Alan Jefferis | Kenneth D. Smith, A.I.A.

Commercial Drafting and Detailing

FOURTH EDITION

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Preface

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COMMERCIAL DRAFTING AND DETAILING is a practical, comprehensive textbook intended to introduce students to the development of architectural and structural drawings required to develop a commercial structure. Students are expected to have previously completed either a basic drawing class or a class dealing with residential drafting as well as have a working knowledge of AutoCAD® or Autodesk® Revit®. Students will build on their knowledge gained through residential drafting and design as common materials and construction methods for commercial structures are explored. Throughout the text, students will be exposed to the work that the engineer or architect will do to develop the project. This book is in no way an attempt to transform CAD technicians into junior engineers. The work of the engineer and the architect is presented to help develop an understanding of the technician's role in the overall process of developing a set of plans.

New Features

Codes and Standards – Each chapter has been updated to comply with the 2015 edition of the *International Building Code®* (*IBC®*) published by the International Code Council (http://iccsafe.org), the 2015 *International Energy Conservation Code®* (*IECC®*), the 2012 *International Green Construction Code™* (*IgCC®*), and the 2010 edition of the *ADA Standards for Accessible Design* published by the Department of Justice of the U.S. federal government (ada.gov/2010ADAstandards).

Note Boxes – These are provided throughout the text to draw your attention to key items that may have gotten lost in a sea of text. It's important to read the chapters, but pay close attention to the information presented in these boxes to gain valuable information related to key drawing procedures, safety precautions, and office skills needed for advancement.

Going Green – You're preparing to enter the AEC industry at a time when consumers, design professionals, and construction companies are focused on conserving energy and recycling materials. These boxes are used throughout the text to highlight current and experimental energy-efficient products and construction techniques. Using the links presented at the end of each chapter to advance your understanding of energy-efficient technology and construction methods will aid you in gaining your first job and in advancing your career.

CAD Boxes – Assuming that you've successfully completed a CADD class prior to starting the projects contained in this text, these boxes contain a list of the basic CAD skills that should be mastered prior to attempting to complete the specific projects in each chapter. Use the listed skills as a review to ensure that you have the needed skills to attempt a project. Attempting a new drawing project for the first time can be confusing. Attempting new drawing projects without the necessary skills will lead to unneeded frustration. Make sure you're properly armed prior to attacking each drawing project.

Revit Boxes – In addition to working with AutoCAD, many AEC firms are now using Autodesk Revit to create and view their projects. Each drawing chapter contains an overview of how Revit can be used to generate a model of the material presented in the chapter.

Team Projects – In an effort to prepare you for work in a professional office setting, team projects have been added to this text. These projects are intended to introduce you to situations you will encounter in the team atmosphere of an office. Team projects will allow you to build on these skills to help you work successfully with other team members. These projects are designed to help you plan a project, research needed product information, complete and coordinate drawings components with other team members, evaluate drawings and the performance of team members, and plan changes in procedures that you would implement when completing future projects.

Layout

This text has two major divisions. Chapters 1 through 12 are designed to introduce the reader to the materials and construction methods common to commercial construction. This portion of the book is itself divided into two major sections. Each chapter provides an end-of-chapter test to assess understanding as well as practical drawing problems to apply knowledge. Many drawing problems are intended to force the student to make use of *Sweets Network*™, vendor websites, or local suppliers to prepare for the research that is expected in most professional offices.

Section 1 introduces students to the major codes that they will encounter in an engineer's or architect's office. The content of the entire book is based on the 2015 edition of the *IBC*. Students are also introduced to ADA standards that affect commercial structures. Although this is information that the project designer will be responsible for, we feel it is critical for the CAD technician to understand the codes that shape design.

Section 2 deals with the materials that shape the construction process, including wood, engineered lumber, timber, steel, concrete block, poured concrete construction, and the fasteners used to connect these materials. Each chapter could serve as the core for a class dealing with each material or as an overview of the entire process.

