization chart in Figure 2.23, you'll see that a Revit project is managed with settings such as line styles, phasing, and view templates.

To cover all aspects of project management in this one chapter would be overwhelming; therefore, you can find more detailed information about the following topics throughout this book:

- For object styles, line styles, fill patterns, line weights, and view templates, refer to Chapter 4.
- For worksets and worksharing, refer to Chapter 5.
- For phasing and design options, refer to Chapter 11.
- To learn about locations and shared positioning, refer to Chapter 3.

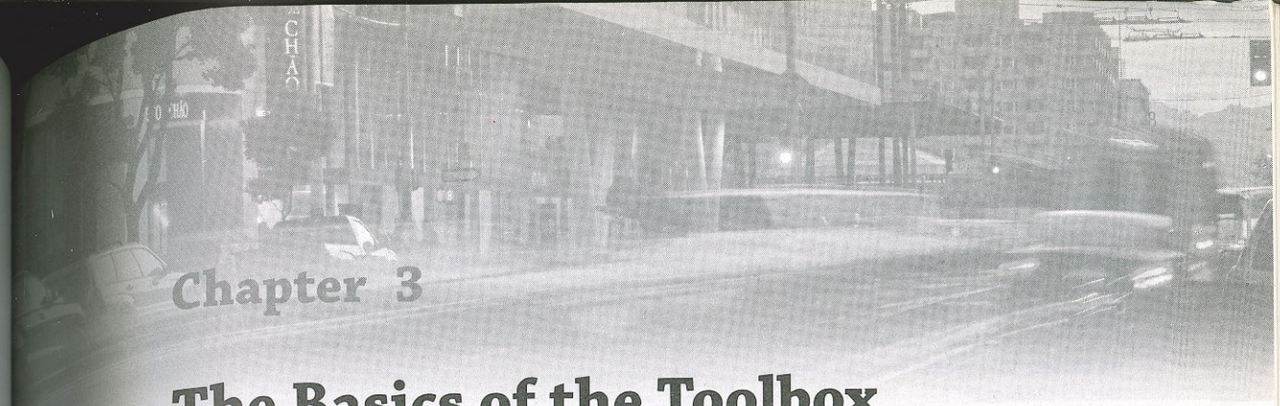
The Bottom Line

Understand the user interface. In addition to understanding how your project is organized, to use the Revit well, you must understand how the UI is organized. Once you grasp both of these concepts, you will be ready to move ahead.

> **Master It** The "big" areas of the UI are the ribbon, the Properties palette, the Project Browser, and the drawing area. How do these areas work together, and what tabs correspond to an iterative design process?

Understand project organization. The compelling advantage of being able to design, document, and manage your project across multiple disciplines—the architectural, structural, and mechanical disciplines—is something that you can do in Revit projects, and understanding project workflow is key to getting off on the right foot.

> **Master It** Thinking back to the Revit organizational chart shown in Figure 2.23, what are the main components of a Revit project, and how can you apply them to your design process? How do these categories directly affect your design workflow?



Chapter 3

The Basics of the Toolbox

The road to mastering Autodesk® Revit® 2020 will always include reinforcement of fundamental skills. Just as an accomplished musician will practice her scales, here you will "practice" by reviewing the fundamental selection and editing tools throughout the Revit program. There are many tools that can assist you in refining your models and project designs. Some are simple geometry-editing functions, whereas others possess more powerful capabilities.

IN THIS CHAPTER, YOU'LL LEARN TO

- Select, modify, and replace elements
- Edit elements interactively
- Use other editing tools
- Explore A360 features for collaboration
- Create site context for your project

Selecting, Modifying, and Replacing Elements

Knowing how to select, modify, and replace elements efficiently is fundamental to working productively in Revit. These interface operations are the foundation on which you will build skills to create and edit your project models. In the following sections, we will review methods for selecting, filtering, and modifying properties.

Selecting Elements

Revit was one of the first programs that had the ability to highlight elements as you hovered the mouse pointer over them, before actually clicking to select. Not only does this give you a clear idea of what you are about to select, but it also displays information about that object in the status bar and in a tooltip near the mouse pointer. When you hover over any element in Revit, it highlights; click the highlighted element, and it turns blue, indicating that it is selected.

Once an element is selected, the ribbon changes to Modify mode, where consistent editing tools are located on the left side and context-sensitive tools appear to the right. Notice the subtle differences in the ribbon, as shown in Figure 3.1, when a roof, wall, and floor are selected.

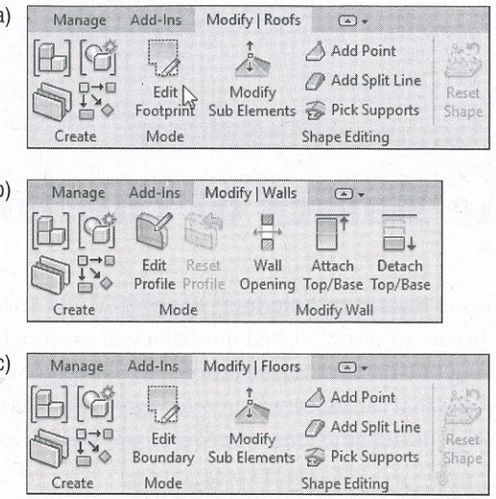


FIGURE 3.1
The right end of the Modify tab changes based on the element that is selected: (a) the Modify | Roofs tab; (b) the Modify | Walls tab; (c) the Modify | Floors tab.

CHANGING SELECTION COLORS

You can customize the default colors for selection, pre-selection, and alerts to your own color palette. To do this, click the File tab and select Options. In the Options dialog box, select the Graphics option on the left to edit the settings for colors.

While selecting an element is a seemingly simple task, Revit provides you with a few ways to perform a selection:

Add or Subtract You can build a selection of individual elements by using the Ctrl and Shift keys on your keyboard. To add elements, press and hold the Ctrl key, then click an element. To remove elements, press and hold the Shift key, then click an element. Notice that the mouse pointer indicates a plus sign (+) when you hold the Ctrl key and a minus sign (–) when you hold the Shift key.

Window To select a large number of elements in a view window, you can click and drag the mouse to form two different types of selection windows. Click and drag from left to right, and only the elements completely within the window will be selected—this implied window is displayed as a solid line. Click and drag from right to left, and any element within or crossing the window will be selected—this implied window is displayed as a dashed line. To activate either window-selection tool, you must begin by clicking in a blank area (not on an element) within the view window.

Chain Chain-select is an intelligent method for selecting connected elements such as walls, lines, sketch segments, and line-based components. To activate this mode, hover (but don't click) your mouse over one linear element that is connected to several other linear elements. While the element is pre-selected, press the Tab key once and the connected elements will be pre-selected. You can then click to select the chain of elements. When selecting objects, use the Tab key to cycle through all available objects near your mouse pointer. If a floor edge happens to be near the edge of a wall that you are trying to chain-select, you can skip the chain of walls and select the floor. Be sure to look at the status bar; it will indicate "Chain of walls or lines" when you have selected correctly.

Select Previous Command A little-known feature allows you to select elements you had previously selected. Either right-click and choose Select Previous from the context menu or press Ctrl and the left-arrow key on your keyboard.

Selection Options

You have the ability to choose elements that will be included or excluded when you select elements in a model. For instance, you can choose to select elements that are within a linked file. Or not. There are two ways to adjust these settings, as shown in Figure 3.2: click the drop-down menu under the Modify button in the ribbon or use the icons at the right end of the status bar. Note that the icons in the status bar will change slightly to indicate the status of each option. When a mode is disabled, a small red X will be displayed on the icon (the first, second, third, and fourth icons show that X in Figure 3.2b). One of these selection options is Select Elements By Face, which allows you to select elements simply by picking any face of the element.

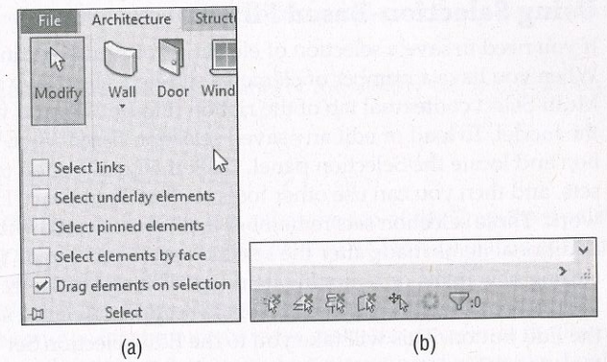


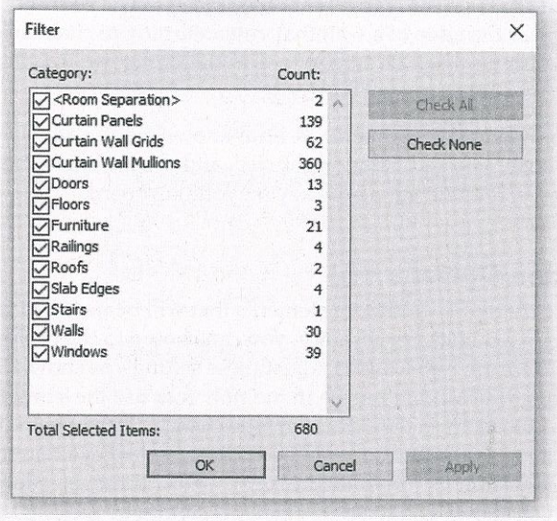
FIGURE 3.2
Use selection options to avoid picking elements, such as links or pinned elements. These options are found in (a) the Select expanded panel and (b) the status bar.

Filtering Your Selection

Once you have elements selected, a count of selected objects is displayed at the right end of the status bar. You can also filter the selection into object categories by clicking the Filter icon in the status bar or ribbon. Just as when selecting folders in Windows Explorer, you can select multiple categories while holding the Shift key or add a single category by holding the Ctrl key. This tool allows you to select large numbers of elements and then focus your selection by removing categories you don't need, as shown in Figure 3.3. For example, if you window-select an entire floor plan, you will have a selection set of many different categories. Using the Filter tool, you can limit the selection to just the Doors category—or perhaps Doors and Door Tags.

You can also use the Properties palette as a filter; see the section "Using the Properties Palette" later in this chapter for more information.

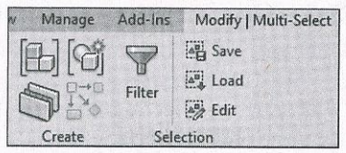
FIGURE 3.3
Use the Filter dialog box to fine-tune your selections.



Using Selection-Based Filters

If you need to save a selection of elements for future editing, you can save a selection-based filter. When you have a number of elements selected, click Save at the far right of the Modify | Multi-Select contextual tab of the ribbon (Figure 3.4), and you can create a named selection set in the model. To load or edit any saved selection-based filter, go to the Manage tab in the ribbon and locate the Selection panel. Click the Load button to activate any of the saved selection sets, and then you can use other tools such as Temporary Hide/Isolate to continue your task work. These selection sets remember the items selected within the categories and will not select additional items made after the selection set was created. You may update the selection set by adding new items or removing items by clicking Edit Selection, located immediately below the Load icon. When the Edit Filters window appears, click a saved selection set you want, then click the Edit button. This will take you to the Edit Selection Set contextual ribbon. Use the available tools to add or remove elements, then click Finish Selection when the operation is complete.

FIGURE 3.4
The Selection Panel within the Modify | Multi-Select tab



Selecting All Instances

Another fast and powerful method for selecting objects is the Select All Instances function. When you right-click a single object in the drawing area or a family in the Project Browser, the Select All Instances tool gives you two options: Visible In View or In Entire Project. Selecting the Visible In View option will select only those items you can see in the current view. This will *not* select elements that have been either temporarily or permanently hidden in the view.

Use the In Entire Project option carefully because you could modify elements in many places that you did not intend to change. Always remember to look at the selection count in the status bar when you use Select All Instances. Here are some common situations where you might use this tool:

Viewports—When updating graphics for all views

Walls—When switching from generic to specific types across the entire model

Title blocks—Moving from design to detail documents for all title blocks

Viewports—Useful when trying to purge unused viewports

TIP Note that Select All Instances does not work on model lines or symbolic lines. This limitation exists because lines not only are drawn in project views but also are integral parts of other objects such as filled regions and shaft openings.

Using the Properties Palette

The Properties palette is a floating palette that can remain open while you work within the model. The palette can be docked on either side of your screen, or it can be floated to any location or a second monitor. You can open the Properties palette using any one of the following methods:

- Click the Properties icon in the Properties panel of the Modify tab in the ribbon.
- Select Properties from the context menu.
- Press Ctrl+1 or PP on your keyboard.

As shown in Figure 3.5, the Type Selector is located at the top of the Properties palette. When you are placing elements or swapping types of elements you've already placed in the model, the palette must be open to access the Type Selector.

When no elements are selected, the Properties palette displays the properties of the active view. If you need to change settings for the current view, make the changes in the Properties palette and the view will be updated. For views, you do not even need to use the Apply button to submit the changes—simply move the mouse out of the Properties palette, and the changes will automatically be accepted.

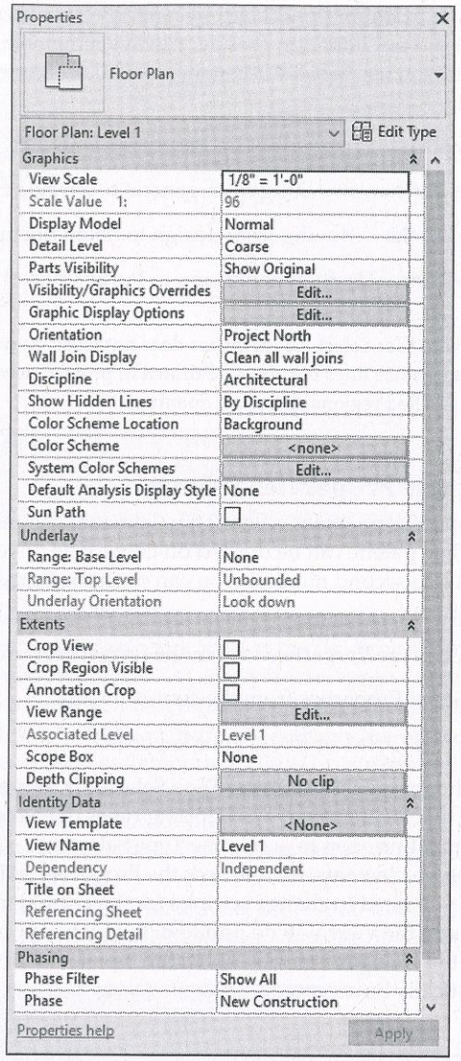
CUSTOMIZING THE APPLY BUTTON BEHAVIOR

You can modify the behavior of the Apply button in the Properties palette by editing the `Revit.ini` file. By default, the Apply button applies any changes the second your mouse leaves the Properties palette. If you want to disable the automatic acceptance of settings when you move the mouse, add the following code to the `Revit.ini` file:

```
[UserInterface]
DisableMppAutoApply=1
```

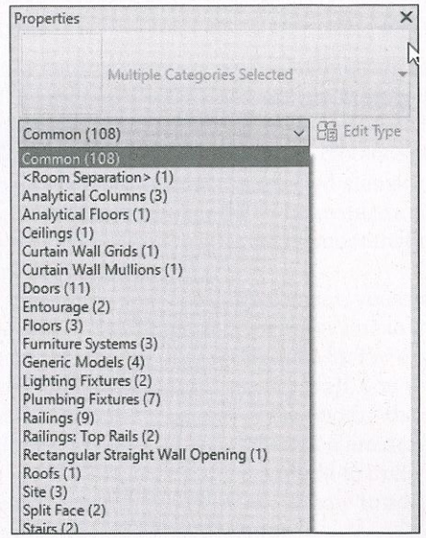
If the bracketed text `[UserInterface]` already exists in the `Revit.ini` file, simply add `DisableMppAutoApply=1` below it. You should restart Revit after making any changes to the `Revit.ini` file.

FIGURE 3.5
The Properties palette contains the Type Selector and is used to set view properties when no objects are selected.



Finally, you can also use the Properties palette as a filtering method for selected elements. When you select elements from different categories, the drop-down list below the Type Selector displays the total number of selected elements. Open the list and you will see the elements listed per category, as shown in Figure 3.6. Select one of the categories to modify the parameters for the respective elements. This process is different from the Filter tool in that the entire selection set is maintained, allowing you to perform multiple modifying actions without reselecting elements.

FIGURE 3.6
Use the Properties palette to filter selection sets.



Matching Properties

Located on the Modify tab of the ribbon in the Clipboard panel, the Match Type Properties tool allows you to select one element and apply its type and instance properties to other elements of the same category. Once you select one element, the brush icon near the mouse pointer appears filled. Each subsequent pick on elements of the same category will replace the selected element with the properties of the first element picked. Clicking in an open space will clear the brush icon and allow you to pick a new source object without restarting the command.

If you want to use the Match Type Properties tool for multiple objects in a more controlled manner, click the Select Multiple button in the contextual tab of the ribbon after the source object is selected. Proceed to use any of the usual selection methods described earlier in this chapter. When your selection is complete, click the Finish button on the ribbon.

Be careful when using this tool with walls, because not only does it change the wall type, it also changes the top and bottom constraints of the walls being matched. One best practice for changing wall types without affecting height constraints is to pick a wall and use the Type Selector to modify its type.

Using the Context Menu

The context menu that appears when you right-click in the view window contains several options. You can activate the last command or select from a list of recent commands, as shown in Figure 3.7. The context menu will also show you the shortcuts for any commands that have a shortcut assigned. In Figure 3.7, you can see the shortcut for the wall command is WA (shown in parentheses).

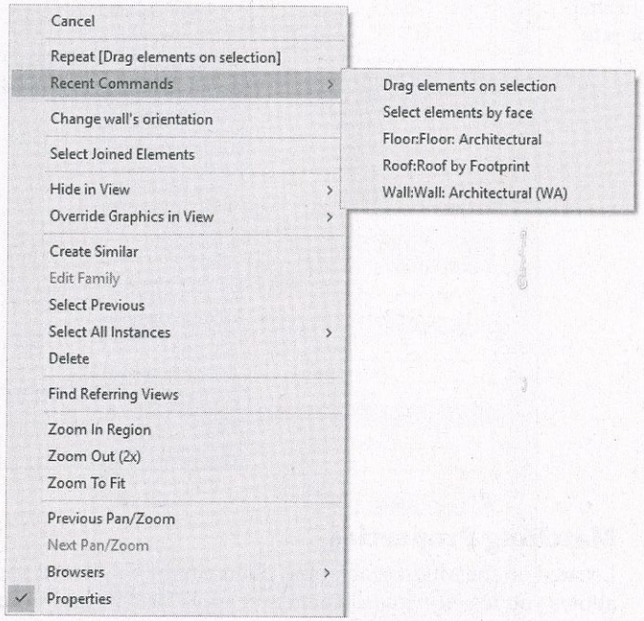


FIGURE 3.7
Run recent commands from the context menu.

In addition to the other right-click commands listed throughout this chapter (such as Create Similar), zoom commands, including Previous Pan/Zoom, are on the context menu. There are also useful commands when you right-click views in the Project Browser. For example, activate a plan view and then try right-clicking a 3D view in the browser. Select Show Section Box, and you can edit the extent of the 3D view's section box while in a floor plan.

Editing Elements Interactively

Revit provides a range of options to edit elements in the model interactively. The most obvious are selecting elements and then dragging them on the screen or using the blue control grips to extend walls, lines, shape faces, and region boundaries; however, you often need more precise ways of moving and copying objects. Let's look at some ways to do that.

Moving Elements

You can move elements in several ways, ranging from choosing traditional tools to using interactive dimensions that appear on-the-fly when you select elements. Become familiar with each method and determine what is best for your workflow.

Using Temporary Dimensions

You have likely noticed by now that dimensions appear when elements are selected or newly placed. These dimensions are called Temporary Dimensions and are there to inform you of the location of the elements relative to other elements in the model, as well as to help you reposition them. Clicking the blue dimension value (the text representing the distance measurement) makes it an active and editable value. Type in a new value, and the selected element will move relative to the element from which it is dimensioned. Remember that when you are editing the position of an element via the dimensions, it will always be the selected element that moves. You can't modify a dimension value if an element is not selected.

If a temporary dimension is not referencing a meaningful element, you can choose a different reference by dragging the small blue dot on the dimension's witness line to a new, parallel reference, which will highlight when the mouse moves over it (Figure 3.8). For example, if you want to position a door opening at a specific dimension from a nearby wall, you will need to drag the grip of the temporary dimension that references the center of the door to the side of the opening. Then you can edit the value of the dimension as required. When you are dragging the grip of a temporary dimension, you can also use the Tab key on the keyboard to cycle through available snapping references near the mouse pointer. To learn more about how to add references to families, refer to Chapter 15, "Designing with the Family Editor."

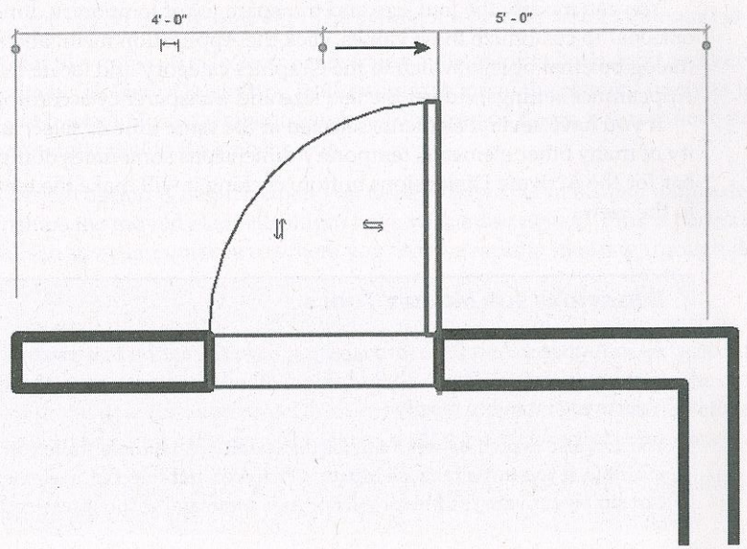


FIGURE 3.8
Drag or click the blue grip to change the reference of the temporary dimension.

If you click a blue grip, it cycles to the next possible reference in the element. For example, clicking the grip of a dimension to a door or window cycles between the left and right openings and the center reference. The same applies to walls: try clicking the grip on the temporary dimension extending from a wall and see how the dimension cycles through the various references in the wall (interior face, centerline, exterior face). Note that when you drag a temporary dimension reference to a different position, the new reference is remembered when you return to the element for future editing.

You can also change the default behavior of temporary dimensions using the Temporary Dimension Properties dialog box, shown in Figure 3.9 (on the Manage tab, click Additional Settings and then select Temporary Dimensions). Here you can specify how temporary dimensions will independently reference walls, doors, and windows.

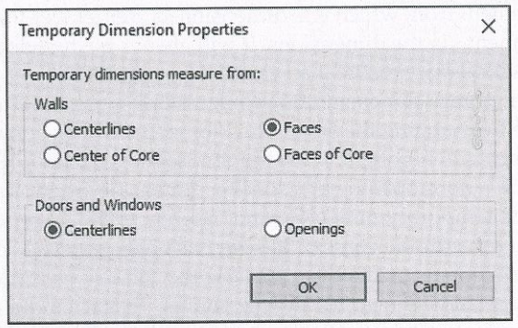


FIGURE 3.9
The Temporary Dimension Properties dialog box lets you define default behaviors based on your modeling needs.

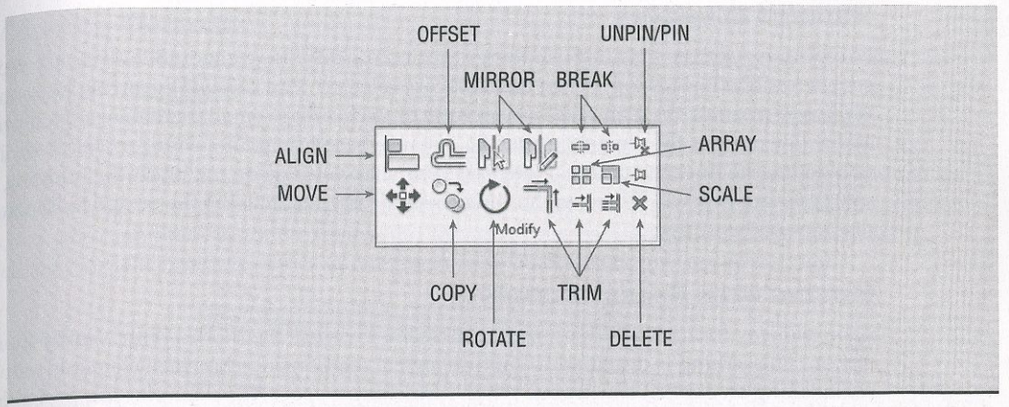
You can modify the font size and transparency of temporary dimensions in the program options. To customize these values, click the Application menu and select Options. In the Options dialog box that opens, switch to the Graphics category and locate the Temporary Dimension Text Appearance settings. Adjust the text size and transparency according to your needs.

If you have several elements selected at the same time or select an element within the proximity of many other elements, temporary dimensions sometimes don't appear. Check the Options bar for the Activate Dimensions button; clicking it will make the temporary dimensions appear in the view.

BEHAVIORS FOR MODIFY TOOLS

As in Autodesk AutoCAD software, you have the option to activate the Modify tools without any elements selected. If you choose this method, you must press the Enter key after selecting the objects you intend to modify.

You can also switch between any of the Modify panel tools while you have elements selected. For example, if you initially chose Mirror – Pick Axis and selected an element during the command, you can simply activate the Mirror – Draw Axis command without reselecting the elements.



USING THE MOVE TOOL

To relocate elements with more precision, use the Move tool rather than simply dragging the element. The tool allows you to type in values or use temporary dimensions as helpers to precisely locate your object.

Moving elements is a two-click process. First, you define a start point; then, you click to define a destination. If you know you need to move something a specific distance, it does not matter where your two picks take place. All that matters is that the distance between the two clicks is the specified distance and in the specified direction. Alternatively, you can guide the mouse pointer in the desired direction of the move and key in the desired dimension value.

There are a few options on the Options bar to be aware of when the Move command is active:

Constrain When this option is selected, it constrains movement to horizontal and vertical directions relative to the view. Deselecting it allows you to move the element freely as long as the element is not hosted. Hosted elements, such as windows or doors, always move in a constrained manner parallel to their host's axis.

Disjoin The Disjoin option is helpful when you need to move elements and eliminate any joining relationships the moved elements might have with other objects. This is particularly useful with walls in some circumstances where you may be rapidly iterating through design scenarios.

You might also attempt to use the Disjoin option to move a hosted element, such as a door, to a new host. Don't use the Move tool to perform this action; instead, you must select the hosted element, and from the contextual tab in the ribbon, click Pick New Host. The object will be relocated to the new host you select. This method is also preferred over deleting and re-creating because it maintains the data associated with the original element instance.

Multiple The Multiple option is not active for the Move tool. This option is available only when you switch to the Copy tool.

Nudging Elements

Nudging is a simple way to push things around quickly, as you would in software programs such as Adobe Photoshop. When elements are selected, you can use the arrow keys on the keyboard to move the elements horizontally or vertically in small increments. Each press of an arrow key nudges the element a specific distance based on your current zoom factor. The closer you zoom, the finer the nudge. Note that your snap settings do not affect the nudging distances set by the zoom level. However, holding the Shift key while using the nudge tool increases the distance of the nudge.

Moving with Nearby Elements

A simple way to constrain freestanding elements is to use the Moves With Nearby Elements option. This setting is designed to capture logical relationships between elements without establishing an explicit constraint. When furnishing a space, for example, you probably want to align the bed or dresser with an adjacent wall. If you change the design of the space, you want the furniture to follow the wall to the new location. For this purpose, select the furniture and then select Moves With Nearby Elements in the Options bar, as shown in Figure 3.10.

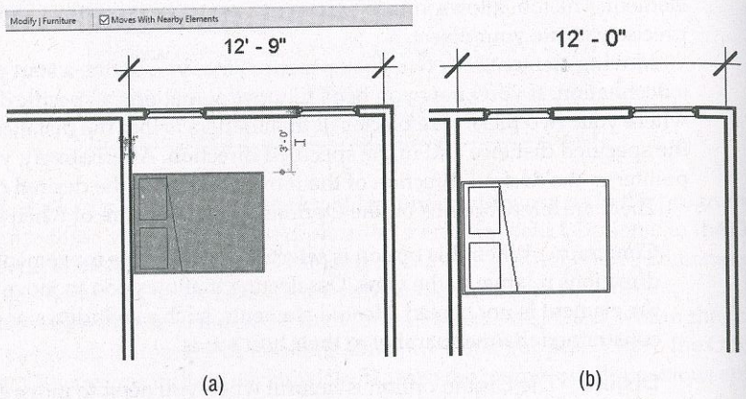


Figure 3.10
Once an object is selected, it can be set to move with nearby elements: (a) select the furniture and then select the Move With Nearby Elements tool; (b) note that the elements keep their relationships.

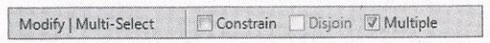
By setting this option, you create an invisible relationship between the bed and the wall so that each time you move the wall, the bed moves with it. To clarify the difference between this approach and other constraint relationships, you could create a wall-hosted family, but that would limit your placement options and would subject instances to deletion if the host is deleted. You could align and constrain the family to its host, but too many explicit constraints will adversely affect model performance.

The Moves With Nearby Elements option is also a simpler alternative to using a hosted family. When a component family does not need to cut or carve the host geometry, consider using a freestanding family or just a face-based family in conjunction with the Nearby Elements option. Refer to Chapter 15 for more information about hosted versus non-hosted values.