The second half of this text is intended to be a practical approach to the development of the architectural and structural drawings. The key elements that make up the architectural and structural drawings will be introduced in Chapters 15 through 24. In Chapter 15, the site drawings for four major projects will be introduced, with each project reflecting one of the major building materials. These projects and their related projects in future chapters include the following:

- Wood: multifamily complex

  Problems 15-3, 16-1, 17-3, 18-1, 19-1, 20-1, 21-5, 22-1, 23-1, 24-11 are related to this project.
- Concrete block/truss roof: retail sales

  Problems 15-4, 16-2, 17-4, 18-2, 19-2, 20-2, 21-5, 22-2, 23-2, 24-12 are related to this project.
- Concrete block: warehouse with mezzanine, panelized roof

  Problems 15-5, 16-3, 17-5, 18-3, 19-3, 20-3, 21-5, 22-3, 23-3, 24-13 are related to this project. Each portion of this project can be completed as a team or as an individual project. Verify with your instructor how the project is to be approached.
- Precast concrete: warehouse with mezzanine, truss roof

  Problems 15-6, 16-4, 17-6, 18-4, 19-4, 20-4, 21-5, 22-4, 23-4, 24-14 are related to this project. Each portion of this project can be completed as a team or as an individual project. Verify with your instructor how the project is to be approached.

As noted, various aspects of these projects are presented throughout the remaining chapters to help you develop the key drawings that make up a set of architectural and structural drawings related to one structure. Portions of each of the projects contained in Chapters 15 through 24 can be accessed from the student companion website in the DRAWING PROJECTS folder and used as a base to complete the assignment. The drawings are a rough draft only and need to be updated to reflect common standards; appropriate symbols, linetypes, and dimensioning methods; and notation methods.

NOTE:

The drawings contained at the end of the chapters are to be used as a guide only. You should use these drawings with the mindset that the previous technician who started the drawings was ***fired****. Information* ***may not be reliable****. Because your name will go in the title block, you must be very careful before blindly accepting another person's layout. As you progress through the drawings you'll find that* ***some portions of the drawings do not match*** *things that have been drawn on previous drawings. For instance, if the information on the floor plan and elevations do not agree, alter the elevations to match the floor plan.*

Each project has errors that will need to be solved. The errors are placed in the project to force you to think in addition to drawing. Most of the errors are so obvious that you will have no trouble finding them. If you think you have found an error, do not make changes until you have discussed the problem and possible solutions with your engineer (your instructor). It's not enough to find the mistakes. Come up with a solution that incorporates materials that have been completed in previous chapters, and coordinate your ideas with materials that will be drawn in future chapters.

@Instructor Resources

The Instructor Resources section, found on cengagebrain.com, was developed to assist educators in planning and implementing their instructional programs. It includes: detailed lesson plans for each chapter; PowerPoint® lecture slides that present the highlights of each chapter; an image gallery of images from the book; and an instructor's guide.

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Student Companion Website

A website icon found throughout this textbook guides students to material found on the student companion website. To access the site students go to www.cengagebrain.com, type **9781285097398**. When the book's main page is displayed, click the **Access** button under **Free Materials** tab. To download files, select a chapter number and then click on the **Assets** tab on the left navigation bar to download the files.

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- An interactive ebook with highlighting, note taking, and search capabilities.
- Interactive learning tools including chapter quizzes and flashcards.
- And more! Go to login.cengagebrain.com to access these resources.

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Suite 140
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Engineered Wood Association (formerly
the American Plywood Association)
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Tacoma, WA 98466-5333
Website: www.apawood.org

Americans with Disabilities Act
Federal Register Vol 56, No 144, July 26, 1991

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6060 Sunrise Vista Dr.
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Citrus Heights, CA 95610
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Section 1

CAD Drafting and Design Considerations of Commercial Structures

Chapter 1

Professional Careers and Commercial CAD Drafting

KEY TERMS

Architect
CAD technician
CAD technician, senior
Commercial structures
Construction estimator
Construction inspector
Engineer
Engineer, civil
Engineered lumber
Engineer, electrical
Engineer, mechanical
Engineer, structural
Illustrator
Inspector
Interior designer
LEED
Plans examiner

You are about to start the exciting exploration of commercial drafting. As authors who have spent our lives in commercial design and education, we wrote this book with the expectation that you will enter the drawing field as a CAD technician, or use the skills you will acquire in this text to progress through an accredited architectural or engineering program. The exploration of commercial drawing will occur in four distinct stages, including:

- CAD drafting and design consideration of commercial structures
- Common materials and building methods of commercial construction
- Preparation of architectural drawings
- Preparation of structural drawings

This chapter opens our exploration of commercial construction by discussing:

- Common employment opportunities in the design and drafting of commercial structures
- The effect of green construction on the design and construction of commercial structures

Employment Opportunities in Commercial Design and Drafting

To many in the architecture, engineering, and construction (AEC) fields, commercial drafting is the development of the construction drawings for any nonresidential structure. For most professionals involved in the design process, the general area of commercial drafting comprises public, industrial, institutional, and commercial projects. Examples of each are listed below.

- *Public structures* are buildings or portions of structures used for assembly, education, or civic administration, such as schools, churches, stadiums, post offices, and libraries.
- *Industrial structures* are buildings or portions of structures used for manufacturing, assembly, or storage, such as factories, warehouses, and businesses involved in hazardous, toxic, or unstable materials.

- *Institutional structures* are buildings or portions of structures used by occupants with limitations caused by health, age, correctional purposes, or in which the mobility is restricted, such as residential care facilities, medical facilities where 24-hour care is provided, day care facilities, jails, and prisons.
- *Commercial structures* are defined by the *International Building Code®* (*IBC®*) as buildings or portions of structures used for sales, business and professional, or service transactions, including office buildings and eating and drinking establishments. The *International Energy Conservation Code®* (*IECC®*) defines any building that is not a residential building with an occupancy of R-2, R-3, or R-4, and is three stories or less, as a **commercial structure.**

This text will look at commercial drafting as it relates to all these fields. Your role in the development of commercial drawings will vary depending on the size and structure of the firm where you work. Most architectural and engineering firms consist of a single office. As the size of a firm increases, it may have multiple offices located throughout the country, and some very large companies are international. The size of the company will affect the types of structures it works with. Some design firms are very specialized and work only in one field, such as educational or institutional facilities. As the size of the firm increases, it may have different divisions within the company for designing various areas of occupancy. Chapter 4 will introduce specific areas of construction based on the occupancy of the structure.

No matter how you define commercial construction, commercial drawing offers far more career options and challenges than residential drawing. Commercial projects are typically much larger and are completed by a team rather than an individual. In addition to the design team, engineers, architects, interior designers, and CAD technicians from different firms in a variety of construction fields complete the project.

The field of architecture has always offered many career opportunities. The use of computers and the development of software have revolutionized architectural and engineering offices and opened an almost unlimited potential for design. This chapter explores some of the main areas of employment in the field of commercial architecture and explains how CAD has affected each area. Chapter 3 explores essential AutoCAD® skills required to obtain your first job as a professional CAD technician as well as introducing other common CAD software you might encounter at your first job. Major areas of employment in the architectural field are that of CAD technician, designer, interior designer, architect, and engineer.

NOTE:

If you've followed employment trends in the AEC fields, you know that the availability of jobs in all phases of the field is down. The good news though is that according to the International Code Council® (ICC®) studies, permit applications for multiunit housing and commercial structures were up at the end of 2012, with predictions for continued growth. Don't be discouraged from completing your studies in the field. The market will get better, but you'll need to be well prepared with a well-rounded education to compete for a job.