Copying Elements

The Copy tool is another modifying tool that is nearly identical to the Move tool, but it makes a copy of the selected element at the location of the second pick. This tool doesn't copy anything to the Clipboard; it copies an instance of an element or selection of elements in the same view. If you change views while using this tool, your selection is lost.

To activate this tool, choose elements you want to copy and then select the Copy tool in the Modify tab in the ribbon; alternatively, activate the Copy tool first, select elements you want to copy, and then press the Enter key to start the copy process. Using the Options bar, you can choose to make multiple copies in one transaction by selecting the Multiple option.



An alternative to using the Copy tool is to use standard Windows accelerator keys to copy elements. To quickly copy a single element without the precision of the Copy tool, click and drag an element while pressing the Ctrl key on your keyboard. This technique is useful for quickly populating a quantity of elements in a design without the required precision of the multiple picks of the Copy tool.

Copying Using Worksets

If you are working in a model in which worksharing is enabled, be careful when performing any method of copying. These methods include pasting from the Clipboard, mirroring, and arraying, as well as using the Copy tool. Copied elements will always be placed on the active workset, not the workset of the original object. For example, if you are copying chairs that have been placed on the workset named Furniture but your active workset is Structure, the copied chairs will be assigned to the Structure workset. For more information, refer to Chapter 5, "Collaborating with a Team."

Rotating and Mirroring Elements

When refining or expanding your building design, you will likely find a frequent need to rotate or mirror one or more objects. Just as with moving or copying, there are a few methods for these types of interactive operations. We will review these methods in the following sections.

Using the Spacebar

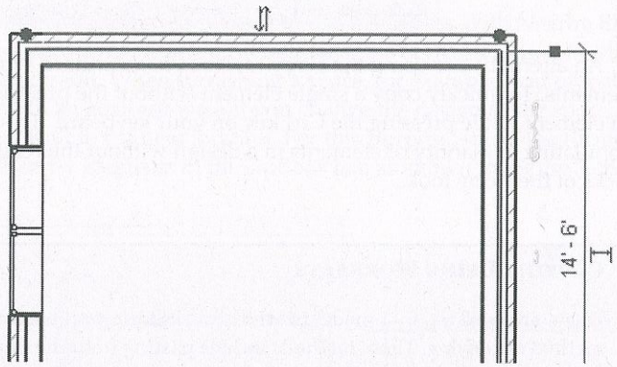
You can use the spacebar to rotate an element, both at the time of initial placement and after it has been placed. In addition to rotating an object in 90-degree increments, pressing the spacebar will locate any nearby non-orthogonal references (walls, grids, or reference planes) as rotation candidates. This is a great time-saving command to become familiar with because you can forgo the necessity of using an additional tool, such as Rotate or Mirror, after placing an object. Here are a few examples:

Doors and Windows If you have a door with its swing in the wrong direction, select it and press the spacebar. You can cycle through all four possible orientations of the door using the spacebar. The same holds true for windows; however, many window families only let you flip

the window from inside to outside because many windows are symmetrical in elevation. If you are creating an asymmetrical window family, be sure to add flip controls to the window family during its creation. These controls allow the spacebar to work on hosted elements.

Walls If you select a wall, pressing the spacebar flips the element as if it were being mirrored about its length. Walls flip based on their location line, which often isn't the centerline of the assembly. If you aren't sure which direction your wall is facing, select it and look for the flip-control arrows. These are always located on the exterior side of walls (Figure 3.11). You can also use the spacebar to flip the direction of an object. Simply select the object and hit the spacebar to toggle through placement options while you're locating a component.

FIGURE 3.11
The flip arrow is another way to reorient an element. For walls, it is always found on the exterior side.

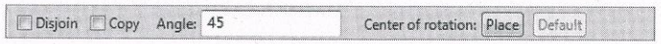


Freestanding Elements If you select a freestanding element, the spacebar rotates the element around the center reference planes defined in the family. Depending on how the family was built, the rotation origin may not make the most sense. If you decide to edit a family to change the location of the geometry relative to the center reference planes, be careful: when the family is loaded back into a project, all instances of the family will jump to a new location based on the change you made relative to the reference planes.

USING THE ROTATE TOOL

To rotate an element, select it and click the Rotate tool in the Modify panel. Remember, you can also activate the Rotate tool first, select one or more elements, and then press Enter to begin the operation. This is a two-click operation similar to the Move and Copy tools. The default rotation point is based on the center of the selected elements; however, you will most likely want to designate a more meaningful center.

To choose a new center of rotation, you have a couple of options. You can drag the center icon to a new location before clicking to set the starting reference angle. Note that you might have to zoom out in order to find the center icon. The second option is to select elements you want to rotate and then use the Place button in the Options bar to simply place the rotation point in the desired location without dragging. Once the center is established, begin rotating the element using the temporary dimensions as a reference or by typing in the angle of rotation explicitly.

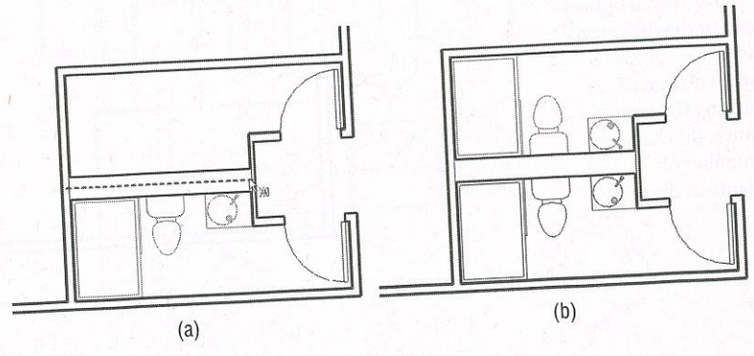


Note that you can also use keyboard snap shortcuts to refine the location of the center of rotation while dragging it. For example, type **SE** to snap to an explicit endpoint while dragging.

USING THE MIRROR TOOL

The Mirror tool allows you to mirror elements across an axis in order to create a mirror image of an element or multiple elements. You can either pick an existing reference in the model with the Mirror – Pick Axis tool or draw the axis interactively using the Mirror – Draw Axis tool. In Figure 3.12, the centerline of the plumbing chase wall was picked as the axis for mirroring the plumbing fixtures.

FIGURE 3.12
The sink, toilet, and bath fixtures are mirrored around the centerline of the chase wall: (a) selecting the axis; (b) the mirrored elements.



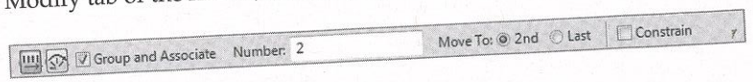
Like the other Modify tools you have seen so far, the Mirror tools have the option to create a copy of the selected elements or to simply mirror the selected elements to a new position. You can find the Copy option in the Options bar after you activate either of the Mirror tools.

BEING CAREFUL WHEN MIRRORING

The Mirror tools should be used carefully on any type of freestanding elements that may be asymmetrical in design. You can use the Mirror tools on any object, but keep in mind that performing this operation to suit a design may distort a product component. For example, if an asymmetrical chair family was loaded into your model and you decide to mirror it to fit a space layout, the mirrored version of that chair may not be a viable product offered by the manufacturer. Remember that although an object can be scheduled, the schedule cannot determine whether the object has been mirrored.

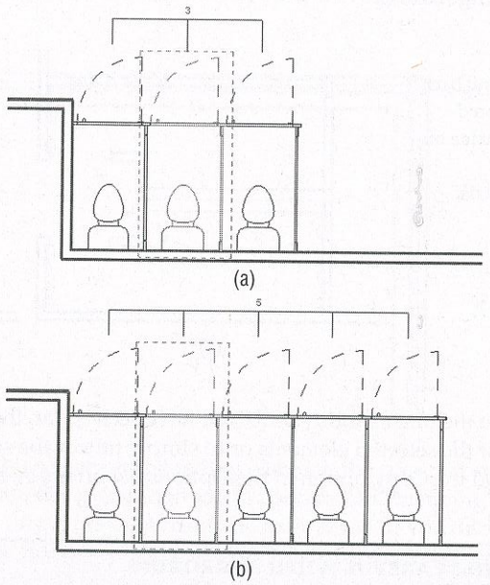
Arraying Elements

The Array tool allows you to copy instances of an element with equal spacing between the instances. You have the option to create intelligent arrays that can be grouped and associated for further refinement, as well as one-off, unassociated arrays. Like the other tools we have reviewed in the Modify tab of the ribbon, the array options are presented on the Options bar.



You can create two types of arrays: linear and radial. *Linear* arrays are set as the default because they're the most common. As you would expect, a linear array creates a series of elements in a line. Each element in the array can be given a defined distance from the previous element (Move To 2nd option) or can be spaced equally based on a defined overall array length (Move To Last option). Figure 3.13 shows a linear array where the Move To 2nd option was selected to define a fixed distance between each instance in the array. Think of this type of array as additive and subtractive: if you change the number, the length of the array increases or decreases.

FIGURE 3.13
The Move To 2nd option is used in the Array tool to set a fixed distance between instances: (a) setting the array distance; (b) changing the number of elements in the array.



If you want to arrange elements in a fixed space and the exact spacing between elements is less important, use the Move To Last option. Figure 3.14 shows an array where the location of its last element was picked and the elements were placed equally between the first and last elements. With this option, the length is fixed and the array squeezes elements within that constraint as the number changes.

A *radial* array uses the same options as a linear array, but it revolves around a center point. The Move To 2nd and Move To Last options function as angles instead of distances in a radial array. You can specify the instance angle or overall array angle with two picks, or you can enter a specific value. With this type of array, elements auto-rotate so that each element faces the center of the array, as shown in Figure 3.15.

FIGURE 3.14
This array uses the Move To Last option and fills instances between the first and last instances: (a) creating an array first to last; (b) adding more elements to this array to keep the end element in the same location but add more in between.

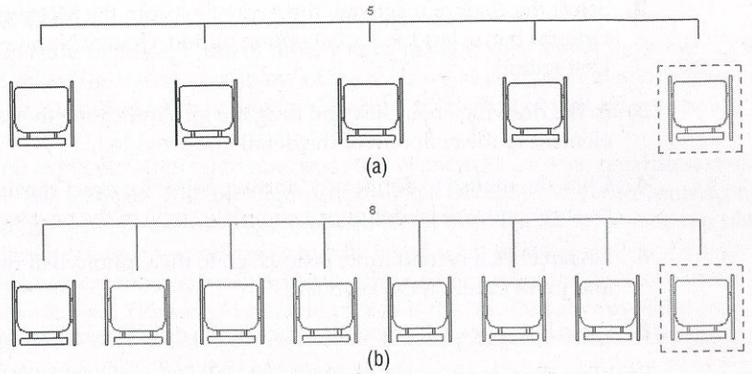
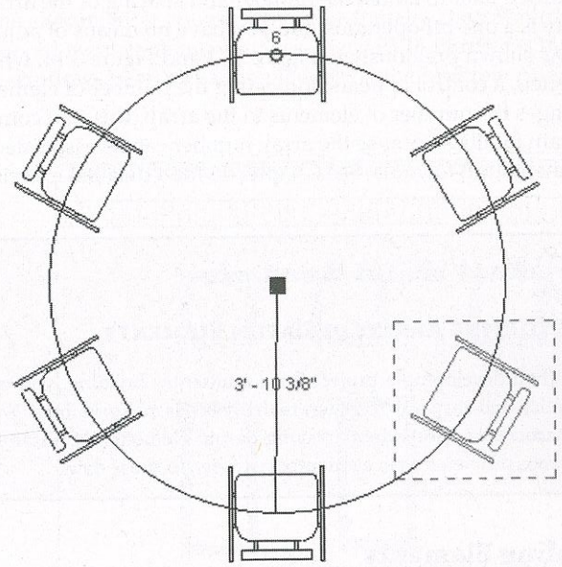


FIGURE 3.15
Elements will auto-rotate in a radial array.



The radial array is a little trickier than a linear array. Here is how to achieve the example shown in Figure 3.15:

1. Download and open the file `c03-Array.rvt` from this book's web page at `www.wiley.com/go/masteringrevit2020`. Activate the Level 1 floor plan. To assist in starting the radial array, we provided a detail line to help locate the intended center of the array.

2. Select the chair and activate the Array tool from the Modify tab in the ribbon. In the Options bar, select the Radial option button, change Number to **6**, and choose the Move To Last option.
3. In the drawing area, click and drag the grip indicating the center of rotation off the element to the endpoint of the detail line provided.
4. Click the mouse to define any starting point. An exact starting point is not important, because you will be defining a complete circle in the next step.
5. Do not click a second time; instead, go to the Options bar, type **360** in the Angle option, and press Enter on the keyboard.
6. Press Enter or click any open space in the drawing area to complete the command.

Enabling the Group and Associate option allows you to treat an array as a group that can be modified later to adjust the number and spacing of the array. If this option is unchecked, the array is a one-off operation and you have no means of adjusting it after it is created.

As shown previously in Figure 3.13 and Figure 3.14, when an element in a grouped array is selected, a control appears, indicating the number of elements in the array. Editing that number changes the number of elements in the array. This tool comes in handy when you are creating certain families because the array number can be associated with a parameter or driven by a mathematical formula. See Chapter 15 for a detailed exercise.

Real World Scenario

GROUPING ARRAYS OF DATUM ELEMENTS

When developing a project for a multistory building, you may find that using the Array tool is a quick and easy way to generate many levels and grid lines. We recommend not using the Group and Associate option when arraying datum elements. Maintaining grids and levels inside groups can cause problems with elements that refer to those data.

Scaling Elements

The Scale tool lets you scale certain lines and graphic elements in 2D that are appropriate for scaling, such as imported raster images and 2D line shapes. Although it's not an obvious option, the Scale tool can be used in Sketch mode for any type of sketch-based element in a project or for solid and void geometry sketches in the Family Editor.

Keep in mind that you are working with a model made of real-world objects, not abstract primitive forms. You cannot scale most elements because it's not practical or meaningful and may cause dangerous errors in scheduling and dimensions. For example, you shouldn't scale the size of a door, wall, or sink because they represent real assemblies and scaling them would mean resizing all their components. This would lead to impractical results, such as a sink being displayed as a fraction of its actual manufactured size.

Aligning Elements

If you've been using Revit for any amount of time, you have likely discovered the power of the Align tool. It can supplant the need to use many of the tools we have already discussed, such as Move and Rotate. The Align tool lets you line up elements in an efficient way that works on almost all types of objects.

With this tool, you explicitly align references from one element to another, regardless of the type of either object. For example, you can align windows in a facade so that their centers or openings are all in alignment. To use the Align tool, activate it from the Modify tab in the ribbon and first select the target reference—a reference to which you want to align another element. Next, select what you want to align to that reference—the part or side of the element whose position needs to be modified. The second element picked is the one that always moves into alignment. This selection sequence is the opposite of the other editing tools we've discussed so far, so remember, *destination first*, then the element to align.

As soon as you make your second pick and the aligned element is moved, a lock icon appears, allowing you to constrain the alignment. If you click the icon, thereby constraining the alignment, the alignment is preserved if either element moves. Figure 3.16 illustrates the use of the Align tool to align multiple windows in an elevation view using the Multiple Alignment option on the Options bar.

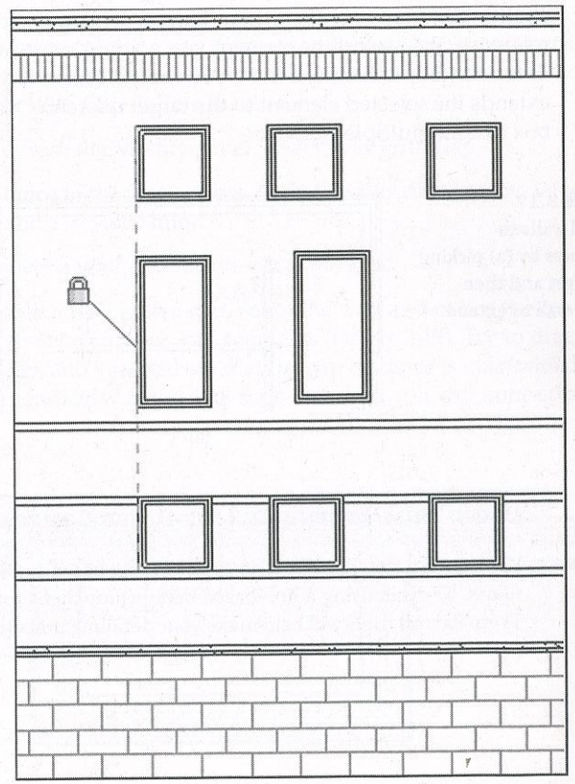


FIGURE 3.16
You can use the Align tool to line up edges of windows in a facade.

The Align tool also works within Filled Region model patterns, such as brick or stone on surfaces of model objects. Select a line on an object such as the edge of a wall and then select a line in the surface pattern. Use the Tab key if you cannot get surface patterns selected with the first mouse click. Note that the Align tool will also rotate elements in the process of aligning them to objects that are not parallel. This is a real time-saver compared to moving and rotating.

Trimming or Extending Lines and Walls

You can trim and extend lines and walls to one another using the Trim/Extend tools on the Modify tab of the ribbon. There are three separate tools in the ribbon: Trim/Extend to Corner, Trim/Extend Single Element, and Trim/Extend Multiple Elements. With the Trim/Extend tools, you first activate the tool and then operate on elements in the model, selecting two lines or walls that need to meet in a corner or at a T-intersection.

The Trim/Extend tools are used frequently for editing sketches of floors and roofs because it's easy to end up with overlapping lines that need to be trimmed to form a closed loop. Keep in mind that with the Trim/Extend tools, you are selecting pairs of elements to *remain*, not to remove. Although the Single Element and Multiple Elements tools are similar to the Extend command in AutoCAD, the behavior of the Trim/Extend to Corner tool in Revit is more like that of the Chamfer or Fillet command rather than its Trim command.

The Trim/Extend tools for extending a single element or multiple elements function in a slightly different way than Trim/Extend To Corner. To extend a wall or line, first select a target reference; then select the element you want to extend to that target (Figure 3.17). Using the Trim/Extend Multiple Elements tool, you first select the target reference; then each subsequent pick extends the selected element to the target reference. You also have the ability to use a selection box to trim multiple elements.

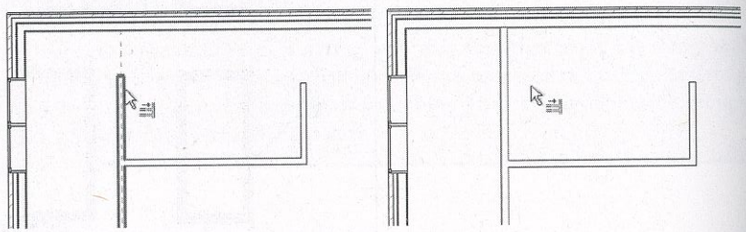


FIGURE 3.17
Extend walls to references by (a) picking the target and then (b) the wall to extend.

USING TRIM/EXTEND ON LINE-BASED COMPONENTS

You can use the Trim/Extend tools on line-based families that are either model or detail components. Try this using a line-based detail component for batt insulation or gypsum wallboard. The Trim/Extend tools will help make your detailing process much more efficient and fun!

Splitting Lines and Walls

The Split Element tool operates on walls and lines and lets you divide an element into two pieces. To cut an element, activate the Split Element tool from the Modify tab in the ribbon and place the mouse pointer over the edge of a wall or line. Before you click, you will see a preview of the split line. The split line will automatically snap to any adjoining geometry.

The Options bar displays a nice feature called Delete Inner Segment that removes the need to use any of the Trim tools after a splitting operation. In the example in Figure 3.18, the middle section of a wall needs to be removed so that you end up with a clean set of wall joins. Using the Split Element tool with the Delete Inner Segment option checked, you can accomplish this with two clicks and get a clean condition without having to return with any of the Trim commands.

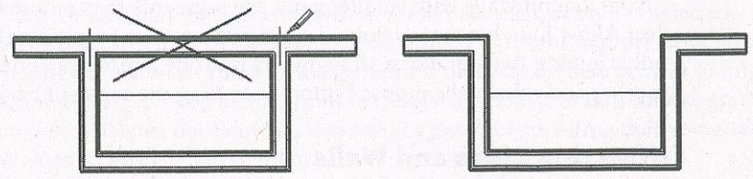


FIGURE 3.18
Using the Split Element tool with the Delete Inner Segment option checked

SPLIT WITH GAP

The Split With Gap tool allows you to specify a gap distance and pick a single point on a wall. Although the wall is divided into two separate segments, the gap distance is maintained with an automatic constraint. To use Split With Gap, follow these steps:

1. Go to the Modify tab, and from the Modify panel, select Split With Gap.
2. Specify the Joint Gap distance in the Options bar. Note that this distance can be set only between 1/16″ (1.6 mm) and 1′-0″ (300 mm).
3. Move the mouse pointer over a wall and click to place the gap.

Once you have successfully split a wall with a gap, select the wall and notice the constraints (locks) on the gap and between the two parallel wall segments (Figure 3.19). Try to drag either of the wall ends separated by the gap, and you will see that the gap distance is maintained. Try to move the wall in a direction perpendicular to the wall segments, and you will notice that the two wall segments remain aligned.

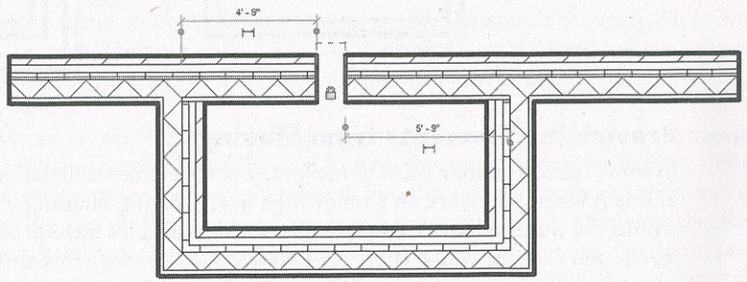


FIGURE 3.19
Using the Split With Gap tool

If you would like to rejoin walls that have been split with a gap, follow these steps:

1. Select a wall that has been split with a defined gap.
2. Click the constraint icon in the gap to unlock the dimension constraint.
3. Select each wall segment and click the Allow Join icon near the end of the wall that was split.
4. Select the other wall and repeat step 3.
5. Drag the wall end grip of one wall segment to the end of the other segment. The walls should join.

Note that on walls with smaller gaps, the segments may automatically join as soon as you select Allow Join; however, rejoined segments may not form a single segment. If you have trouble joining two parallel wall segments into one, try to drag one of the wall ends away from the other and release the mouse button; then drag the segment back to the other end.

Offsetting Lines and Walls

Offset is similar to the Move and Copy tools in that it moves and makes a copy of an element by offsetting it parallel to an edge you select. You can find the Offset tool in the Modify tab of the ribbon. You can also specify an offset distance as an option in the Options bar to give an offset distance or choose the Graphical option if you want to manually locate the offset element.

This tool is especially useful in the Family Editor when you are making shapes that have a consistent thickness in profile, such as extruded steel shapes. The Offset tool has a Copy option available in the Options bar that determines whether the offsetting operation generates a copy of the selected elements or simply moves them.

Remember that you can Tab-select a chain of elements and offset them in one click, as shown in Figure 3.20. When the Offset command is active, the dashed line appears on the side of the element to which the offset will be created.

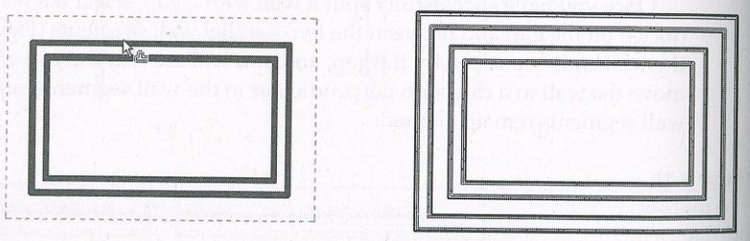


FIGURE 3.20
Use Offset with Tab-select to copy a chain of elements.

Preventing Elements from Moving

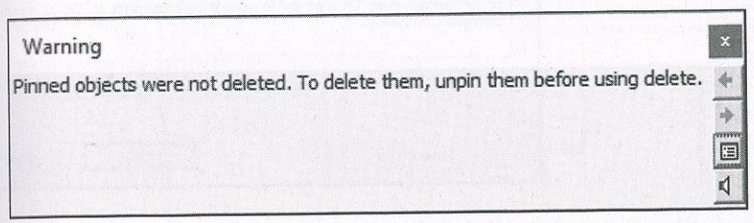
In some cases, you may want to make sure some elements in the model never move. An example of this is when you work on a renovation to an existing building. For obvious reasons, you would not want to move existing walls. Other examples include imported drawings, grids, levels, and exterior walls. There are two ways to deal with this and lock certain elements, thus preventing them from moving.

PINNING ELEMENTS

You can restrict an element's ability to move by pinning it with the Pin tool. Use this tool to lock down critical elements that need to remain fixed for extended periods of time. As one example, this is a valuable tool to use on referenced CAD files because it is easy to accidentally select a reference and drag it or move it. This kind of accidental modification can lead to coordination problems, even in a BIM environment. Also, a very common practice is to pin grid lines and levels because you certainly do not want to accidentally relocate those either.

This tool is in the Modify panel of the Modify tab in the ribbon. Select one or more elements for which you want to prevent movement and click the Pin tool. If you try to move the element, nothing will happen—you will not even get a preview of a potential move. To unpin an element, select it and click the Unpin tool, which is also located in the Modify panel. You can also unpin an element by clicking the pin icon that appears near a pinned element when it is selected.

Revit helps you avoid accidentally deleting elements. Instead of permitting the deletion and providing a warning, Revit will warn you that the element is pinned and instruct you to unpin the element before using Delete. If you select multiple elements (some pinned and some not pinned) for deletion, Revit deletes the elements that are not pinned and warns that you must unpin the pinned elements before deleting them.



Combining the Pin tool and the selection filters will allow a BIM coordinator to create a selection set for pinned items. By loading the selection set, the coordinator can double-check that the items are indeed pinned.

CONSTRAINTS

Constraints aren't as rigid as the Pin tool, but they do allow you to create dimensional rules in the model so that elements remain fixed relative to other elements. You can create a constraint using dimensions or alignments and then click the lock icon that appears upon creation of a dimension or completion of an alignment operation.

A simple example of using constraints is maintaining a fixed distance between a door and a side wall. If the wall moves, the door will also move. If you try to move the door, the software will not let you move it. Look at Figure 3.21; the door has been constrained to remain 4″ (100 mm) from the wall face.

This type of constraint is accomplished by placing a dimension string between the doorjamb and the face of the wall and then clicking the lock icon on the dimension. Note that the dimension can be deleted while preserving the constraint. If you delete a constrained dimension, an alert will appear, giving you the option to unconstrain the elements or simply delete the dimension while maintaining the constraint (Figure 3.22). Note that you can determine where constraints were by creating new dimensions; constrained relationships will still display with the lock icon.

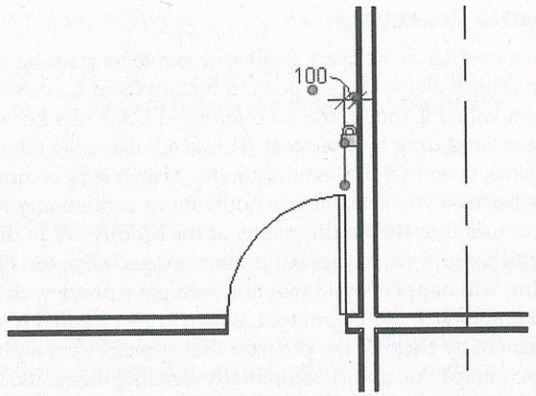


FIGURE 3.21
A door constrained to a wall can't be moved independently of the wall.

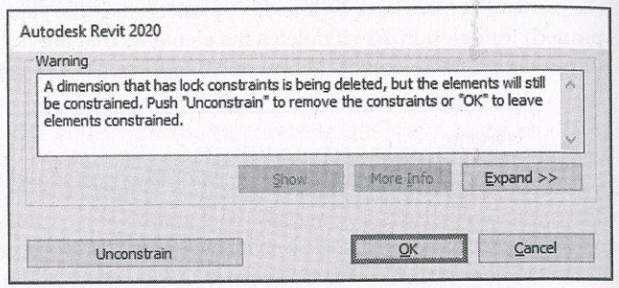


FIGURE 3.22
Deleting a constrained dimension generates an alert.

You can view these relationships when a constrained element is selected. Simply hover the mouse pointer near the constraint icon, and you will see the dimension constraint represented as a dashed dimension string. Another option to see what is constrained in your model is to use the Reveal Constraints tool on the view control bar. Selecting this will toggle a setting allowing you to see what elements are constrained in the model (Figure 3.23).

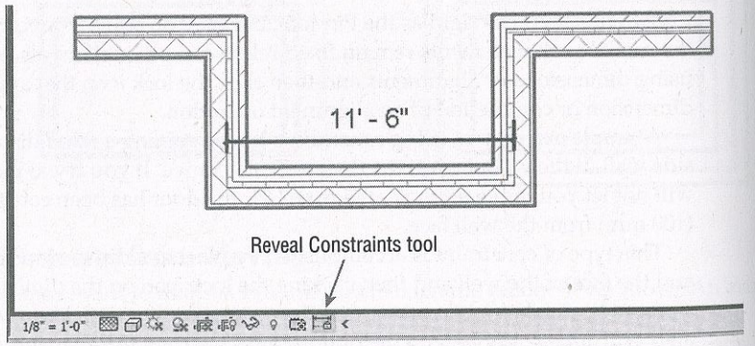


FIGURE 3.23
Showing constrained elements using the Reveal Constraints tool in the view control bar

Exploring Other Editing Tools

Many other editing tools are available, and we will cover them in subsequent chapters when they're used in specific operations. However, there are a few you should know about now because they are generic tools you can put to immediate use on any project.