CAD Technician

A **CAD technician** is a person who draws the designs that originate with another person. Traditionally referred to as a *drafter* in the days of manual drafting, most firms and job postings now use the term *CAD technician* or use both terms interchangeably. In addition to these terms, job listings may also be described with the terms *CAD designer, engineering technician, CAD operator, CAD design technician, CAD engineering design technician, technician,* and *design drafter.* The CAD technician's main responsibility is to take a drawing similar to Figure 1.1 and fill in the missing material, using acceptable office standards so that it resembles the drawing in Figure 1.2. The experience and education of the technician affect the actual job assignments.

ENTRY-LEVEL TECHNICIAN

An entry-level CAD technician is typically preoccupied with making corrections, running prints, and completing simple drawings while confidence is gained in the standard office procedure. In some areas of the country, and in a thriving economy, it is possible to obtain an entry-level technician intern position as a high school student. In a stagnate job market you might find yourself competing with someone with a four-year degree. Even in a strong economy, because of the complexities involved in creating commercial drawings, most offices require college training. A new CAD technician with some college or trade school experience will typically start a new job by making corrections to existing drawings. To advance in an office you'll need to become proficient using the firm's computer standards and any special menus and list-processing language (LISP) routines needed to work efficiently. An understanding of basic construction techniques is also essential for advancement.

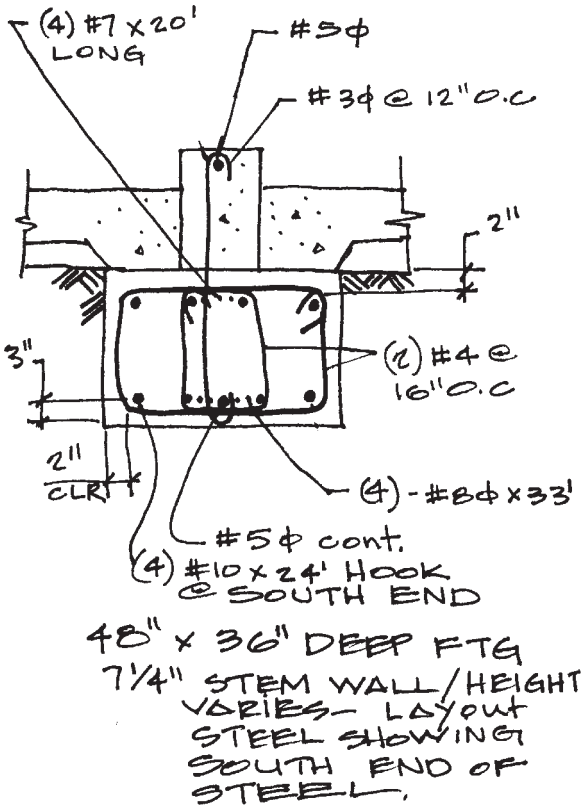


FIGURE 1.1a The project manager will typically provide a sketch for an entry-level CAD technician to use as a guide. The job of the drafter is to accurately represent all materials using the proper office formatting for lines and layers.

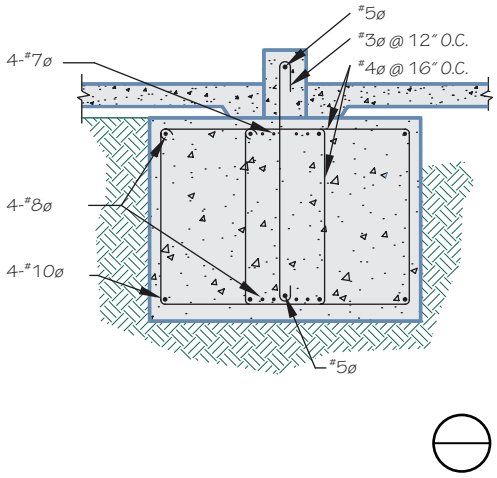


FIGURE 1.1b Another common type of project an entry-level CAD technician will encounter is to take a drawing started by someone else and complete the drawing using the proper office standards.