Using the Join Geometry Tool

Joining walls to floors and roofs creates clean-looking drawings, and Revit will attempt to create these joins automatically; however, in some cases, elements don't look right until they are explicitly joined. This is where the Join Geometry tool comes into play. This tool creates joins between floors, walls, ceilings, roofs, and slabs. A common use for this tool is in building sections, where floors and walls may appear overlapped and not joined. Figure 3.24 shows a floor intersecting with some walls that aren't joined. Using the Join Geometry tool, you can clean up these conditions nicely.

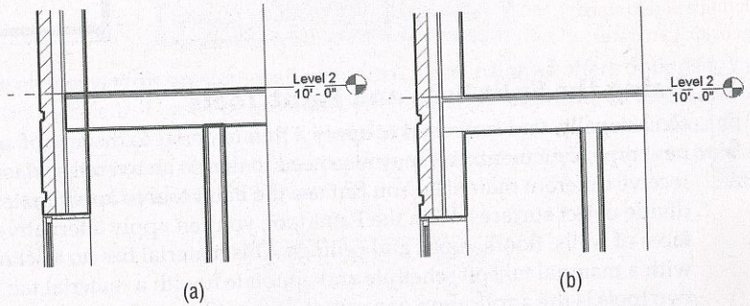
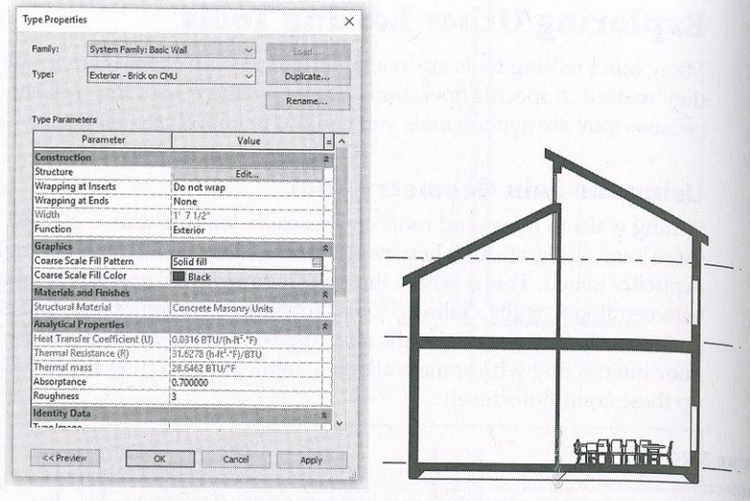


FIGURE 3.24
Intersections at Level 2 have been joined: (a) unjoined; (b) joined.

You might notice that some joins—especially in a view set to the Coarse detail level—contain a thin dividing line between two elements. This is usually because the two elements you joined consist of differing materials. Ensuring consistent material application will give you increased graphic quality in your project views.

You should also be aware that joining large host elements to many other elements may degrade model performance. One way to avoid this is to apply a black solid fill to elements in the cut plane of your coarse view sections and avoid overall manual joining; then selectively join for medium and fine views. You can do so easily by selecting the element in question (wall, floor, and so forth) and choosing Edit Type from the Properties palette. By default, the Coarse Scale Fill Pattern is set to No Pattern. Set this to Solid Fill; in all your coarse views, your elements will show as solid black (Figure 3.25).

FIGURE 3.25
Using Solid Fill to show walls, floors, and roofs as joined in a Coarse view setting



Using the Split Face and Paint Tools

Occasionally, you may need to apply a thin material to the face of an object without making a new type of element. You may also need to divide an overall surface into smaller regions to receive different materials. You can use the Paint tool to apply materials and the Split Face tool to divide object surfaces. With the Paint tool, you can apply alternative materials to the exterior faces of walls, floors, roofs, and ceilings. This material has no thickness, but you can schedule it with a material takeoff schedule and annotate it with a material tag. A typical use case for these two tools is the application of a carpet or thin tile to a floor. See Chapter 14, "Modeling Floors, Ceilings, and Roofs," for a detailed exercise on this topic.

Copying and Pasting from the Clipboard

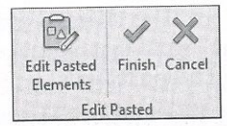
Copying and pasting is a familiar technique used in almost all software applications, and Revit provides the basic features you would expect (Ctrl+C to copy and Ctrl+V to paste). It also has some additional time-saving options that are specific to working on a 3D model.

To copy any element or group of elements to the Clipboard, select them and press Ctrl+C. To paste, press Ctrl+V. In the majority of cases, the software pastes the elements with a dashed bounding box around them. You then determine where to place the elements by clicking a point to define its final position. In the Options bar, you will find a Constrain option that when clicked will only let you define the location of the pasted content orthogonally to the original elements. With the elements copied to the Clipboard, you'll also find some additional tools on the Clipboard panel of the Modify tab.

EDIT PASTED

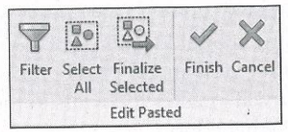
Immediately after you select a point for the location of the pasted content, you will find a new panel in the ribbon called Edit Pasted (Figure 3.26). You can click Finish to complete the pasting action or start another command. If you are unsatisfied with the pasting action, select Cancel.

FIGURE 3.26
Additional actions are available when pasting elements.



If you select Edit Pasted Elements, a special mode will be started with the Edit Pasted tools appearing at the top left of the drawing area (Figure 3.27). In this mode, only the pasted elements are editable. You can use the Select All or Filter button to refine those elements within the pasted selection. When your edits are completed, click the Finish button.

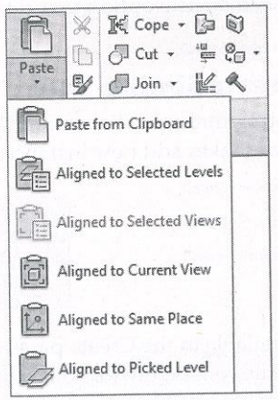
FIGURE 3.27
Edit Pasted mode allows additional modification of pasted elements.



PASTE ALIGNED

If you need to paste elements with greater location control, Paste Aligned offers options to make the process simple and efficient. These options allow you to quickly duplicate elements from one view or one level to another while maintaining a consistent location in the x-coordinate and y-coordinate planes. After selecting elements and copying them to the Clipboard, find the Paste button in the Clipboard panel, as shown in Figure 3.28.

FIGURE 3.28
Paste Aligned options



Five options, in addition to the Paste from Clipboard option, are available when you click the Paste drop-down button. Depending on the view from which you copy and what kinds of elements you copy, the availability of these options will change. For example, if you select a model element in a plan view, you will not have the Aligned To Selected Views option. These options are as follows:

Aligned To Selected Levels This is a mode you can use to quickly paste copied elements to many different levels simultaneously. When you select this option, you choose levels from a

list in a dialog box. This is useful when you have a multistory building design; you want to copy a furniture layout that repeats on many floors and selecting level graphics in a section or elevation would be too tedious.

Aligned To Selected Views If you want to copy view-specific elements, such as drafting lines, text, or dimensions, this option allows you to paste them by selecting views from a list of views in a dialog box. In the list available for selection, you do not see levels listed but rather see a list of parallel views. For example, if elements are copied from a plan view, all other plan views are listed. Likewise, if you copy from an elevation view, only elevation views are listed.

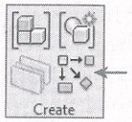
Aligned To Current View This option pastes the elements from the Clipboard into the active view in the same spatial location. For example, if you copy a series of walls in one view, switch to another view in the Project Browser, and paste with the Aligned To Current View option, the software pastes the walls to the same x-coordinate and y-coordinate locations in the view you switched to.

Aligned To Same Place This option places elements from the Clipboard in the exact place from which they were copied or cut. One use for this tool is copying elements into a design option; see Chapter 11, "Working with Phasing, Groups, and Design Options," for an explanation of design options.

Aligned To Picked Level This is a mode you can use to copy and paste elements between different floors by picking a level in a section or elevation. Although you can cut or copy elements from a plan view, you must be in an elevation or section to paste using this option. You might use this paste option to copy balconies on a facade from one floor to another.

Using the Create Similar Tool

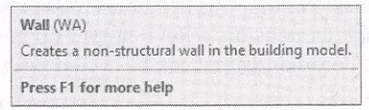
Rather than hunting through a list of families or making copies you'd have to edit later, try using the Create Similar tool to add new instances of a selected element to your model.



This tool is available in the Create panel of the Modify tab of the ribbon when an object is selected or from the context menu. To use this method, select an existing instance of the same type of element you'd like to create, click the Create Similar tool, and you will immediately be in a placement or creation mode according to the type of element. For example, if you use Create Similar with a floor selected, you're taken directly into Sketch mode, where you can start sketching the boundary for a new floor.

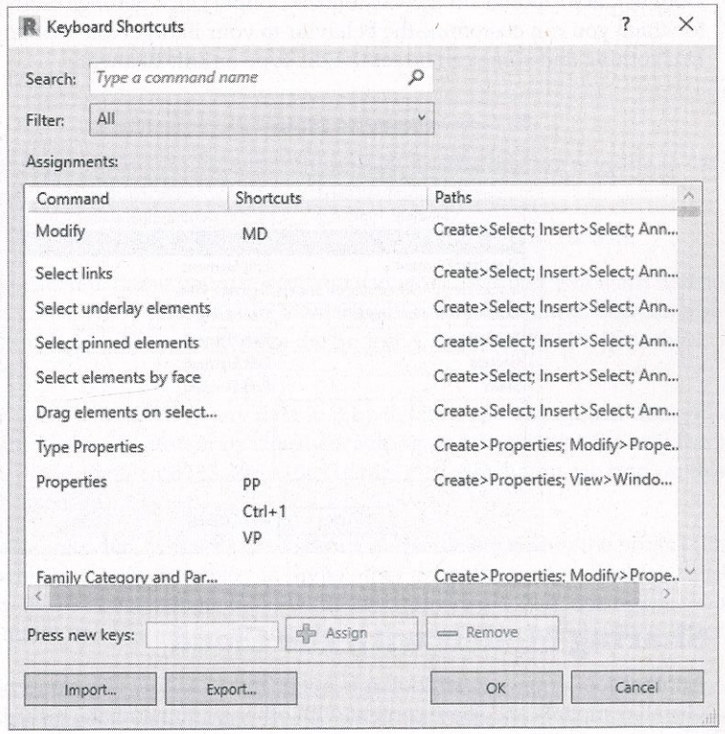
Using Keyboard Shortcuts (Accelerators)

To increase your productivity even further, you may like to use keyboard shortcuts to speed up common commands and minimize interruptions to your workflow. When you hover your mouse pointer over any tool in the ribbon, the keyboard shortcut is indicated to the right of the tool name, as shown here.



You can customize the keyboard shortcuts assigned to all commands. To access this tool, go to the View tab in the ribbon, find the Windows panel, and select User Interface ➤ Keyboard Shortcuts. When the Keyboard Shortcuts dialog box appears (Figure 3.29), you can search for commands in the Search box.

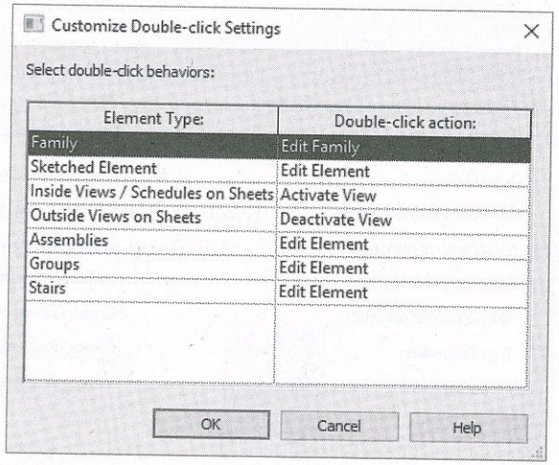
FIGURE 3.29 Customize keyboard shortcuts for commonly used Revit commands.



Once you find a command to which you'd like to assign a shortcut, select it and type the shortcut in the Press New Keys box. Click the Assign button, and you will see the new shortcut added to the selected command. Click OK to close the dialog box, and the keyboard shortcuts will be ready for immediate use. If you choose to modify the shortcut, it is recommended to keep commands unique. Though Revit 2020 allows for multiple commands to be associated to an identical keyboard shortcut, a warning message with instructions on how to cycle between multiple commands notifies you that this is the case. As an example, if you use the shortcut AA for both Align and Angular Dimension, a Revit helper tip next to the cursor notifies you that there are other associated commands that can be cycled with the arrow keys.

Double-Clicking to Edit

Revit allows you to double-click families and components to launch the respective editing mode. Although this may be the epitome of editing efficiency, you also have the ability to customize this behavior—even completely disabling it. From the File tab menu, click the Options button. In the Options dialog box, select the User Interface settings, and then click the Customize button next to Double-Click Options. In the Customize Double-Click Settings dialog box, you will see the limits to which you can customize the behavior to your liking. Note that any of the actions can be set to Do Nothing and some can be set to Edit Type or Edit Element.



Sharing Models with the Cloud

Another tool in your Revit toolkit is A360. This is Autodesk's cloud platform that allows you to visualize models and share content with other team members, regardless of whether they are using Revit. A360 is a cloud-based application. You can find the site at `https://A360.autodesk.com`. If you have purchased an Autodesk product, you have an account on A360. The default account comes with 5 GB of storage space as its only limitation. When you visit the site, it will allow you to either log in or set up an account if this is your first time using A360. The default

site works best in Google's Chrome browser and looks like Figure 3.30. There is also a companion Android and iPhone/iPad app you can download.

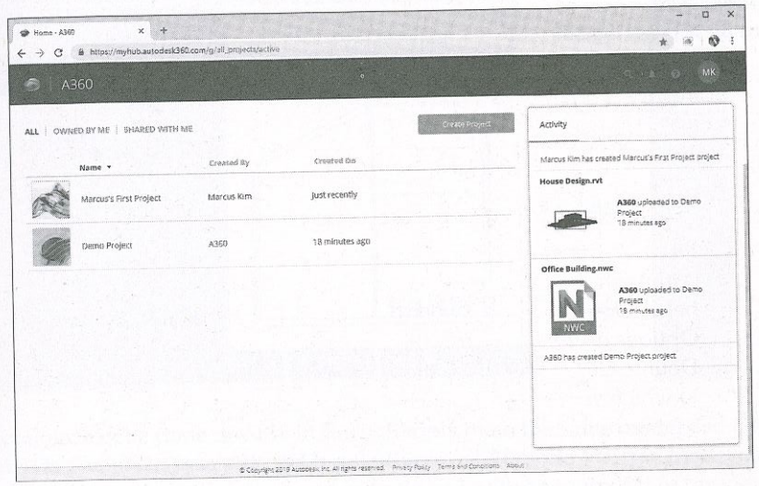


FIGURE 3.30
The default A360 site

For the sake of familiarizing you with the site and its capabilities, we're going to set up a new project and upload a sample model. To do this, follow these steps:

1. Select the Create Project button on the main page after you've signed in.
2. You will be asked to name your project. You can enter anything you want here to define the project name. We're going to use **Mastering Revit Architecture**. You can also upload a customized image to better customize the project. Choose Create Project when you're done.
3. The new project will not have any data in it by default. You can upload data either by choosing the Upload button or by simply dragging and dropping a file into the browser window. Upload the file `c03-Sample-Building.rvt`, which you can find on this book's companion website.

Once your file is uploaded, you will see it shown in the file list within the project (Figure 3.31). On this page as well, you have the ability to invite other people to your project for collaboration and view changes in the activity. Note that the file you uploaded is versioned (this one shows as v1) and subsequent uploads are saved on the site. You can roll back to a previous version at any time.

With the model uploaded, select it from the file list. It will open the default 3D view, and you'll be able to navigate the model, pan, zoom, and select elements to get their properties, and perform many of the same functionalities you have in Revit, but here you will not be able to edit anything. Note that you can use all of these tools without having Revit installed on your computer. Figure 3.32 shows the default 3D view with a wall element selected and its property window activated. You also have the ability to mark up and comment on any aspect of the

model. Using the tools at the bottom of the screen, project team members can leave comments about the design or other aspects of the model.

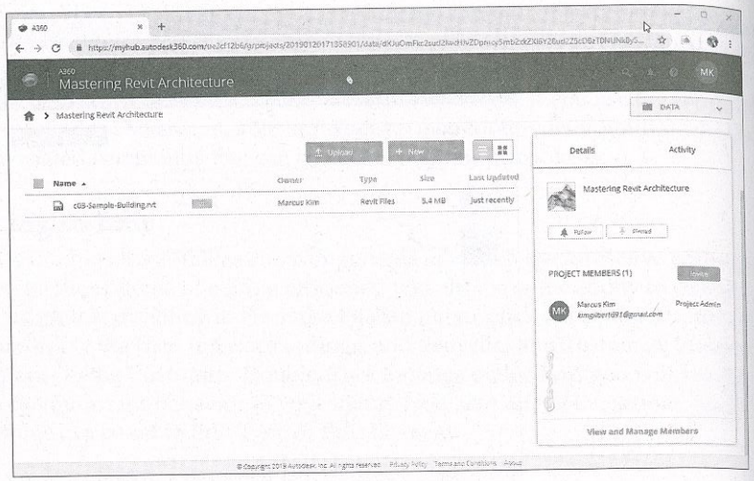


FIGURE 3.31
The project view in A360

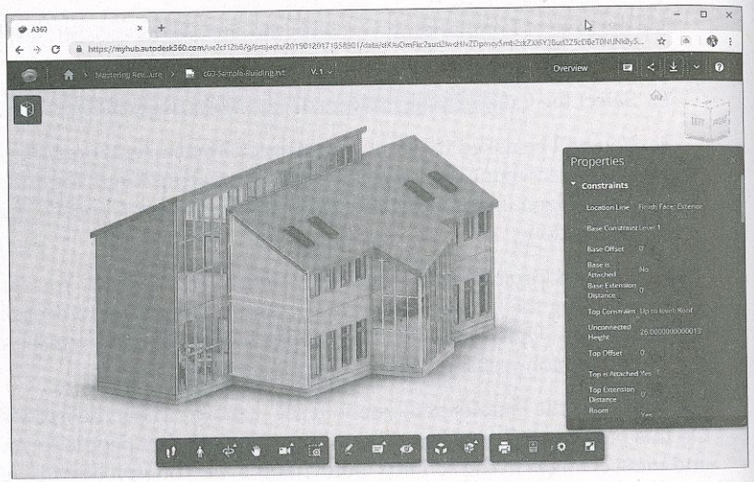


FIGURE 3.32
The A360 default 3D view

As a last tool to explore, select the 3D box icon at the upper-left corner of the site. From this expanded menu, you can select and view any of the views that are already defined in the model. You can open up sheets, 2D views, and 3D perspectives. If it's in the model, you have the option to view it on A360! Figure 3.33 shows the view of the building section. Note that you also have all of the web tools available to zoom, select elements, or create markups.

While the A360 site gives you a lot of versatility, you might want to curate the content for what is viewable (or not viewable) on the site. Depending on who you're sharing the content with, you might only want them to see views that are in a more finished state, or you might want to exclude design options and other "works in progress."

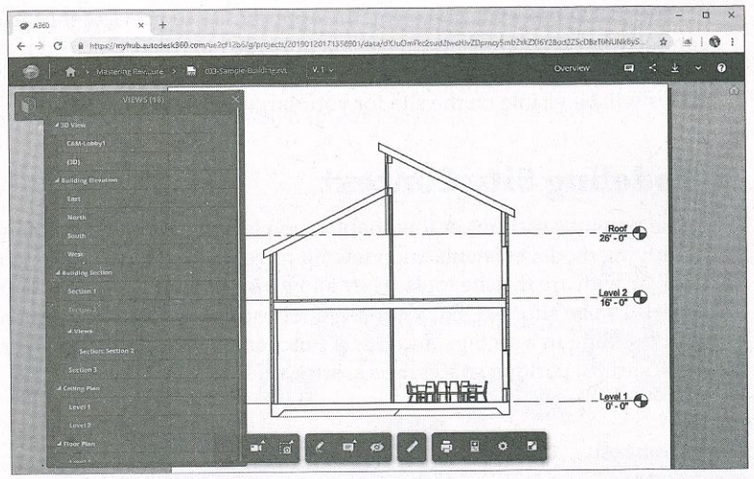


FIGURE 3.33
The view of the building section

Managing the content can be done directly in Revit. Simply open the same model and choose the Collaborate tab. Here you can select the Publish Settings tool from the Manage Models panel. This will open the Publish Settings dialog box and provide you with an entire list of the views and sheets that are currently in the model. Here you can assign Sets to the views for further organization as well as selecting or deselecting the views you want to show in A360 (Figure 3.34).

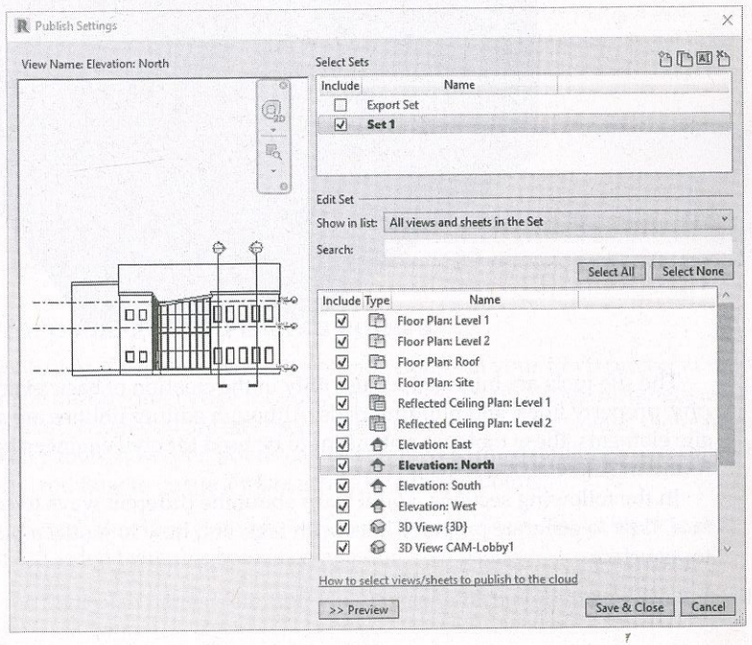


FIGURE 3.34
Managing the A360 content from Revit

The dialog box even gives you the opportunity to preview the view you've selected so you can see what it will look like once it is uploaded to A360. Once your changes are made, choose Save & Close to save your settings. The next time you upload a model to A360, only the selected views will be visible on the site for your larger team.

Modeling Site Context

In the previous sections of this chapter, you learned about the fundamental tools for editing and modifying model elements and viewing project files online. Other tools you should become familiar with are the site tools. They allow you to create a context within which your building models can be situated. For example, a toposurface will create a hatched area when you view your building in a section, and it will function as a hosting surface for site components such as trees, shrubs, parking spaces, accessories, and vehicles (Figure 3.35).

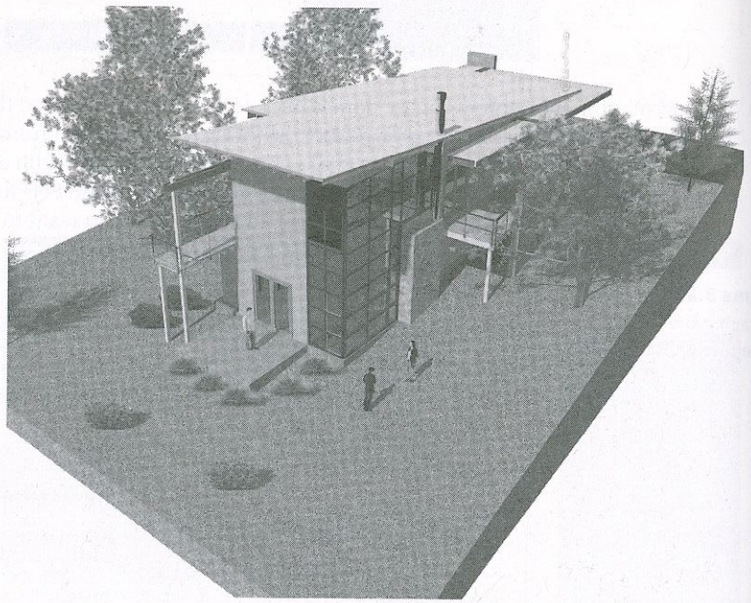


FIGURE 3.35
A toposurface can host components, such as trees, people, vehicles, and other entourage.

The site tools are intended for use only in the creation of basic elements, including topography, property lines, and building pads. Although editing utilities are available to manipulate the site elements, these tools are not meant to be used for civil engineering like the functionality found in AutoCAD® Civil 3D®.

In the following sections, you'll learn about the different ways to create and modify a toposurface, how to generate property lines with tags, and how to model a building pad within a toposurface.

Using a Toposurface

As its name suggests, a toposurface is a surface-based representation of the topography context supporting a project. It is not modeled as a solid; however, a toposurface will appear as if it were solid in a 3D view with a section box enabled (Figure 3.36).

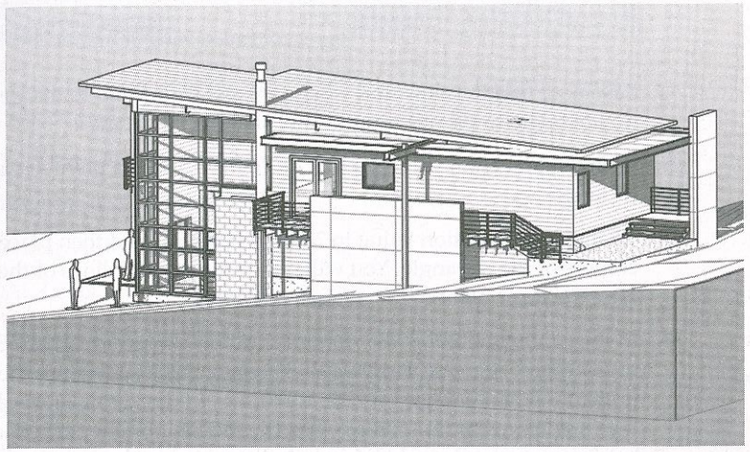


FIGURE 3.36
A toposurface will appear as a solid in a 3D view only if a section box is used.

You can create a toposurface in one of three ways: by placing points at specific elevations, by using a linked CAD file with lines or points at varying elevations, or by using a points file generated by a civil engineering application. We'll examine these techniques in the following exercises.

TURNING ON AND OFF TABS

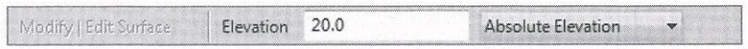
If you don't see the Massing & Site tab, just navigate to the File tab menu and choose Options. From there, select the User Interface category. Here you can turn on and off any of the tabs from the ribbon.

CREATING A TOPOSURFACE BY PLACING POINTS

The simplest way to create a toposurface is by placing points in your Revit project at specific elevations. To create a clean outer edge for your toposurface, draw a large rectangle using detail lines in your site plan. When you are creating a toposurface by placing points, there are no line-based geometry tools; however, points can be snapped to the detail lines. The following exercise will show you how to create a toposurface by placing points:

1. Begin by opening the file `c03-Site-Tools.rvt` or `c03-Site-Tools-Metric.rvt`, which can be downloaded from this book's companion web page.
2. Activate the floor plan named Site, and you will see a rectangle created from detail lines.

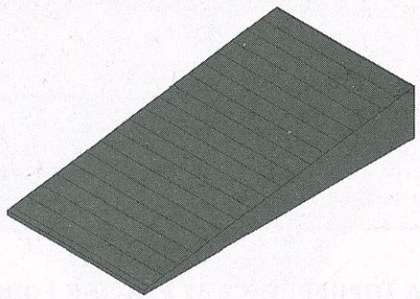
3. Go to the Massing & Site tab, and from the Model Site panel, click Toposurface. Notice in the contextual tab in the ribbon that the default tool is Place Point.
4. Notice the Elevation value in the Options bar. Set the value of the points you are about to place.



Also note that the elevation values are always related to the Revit Project Base Point. They do not relate to the elevation of any shared coordinates.

5. With the Elevation value set to 0′-0″ (0 mm), place a point at each of the left corners of the rectangle.
6. Change the Elevation value to 20′-0″ (6000 mm) and then place a point at each of the right corners of the rectangle. You will notice the contour lines of the surface begin to appear after the third point of the surface is placed.
7. In the contextual tab of the ribbon, click Finish Surface (green check mark) to complete the toposurface. Activate the Default 3D view, and you will see the sloping surface, as shown in Figure 3.37. And keep in mind that this will be a thin surface, not a solid. Notice that the 3D view in this project already has the section box property enabled. To adjust the section box, activate the Reveal Hidden Elements tool in the view control bar.
8. Save the file for use in a subsequent exercise in this chapter.

FIGURE 3.37
A simple toposurface created by placing points



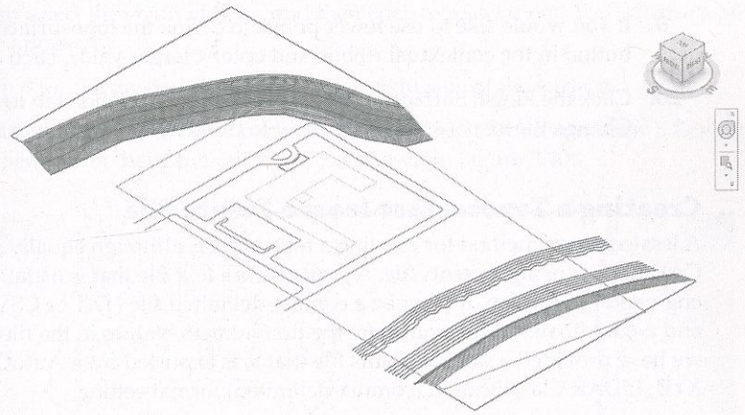
CREATING A TOPOSURFACE FROM IMPORTED CAD DATA

A common workflow you may encounter involves the use of CAD data generated by a civil engineer. In this case, the engineer must create a file with 3D data. Keep in mind that Revit models are in real-world units (feet, inches, meters, and so on), so any content you bring into the model from other sources, like a civil engineer, would also need to be modeled in real-world units. Blocks, circles, or contour polylines must exist in the CAD file at the appropriate elevation to be used in the process of generating a toposurface in Revit.

In the following exercise, you will download a sample DWG file with contour polylines. You must link the file into your Revit project before creating the toposurface:

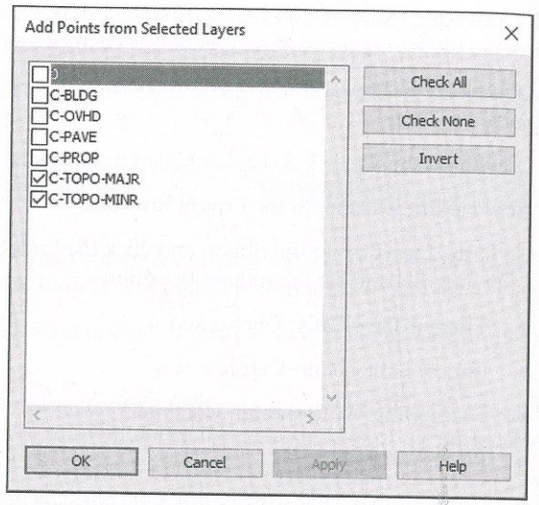
1. Download and open `c03-Site-Link.rvt` or `c03-Site-Link-Metric.rvt` from this book's website.
2. Download the file `c03-Site-Link.dwg` from this book's web page.
3. Activate the Site plan in the Project Browser.
4. Go to the Insert tab in the ribbon and click the Link CAD button. Select the `c03-Site-Link.dwg` file and set the following options:
   - Current View Only: Unchecked
   - Import Units: Auto-Detect
   - Positioning: Auto-Center To Center
   - Place At: Level 1
   - Correct Lines That Are Slightly Off Axis: Unchecked
5. Click Open to complete the insertion of the CAD link. Open a Default 3D view to examine the results (Figure 3.38).

FIGURE 3.38
Linked CAD file as seen in a 3D view



6. From the Massing & Site tab in the ribbon, click the Toposurface button. In the Tools panel of the Modify | Edit Surface tab on the ribbon, select Create From Import and then Select Import Instance.
7. Pick the linked CAD file, and the Add Points From Selected Layers dialog box will appear (Figure 3.39). Click the Check None button and then select the layers C-TOPO-MAJR and C-TOPO-MINR.

FIGURE 3.39
Select only the layers containing 3D contour information.



8. Click OK to close the dialog box. It may take a few seconds to generate the points based on the contour polylines in the linked file, but they will appear as black squares when they have all been placed.
9. If you would like to use fewer points to define the toposurface, click the Simplify Surface button in the contextual ribbon and enter a larger value, such as **1'-0"** (**300** mm).
10. Click the Finish Surface button in the contextual ribbon tab to complete the toposurface. Change the visual style of the view to Consistent Colors to examine your results.

Creating a Toposurface from a Points File

A less-common method for creating a toposurface, although equally effective when using linked CAD data, is using a points file. A *points file* is a text file that is usually generated from a civil engineering program. It must be a comma-delimited file (TXT or CSV format) in which the x-, y-, and z-coordinates of the points are the first numeric values in the file. In the following exercise, we have provided a sample points file that was exported from AutoCAD Civil 3D using the XYZ_LIDAR Classification (comma-delimited) format setting:

1. Open the file `c03-Site-Points-Start.rvt`, which can be downloaded from this book's web page.
2. Download the file `c03-Points.csv` from this book's web page to your local computer.
3. Activate the Site plan in the Project Browser.
4. From the Massing & Site tab on the ribbon, click the Toposurface button. In the Tools panel of the Modify | Edit Surface tab, select Create From Import and then choose Specify Points File.
5. Navigate to the `c03-Points.csv` file and click Open. Note that if you were using a TXT format file, you would change the Files Of Type option to Comma Delimited Text.

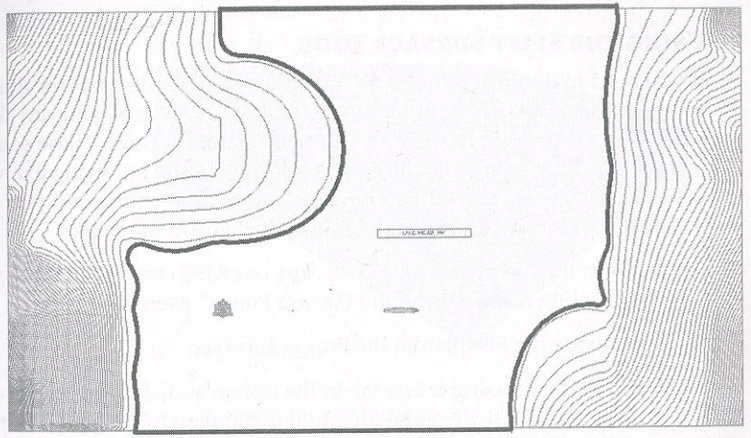
6. In the Format dialog box, select Decimal Feet. It is important to understand the units of the values in the points file to ensure that the toposurface will be created at the correct scale. Click OK to close the dialog box.
7. Click the Finish Surface button in the contextual ribbon to complete the toposurface. Open the Default 3D view to examine your results. You may have to use the Zoom to Fit command to see the extent of the new toposurface.

Modifying the Surface with Subregion

The points file example in the previous exercise represents a section of terrain across Lake Mead, Nevada. If you wanted to define an area of the toposurface with a different material but not change the geometry of the overall surface, you would use the Subregion tool. In the following exercise, you will use this tool to create a region that will represent the water of the lake:

1. Download and open the file `c03-Site-Lake.rvt` from this book's website and then activate the Site plan from the Project Browser. In this view, there are dashed detail lines that represent the edge of the water.
2. Go to the Massing & Site tab in the ribbon and click the Subregion tool.
3. Switch to Pick Lines mode in the Draw panel of the contextual ribbon.
4. Hover your mouse pointer over one of the dashed detail lines on the left side of the surface, Tab-select the chain of lines, and then click to select them. You will see a purple sketch line appear.
5. Repeat step 4 for the dashed detail lines at the right side of the surface.
6. Switch to Line mode in the Draw panel of the contextual ribbon and draw a line connecting each open end of the water edge lines, as shown in Figure 3.40.

FIGURE 3.40
The sketch boundary for a subregion must be a closed loop but can overlap the edge of the toposurface.

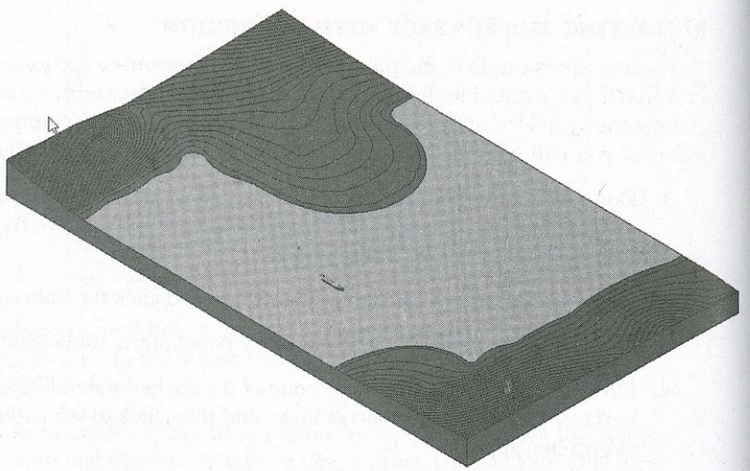


7. Click Finish Edit Mode in the contextual ribbon to complete the subregion.
8. Activate the Default 3D view and select the subregion you created in the previous steps.

9. In the Properties palette, select the Material parameter, and click the ellipsis button to open the Material Browser dialog box. Locate and select the material named Site - Wat Note that you can easily find this material by typing **Water** in the search field at the top the dialog box.

10. Click OK to close the Material Browser dialog box; you will see the results in the 3D vie as shown in Figure 3.41.

FIGURE 3.41
The subregion is assigned a different material for visualization purposes.



When you use the Subregion tool, the geometry of the original surface remains unchanged. you no longer need the subregion, you can select it and delete it. Be aware that topographic surfaces cannot display surface patterns assigned to materials.

USING THE SPLIT SURFACE TOOL

If you need to divide a topographic surface into separate parts for the purpose of editing the geometry, you can use the Split Surface tool. With this tool, you can sketch a single line along which the surface will be divided into two editable entities. These separate entities can be recombined later using the Merge Surfaces tool. In the following exercise, you will split a topographic surface and edit some of the points. Remember that you can also use Split Surface to delete a portion of a topographic surface. Here are the steps:

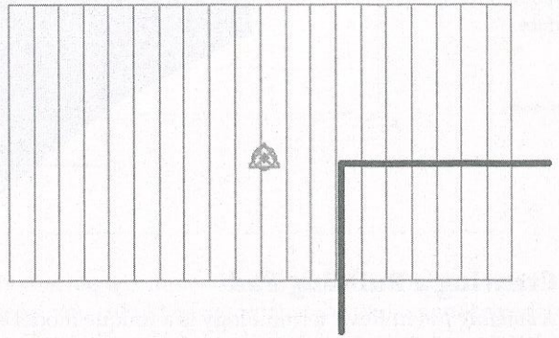
1. Open the file `c03-Site-Tools.rvt` or `c03-Site-Tools-Metric.rvt` you saved in the "Creating a Toposurface by Placing Points" exercise.

2. Activate the Site plan in the Project Browser.

3. Go to the Massing & Site tab in the ribbon and click the Split Surface tool. Remember that you should use the Subregion tool if you plan to assign a different material only to the split region of the original surface.

4. Select the topographic surface, and you will enter Sketch mode. Using the Line mode in the Draw panel of the contextual ribbon, draw two lines that overlap the edges of the surface, as shown in Figure 3.42.

FIGURE 3.42
Sketch lines that overlap the edge of the topographic surface.



5. Click Finish Edit Mode in the ribbon, and you will see the split surface highlighted in blue.

6. Activate the Default 3D view from the Quick Access toolbar or from the View tab.

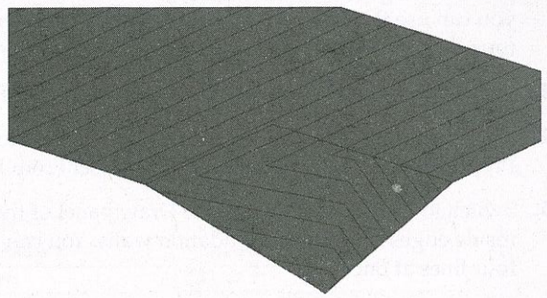
7. Turn off the Section Box option in the Properties palette.

8. Select the split surface, and click the Edit Surface tool in the Modify | Topography tab of the ribbon.

9. Select the point at the outer corner of the topographic surface, and change the Elevation value in the Options bar from 20′-0″ (6000 mm) to **10′-0″** (**3000** mm).

10. Click the green check (Finish Edit Mode) in the contextual ribbon, and you will see the result shown in Figure 3.43.

FIGURE 3.43
A split region after editing the elevation of a corner point



11. To illustrate the difference between a split surface and other topographic surface edits, select the main surface and click Edit Surface in the contextual ribbon. Select the point at the upper corner opposite from the split region and change the Elevation value to **10′-0″** (**3000** mm). Notice how the topology of the smaller split surface remains the same but the larger surface area's grading changes to conform to the new Elevation value (Figure 3.44).

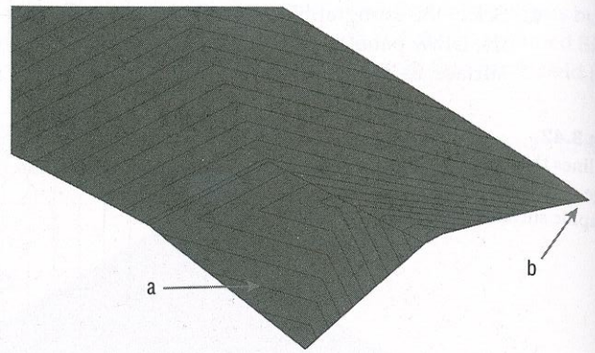


FIGURE 3.44
Compare the difference between (a) an edited split region and an (b) edited point directly on the surface.

Creating a Building Pad

A *building pad* in Revit terminology is a unique model element that resembles a floor with a grade underneath it. It can have a thickness and compound structure, it is associated with a level, and it can be sloped using slope arrows while you're sketching its boundary. The building pad is different from a floor because it will automatically cut through a toposurface, defining the outline for your building's lowest level or basement.

The process of creating a building pad is virtually identical to that of creating a floor. Let's run through a quick exercise to create a building pad in a sample project:

1. Open the file `c03-Site-Pad.rvt`, which can be downloaded from this book's web page.
2. Activate the floor plan named Site in the Project Browser. You will see an existing topographic surface and property line. Notice that reference planes were created to demarcate the required zoning setbacks from the property line. Foundation walls have been created within these reference planes.

   Note that you don't have to create a property line and walls before creating a building pad. You might create a building pad before any other building elements. Just realize that you can use the Pick Walls mode to associate the boundary of the building pad with the foundation walls.
3. Activate the Basement floor plan from the Project Browser.
4. Go to the Massing & Site tab in the ribbon, and click the Building Pad button. In the Properties palette, change the Height Offset From Level value to **0**.
5. Switch to Pick Walls mode in the Draw panel of the contextual ribbon and then pick the inside edges of the four foundation walls. You can use the Tab-select method to place all four lines at once.
6. Click the Finish Edit Mode button in the contextual ribbon to complete the sketch and then double-click the section head in the plan view to examine your results. Notice that the top of the building pad is at the Basement level, and the poché of the topographic surface has been removed in the space of the basement (Figure 3.45).

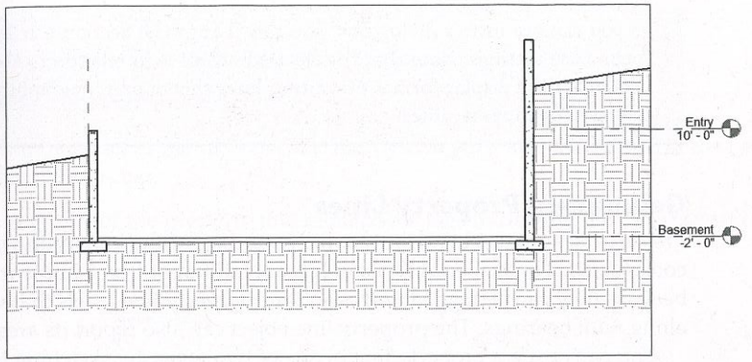
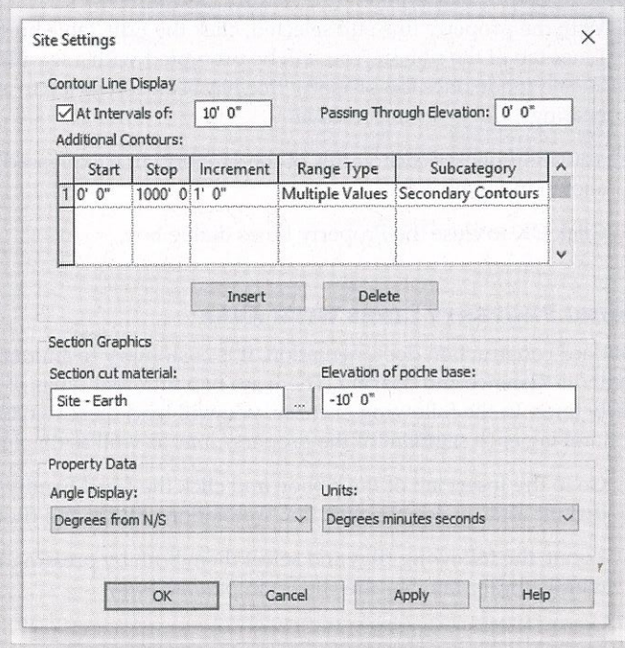


FIGURE 3.45
This section view illustrates how the building pad adjusts the extents of the topographic surface.

If you are working on a project that has a complex site condition that might require several building pads at different elevations, you should be aware that the pads cannot overlap; however, they can share common boundary edges. To help avoid this situation before you get too involved in modeling any of the pads in your project, try using detail lines in your site plan to lay out the pad design first.

ADJUSTING THE SECTION POCHÉ FOR TOPOGRAPHIC SURFACES

If you would like to customize the settings for the fill pattern and depth of the poché, click the dialog launcher at the bottom of the Model Site panel in the Massing & Site tab of the ribbon. This will open the Site Settings dialog box, shown here.



As you can see in this dialog box, you can change the Section Cut Material and the Elevation Of Poche Base settings. Note that the elevation value is in relation to the Project Base Point. You can also adjust the display format of contour lines shown on topographic surfaces, as well as the units displayed by property lines.

Generating Property Lines

Property lines are used to delineate the boundary of the lot within which your building will be constructed. These special types of lines are different from simple model lines or detail lines because they can be tagged with standard property line labels that will display segment lengths along with bearings. The property line object can also report its area in a special tag.

You can create a property line in one of two ways: by sketching lines or by entering distances and bearings in a table. In the following exercise, you will create a simple property line by sketching and converting the sketched property line into a table of distances and bearings for comparison:

1. Open `c03-Site-Prop-Lines.rvt` or `c03-Site-Prop-Lines-Metric.rvt`, which you can download from this book's companion web page. Activate the Site plan view in the Project Browser.
2. Go to the Massing & Site tab and click the Property Line button. When prompted by the Create Property Line dialog box, choose Create By Sketching.
3. Switch to the Rectangle tool in the Draw panel of the contextual ribbon and draw a rectangle measuring 120′ × 70′ (36 m × 21 m).
4. Click the Finish Edit Mode button in the contextual ribbon to complete the sketch.
5. With the property line still selected, click the Edit Table button in the Modify | Property Lines tab of the ribbon. You will be prompted with a warning that you cannot return to Sketch mode once the property line has been converted to a table of distances and bearings. Click Yes to continue.

   You will now see each vertex of the property line expressed as a distance and a bearing, as shown in Figure 3.46.
6. Click OK to close the Property Lines dialog box.

Tagging Property Lines with Area

In standard construction documentation, it is customary to annotate each vertex of a property line with its distance and bearing. There are two different types of tags you can use to annotate property lines. In the following exercise, you will load these two types from the Revit default library and tag each segment of the property line, as well as display the area contained within it:

1. Go to the Insert tab of the ribbon and click the Load Family button. Navigate to the Revit default library; double-click the Annotations folder and then the Civil folder.
2. Locate the following files and select them both by pressing the Ctrl key (the equivalent metric library families are shown in parentheses):

- `Property Line Tag.rfa` (`M_Property Line Tag.rfa`)
- `Property Tag - SF.rfa` (`M_Property Tag.rfa`)

3. Click Open to load both families.
4. Go to the Annotate tab of the ribbon, click Tag By Category, and then deselect the Leader option in the Options bar.
5. Click each segment of the property line to place the tags indicating the distance and bearing, as shown in Figure 3.47.

FIGURE 3.46
A property line can be defined in a table of distances and bearings.

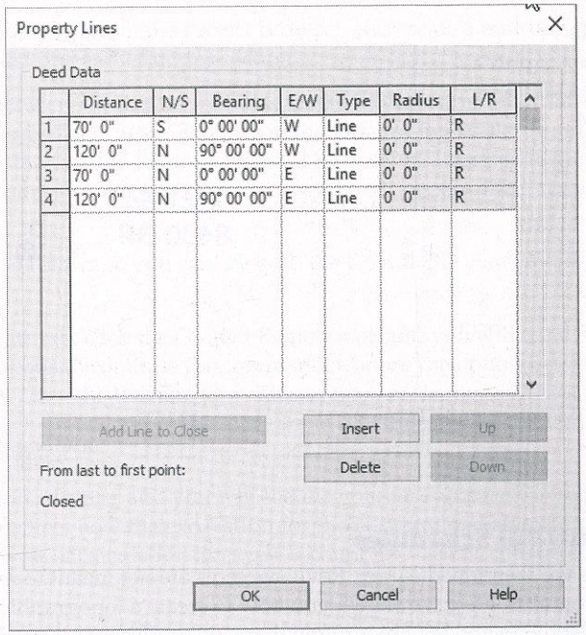
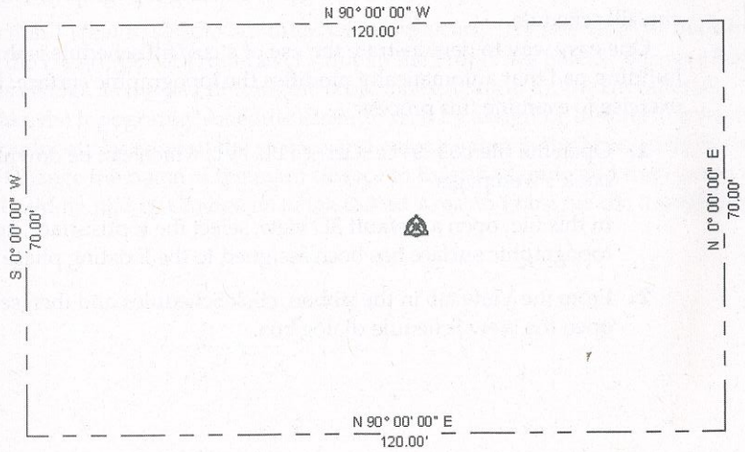


FIGURE 3.47
Tags are applied to display the distance and bearing of each segment of the property line.



Now that you have tagged the individual vertices of the property line, it is time to display the area within the property line. This process is not the same as applying an area tag because an area object doesn't exist for the property line. Instead, the annotation family `Property Tag - SF.rfa` (`M_Property Tag.rfa`) is designed to apply to the property lines when all its segments are selected.

You can try this with the property line you created earlier. Go back to the Annotate tab in the ribbon and click Tag By Category. Instead of picking a single vertex of the property line, hover your mouse pointer over one segment and use Tab-select to highlight the entire chain of property line segments. Click to place the property area tag. Click the question mark above the area to change the name of the property line, as shown in Figure 3.48.

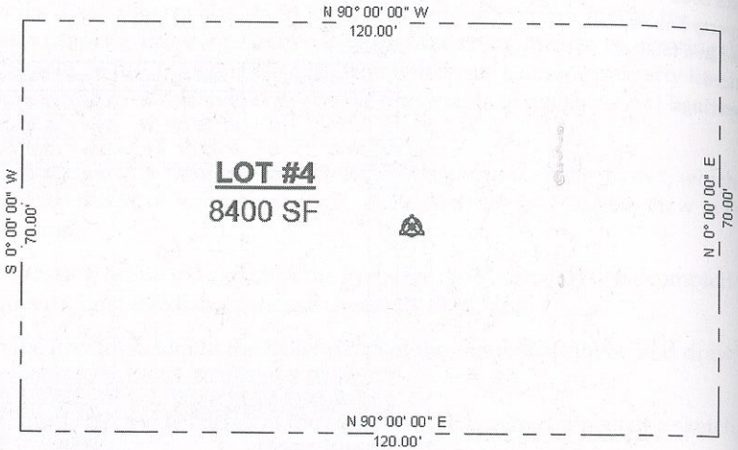


FIGURE 3.48
Use Tab-select to place a property area tag for all segments.

Cut/Fill Schedules

As we mentioned earlier, Revit site tools are not meant to replace civil engineering software programs. We have shown you how to create a topographical surface in a variety of ways as well as some methods of modifying these objects. There is also a way to quickly quantify how much earth is displaced by proposed changes to existing topography. This is commonly referred to as a cut/fill schedule.

One easy way to demonstrate the use of a cut/fill schedule is through the creation of a building pad that automatically modifies the topographic surface. Let's go through a quick exercise to examine this process:

1. Open the file `c03-Site-Cut-Fill.rvt`, which can be downloaded from this book's web page.

   In this file, open a Default 3D view, select the toposurface, and you will notice that the topographic surface has been assigned to the Existing phase in the Properties palette.

2. From the View tab in the ribbon, click Schedules and then select Schedule/Quantities to open the New Schedule dialog box.

3. From the Category list, choose Topography, set Phase to New Construction, and then click OK.

4. In the Fields tab of the Schedule Properties dialog box, choose Name, Projected Area, Net Cut/Fill, Phase Created, and Phase Demolished, clicking Add after each one. Click OK to close the dialog box.

5. While you are still in the working view of the schedule, go to the Properties palette and set the Phase Filter value of the schedule to Show Previous + New. This will allow only the modified toposurfaces affected by the Graded Region command to appear in the schedule. The complete existing topography will not be listed in the schedule.

6. Activate the Basement plan from the Project Browser, and create a building pad in the same way you created one earlier in this section.

   After you complete the creation of the building pad and the topographic surface is modified, notice that the Net Cut/Fill values in the topography schedule still have a value of 0. This is because the Graded Region tool must be used on a surface to generate the differences required to calculate what volume must be cut versus filled in the proposed design.

7. Tile the open Revit windows so you can see both the Default 3D view and the topography schedule.

8. On the Massing & Site tab, click the Graded Region tool, and you will see a dialog box appear with two options to continue the command. Choose the option Create A New Toposurface Exactly Like The Existing One. This option creates overlapping existing and proposed surfaces, which will allow the software to schedule the differences between the two as cut or fill volumes.

9. Select the existing toposurface, and you will see the volume values in the topography schedule update to reflect how the excavation for the building pad affected the overall soil. Note that this type of calculation does not account for various construction methods, such as backfilling.

10. Click the Finish Surface icon in the contextual tab of the ribbon to complete the Graded Region command.

Activate the Section 1 view to see the building pad more clearly. Try selecting the building pad and changing the Height Offset From Level value in the Properties palette. Observe how the Net Cut/Fill values change as the pad defines the scope of excavation for the foundation.

You can also make the topography schedule easier to read by assigning descriptive information to each topographic surface. Select the surface and enter a value in the Name field in the Properties palette. Change the name of the main surface to **Existing Grade** and then locate the surface where the building pad is. Change its name to **Pad Area** and observe the topography schedule once again.

SELECTING TOPOSURFACES WITH THE FILTER COMMAND

If you have trouble selecting the toposurfaces, you can select the objects in the drawing window with a crossing window and use the Filter command to select each toposurface.

If you would like to explore the completed project file for this exercise, you can download `c03-Site-Cut-Fill-FINISHED.rvt` from this book's companion web page.

The Bottom Line

Select, modify, and replace elements. Many fundamental interactions are supported by Revit to select just what you need and to modify elements efficiently.

Master It How can you quickly select only the door tags in a plan view and switch them to another type?

Edit elements interactively. The editing tools in Revit are similar to those found in other CAD and BIM software programs. Tools such as Move, Copy, and Trim are available on the Modify tab of the ribbon.

Master It How do you create a parametric repetition of an element?

Use other editing tools. Beyond the basic editing tools are more advanced commands to help you consistently and intelligently populate a building model with content.

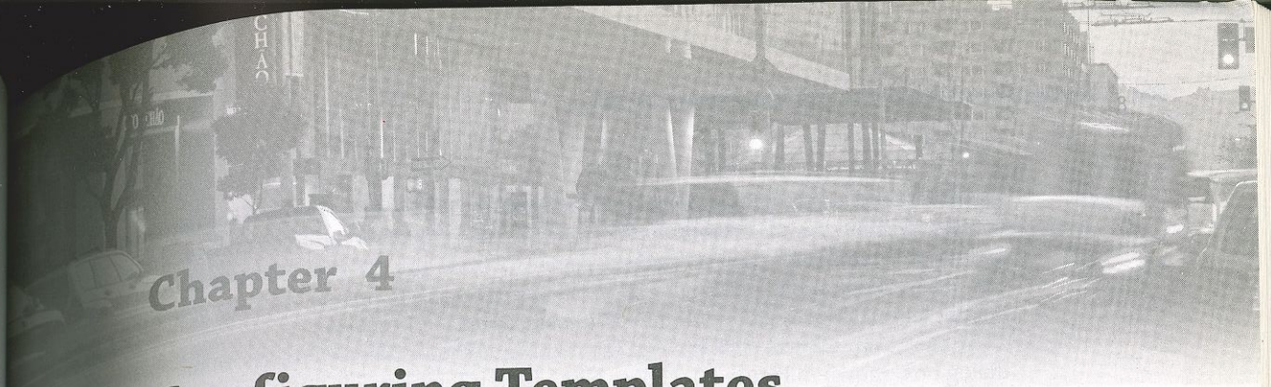
Master It How do you copy model elements in the same location for a multi-story building?

Explore A360 features for collaboration. While Revit has a great interface for creating and editing project content, there are times when you will want to share the model with clients or consultants who don't have Revit.

Master It Describe the functionalities and limitations of loading your project model up to `https://A360.autodesk.com`.

Create site context for your project. The site tools allow you to create context for your building models, including topographic surfaces, graded regions, and property lines.

Master It Describe the different methods used to create a topographic surface.



Chapter 4

Configuring Templates and Standards

In this chapter, we discuss how to configure and manage standards through the development and use of a project template. Such templates can be rich with information that goes beyond the out-of-the-box content that Autodesk provides. We will present proven methods for establishing template settings and content, as well as explain how the reuse of work will increase productivity with each successive project.