One of the best ways to gain an understanding of typical construction practice is to spend time at construction sites. Being able to follow a project through the various stages of construction will greatly aid a new CAD drafter in gaining an understanding of the information that is entered at the keyboard.

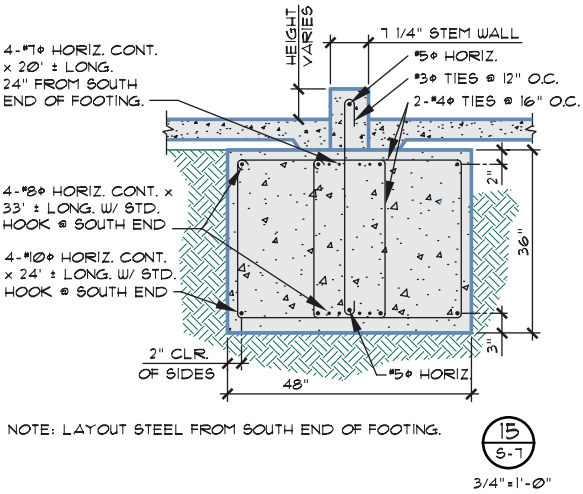


FIGURE 1.2 The CAD technician's main responsibility is to accurately convey information from the architect or engineer to those involved in the construction project using acceptable office standards. This drawing was completed by the technician using the sketch in Figure 1.1 as a guide, along with vendor catalogs.

NOTE:

A visit to a construction site requires preparation. Because of the high risk or injury, and the dangers that construction firms face from theft and insurance liability, not everyone is a welcome guest at a construction site. If possible, call the site to schedule a visit. Rarely will you be allowed to just roam the site unattended, so someone will need to be available to guide your tour. You'll rarely be welcome when overhead deliveries are in progress. Knowing when crews take rest breaks, break for lunch, or end their day will make it more likely that you'll be allowed to tour the site. When you do go to the site, report immediately to the job trailer to verify that your visit is approved. Don't show up in flip-flops and expect to tour the construction site. Hard-soled shoes are required and steel-toed work boots are preferred. An orange or yellow shirt will increase your visibility, and a hard hat is a must. The site supervisor will typically supply an orange vest and a hard hat to allow you to comply with OSHA safety standards.

In addition to improving CAD drafting skills, most employers expect academic skills to increase before more challenging projects are assigned. Other necessities for advancement are confidence and the ability to work in a team. As confidence is gained, and understanding of the types of drawings being completed increases, the supervisor will be able to provide sketches with less detail and rely on the technician to research a solution based on the governing code and similar projects that have been

Professional Perspective

One of the best ways to advance within a work setting is performing an assigned task in an accurate, fast, and efficient manner. Your chances for success are greatly improved if you listen attentively, take notes, and ask relevant questions about the project. Verify project requirements, deadlines, and common blocks or drawings that would be appropriate for the new project. Because verbal communication can often be misunderstood, a second aid to improving your success is to summarize your understanding of the project to your team captain. Remember that time is money in the business setting, so summarize the assignment in short statements. Go to team meetings prepared to excel, listen attentively, take notes, confirm, and be successful.

completed in the office. The decisions involved in making drawings without sketches also require the technician to have a good understanding of what is being drawn. This understanding does not come just from a textbook. A good method to gain an understanding of what you are drafting is to spend time at a construction site of some of the projects that you've worked on so that you understand what a craftsperson must do as a result of what you have drawn.

Personal Requirements An additional skill required for an entry-level technician is to be reliable. Reliability within an office is measured by the maintenance of good attendance patterns and the production of drawings as scheduled. Little things like showing up on time, performing your job assignments on time, and offering to help around the office are greatly rewarded in the long run. Occasionally coming in early to do research regarding company standards or staying late without pay or whining help show that you want to be a respected part of the design team.