IN THIS CHAPTER, YOU WILL LEARN TO

- Define settings for graphic quality and consistency
- Organize views for maximum efficiency
- Create custom annotation families
- Start a project with a custom template
- Develop a template management strategy

Introducing Project Templates

Like many other applications, the Autodesk® Revit® application allows you to start with a basic template and then evolve your own custom templates to suit specific needs. As your knowledge of the software progresses, you will begin to create new and reusable content such as wall types, roof types, ceilings, stairs, tags, and other families to meet your design and documentation needs. This is also the case with the graphical language that you or your firm has established and needs to implement within Revit; for instance, how you graphically present elements such as text, dimensions, annotations, keynotes, and hatch patterns to define your graphic style of design documentation. In reality, the architectural profession tends to develop stylized graphics to convey design intent, and Revit respects this by enabling the customization of almost all aspects of the project template.

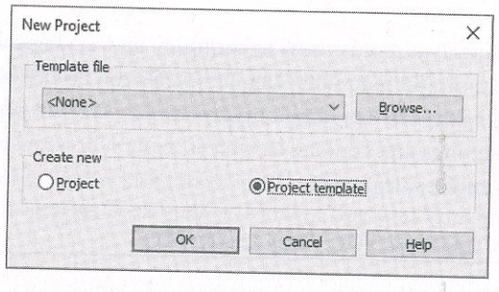
You can configure project templates by one or more of the following methods:

- Predefining all project graphic and annotation requirements
- Preloading the model with annotation families and styles
- Defining standard system families

We will explain these methods in greater detail throughout this chapter. For now, know that you can save the completed settings as a new project template (with the filename extension .rte) and use this template whenever you start a new project. You can create templates by using a completely blank project, by saving an existing project as a template, or by using one of the default templates provided with the Revit installation.

To start from scratch, click the File Tab menu and choose New ➤ Projects. In the New Project dialog box, shown in Figure 4.1, choose None for the Template File option, and choose Project Template for the Create New option. Once you click OK, you will be asked to choose a default unit of measurement—imperial or metric. This dialog box also appears when you press Ctrl+N or go to the Home page and choose New under the Models section.

FIGURE 4.1
Starting a new project template from scratch



Starting a new project template without a base template requires you to develop *all* common content such as levels, grids, sections, callouts, tags, and model elements. Before you start loading all new graphic content, do a review comparing your requirements to the default symbology. Determine whether you can use or modify existing families before you begin creating new ones to load into your new template. If you have only custom graphics and system families, this approach would be appropriate; however, if much of your graphic style is similar to the defaults, we suggest you start with one of the default templates and edit it as necessary. This is also a much faster approach to get you up and running. You can find these templates by clicking Browse in the Template File area of the New Project dialog box. By default, the template files are installed in the root folder of the templates directory: `C:\ProgramData\Autodesk\RVT 2020\Templates`.

Customizing Project Settings for Graphic Quality

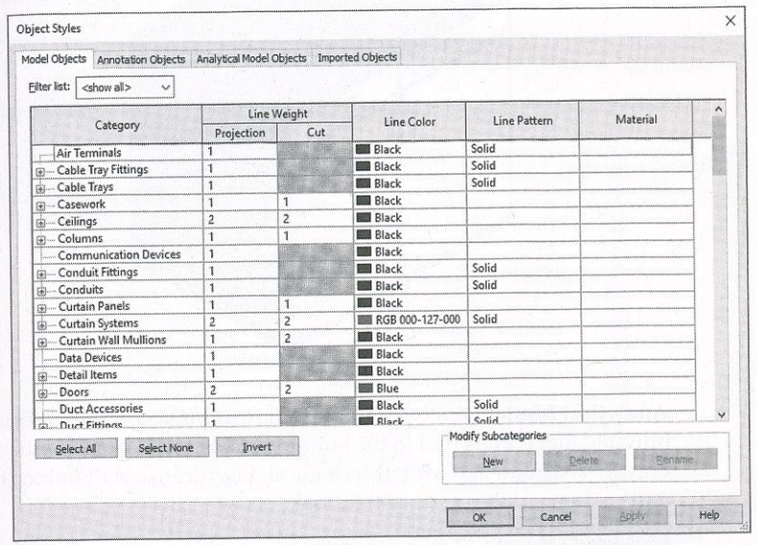
One of the most common complaints from teams implementing Revit software on their first projects is poor graphic quality of printed documents. When you first install the software, only some default settings are defined to approximate a standard graphic appearance of architectural drawings. For example, the lines for walls cut in sections are thicker than those shown in projected views, and callout boundaries are dashed; however, almost all annotation categories are set to a line weight of 1. Fortunately, you can easily overcome these problems with some basic configuration.

Discovering Object Styles

The primary means of controlling graphic consistency throughout a project is through *object styles*. To access these settings, select the Manage tab and choose Object Styles from the Settings

panel. As shown in Figure 4.2, the dialog box is divided into four tabs: Model Objects, Annotation Objects, Analytical Model Objects, and Imported Objects. Settings for Line Weight, Line Color, Line Pattern, and Material are established for each category.

FIGURE 4.2
The Object Styles dialog box gives you graphic control of all Revit categories and their subcategories.



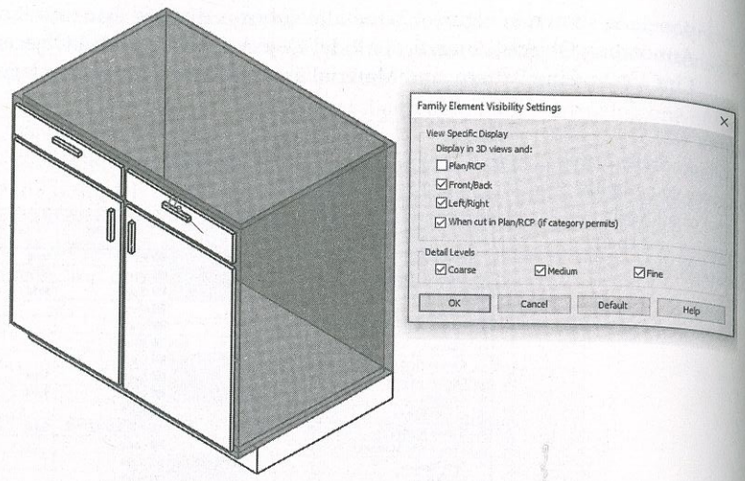
Model Objects The Category column on the Model Objects tab lists all available categories and subcategories of model elements. It is important to note that the subcategories for model and annotation objects are created in families, which are loaded into the project or template. This will be discussed in greater detail in Chapter 15, "Designing with the Family Editor."

The next two columns, under Line Weight, define the line weight used when the elements are displayed in projection or cut view. You use a projection view when you are looking at the object from a distance; you use a cut view when your view plane is intersecting the element as in a section. In some categories, the Cut setting is unavailable; these element categories will never be cut in plan or section views, regardless of the location of the view's cut plane. For categories that enable cut display, you can set element geometry in the Family Editor to follow that rule or not, as shown in Figure 4.3.

Line Color and Line Pattern allow you to customize the display properties of each category and subcategory, but remember that printing a Revit view is WYSIWYG (what you see is what you get)—colors will print as colors unless you override them to print as grayscale or black in the Print Setup dialog box. The last column, Material, allows you to define a default material to be associated with the category or subcategory in case family components in that category don't have materials explicitly defined. If a family has materials set to By Category, it references the material defined in the corresponding object style within the project environment.

Annotation Objects The Annotation Objects tab is similar to the Model Objects tab except there are no material definitions. There is also only one column for line weight (Projection) because lines do not have three-dimensional properties like model objects and cannot be "cut."

FIGURE 4.3
Customizing the cut display of geometry in a family



Analytical Model Objects This tab allows you to color the various physical conditions in the building that correspond to the building's structural components. Analytical settings apply only to structural and MEP (Mechanical, Electrical, and Plumbing) analysis tools within Revit and are beyond the scope of this book.

Imported Objects You can control the graphic appearance of layers (DWG) and levels (DGN) within linked or imported CAD files throughout the project on the Imported Objects tab of the Object Styles dialog box; however, we will cover this in greater detail in Chapter 7, "Interoperability: Working Multiplatform."

ASSIGNING LINE WEIGHT 1

You may want to avoid assigning a line weight of 1 to objects because this is the weight used by most fill patterns. Reserving its use will help object profiles stand out compared to their patterns.

Using Line Settings

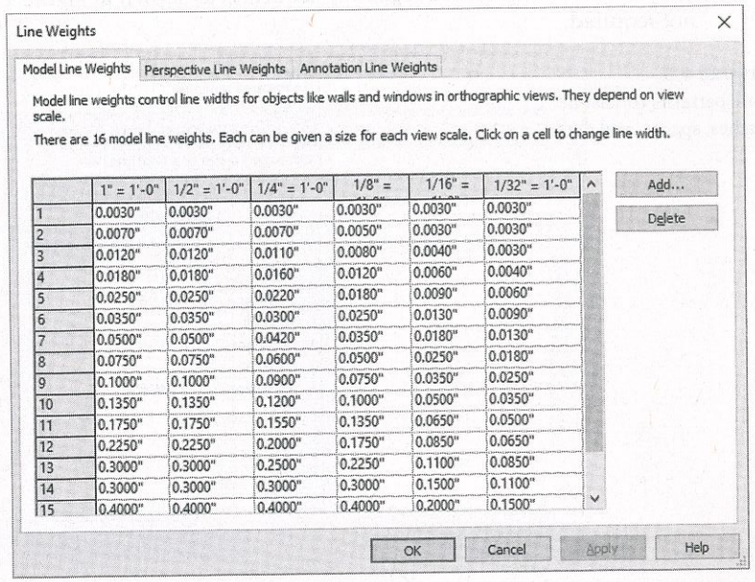
You can use lines in a variety of ways. Some lines relate to obvious tools, such as detail lines and model lines, whereas you can place others with filled regions and by using the Linework tool. Lines also relate to the graphic representation of model and annotation elements, as previously discussed. Achieving the desired graphic quality requires a review of line weights, patterns, and styles.

SETTING LINE WEIGHTS

To open the line weight settings, click the Manage tab and choose Additional Settings ➤ Line Weights. The dialog box shown in Figure 4.4 manages the printed line weights relative to a numbered assignment from 1 to 16. For model objects, heavier line weights vary between view scales. If you require more granular control between scales, click the Add button to insert another scale value column and edit the line weights as required. In the Perspective Line Weights and Annotation Line

Weights tabs there is only one column to specify line weights. This is because annotation is always displayed at 1:1 scale and perspective views are not defined at any measurable scale.

FIGURE 4.4
Model line weights vary depending on the view scale.

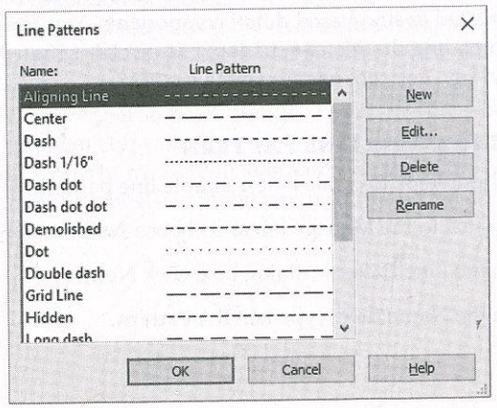


We recommend that you first customize the graphic appearance of model and annotation elements with object styles before trying to manipulate any of the information in the Line Weights dialog box. You should attempt to refine the line weight settings only with a rigorous investigation of printed views in multiple scales, because changes in one area can have an impact on several others.

SETTING LINE PATTERNS

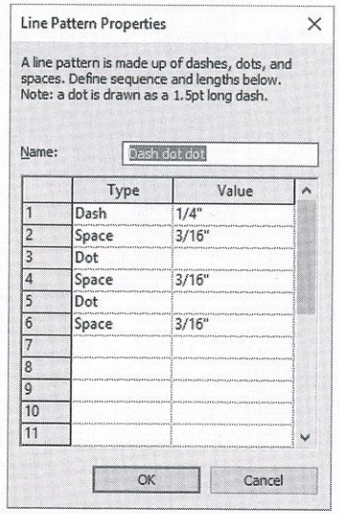
Line patterns are created from a repetitive series of dashes, spaces, and dots. To edit or create line patterns, switch to the Manage tab and choose Additional Settings ➤ Line Patterns. The Line Patterns dialog box, shown in Figure 4.5, displays a list of existing line patterns in the project.

FIGURE 4.5
This dialog box displays all line patterns in the project.



To edit an existing pattern, select a pattern from the list and then click the Edit button. Click New to create your own patterns. You create and edit patterns by specifying dash and space lengths, which will form a repeating sequence, as shown in Figure 4.6. For dots, a length value is not required.

FIGURE 4.6
Line patterns consist of dashes, spaces, and dots.



Using Caution When Deleting Line Patterns

Before deleting a line pattern, you must verify that it hasn't been used anywhere in your project, because Revit does not have any method for purging unused line patterns. You can do so only by manually checking Object Styles, Line Styles, and Visibility/Graphic Overrides. If you fail to do so, all line styles using the deleted pattern will be assigned as Solid.

Frequently, a line pattern is required to include a symbol or text for elements such as fence lines, piping, or underground utilities. In Autodesk® AutoCAD® software, shape definitions can be used within linetype definitions to achieve the desired results. In Revit, these special lines can be created as line-based detail components. You can find samples of this type of custom line by downloading the file `c04-Lines.rvt` or `c04-Lines-Metric.rvt` from this book's web page at `www.wiley.com/go/masteringrevit2020`.

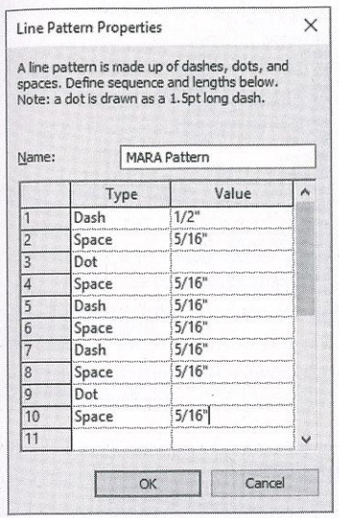
Creating a New Line Pattern

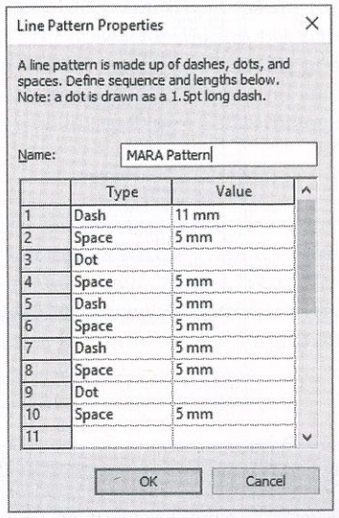
Follow these steps to create a new simple line pattern:

1. Switch to the Manage tab and choose Additional Settings ➤ Line Patterns.
2. In the Line Patterns dialog box, click New.
3. In the Name field, type **MARA Pattern**.

4. Define the sequence, as shown in the following image.

   Any dash or dot must be followed by a space, and all dashes and spaces must have a defined length.





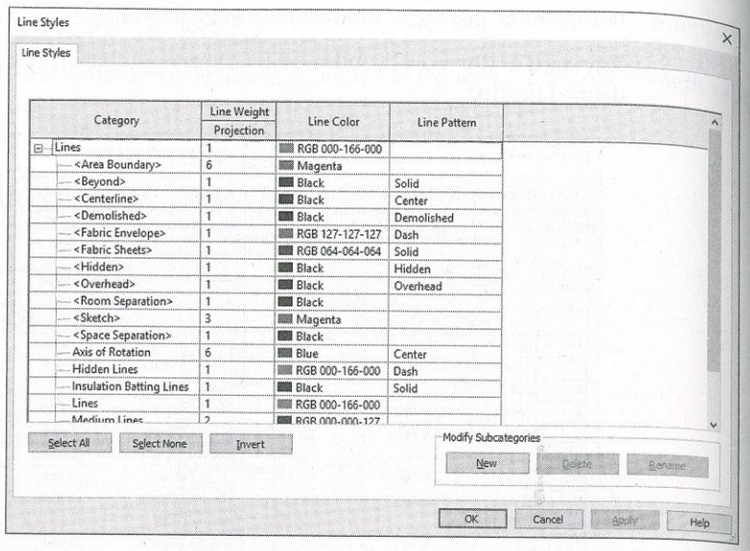
5. Confirm by clicking OK.
6. The resulting line pattern looks like this:

Setting Line Styles

Now that we have discussed the basic components of lines (weight and pattern), the two are combined with a color to create *line styles* for use in detail lines, model lines, filled regions, and masking regions. They are also available when the Linework tool is used to override a part of a model element. To open the Line Styles dialog box (shown in Figure 4.7), switch to the Manage tab and choose Additional Settings ➤ Line Styles. Note that you may need to expand the list of line styles by clicking the plus sign next to Lines.

In the Line Styles dialog box, notice that some of the style names are bracketed—for example, <Hidden>. These are internal, "system" types of lines that cannot be renamed or deleted and associated to functions in Revit. Similarly, the default standard line styles provided out of the box (Thin Lines, Medium Lines, and Wide Lines) cannot be renamed or deleted. In both cases, their weight, color, and pattern can be modified.

FIGURE 4.7
Line styles consist of weight, color, and pattern.



USING CAUTION WHEN DELETING LINE STYLES

If you delete a line style used in a project, any elements using the deleted style will be unable to reference that style anymore. The lines assigned to the deleted style will be reassigned to a common style such as Thin Lines—possibly producing undesirable results.

Establishing the best styles for your templates will be completely up to you, but we will offer some proven examples for inspiration. First, realize that the application already uses common line styles such as Thin Lines, Medium Lines, and Wide Lines. If you are creating a complete array of customized line styles for your colleagues to use, simply add new line styles that conform to your graphic standard. Be sure to provide a naming convention that identifies the new lines styles.

One common approach is to create line styles organized by their weight number along with any variable to their appearance, such as (3) Gray Dashed or +Line 01. The parentheses (or the use of any special characters at the beginning of the line's name) keep your custom line styles sorted to the top of the list in the Line Styles dialog box as well as in the Type Selector when you're using a line-based tool. This approach has proven to be effective and efficient when creating details in drafting views or generating fill or masking regions.

Another approach reserves certain line styles for special circumstances where lines represent aspects of a building in a plan, elevation, or section and must be assigned to a specific layer when views are exported in CAD format. For example, the crossing lines typically used to indicate an area in plan that is "open to below" may need to be assigned to the CAD layer A-FLOR-BELW. This is difficult if you used a line style based solely on weight and pattern such as (2) Dashed. You cannot separately assign that line style to A-FLOR-BELW for the floor plan export and A-DETL-THIN for all other exports. Here are some examples of line styles you could create:

- Open to Below
- ADA Circles

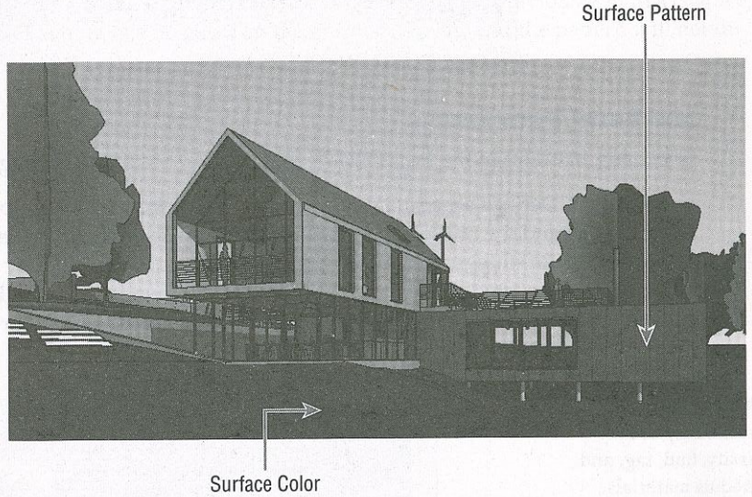
- Curbs
- Fire Rating

In summary, take care to understand the different settings when you are beginning to customize graphic settings for lines in the Revit template. To change the displayed weight of an element in a project, you should make changes not in Line Weights but rather through the Object Styles dialog box. For example, if you want to increase the cut line weight of a wall already set to (5), do not increase the value of (5) in the Line Weights dialog box. You would change this value by selecting (6) or (7) as the cut weight of a wall in the Object Styles dialog box.

Defining Materials

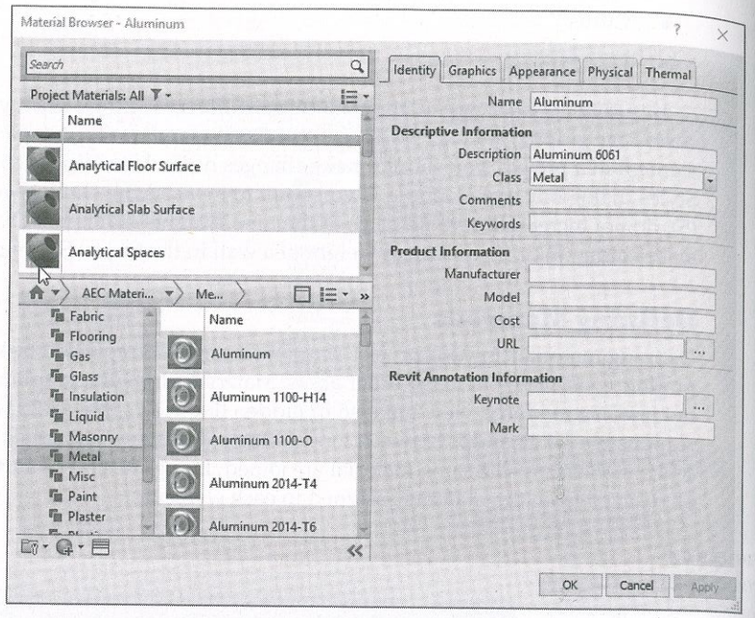
Defining materials in your project template is another important task that can help maintain graphic consistency in many other areas. Materials drive the graphic representation of elements, not just in a rendered view but also in hidden line views that are 2D or 3D. They are also responsible for cleanups between model elements because materials can merge with one another when elements of the same material are joined. In Figure 4.8, the surface patterns and colors are all derived from the material assigned to each element.

FIGURE 4.8
Materials define the surface and cut patterns, color, and render material of the elements.



Materials in Revit are organized into groups of properties called *assets*, consisting of the following: Identity, Graphics, Appearance, Physical, and Thermal. Let's explore these by opening the Material Browser. Switch to the Manage tab and choose Materials on the Settings panel to open the Material Browser (Figure 4.9). The left side of the dialog box shows the materials that exist in the active project, including a search bar to help you quickly find materials for editing. Click the icon just below the search bar to show or hide the Library Panel. On the right, the selected material's assets are displayed as tabs.

FIGURE 4.9
Manage material properties using the Material Browser.

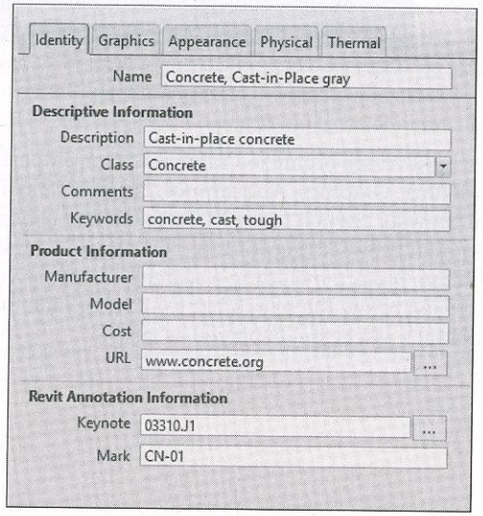


MATERIAL PROPERTIES

Select any material in the Project Materials list, and we'll step through each of the asset tabs.

Identity Defines schedule values and keynotes for materials. Specifying correct identity data for your standard or typical materials will increase efficiency when you're using annotation such as material tags, as well as facilitate quality management by aligning model data such as manufacturer, model, and mark with your project specifications. In Figure 4.10, we've entered some sample identity data. The use of material identity data in project annotation is also discussed in Chapter 19, "Annotating Your Design."

FIGURE 4.10
Use identity data to classify, find, tag, and schedule materials.



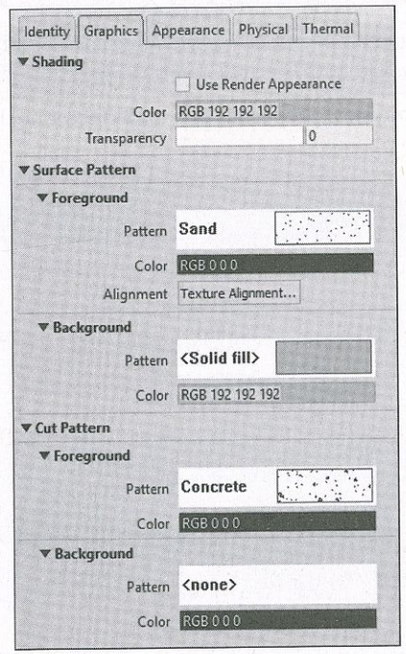
Graphics Defines shading color, surface patterns, and cut patterns. These properties will determine how a model element displays in non-rendered views (Hidden Line, Shaded, or Consistent Colors).

NOTE As of the 2019 release, you can specify separate patterns for Foreground and for Background for each pattern category. This feature allows for the creation of more flexible patterns. For example, you could specify a Sand pattern for Foreground and a light-gray Solid fill pattern for Background. The result would be a solid light-gray fill pattern with a Sand dotted pattern overlaid on top of the gray.

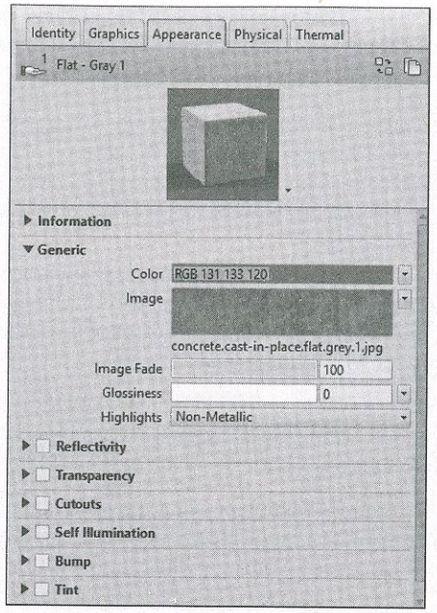
Shading Defines the color and transparency of a material. Note that the color can be dependent on the material's render appearance. If the Use Render Appearance option is selected, the color and transparency are adopted from the Appearance asset settings and the shading controls will be disabled.

Surface Pattern Allows the selection of a *model pattern* to be displayed on the faces of elements in elevation, plan, and 3D views. Note that a material's surface pattern does not appear in rendered views; a pattern can be defined in the Appearance asset tab.

Cut Pattern Allows the selection of a *drafting pattern* to be displayed when an element is cut in a model view. Some elements can't be cut, as discussed previously in this chapter; in these cases, this setting has no effect on the graphic display, and the pattern will not display.

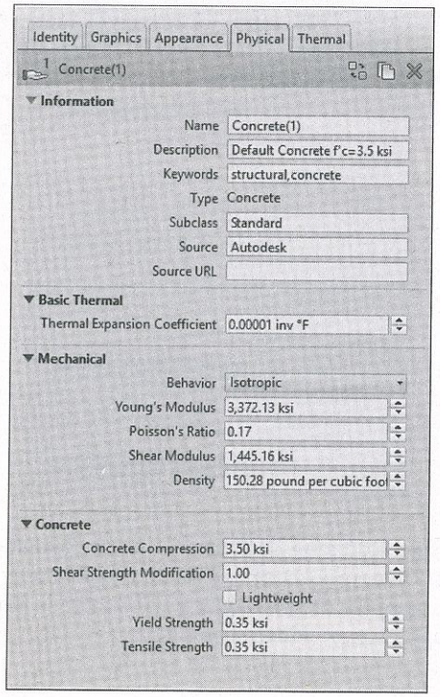


Appearance Defines rendering attributes for use in Realistic and Ray Trace display modes as well as renderings. These properties will become visible only when you render a view and will not affect other graphic display styles, unless the Use Render Appearance option is selected in the Graphics asset under Shading.

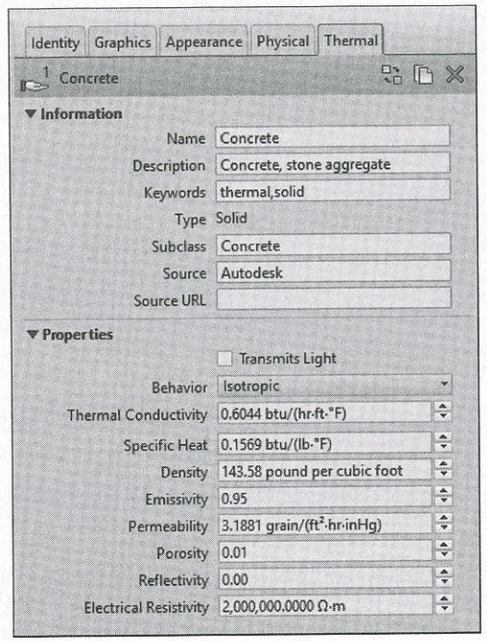


Identity, Graphics, and Appearance are the three assets that are required for every material in Revit. You can add Physical and Thermal assets for analysis, if necessary.

Physical Defines physical properties of a material for analysis.



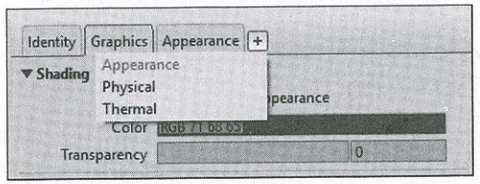
Thermal Defines thermal properties of a material for analysis.



Adding and Replacing Material Assets

You can also replace an asset for Appearance, Physical, or Thermal properties with one from any asset library. Let's review the process to add a new asset to a material. To complete the following exercises, download and open `c04-Materials.rvt` from this book's web page.

1. On the Manage tab, select the Materials tool to open the Materials Browser. Select the material Concrete - Cast-In-Place Concrete from the Project Materials list.
2. Click the plus button in the tabbed list of assets and then select Physical.



3. The Asset Browser dialog box will open (Figure 4.11). In the asset selection tree at the left, expand the Autodesk Physical Assets tree and navigate to Concrete and then Standard. Find the asset named Concrete 3.5 ksi, and with the mouse pointer hovered over the asset, click the arrow located at the right end of the asset listing.
4. Click the X to close the Asset Browser and return to the Material Browser.

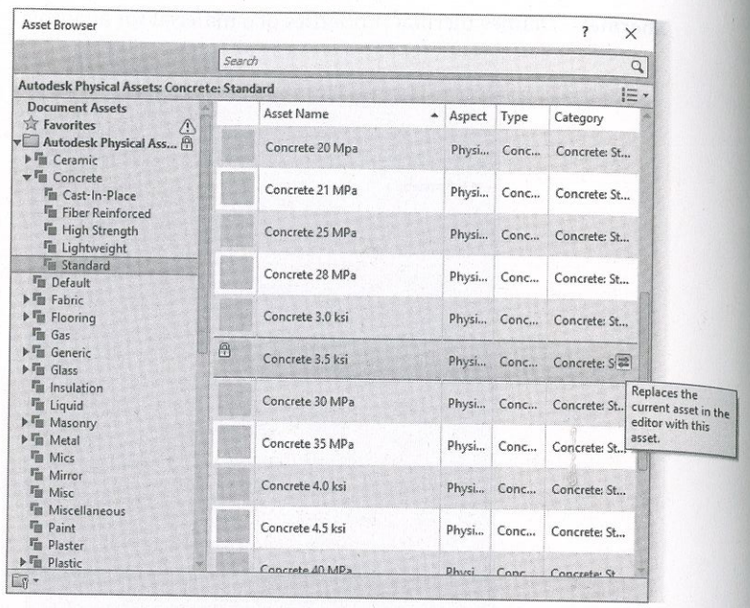


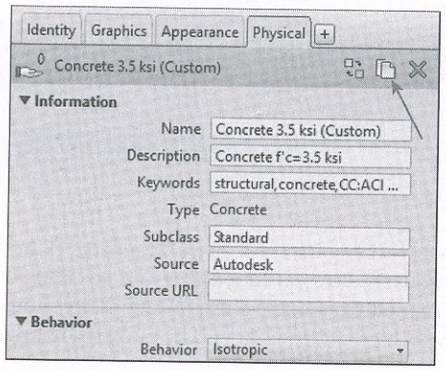
FIGURE 4.11
Use the Asset Browser to access material assets in the document or a material library.

You will see a new Physical Asset tab next to the Appearance tab.

You cannot change any of the asset properties in the Autodesk Physical Assets library; however, after an asset has been assigned to a project, you can change the values. Let's experiment with this process in a quick exercise. Remember that altering any physical or thermal assets may produce undesirable results in analysis or simulation.

1. Continuing from the previous exercise, make sure the Material Browser is open and the Concrete - Cast-In-Place Concrete material is selected. Select the Physical Asset tab.
2. Click the Duplicate This Asset icon at the top of the tab.

   It should change the name of the asset to Concrete 3.5 ksi(2). To change the name of an asset, expand the Information drop-down menu and click in the Name field. Change the name to **Concrete 3.5 ksi (Custom)**.



3. Change the Source field to your name and then expand the Concrete drop-down menu. Change the Shear Strength Modification to **1.75**.
4. Return to the Project Materials list and select Cast-In-Place.

   You will now add the customized physical asset to this project material.
5. Click the plus button in the tabbed list of assets and select Physical.
6. In the Asset Browser, scroll to the top of the list of assets and select Document Assets. From this list, you will find Concrete 3.5 ksi (Custom). Hover the mouse pointer over this asset and click the arrow at the end of the row to add it to the selected material. This will update the material properties.

Another way you can quickly change assets is by using the Replace Asset command. Instead of manually changing each asset property, simply select a material in the Material Browser, and in one of the asset tabs, click the Replace Asset icon. Let's explore this functionality with another quick exercise:

1. With the Material Browser still open, select the material named Concrete - Precast Concrete and then select the Appearance tab.
2. Click the Replace This Asset icon in the Appearance tab.
3. In the Asset Browser, navigate to the Appearance Library folder and then click Concrete.

   Notice that the list of assets is automatically filtered to show only those assets with the Aspect field specified as Appearance.
4. Select the Smooth Precast Structural asset and double-click it, or click the replace arrow at the end of the row, as shown in Figure 4.12.
5. Click the **X** to close the Asset Browser and then click OK to close the Material Browser.

Planning Material Strategies

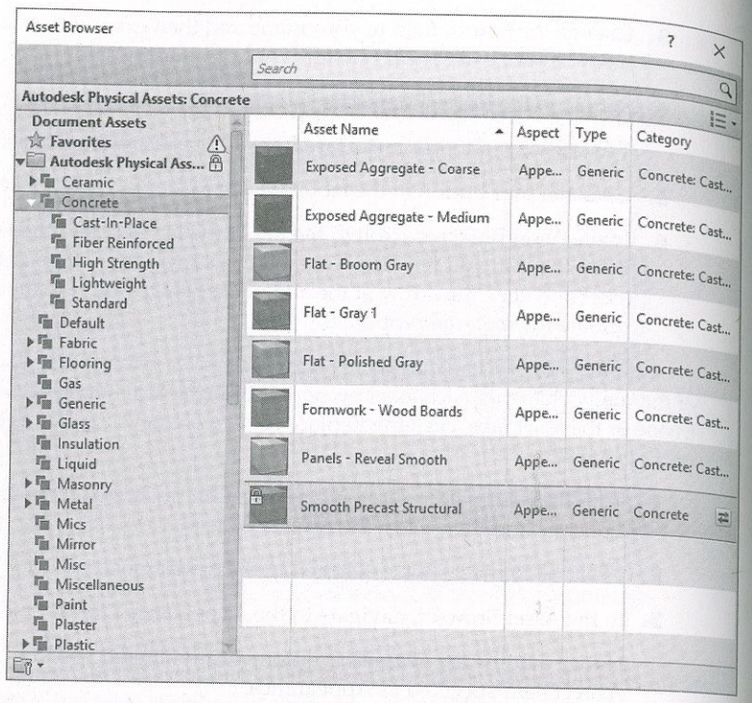
It may seem impossible to imagine all the materials you will need in a project, which may make the process of building a template seem daunting. Think of the basic materials you're likely to use—wood, brick, concrete, glass, and so on—and build from those. Remember, a template is just a starting point, and you can always expand it. If you create a number of high-quality materials over the course of a project, use the Transfer Project Standards function to copy those materials back into your templates. You can also create custom material libraries for your own reuse or for larger project teams.

Your organization's existing graphic standards taxonomy is likely the starting place when you are looking to manage materials. If there is not an existing system, you can create one based on the workflows of your teams. When you start to organize materials by name, there are many prevailing theories too numerous to list here, but here are a few suggestions:

By Type Each material is prefixed with a descriptor such as *Metal*, *Paint*, *Carpet*, *Wood*, and so on.

By Use Each material is prefixed with a description of its application, such as *Cladding*, *Interior*, *Exterior*, *Site*, and so on.

FIGURE 4.12
The Asset Browser can also be used to replace an asset assigned to a material.



Alphabetical Materials have no prefixes.

By CSI Division Each material is prefixed with a MasterFormat numerical descriptor corresponding to its specification section.

By Mark Each material is prefixed with the designation of its Mark annotation parameter (for example, WD01-Wood-Cherry).

Whatever naming convention you choose for materials, the Material Browser can help you organize and manage them efficiently. First, note that you can change the display of the material list, including sorting options, by clicking the drop-down arrow at the upper right, as shown in Figure 4.13. You can also filter the list of materials according to the Class property by clicking the funnel icon at the upper left.

You can also use the Search bar to quickly find matching text in any material property field. For example, try typing **sample** in the Search bar and the list will reflect those materials that include that term in the Keywords property.

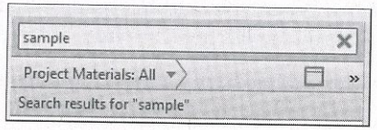
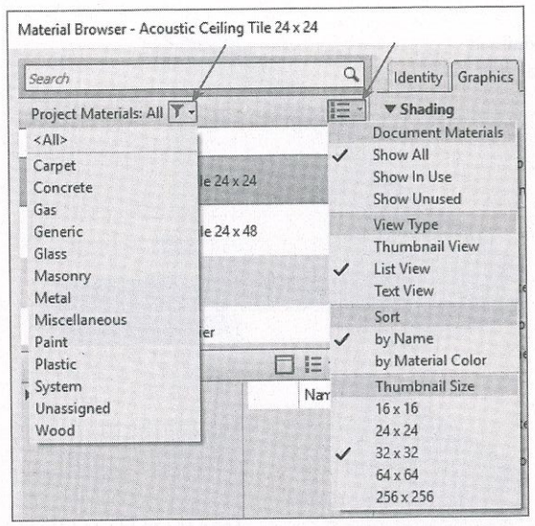


FIGURE 4.13
Accessing different sorting options in the Material Browser



CREATING A SIMPLE EXTERIOR GLAZING MATERIAL

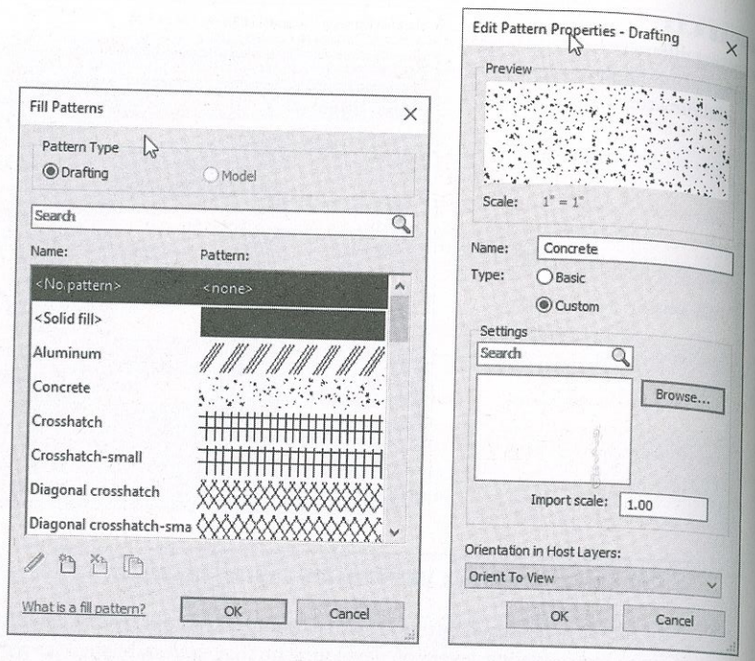
In the early phases of design, you may want to keep the level of detail to a minimum. In fact, guidelines for modeling levels of development may be established as part of a BIM execution plan. (See AIA G202-2013 Project Building Information Modeling Protocol Form at `www.aia.org/contractdocs` or the BIM execution planning guide from Penn State at `bim.psu.edu`. You can also reference Level of Development Specification from BIM FORUM at `https://bimforum.org/wp-content/uploads/2013/08/2013-LOD-Specification.pdf`.) To simplify the creation of exterior enclosures such as a curtain wall, try creating a glass material with a surface pattern approximating the layout dimensions of a curtain wall system (such as 5′ × 12′ or 1.5 m × 3.5 m). Then create a generic wall type using this material, and you will have a much lighter wall type to explore design options with great ease.

Defining Fill Patterns

Materials are often represented with simple hatch patterns. For any material used, you can define a *surface pattern* and a *cut pattern*. For simple parallel hatches and crosshatches, you can use the patterns already supplied or you can make your own patterns.

For more complex patterns, you need to import an external pattern file (with the filename extension `.pat`). Such pattern definitions can be imported from pattern files used by AutoCAD—a process we explain later in this chapter. To create, modify, or view an available fill pattern, switch to the Manage tab and choose Additional Settings ➤ Fill Patterns (see Figure 4.14). On the left side of the Fill Patterns dialog box, you can view the names and small graphic previews of the patterns. Below those are the Pattern Type options, where you choose what type of pattern to create and specify what type of pattern you want to edit (Model or Drafting).

FIGURE 4.14
Fill patterns are defined separately for drafting and model representations.



Model patterns are used to convey real-world dimensional patterns to represent a material, whereas *drafting patterns* are intended for symbolic representations. For example, a model pattern is used to show a brick pattern in 3D and elevation views, whereas a brick drafting pattern is used to represent the material in plan and section. Figure 4.15 shows how concrete masonry units (CMUs) are represented with a running bond pattern (model) as well as a crosshatch (drafting). To display cut patterns in a 3D view, you must enable and adjust a section box to intersect a model element.

Model patterns have specific behaviors that are not dependent on any view. The scale you establish in a model pattern will always be that size, regardless of the view scale. In the example shown in Figure 4.15, the surface of the CMU wall displays a block pattern that measures 16″ × 8″ (400 mm × 200 mm). If you were to change the view scale, the pattern would appear larger or smaller, but it would always measure the same. With a drafting pattern, the opposite is true: the pattern adjusts with the view scale, so the pattern looks identical in all scales.

Fill patterns are also created as one of two types: simple or custom. Figure 4.16 illustrates some examples of each option.

Simple These patterns are generated with parallel or crosshatch lines that can have different angles and spacing. With both the Crosshatch and Parallel Lines options, you can specify only one angle for the entire pattern. Using crosshatch, you can set two spacing values.

Custom To create a more complex custom pattern, you have to import a pattern (PAT) file from an external source. This is often necessary because of the current limitation in creating natively complex patterns. Your office may have a set of established patterns that have been used for years, and the Custom option allows you to import and reuse them without having to make them again from scratch. Custom patterns let you import a PAT file from anywhere on your hard drive or on a network and use it as a base pattern for a new fill pattern.

FIGURE 4.15
The CMU wall has both a drafting pattern (cut) and a model pattern (surface) defined.

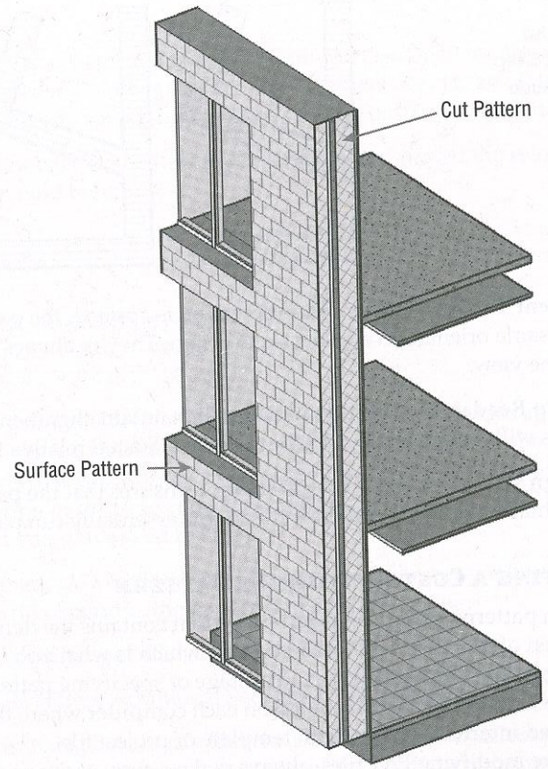
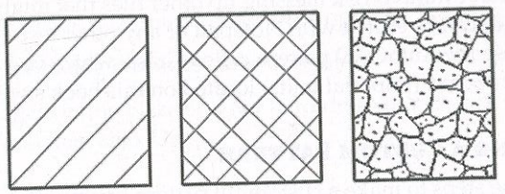


FIGURE 4.16
From left to right: a simple fill pattern, a simple fill pattern with the Crosshatch option selected, and a custom fill pattern



CREATING A NEW SIMPLE PATTERN

To create a new simple pattern, first choose either Model or Drafting and then click the New button. A generic pattern appears in the New Pattern dialog box. You can then design your pattern and assign orientation behavior.

The option Orientation In Host Layers is particularly useful when you're making drafting patterns. This option allows you to specify how a pattern orients itself relative to host elements such as walls, floors, roofs, and ceilings when they are represented as cut. Note that the option is not available for model pattern types. As shown in Figure 4.17, the orientation options are Orient To View, Keep Readable, and Align With Element.

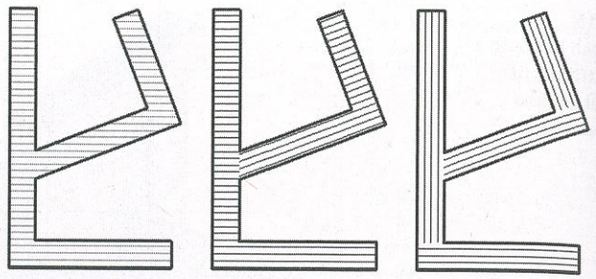


FIGURE 4.17
From left to right: Orient To View, Keep Readable, and Align With Element

Orient To View When this orientation is applied, the patterns used in the project all have the same orientation and the same origin. They're always perfectly aligned with the origin of the view.

Keep Readable This orientation will maintain alignment with the view (that is, horizontal lines will remain horizontal) but will be adjusted relative to angled host elements.

Align With Element This orientation ensures that the pattern orientation depends on the orientation of the host element. Patterns essentially run parallel to the element.

CREATING A CUSTOM COMPLEX PATTERN

Custom patterns require an external file that contains the definition of the pattern. The filename extension of that pattern should be `.pat`, which is what you'll make in this exercise by editing an existing AutoCAD PAT file. An advantage of specifying patterns in the template file is that the PAT file won't need to be installed on each computer where the application is installed; patterns are stored internally in the Revit template or project file.

Before modifying PAT files, always make a copy of the original PAT file you intend to use as a base; you don't want to risk messing up other files that might already be using that original PAT file. PAT files can be edited with Notepad or any other text-editing application. For this exercise, you'll choose the AutoCAD pattern called Grass, which you can find in `acadiso.pat` (in metric units) or `acad.pat` (imperial units) located on this book's web page.

IMPORTING A CUSTOM PATTERN

Follow these steps to make a custom fill pattern by importing an existing pattern definition:

1. Using Notepad or a similar text editor application, open the file `acadiso.pat` (Metric patterns) or `acad.pat` (Imperial patterns).
2. Highlight the lines that define the pattern, and select them.

```
*GRASS,Grass area
90, 0, 0, 17.9605, 17.9605, 4.7625, -31.1585
45, 0, 0, 0, 25.4, 4.7625, -20.6375
135, 0, 0, 0, 25.4, 4.7625, -20.6375
```

   The actual numbers in the pattern may differ slightly, depending on whether you are using `acadiso.pat` or `acad.pat`.

3. Choose Edit ➤ Copy.
4. Open a new text file and paste the selection. (You can also open the Revit `metric.pat` or `revit.pat` file located in `C:\Program Files\Autodesk\Revit 2020\Data`, in which all Revit patterns are already saved. In that case, you can paste the selected text in that file.)
5. This is the important part; in the new text file where you pasted the selected text, add the two lines shown in bold here:

```
;%UNITS=MM
*GRASS,Grass area
;%TYPE=DRAFTING
90, 0, 0, 17.9605, 17.9605, 4.7625, -31.1585
45, 0, 0, 0, 25.4, 4.7625, -20.6375
135, 0, 0, 0, 25.4, 4.7625, -20.6375
```

   The first line that you write before the pattern text, `;%UNITS=MM`, can appear only once in the text file. It defines the value for the units used in the pattern. In the example, the units are millimeters (MM); if you wanted to work in imperial units, it would be `;%UNITS=INCH`. (If you use the option in step 4 to collect all patterns in the master PAT file, then this line already exists and you don't need to add it.)

   The second statement, `;%TYPE=DRAFTING`, helps define whether you're creating a drafting or model pattern. In this example, the pattern is the Drafting type.

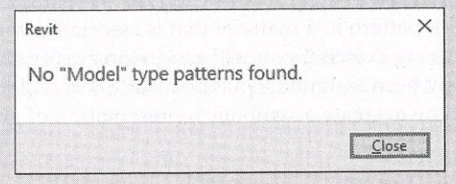
6. Save your text file with a `.pat` filename extension.
7. On the Manage tab, choose Additional Settings ➤ Fill Patterns.
8. In the Fill Patterns dialog box, verify that the Drafting option is selected, and click the New fill pattern icon, in the bottom-left corner of the Fill Patterns dialog box.
9. In the New Pattern dialog box, select the Custom option.

   The lower part of the dialog box offers new options.

10. Click Browse, navigate to the place on your hard drive or network where you saved the PAT file, select it, and then click Open.

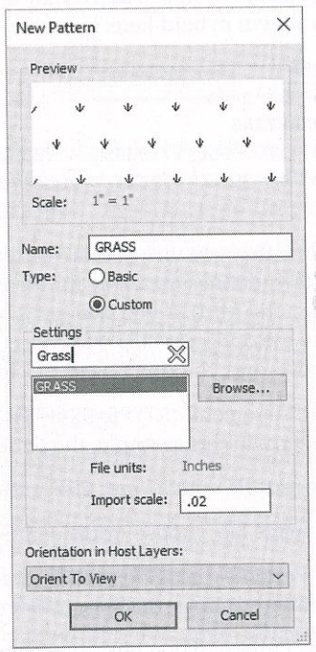
IMPORTING PAT FILES

It's important to know that when you import a new pattern, the type of pattern needs to be the same as the new type of pattern you're making. In other words, if you're making a new model pattern, you can't import a drafting pattern. If you try to do so, you'll see a warning message like the one shown here.



In the list that appears to the right of this button, you can see the name of the pattern you created: GRASS, as shown in Figure 4.18. (If you have a PAT file with many patterns defined, you'll see all the other drafting patterns available in that list.) The name of the pattern automatically becomes the name of your fill pattern, but you can change that if you like.

FIGURE 4.18
The New Pattern dialog box displays the imported PAT file in the Custom group.



If necessary, you can adjust the scales of the imported pattern. The Preview window displays the graphic of the pattern, always in 1:1 scale. This informs you if you need to scale the pattern up or down. You'll know that you need to scale the pattern if the preview appears as a solid black box—that means the pattern is too dense. As an alternative, if the preview box shows only white, your scale might need to be reduced. In Figure 4.18, we used the import scale of 0.01 to accommodate the scaling.

11. If you're happy with the result, confirm by clicking OK.

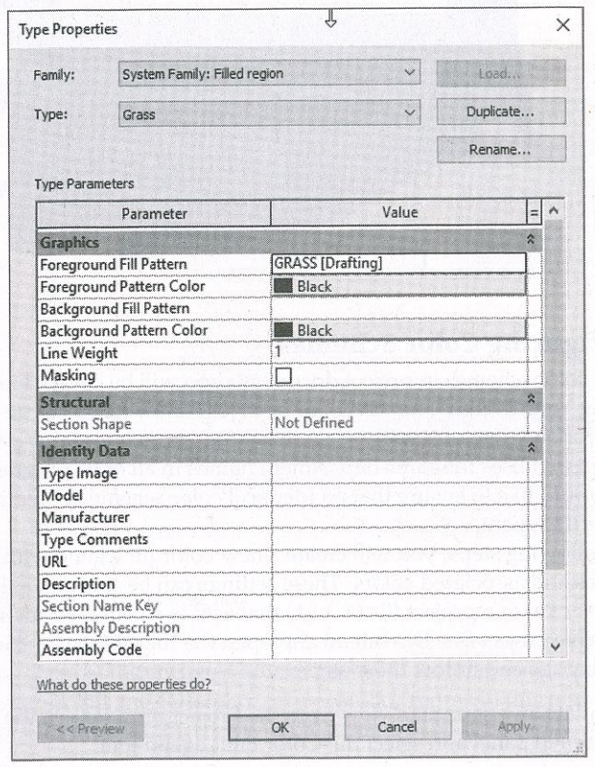
Now that you have created a fill pattern, you can use the pattern in a number of ways. One of the simplest ways is to assign the pattern directly to a material. We purposely instructed you to create a grass pattern in the previous exercise to illustrate a limitation in Revit—you cannot assign a surface pattern to a material that is associated with a toposurface.

In the following exercise, you will assign the grass pattern to a material in the sample project that has already been assigned to a toposurface. We will then show you how to create a new filled region type to create a symbolic representation of grass in the site plan.

1. Continuing with the `c04-Materials.rvt` file, switch to the Manage tab and click Materials.
2. In the Material Browser, find the material named Site - Grass and choose the Graphics tab. Under the Surface Pattern properties ➤ Foreground, click the Pattern field and then choose the GRASS pattern you created in the previous exercise. Click OK.

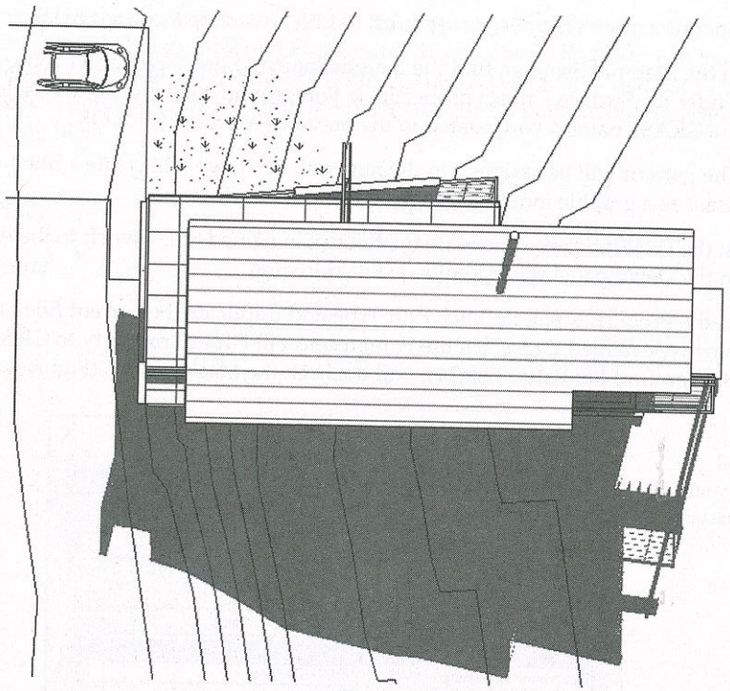
   The pattern will be assigned to the material. Next, we will create a filled region type and use it as a graphic indicator on a site plan.
3. In the Project Browser, activate the floor plan named Site. Switch to the Annotate tab and in the Detail panel select Region ➤ Filled Region.
4. In the Properties palette, click Edit Type and duplicate the current filled region type to a new type named **Grass**. Set the Foreground Fill Pattern property to GRASS, leave the Background Fill Pattern empty, and uncheck the Masking box. (Figure 4.19).

FIGURE 4.19
Create a new filled region type with your new custom fill pattern.



5. Click OK to close the Type Properties dialog box, and draw a shape on the Site plan using any configuration of lines, making sure your lines form a closed loop.

Remember to click the green check mark in the contextual ribbon to complete the sketch of the filled region. Take a moment to experiment with the <Invisible Lines> type and draw the boundary condition of the filled region. Next, apply a second fill pattern (Sand) to the Background Fill Pattern. You will achieve a similar result as shown in the following sketch.

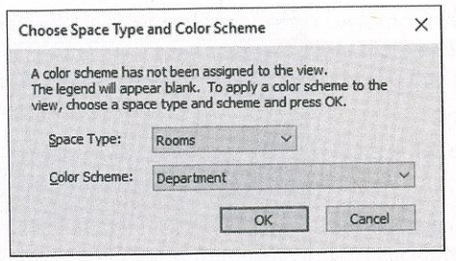


Preconfiguring Color Schemes

The use of color schemes in project documentation will be covered in greater detail in Chapter 21, "Presenting Your Design"; however, for now, just know that you can preconfigure them in project templates for a variety of scenarios. For example, an architect may perform many projects for a single client that uses the same department names in all of its program design requirements. The architect would like to ensure that an identical color scheme is used in the colored plans in all projects for this client.

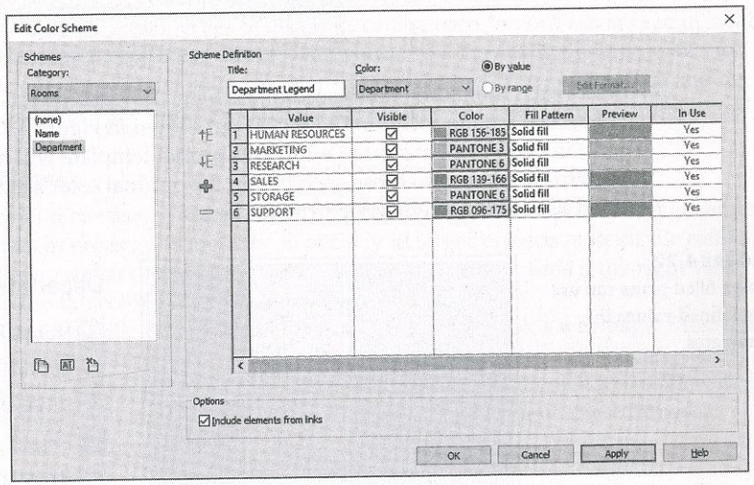
In the following steps, you will create a new color fill legend with some predefined department values and associated colors. These settings can be saved in either a custom project template (`*.rte`) or a project file (`*.rvt`) that acts as a container for settings to be transferred into another active project file. Download and open the file `c04-Color-Schemes.rvt` from this book's web page and follow these steps:

1. Activate any floor plan view from the Project Browser. On the Annotate tab, choose the Color Fill panel and select the Color Fill Legend tool.
2. Place a legend in the floor plan view, and you will see the Choose Space Type And Color Scheme dialog box. Set Space Type to Rooms and Color Scheme to Department (these choices can be modified later) and then click OK.