To become a valued member of the drawing team will require you to become an effective manager of your time. This includes the ability to determine what drawings will need to be created, to select them from a stock library and edit them, and to estimate the time needed to complete these assignments and meet deadlines established by the team captain, the client, the lending institution, or the building department. It is also important that you be able to accurately estimate the time required to complete each project. You can develop this skill while working on school projects by estimating the amount of time that will be required to complete the project prior to starting the drawing. In the planning stage, break the project into components and estimate how long each component will take. When the drawing is complete, review your estimates and use the AutoCAD TIME command to determine the actual time required to complete the drawing. Although most firms would prefer a drafter who can quickly complete a project, speed is no substitute for accuracy. Push yourself as a student to meet a self-imposed time deadline while maintaining quality and accuracy. Reliability is also important because a team completes the drawings for a structure. The ability to get along with others, to complete assigned projects in a timely manner, and to coordinate different parts of a project with others will greatly affect how fast a drafter will advance.

Workplace Ethics Ethics are rules and principles that define right and wrong conduct. As a student your school will typically have guidelines in a student handbook or web page outlining what is and is not acceptable behavior in the classroom. As a design professional, one of your first jobs should be to determine what is expected of you. Information can be gained from a discussion as you complete the required documents for receiving a paycheck and paying taxes or from a company website from a link outlining behavior. As a new employee, you must be able to access appropriate resources to identify roles, rights, and responsibilities for both you and your employer.

Although ethics guidelines can be as simple as treating others as you would like to be treated, many businesses have a formal code of ethics that employees are required to sign to obtain a job. This is a formal document that states an organization's values and the rules and principles that employees are expected to follow. In general, a code of ethics contains these main elements: be dependable, obey the laws, and be good to customers. Following is an example of an architectural firm's standard for ethical business conduct.

Professional Perspective

Many of the tips for behavior and ethics presented in this chapter include the same information that you were taught in kindergarten: share, play nicely, keep your mitts off others, and be kind. Sadly, somewhere along the line many people have forgotten to be nice and play fair. Incorporating the concepts in this chapter into your professional life will be helpful in building and keeping relations with your teammates, supervisors, construction workers, and building department officials. You'll be able to tell when the relationships with each of these groups are satisfactory because other classmates and employees will be anxious to work with you, your supervisors will keep you around, contractors will be willing to work with you, and your plans will sail through the permit process. Tick off an inspector, and he or she can find hundreds of ways to brighten your day.

1. *Honesty:* to be truthful in all our endeavors, to be honest and forthright with one another, with our customers, and with our communities
2. *Integrity:* to say what we mean, to deliver what we promise, and to stand for what is right
3. *Respect:* to treat one another with dignity and fairness, appreciating the diversity of our workforce and the uniqueness of each employee
4. *Trust:* to build confidence through teamwork and open, candid communication
5. *Responsibility:* to speak up without fear of retribution and report concerns in the workplace, including violations of published or unpublished works that are copyrighted

Don't be discouraged as you consider the typical entry-level CAD position. This is the type of position you might consider during your first year in school, not as a career. Although you might aspire to design the eighth, ninth, and tenth wonders of the world, an entry-level position can offer valuable insight into the world of architecture and supplement your academic course work. Depending on the size of the office where you work, you may also spend a lot of your time as a new employee editing stock details, running prints, making deliveries, obtaining permits, and doing other office chores. Don't get the idea that a technician only does the menial chores around an office. But do be prepared, as you go to your first CAD job, to do things other than drafting.

EDUCATIONAL REQUIREMENTS AND RECOMMENDATIONS

The education required for a CAD technician ranges from a degree from an accredited community college or technical school to a graduate degree from an accredited school of architecture. Getting your first CAD drafting job requires a solid education, a good understanding of basic computer skills, good CAD drawing skills, and the ability to sell yourself to an employer. AutoCAD, Revit®, and AutoCAD Architecture are used in most midsize and larger architectural and engineering firms to aid in collaboration with consulting firms. Many smaller firms that specialize in residential or multifamily projects use a variety of software programs such as Google SketchUp Pro®, Graphisoft®, ArchiCAD®, Chief Architect©, or SoftPlan®. Especially in smaller cities, taking time to research what software is in demand with the AEC design professionals in the area will help you in finding future employment. Making scheduled visits with AEC professionals to research hiring and education requirements for their firms is also a great way to get your foot in the door for a future job interview.