3. Select the color fill legend you placed in the previous step, and click the Edit Scheme icon at the right end of the ribbon. The Edit Color Scheme dialog box will appear.
4. Click the Add Value icon (the plus symbol) to populate the list of departments in the Scheme Definition area. Add the values as shown in Figure 4.20. Choose colors and fill patterns according to your graphic requirements.

FIGURE 4.20
Edit color schemes to add predefined values, colors, and fill patterns.

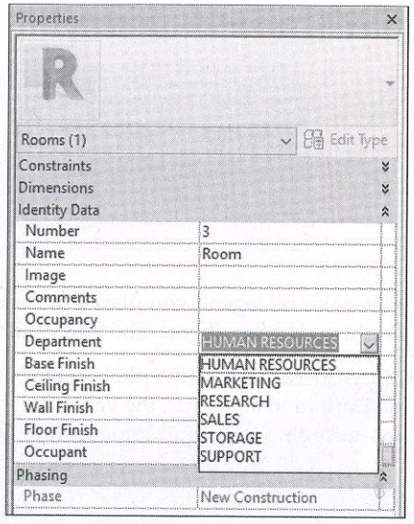


5. Click OK to close the dialog box.
6. Activate the Level 1 floor plan; then, from the Architecture tab, choose the Room button and add rooms to the enclosed spaces shown in the plan view. For clarity, we have turned on the Interior Fill and Reference properties for rooms in this plan view. This will make it easier for you to select the rooms in the next step.

   You will not want to let these rooms remain if you save the file as a project template, but it will help to better visualize the color schemes if you can see them placed in a sample model view.

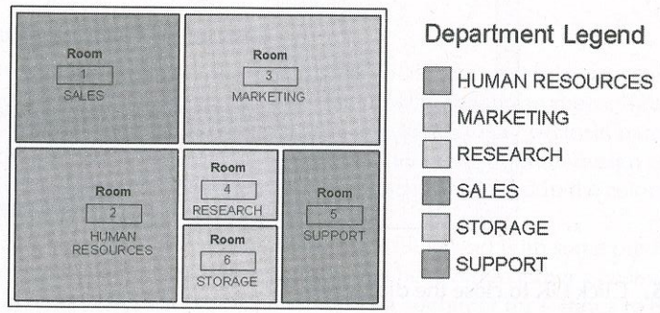
   When rooms are placed, you can either type the values for departments that match the predefined values in the color scheme or select the values in the Properties palette when each room is selected, as shown in Figure 4.21.

FIGURE 4.21
Select from predefined values in the Properties palette of a room.



7. Select each room that you placed in the plan view, and select a Department value in the Properties palette according to the layout shown in Figure 4.22. The department values used in every project started with your project template will have the same colors and fill patterns according to those specified in the original color scheme. You also have a predefined list of your client's department names.

FIGURE 4.22
Color-filled plans can use predefined values in templates.



At this point, you have two options for storing these types of settings. We will discuss strategies for managing templates later in this chapter, but for now you can either save this file as a project template or maintain it as a container file, which is simply an RVT file that holds settings you will transfer into other project files. For a container file, simply leave the file as is, and we will discuss the use of the Transfer Project Standards command later in this chapter. If you want to use this file as a project template, follow these steps:

1. In the plan view, select all the walls, rooms, and room tags, and then delete them.
2. Activate the Room Schedule view under Schedules/Quantities in the Project Browser.

3. Click in the first row of the schedule and then click the Delete button in the ribbon. Repeat this step until all rooms have been removed from the schedule. (Note that deleting rooms from the plan will not delete them from the model. To find unplaced rooms, you will need to re-create a room schedule.)
4. Go to the Application menu and then select Save As ➤ Template. Name the file **`c04-Color-Scheme-Template.rte`**.

You don't have to delete all the modeled content and rooms from your project templates; however, it's likely that you will have a unique layout for each project you design. By deleting the sample walls and rooms, you maintained the color scheme settings with the predefined colors, patterns, and department names.

Increasing Efficient View Management

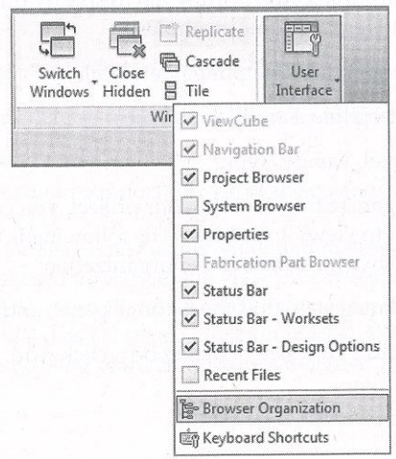
Once you have customized the settings for graphic quality, you can use several other tools and techniques to increase efficiency and ensure that your visual standards are applied consistently throughout your projects. The properties of all views can be used to your advantage in creating a browser organization that meets the needs of your teams. You can apply filters to views for generating graphic overrides based on model element parameters. You can manage and deploy these settings and more in view templates that can be applied to many views simultaneously.

Organizing Views

Maintaining a clear and consistent organization of views within a Revit project can generate measurable increases in project productivity. Especially in larger projects, a Revit file can have more than 1,000 views, which can easily cause confusion and wasted time if the right view cannot be found in the Project Browser when needed.

Download and open the file `c04-Browser-Org.rvt` from this book's web page. Most default project templates contain a few simple Browser Organization types that can be copied and/or customized—except for the type named All. To access these settings, switch to the View ribbon, find the Windows panel, click the User Interface drop-down button, and select Browser Organization, as shown in Figure 4.23.

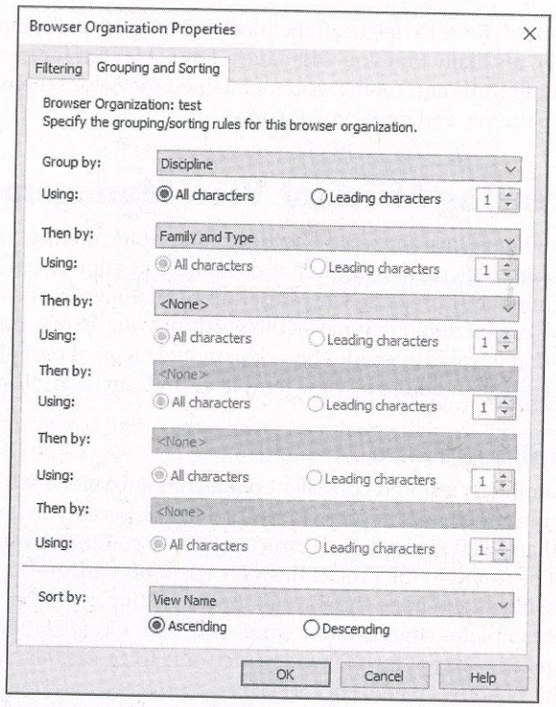
FIGURE 4.23
Accessing browser organization settings in the ribbon



Select any one of the listed types in the Browser Organization dialog box, and click the Edit button. Remember, you can't edit or delete the type named All.

In the Browser Organization Properties dialog box (Figure 4.24) are a Grouping And Sorting tab and a Filtering tab. Grouping And Sorting allows you to group views based on selected view parameters, whereas the Filtering tab gives you the opportunity to display only views that pass selected criteria.

FIGURE 4.24
Use view properties and parameters to create folders for the Project Browser.



Choose the Grouping And Sorting tab to specify three levels of hierarchy to be shown in the Project Browser. Here are some examples:

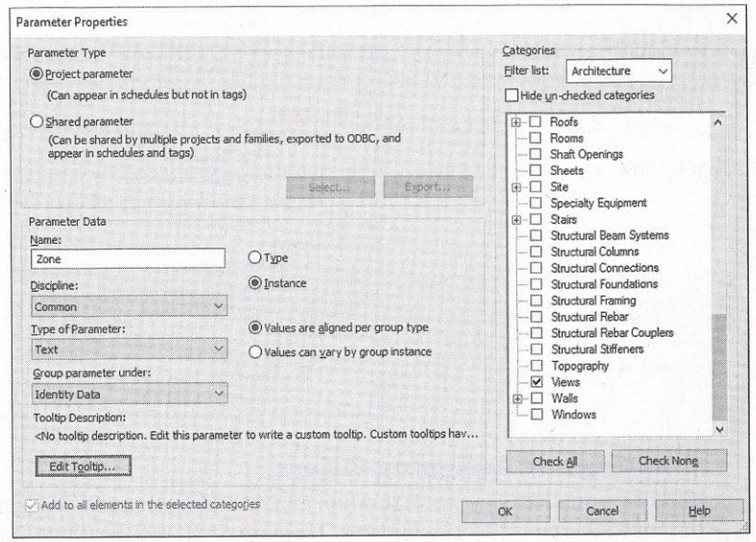
- Family And Type, Discipline, View Scale
- Phase, Discipline, Family And Type
- Detail Level, Family, Type

To further organize the views in your project, you can create additional project parameters and assign them to views and sheets. The following is one example of adding custom text parameters to views for more refined organization:

1. On the Manage tab, find the Settings panel, and click Project Parameters.
2. In the Project Parameters dialog box, click Add.

3. In the Parameter Properties dialog box, create a parameter named **Zone**; and for Type Of Parameter, specify Text. Select the Instance option; then find and check the Views category, as shown in Figure 4.25. You may also set the Group Parameter Under value to Identity Data.

FIGURE 4.25
Create custom project parameters for additional view organization options.

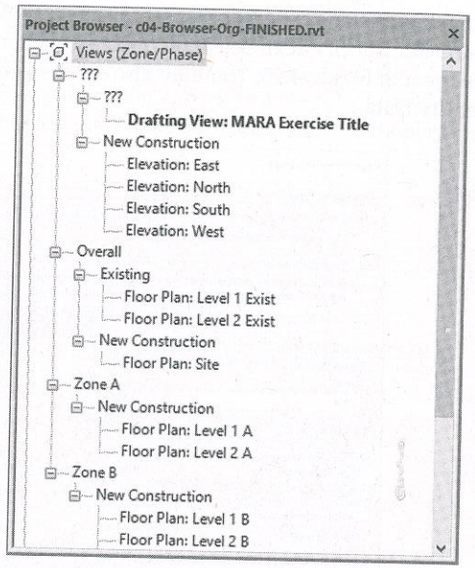


4. Click OK to close both of the open dialog boxes.
5. Return to the Browser Organization dialog box and click New. Name the new type **Zone/Phase** and click OK.
6. Set the following values on the Grouping And Sorting tab in the Browser Organization Properties dialog box:
   - Group By: Zone
   - Then By: Phase
7. Click OK to close the dialog box and return to the Browser Organization dialog box.
8. Check the box next to Zone/Phase to make this browser setting current, and click OK to close the dialog box.

The Project Browser is now ready to support the use of the custom view parameters you created earlier.

It is now up to you to assign values to the custom view parameters created in the previous exercise. These values can be assigned directly to the view properties in the Properties palette or by adding them to view templates. Views that do not have values for these parameters will be found in the browser hierarchy listed as ??? (three question marks). Figure 4.26 illustrates this scenario in which floor plans and ceiling plans have values assigned to the Zone parameters but the elevation views do not.

FIGURE 4.26
Customized browser organizations can make larger projects easier to navigate.



Creating and Assigning Filters

Filters are another view configuration and customization tool that can be developed and deployed in Revit project templates. They are similar to the filters available in schedules in that they can either display or hide elements matching user-specified criteria. However, filters can also override the graphic appearance of elements within a view. The possible combination and application of view filters is virtually limitless, so let's take a look at a few real-world examples.

First, we will review the steps to create and assign a view filter. The fundamental steps are as follows:

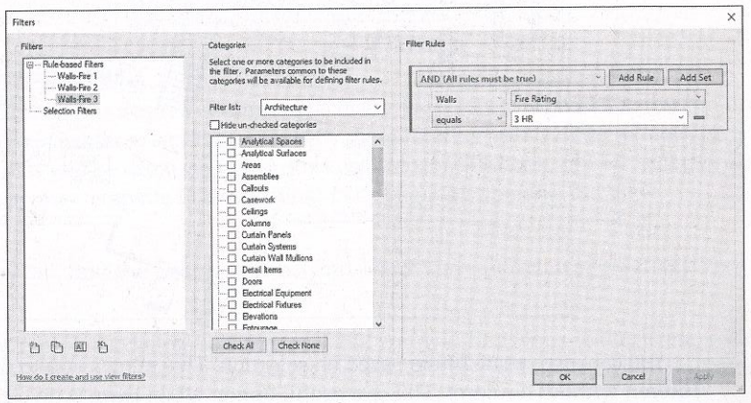
1. Create a named filter.
2. Assign it to object categories.
3. Assign data criteria.
4. Add to the Visibility/Graphic settings of a view.
5. Define graphic overrides.

In the following example, you will create view rule-based filters to identify fire-rated walls with different colors. You can download the sample file `c04-Sample-Building.rvt` from this book's web page. Here are the steps:

1. Open the file `c04-Sample-Building.rvt`. Switch to the View tab, find the Graphics panel, and click Filters.
2. Add a new named filter by clicking the New button on the lower-left side of the dialog box. Name the first new filter **Walls-Fire 1**, use the Define Rules option, and then click OK.

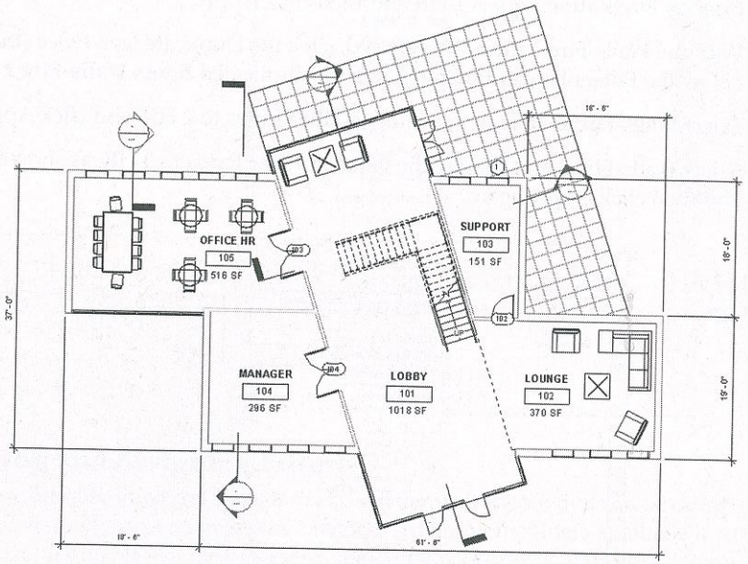
3. When the expanded Filters dialog box appears, first make sure the Walls-Fire 1 filter is selected; then in the Filter List pull-down menu, make sure only Architecture is selected. Finally, in the Categories list, find Walls and check the category.
4. In Filter Rules at the right side, select And (All Rules Must Be True). Define the criterion to filter by Fire Rating Equals 1 HR and then click Apply.
5. With the Walls-Fire 1 filter still selected, click the Duplicate icon twice (the second icon below the Filters list) and then rename the duplicated filters **Walls-Fire 2** and **Walls-Fire 3**.
6. Select Walls-Fire 2, change the value in Filter Rules to 2 HR, and click Apply.
7. Select Walls-Fire 3 and change the value in Filter Rules to 3 HR, as shown in Figure 4.27, and then click Apply again.

FIGURE 4.27
Filter rules applied to walls for fire ratings



8. Click OK to close the Filters dialog box.
9. Activate the Level 1 floor plan, open the Visibility/Graphic Overrides dialog box, and select the Filters tab.
10. Click the Add button, select all three filters you created in the previous steps, and click OK.
11. Click the Override button in each filter row under Cut-Lines and edit as follows:
    - Pattern: Solid
    - Color:
        - Walls-Fire 1 = Green
        - Walls-Fire 2 = Yellow
        - Walls-Fire 3 = Red
12. Click OK to close the Visibility/Graphic Overrides dialog box.

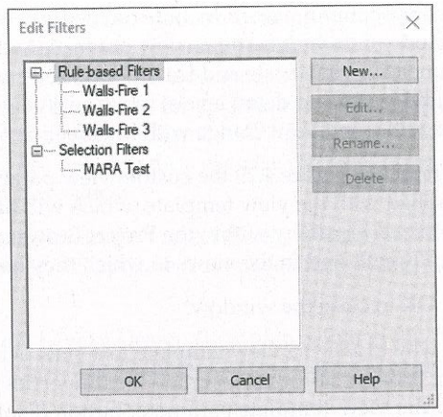
With the filters now applied to the floor plan, walls that have been assigned a fire rating value will appear with the color overrides you assigned to the respective filters. You can create more filters to define graphic styles for specific model elements such as furniture by owner, interior walls, secure doors, or equipment not in contract.



You can also create filters based on selection. This allows you to define the objects to be filtered without a ruleset. This is a useful option when there is no clear rule that will allow the visibility you need. The selection can happen before or after the filter creation, allowing you to add or subtract as needed. To create a selection filter, follow these steps with same file used for rule-based filters:

1. Activate the view Level 1 Design. In the Manage tab, locate the Selection panel.
2. Select Edit Selection. The Edit Filters dialog will appear with a list of rule-based filters and selection filters.
3. Select New.
4. When the Filter Name dialog appears, provide the name **MARA Test** and choose Select. The dialog will close with the ribbon providing the Edit Selection tools. By default, the Add To Selection tool is active.
5. Select several objects in the plan view to add to the set. To remove objects from the set, select Remove From Selection. You will notice the mouse trades its plus symbol for a minus symbol. You will also see that previously unselected objects are now suppressed, allowing you easy access to change your selection set.
6. Once you are satisfied, choose Finish Selection. As shown in Figure 4.28, you now have a filter based on selection, rather than a rule.

FIGURE 4.28
Filter based on selection, rather than rules



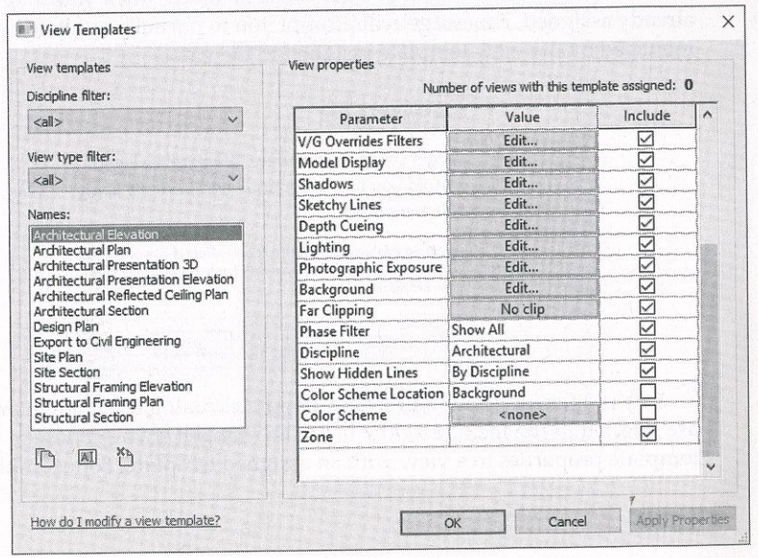
Using View Templates

After you have defined your desired settings in as many view types as possible, you can use view templates to manage these settings and apply them to other views of the same type. The use of view templates will be discussed in various chapters of this book, but we will discuss their importance to the project template in this section. Let's begin by opening the View Templates tool:

1. On the View tab, find the Graphics panel and select View Templates ➤ Manage View Templates.

In the View Templates dialog box (Figure 4.29), you will find icons to duplicate, rename, or delete view templates below the list on the left. On the right are the view properties that can be applied when the view template is applied to a view.

FIGURE 4.29
View Templates dialog box



Notice the column named Include on the right of this dialog box. This column allows you to include or exclude various view properties when you are applying the view template. If you uncheck View Scale and Detail Level settings, you can apply this template to plans of multiple scales and detail levels, while applying settings such as visibility of Object Styles, Phase Filter, and View Range without affecting the View Scale or Detail Level settings.

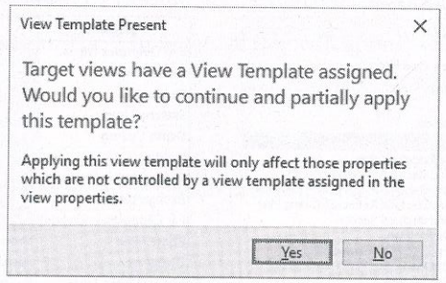
Also notice in Figure 4.29 the custom view parameter created earlier: Zone. This value can be applied with the view template, which will have the effect of cataloging the views in a customized hierarchy within the Project Browser. Changes to view templates are automatically reflected in the views to which they have been assigned.

2. Click OK to close the window.

The only way to *assign* a view template to a view is in the Properties palette. Select any view in the Project Browser and then examine the Properties palette to locate the View Template parameter. If the View Template parameter button displays as <None>, then no view template has been assigned. Click the button to launch the Assign View Template dialog box, and choose an appropriate view template. In contrast to this *assigning* workflow, view template properties can be *applied* to individual views. Applying a view template is a one-time application. Future changes to the view template will not change a view where a template was applied. You can apply a template in various ways, including the following:

- Select multiple views in the Project Browser, right-click, and then select Apply View Template from the context menu.
- From the View tab, click View Templates ➤ Apply Template Properties To Current View.
- Select multiple sheets in the Project Browser, right-click, and then select Apply View Template To All Views from the context menu.

Any of these methods will apply the properties of a view template, but will not assign the view template to the view. If you use these methods and a view happens to have a view template already assigned, a message will prompt you to partially apply the properties that are not being managed by the view template assigned to the view.

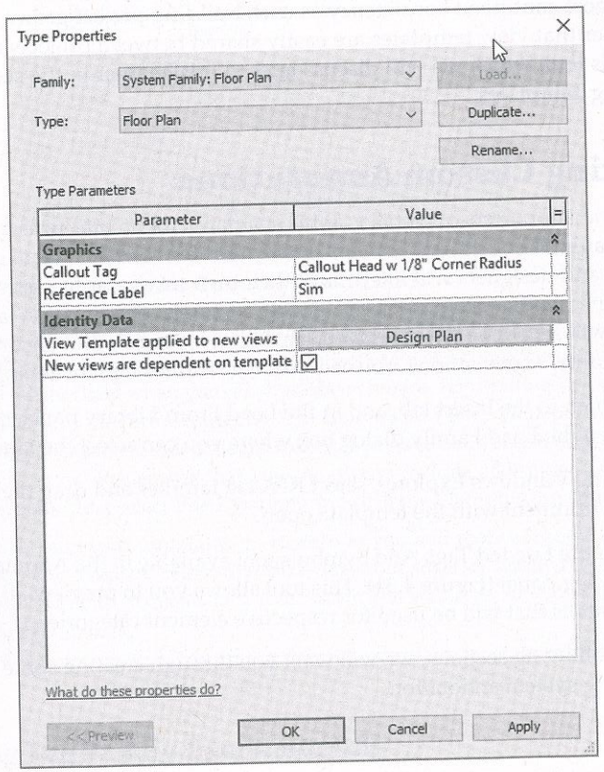


Any properties listed in the View Templates dialog box, shown previously in Figure 4.29, that are selected in the Include field will not be changed if you choose to partially apply view template properties to a view with an assigned template. For example, if model object styles are included in the assigned view template and you are attempting to apply template properties that also have model object style modifications, the model object settings from the assigned view template will not be overridden from the applied properties.

Despite these relatively intuitive methods for applying view templates, you can increase efficiency on larger projects by assigning a default view template for each view type. In the following exercise, continue to use this chapter's exercise file `c04-Sample-Building.rvt` from the filters exercise, and follow these steps:

1. Activate the Level 1 floor plan in the Project Browser, right-click the Level 1 floor plan, and choose Duplicate View ➤ Duplicate from the context menu. Rename the duplicate view **Level 1 Design**.
2. With the properties of the Level 1 Design floor plan active in the Properties palette, click Edit Type. In the Type Properties dialog box, click Duplicate to create a new type named **Design Plans**.
3. Click the button in the View Template Applied To New Views field and select the Design Plan view template (Figure 4.30). Click OK.

FIGURE 4.30
Specify a view template for new views within a view type.



4. Click OK to close the Type Properties dialog box.

   You should notice that the Level 1 Design floor plan in the Project Browser is now listed under Floor Plans (Design Plans); however, the view template has not been applied to this view yet.

5. In the Properties palette, click the View Template field button, select the Design Plan template, and then click OK.

   The floor plan view should appear changed, no longer displaying any annotation.

6. From the View tab, click Plan Views ➢ Floor Plan. In the New Floor Plan dialog box, select Design Plans in the Type drop-down list and then select Level 2 from the list.

7. Click OK, and a new floor plan for Level 2 will be created that has the Design Plan view template already assigned. Rename this view **Level 2 Design**.

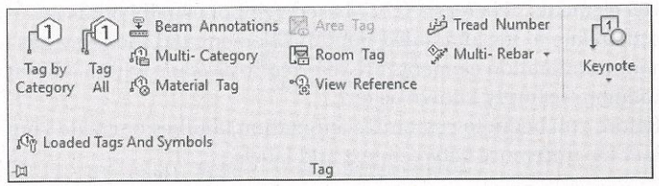
The workflow described in the previous exercise will help you spend less time configuring view settings and more time focused on your designs. Including view templates in your project template will give your teams the ability to quickly apply your standard view settings. It will also support continued consistency as each building project grows in scope and size. Remember that view templates are easily shared between projects using the Transfer Project Standards tool, which we will discuss later in this chapter in the section "Strategies for Managing Templates."

Creating Custom Annotations

We are avid supporters of global graphic standards for architecture and engineering, such as the United States National CAD Standard (`www.nationalcadstandard.org`), but in reality many architects and designers will likely have their own set of graphic conventions that will need to be implemented in their Revit projects. Placing customized annotation families in your project template will save time when you are starting new projects and ensure maximum compliance with your firm's conventions. You can load tag families into the template using several methods:

- Switch to the Insert tab, and in the Load From Library panel, select Load Family. This will open the Load Family dialog box where you can select the families you would like to load.
- Using Windows Explorer, select RFA tag families and drag them into the Revit project environment with the template open.
- Use the Loaded Tags And Symbols tool available in the Annotate tab when you expand the Tag panel (Figure 4.31). This tool allows you to preview all loaded and preset tags and symbols that will be used for respective element categories.

In the following sections, we will walk you through creating some common element tags and customizing system annotation.



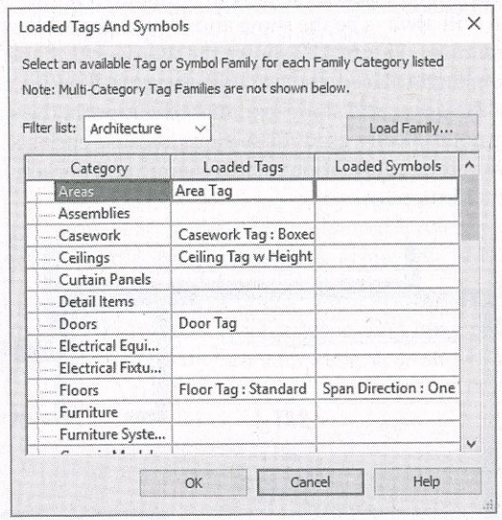


FIGURE 4.31
The Loaded Tags And Symbols dialog box shows loaded annotation families assigned to selected categories.

ARCHIVING AND MANAGING CUSTOM CONTENT

Many new users are unsure where to store custom-created families. It is not advisable to save them in the system folders created during the installation of Revit because you may lose track of them or inadvertently delete them when you reinstall the software. Reinstalling the application erases just about any folder and its entire contents. It is thus wise to keep your personally created content elsewhere, under a separate, independent folder; if you are not a single user, store that folder on a shared network drive. Remember that you can always include additional library shortcuts in the application options. Just select File Locations and click the Places button from the Options menu.

You should also keep your templates up-to-date as you add more content; that way, you need to maintain only a few template files rather than dozens of separate family files. It's even better if you can establish a template manager as a role within the office so everyone isn't making graphical changes to your templates.

Introducing Tag Family Fundamentals

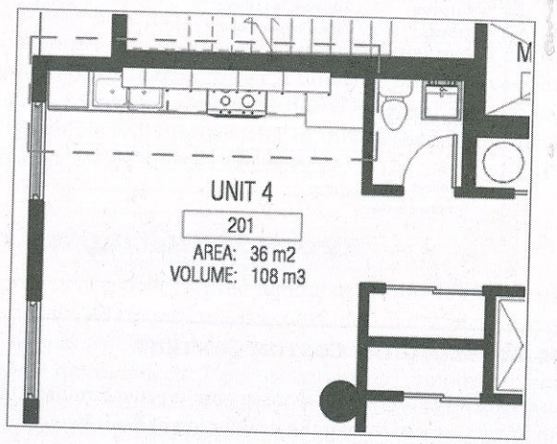
Tags in Revit have various similarities and differences from the annotation symbols you might find in a CAD application. They are similar in that they are created at 1:1 scale and contain lines and other graphic elements. The main difference is that Revit tags merely *report* information from

model elements, whereas a CAD-based symbol usually holds an attribute value that does not directly relate to the annotated building element and therefore has to be entered manually. These dynamic annotation elements are referred to as *labels* within a Revit family, whereas static annotation is simply known as *text*.