CAD skills must include a thorough understanding of drawing and editing commands as well as the ability to quickly decide which option is best for the given situation. This ability will also come with practice. If you work full-time editing details, you'll quickly become proficient in deciding on the best commands to use. The education required for a CAD technician can range from one or more years in a high school drafting program to a diploma from a one-year accredited technical school to a degree from a two-year college program and all the way to a master's degree in architecture. The required education is greatly affected by the size of the city where you're seeking employment and the strength of the economy in that area. Areas of study that will help

you advance as a CAD technician include math, science, English, writing, drawing, and computer drafting.

Math The math required to excel ranges from simple addition to calculus. Although the CAD technician may spend most of the day working with dimensions expressed in feet and inches or millimeters, knowledge of advanced math is helpful for solving many construction problems. You'll often be required to use basic math skills to determine quantities, areas, percentages, and volumes. Clients are always concerned with building cost, sizes, and areas devoted to specific tasks. Building departments are also concerned with the size of individual rooms, opening sizes required for escape, and the percentages of openings/wall areas to be calculated for determining heat loss or gain. Many firms provide their clients with a list of the quantities of specific materials required to construct the project. Area calculations determine the size of each room, areas to meet basic building code requirements, the loads on a structural member, or the size of the structure. Your computer or other hand-held device may be able to aid you in these tasks, but understanding the principles behind these skills will be priceless if the power goes off, or while you wait for your batteries to recharge.

Science Any science class that you can squeeze into your schedule will be helpful. Classes in biology are helpful as you work on environmental areas of a project including managing and tracking requirements for the *International Green Construction Code®* *(IgCC®)*. Chemistry classes will prove helpful as you track chemicals that are contained in the products specified on the drawings to ensure the selection of environmentally friendly products. An understanding of the potential chemicals at a jobsite will be helpful during job visits and for completing safety reports related to each project site. Physics classes will prove useful to help understand an engineer's calculations and as you advance in your design career. Understanding how forces act on a structural member, as well as the entire structure, will help you understand why specific materials were selected. Understanding how energy, momentum, temperature, and pressure affect a structure will be helpful in understanding all areas of the design process.

English, Grammar, and Technical Writing Writing skills will also be very helpful to a new employee and to a senior CAD technician. Your writing ability is an important key just to get an interview to show your work. Although many smaller design firms still accept paper resumes, most mid- to large-sized firms only accept electronic applications. The grammar that you use, your ability to write clear, concise statements, and your willingness to use spell check will all aid you in getting that first interview.

Once you're hired, you'll often be required to complete the paperwork that accompanies any set of plans, such as permit applications, requests for variances, written specifications, and environmental impact reports. You'll also need to effectively communicate with other members within the office and other consulting firms using the Internet, e-mail, text messaging, and tweets. Although many have used these methods of communicating for years, messages that you send professionally must forsake the grammar shortcuts associated with texting; therefore, use proper grammar and English in your communication. The method of sending letters has changed, but the need for proper grammar, sentence structure, and good technical writing skills has not been replaced by the method of sending the letter. You'll also need to effectively use your writing skills as you prepare written estimates, work orders, and memos throughout the design and the construction process that meet professional standards. Most companies require new CAD technicians to be able to

- prepare simple written documents and reports using existing company procedures;
- retrieve and edit existing documents;
- safeguard documents using the SAVE and SAVEAS functions;
- format text using basic formatting functions; and
- employ word processing utility tools such as spell check, grammar check, and a thesaurus.