Before you begin to customize annotation families or create your own, let's take a detailed look at the difference between text and labels.

Text In the Family Editor, placing text in an annotation family or title block means you are defining text that will always be the same and is unchangeable when that family is placed in the project environment. Figure 4.32 shows the words *AREA* and *VOLUME* as text. Regardless of where this room tag is placed, the text will always say AREA and VOLUME. Section tags work the same way: if you add static text, that text appears the same for all section marks. This technique is not typically used for sections because each section is a reference to a unique view, and you want that information to be dynamic and parametric. This is where label functionality comes into play.

FIGURE 4.32
Floor plan showing the room tag

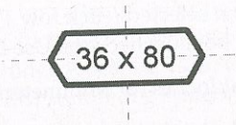


Labels Like static text, a label offers textual information; however, it is a live reference to a parameter value of an element in the project. For example, if you add an Area label, it will pull the value of the area of the room; if you add a Sheet Number label in a Section Head family in the Family Editor environment and then use that section head in a project, the label will automatically display the actual sheet number on which the section view is placed in the project. If you move the section view from one sheet to another, the label will automatically report the new sheet number. In Figure 4.32, UNIT 4 is a label reporting the room name; the number 201 is a label reporting the room number. The label behaves as dynamic text and is always fully coordinated with the value of the model element parameter it represents.

Creating a Custom Door Tag

Imagine you could use the actual width and height of a door element to drive the tag value. You can! As an example of creating custom tags for a basic model element, use the following steps to create the custom door tag shown in Figure 4.33. You can download the template files from this book's web page if you can't find them in the default location.

FIGURE 4.33
Creating a custom door tag

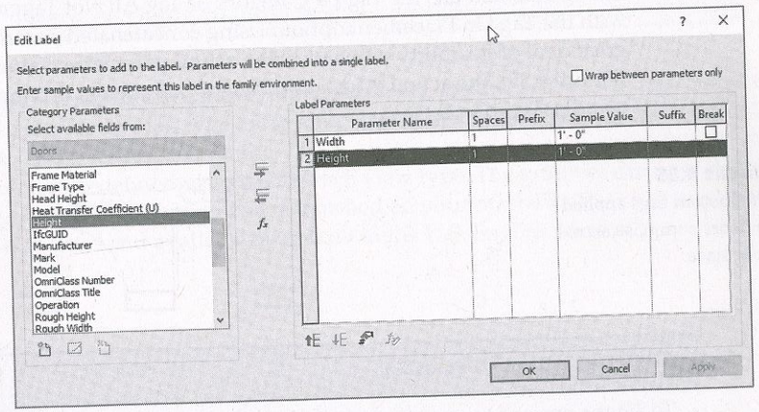


1. Click the File Tab and select New ➤ Annotation Symbol.
2. In the New Annotation Symbol dialog box, select the family template called `Door Tag .rft` or `Metric Door Tag.rft`, and click Open.

   The Family Editor opens in a view with two crossing reference planes, the intersection of which represents the origin of the tag. To avoid problems later, don't move these planes.
3. On the Create tab, find the Text panel and select Label. Click the intersection of the two planes to position the label.

   Note that text and labels do not snap to geometric references; therefore, you will have to manually adjust the placement of labels to achieve the desired alignment.
4. In the Edit Label dialog box that opens, select Width from the column on the left, and click the Add Parameter(s) To Label icon between the Category Parameters and Label Parameters fields. Then do the same for Height, as shown in Figure 4.34.

FIGURE 4.34
Adding more than one parameter to a single label



The Width and Height parameters will be concatenated in a single label, which will display the actual size of the door in the tag. In the subsequent steps, you will customize the display of the label.

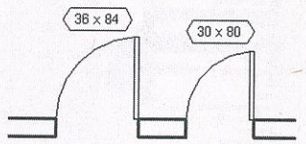
5. Add a space and the letter **x** in the Suffix column of the Width parameter, and change the number in the Sample Value column to **36** (in) or **1000** (mm). Change the sample value of the Height parameter to **80** (in) or **2000** (mm).

6. With the Width row selected (click row 1), click the Edit Parameter's Units Format icon. In the Format dialog box, uncheck the Use Project Settings option and set the following:
   - Units: Decimal Inches (or Millimeters)
   - Rounding: 0 decimal places
   - Unit Symbol: None
7. Repeat the previous step for the Height parameter.
8. Click OK in all open dialog boxes.
9. On the Create tab, activate the Masking Region tool and sketch a six-sided polygon, as shown previously in Figure 4.33.

   Remember to finish the sketch by clicking the green check mark in the Mode panel. A masking region is used instead of just lines because it will allow the door tag to obscure any geometry if it is placed over a model object. If you do not need this graphic convention, simply create the tag outline with lines.
10. Save and name your tag, and load it into your project template.

    Make sure that it is specified as the default tag for doors in the Loaded Tags And Symbols dialog box, and use the Tag By Category or Tag All Not Tagged tool or place new doors with the Tag On Placement option. Using concatenated parameters in tag labels allows a great deal of flexibility while utilizing actual parametric values. In this example (Figure 4.35), the actual Width and Height parameters driving the door size become the text displayed in the tag.

FIGURE 4.35
The custom tags applied to doors comprise actual door sizes.



SETTING SOME DEFAULTS

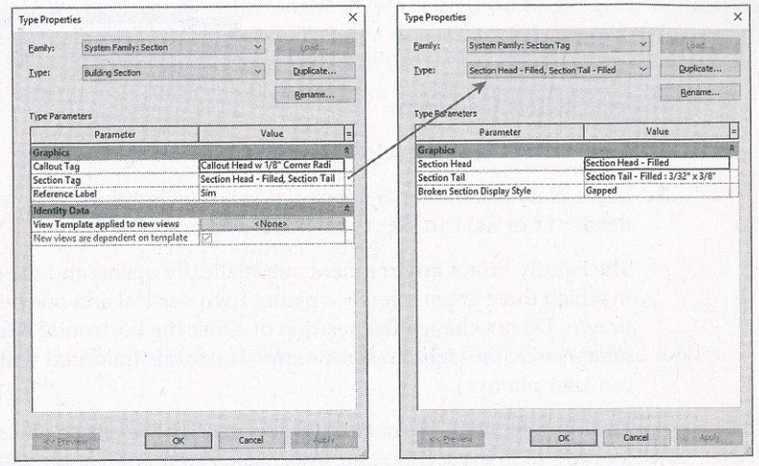
To aid the users of your custom templates, take some time to establish default values for common elements, such as doors, windows, rooms, grids, sheets, and levels. Create one of each element and change the Mark value to a number just below the value at which you would like your users to begin. As an example, enter a value of **0** if you want your users to begin with 1. Unfortunately, this approach does not work for letters because nothing comes before *A*.

Customizing View Tags

Section, callout, and elevation tags are graphic indicators that reference (link to) other views in your project. The graphics for these elements can be customized to meet most scenarios. To create a custom section tag, for example, you have to first create a custom section tag family and

a section tail family and then load them into a template or project. You must then associate them with a section tag system family type, which is then assigned to a section type. Switch to the Manage tab, and choose Additional Settings ➤ Section Tags; you will see the application of separate section head and tail families in a section tag system family type, as shown in Figure 4.36.

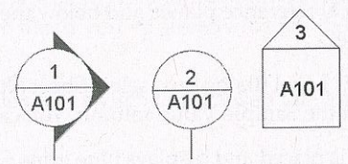
FIGURE 4.36
Creating a SIM-type section tag



In simple terms, view tags are organized in the following hierarchy: the view type refers to a Callout Tag type (and a Section Tag type for section views); the Section Tag type then refers to a section head family and a section tail family.

By default, there is a predefined view tag for each view type. The graphics can vary depending on the language version of Revit you have installed on your machine. The view tags shown in Figure 4.37 are displayed and available by default in the U.S. English version.

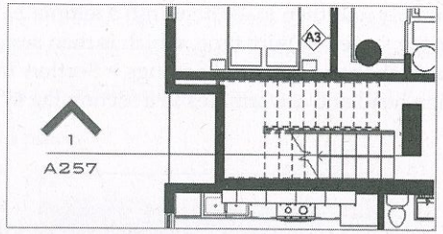
FIGURE 4.37
The default tags



CREATING A CUSTOM SECTION TAG

In the next exercise, you will create a section tag that looks like the one shown in Figure 4.38. You will first need to create a section tag family using the Family Editor before loading the section tag family into the template. You can download the template files from this book's web page if you cannot find them in the default location.

FIGURE 4.38
Customizing the section tag



To begin, follow these steps:

1. Click the File tab, and select New ➤ Annotation Symbol.
2. In the New Annotation Symbol dialog box, select the family template called `Section Head.rft` or `Metric Section Head.rft`, and click Open.

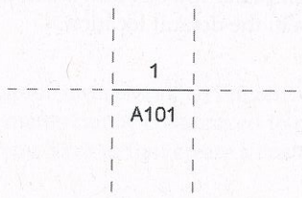
   The Family Editor environment automatically opens, and the drawing area shows a view in which three green reference planes (two vertical and one horizontal) have already been drawn. Do not change the position of either the horizontal reference plane or the vertical reference on the right. In some templates, this is indicated with help text in red (which you can later remove).

   The intersection of the horizontal and the right reference planes defines the connection location with the section line. This means your annotation will be located between the two intersection points.

   A proposed geometric shape is drawn for the annotation: a circle (two arcs) and a horizontal line. The default shape is there to help you visually understand where to begin drawing your new tag geometry.
3. Select the arcs that create the circle and delete them.
4. On the Create tab's Text panel, click the Label button. Position your cursor between the two vertical reference planes and below the horizontal plane, and click to position the start of the label.
5. In the Edit Label dialog box, select Sheet Number. Click the Add Parameter(s) To Label button. In the Sample Value column, you can enter a value; the default is A101. Click OK.

   The label is placed and displays blue grips when selected. These let you change the length of the label text field. The length is important because any value that is added (in a project) that is longer than the length of this box will begin to wrap and could cause undesirable results.
6. Following the same principle, place the label Detail Number above the horizontal reference plane but still between the vertical reference planes, as shown in Figure 4.39.

FIGURE 4.39
Place labels for Detail Number and Sheet Number.



You can reposition a label by selecting it and using the Move button to move it around. For more precise positioning, use the arrow keys on your keyboard to nudge elements in small increments. You can also help yourself by zooming in for a better view. (Zooming in refines the increment for the nudge tools.)

7. On the Detail panel of the Create tab, click the Filled Region button. You'll be put into Sketch mode. Using the Line tool, draw the shape shown in Figure 4.40. In the Properties palette, click Edit Type. In the Type Properties dialog box, check that Foreground Fill Pattern Color is set to Black and Pattern is set to Solid Fill. Click OK to close the Type Properties dialog box, and then make sure the lines you sketched form a closed loop (no gaps or overlapping lines).

FIGURE 4.40
Draw the outline of the filled region to form the section arrow.

8. Click Finish Edit Mode on the Mode panel of the Modify | Create Filled Region Boundary tab.
9. Save the tag you just created as **`Custom Arrow.rfa`** on your hard drive or network, and you're ready to use it in the template or a project. To load it into your project, click the Load Into Project button located in the Family Editor panel. Choose the project where you want to use the symbol and click OK.

Next, you will assign this tag to a section mark system family type in the context of a project or template.

CREATING A SECTION TYPE WITH A CUSTOM HEAD OR TAIL GRAPHIC

To create a section type that uses the section head family you created earlier, you need to load the new section head into the template file (if you've already loaded the custom arrow family in the previous exercise, skip to step 3):

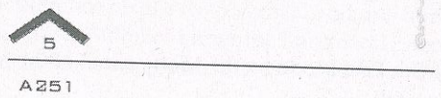
1. If the family is not already loaded, switch to the Insert tab, and on the Load From Library panel, choose Load Family.
2. In the Load Family dialog box, find the `Custom Arrow.rfa` section head you created previously, select it, and click Open.
3. Switch to the Manage tab and select Additional Settings ➤ Section Tags.
4. In the Type Properties dialog box, click Duplicate.
5. In the Name dialog box, name the new type **Custom Filled Arrow**, and click OK.
6. In the section head's Type Properties dialog box, click the drop-down menu for Section Head and select Custom Arrow. For Section Tail, click <none>. This means the other end of the section line will not use a symbol. Click OK.

   The final step is to create a customized section view type, which will use the new section tag type you created in the previous step.

7. Switch to the View tab, and on the Create panel, select Section. By default, in the Properties palette, you will see the default, Section-Building Section. (If this is not showing as the default, click the pull-down menu and make the appropriate selection.)
8. On the Properties palette, select the Edit Type button.
9. In the Type Properties dialog box, select Duplicate.
10. Name the new type **Design Sections**, and click OK.
11. In the Type Properties dialog box, click the ellipsis on the far right end of the Section Tag property, and in the Type drop-down, choose Custom Filled Arrow.
12. Click OK to exit the Type Properties for the Section Tag. Click OK again to exit the Type Properties for Design Sections.

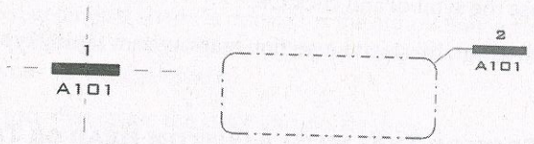
You can now place a section in your drawing area and see the results shown in Figure 4.41. Note that in our sample, the section is referencing a view that has already been placed on a sheet.

FIGURE 4.41
The completed custom section tag



You can repeat the previous exercises using a callout tag family template instead of a section tag template to achieve results similar to those shown in Figure 4.42.

FIGURE 4.42
Customizing the callout tag

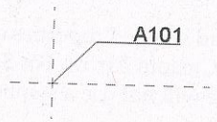


CREATING A CUSTOM ELEVATION TAG

Elevation tags are a bit different from section or callout tags because one tag can simultaneously reference up to four views. You must, therefore, create and nest various parts of a custom elevation tag into one family in order to create custom graphics. Here is how it works:

1. Click the File tab, and select New ➤ Annotation Symbol.
2. In the New Annotation Symbol dialog box, select the family template called `Elevation Mark Body.rft` or `Metric Elevation Mark Body.rft`, and click Open.
3. Using steps similar to those in the section tag exercise, place the Sheet Number label and draw lines as shown in Figure 4.43.

FIGURE 4.43
Define the custom linework and sheet number for the elevation mark body.

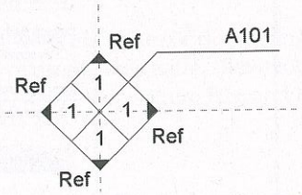


4. Make sure the properties Keep Readable and Fixed Rotation are checked for the label.
5. Save the family as **`Custom Elev Head.rfa`**.
6. Click the Application menu and select New ➤ Annotation Symbol.
7. In the New Annotation Symbol dialog box, select the family template called `Elevation Mark Pointer.rft` or `Metric Elevation Mark Pointer.rft` and click Open.
8. Using methods similar to those in previous steps, place labels for the Detail Number and Reference Label parameters. Draw a diamond with lines and a small, triangular, filled region, as shown in Figure 4.44.

FIGURE 4.44
Custom elevation pointer composed of lines, filled region, and labels

9. Again, remember to make sure the properties Keep Readable and Fixed Rotation are checked for the labels.
10. Save the family as **`Custom Elev Pointer.rfa`** and load it into the `Custom Elev Head .rfa` family.
11. Place four instances of the Custom Elev Pointer family around the intersection of the visible reference planes, as shown in Figure 4.45.

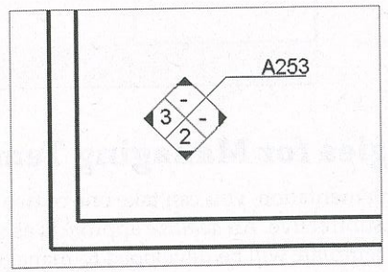
FIGURE 4.45
The nested pointer family is placed four times in the head family.



When this custom elevation tag family is loaded into a project and associated with an elevation type, it will function much like standard elevation symbols.

After the views are placed on a sheet, you get a preview of the completed elevation symbol, as shown in Figure 4.46.

FIGURE 4.46
A customized elevation tag for interior elevations

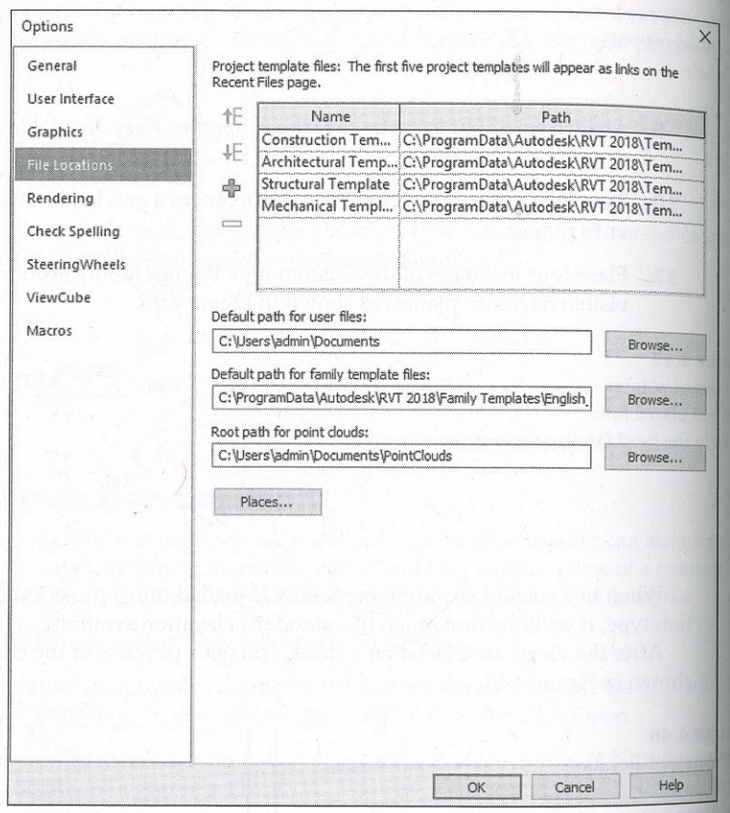


Starting a Project with a Custom Template

Now that we have covered many areas of customization within project templates, you can configure Revit to use any of your custom project templates. To do so, follow these steps:

1. Click the File tab, and at the bottom of the menu, click Options.
2. In the Options dialog box, select the File Locations category. The list of Project Template Files allows you to select several RTE files that will be displayed on the Recent Files screen. You can see these files in a drop-down list when you launch the New Project command either from the File tab or by pressing Ctrl+N on the keyboard.
3. Click the green plus to add RTE files, and use the up and down arrow icons to modify the order of the templates in the list (Figure 4.47).

FIGURE 4.47
Add your custom project templates to File Locations in the Options dialog box.

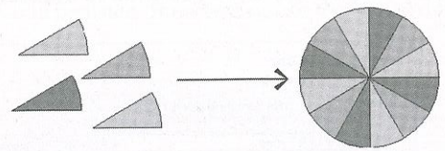


Strategies for Managing Templates

During implementation, you can take one of two approaches when managing project templates: additive or subtractive. An *additive* approach, as shown in Figure 4.48, assumes that more than one project template will be developed to manage standards and content for a single project. Typically, a "base" template is used to start a project with a minimum amount of settings,

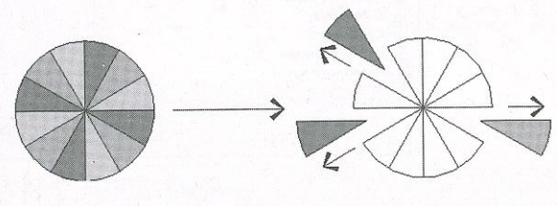
whereas content and settings from "supplemental" templates are appended based on region, project type, or project style. In this scenario, each template file is lighter, but managing the templates becomes more difficult because changes in common settings or families must be applied to all templates.

FIGURE 4.48
Additive template approach



In contrast, the *subtractive* approach, shown in Figure 4.49, uses a single master template that contains all standard settings and content. This method relies on the project teams to remove and purge unused content. Although the file size of these templates tends to be larger, graphic settings and template updates are easier to manage within a single file.

FIGURE 4.49
Subtractive template approach



Aggregating Template Data

Whether you are managing the settings between templates or developing a project with multiple templates in an additive approach, you have useful tools within Revit to help share data between projects, such as Transfer Project Standards, Insert Views From File, and Insert 2D Elements From File.

TRANSFERRING PROJECT STANDARDS

You can easily share Revit families between project files by loading their RFA files; however, most other types of content must be transferred with the Transfer Project Standards command. Types of elements commonly transferred with this command include, but are not limited to, the following:

- Materials
- System family types (Walls, Floors, Roofs, Stairs, and so on)
- Text and dimension styles
- Filled regions
- Grid and level types
- Line styles and patterns
- Object style settings
- Viewport types

To use this command, you must first have both the source and target Revit files open within the same instance of the software. As an alternative, you can have the source file linked into your target file. Next, make the target file the active project. Switch to the Manage tab, and select Transfer Project Standards on the Settings panel. In the Select Items To Copy dialog box (Figure 4.50), choose as many item categories as you want to transfer, and then click OK.

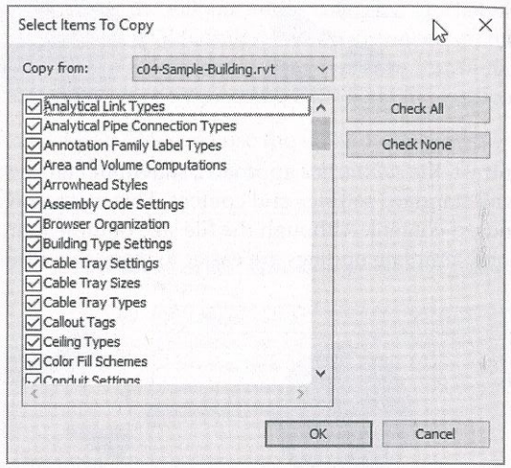


FIGURE 4.50
Select categories to be transferred between projects.

If you choose an element category containing some of the same types that already exist in your current project, you will be prompted with the option to overwrite the existing types or import the new types only (New Only), as shown in Figure 4.51.

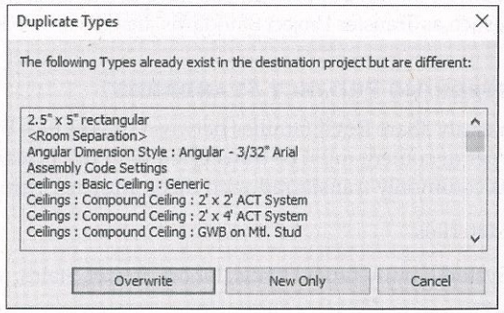


FIGURE 4.51
Transferring project standards with duplicate types

Inserting Views from a File

The Insert Views From File command is useful for sharing views between project files—especially if you use the additive method of template management we mentioned earlier. This command allows you to copy drafting views, renderings, or schedules from one project to another. It can also insert entire sheets with all attached drafting views and associated properties. This procedure is quite useful if you use Revit project files as containers for your standard or typical details. An entire sheet of details can be inserted with one command!

1. Switch to the Insert tab, and choose Insert From File ➤ Insert Views From File in the Import panel.
2. Browse to a Revit project file (with the filename extension `.rvt`), and you will then see the Insert Views dialog box (Figure 4.52). In the left pane, all eligible drafting views, sheets, and schedules will be listed. If necessary, use the Views drop-down list to filter the choices.

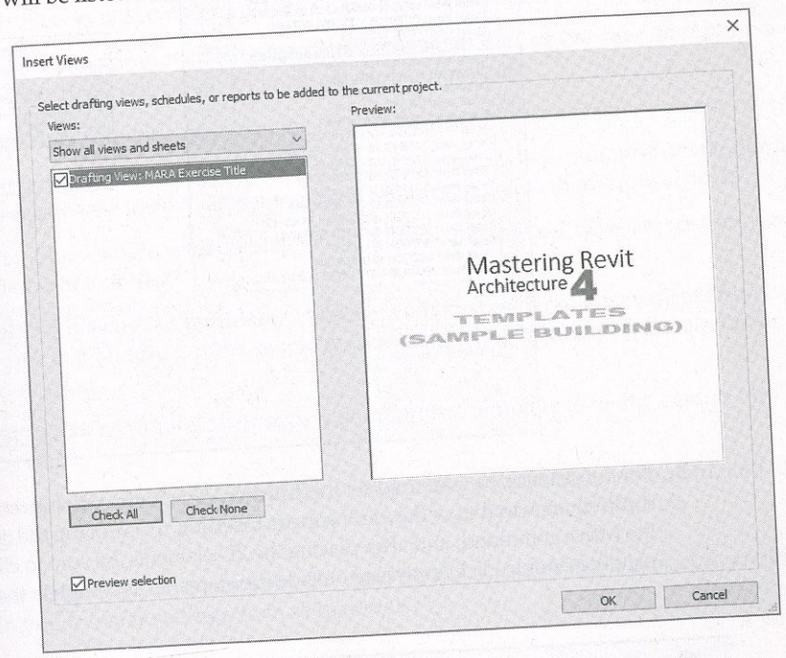


FIGURE 4.52
Insert Views can be used to transfer an entire sheet of drafting views into your project.

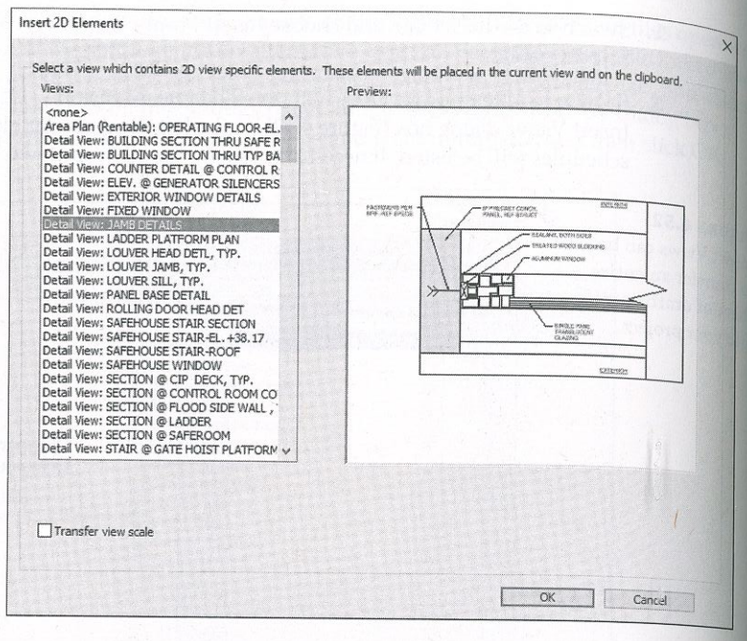
3. If one or more sheets are selected in the Insert Views dialog box, all eligible drafting views placed on those sheets will be inserted into the current project as well. Note that repeating this process does not update the drafting views in the project but instead creates new renamed drafting views and sheets. Also note that any custom view parameters are maintained during the transfer and can fit right into your customized Project Browser organizations, as we discussed earlier in this chapter.

Inserting 2D Elements from a File

The Insert 2D Elements From File command is similar to the Insert Views From File command, but instead of inserting an entire view, it will transfer only the view-specific elements from the selected view to the active view in the current project. You can select only one view from the selected file. This command allows you the flexibility to insert various view-specific elements such as detail lines, filled regions, text, and color fill legends. These elements can be imported from any view—not just drafting views.

1. On the Insert tab, find the Import panel, choose Insert From File ➤ Insert 2D Elements From File, and then navigate to a project file.
2. Choose one of the available drafting views in the Insert 2D Elements dialog box (Figure 4.53).

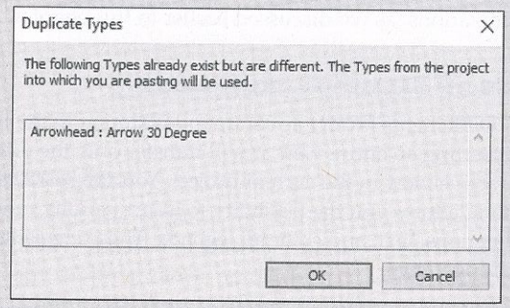
FIGURE 4.53
Insert 2D Elements dialog box



3. For consistency, be sure to select the Transfer View Scale option to convert the scale of the active drafting view to that of the view you are inserting. Try moving the elements into position using the Move command, and after placing the 2D elements, be sure to click Finish in the Edit Pasted panel or double-click anywhere outside the elements to complete the command.

DUPLICATE TYPES WHEN INSERTING

When using Insert Views From File or Insert 2D Elements From File, be sure to watch for warnings about existing types not being overwritten, as shown here, because new element types from the inserted source may contain more desirable properties.



If duplicated types from the inserted source are needed, rather than the existing types, those families can be loaded using the Load Family or Transfer Project Standards tools.

The Bottom Line

Define settings for graphic quality and consistency. The fundamental building blocks for any template are the customized settings for object styles, line styles, fill patterns, materials, and more.

Master It How can a complex custom-fill pattern be imported?

Organize views for maximum efficiency. The project template can be used to capture a framework supporting your visual and organizational standards.

Master It How can you customize the Project Browser to support your business needs?

Create custom annotation families. Developing a graphic style to match your standards will usually require you to edit some annotation families or create them from scratch.

Master It Can a single label display more than one parameter? How are custom view tags loaded into a project?

Start a project with a custom template. Making your custom template available for new projects ensures that all future projects will maintain the same level of graphic quality and efficiency you expect.

Master It How do you set your own custom project template to be the default for new projects?

Develop a template management strategy. Organizing your standards, content, and settings while using Revit tools to transfer content will make your effort more efficient.

Master It How do you insert your standard details from one Revit project to another? How do you transfer settings such as materials?