Many offices also require the CAD technician to keep a job diary or work log to track how the job is progressing. Classes that you take in technical writing will introduce you to the skills to master these requirements in a professional manner. Chapter 14 explores professional writing opportunities and requirements.

Miscellaneous Education Recommendations In addition to standard CAD drafting classes and core educational classes, knowledge of several other fields will be helpful. Classes in public speaking will be helpful in a wide range of professional activities. Skills learned in speech classes will aid you in demonstrating your confidence by making eye contact

Professional Perspective

Whether you take a class or a seminar be sure to get training in the art of writing a resume early in your career. Unlike the old days, you're no longer just competing with another person from your program or from your community. Many large companies allow employees to work off-site electronically. You might be competing with a person in Hong Kong or Mumbai. Do your homework and find out how to make your resume stand out while still being truthful.

You also should take a class or seminar for practicing interviewing skills. It's more than learning how to overcome being nervous. Learn and practice methods that will help you demonstrate leadership skills that you can offer a company, methods of dealing with stress and conflict resolution, and showing that you can work well in a team environment. Determine your own interview questions that you should ask during an interview beyond those that concern how much you will be paid and when you will start. Ending an interview with a question such as "Are there any questions that you have, or areas about me that you're unsure of, or other questions I can answer to help convince you that I can do the job?" is a great way to open a door to information that can't be legally asked.

with those you're speaking with to giving you the confidence to stand and describe a project at a community advisory committee. Speech classes will also help you organize your thoughts so that you can ask intellegent questions for collecting information and clarify exact expectations of the client, your team leader, or building officials. The ability to ask intelligent questions is the first step in being able to deliver a quality project that meets the needs of the client.

Classes in art offer skills in the use of light, balance, and color that will be helpful to advance in most design fields or as an illustrator. Classes in photography are invaluable in moving beyond using your cell phone to snap a photo to developing skills to capture images using good lighting techniques as well as learning methods to mount and display photos. Classes related to construction skills such as surveying, estimating, and building trades classes that teach construction methods are also helpful to advance into areas such as construction management.

In addition to the classes learning how to use CAD drawing programs, most companies require new employees to be skilled in using the Internet for research purposes. New employees should be able to

- effectively search for job-specific products and materials without wasting time looking for inappropriate material;
- select and use appropriate search engines and search procedures;
- navigate websites using software functions;
- access and evaluate Internet resources for accuracy (Just because you find information on the Internet doesn't make it true. Take time to verify the source and the accuracy of the information you've found);
- access business and technical information using the Internet;
- use the Internet to secure needed supplies and resources;
- properly respond to prompts and messages; and
- run applications in accordance with processing procedures.

Learn to use software such as Microsoft® Word, Microsoft Excel, or other programs designed to manipulate spreadsheets required in many large firms. Most offices expect a CAD drafter to perform the following skills using a spreadsheet.

- Create, retrieve, edit, save, and print spreadsheets.
- Input and process data using spreadsheet functions.
- Locate and replace data using the search and replace functions.
- Process data using database functions such as structure, format, attributes, and relationships.
- Perform company-related calculations and analysis on spreadsheet data.
- Create charts and graphs from a spreadsheet.
- Perform calculations using simple formulas.

SENIOR CAD TECHNICIAN

A **senior CAD technician** is part of a design team made up of other technicians and supervised by an architect or engineer in most midsized offices. This person is responsible for supervising several CAD technicians. In small firms, the senior technician is typically in charge of producing the working drawings and is often expected to perform simple beam calculations and preliminary wind and seismic studies during the preliminary stages of the design prior to an engineer doing the complete design of the structure. Other job duties might include assigning projects for the drawing team, site visitations, and conferences with municipal building officials. A senior CAD technician is often instrumental in assigning file and layer names, linetype, and other CAD drawing standards and requirements to be used throughout the project. You'll also need to become familiar with vendors' catalogs. This might involve looking at the website of a specific manufacturer, or comparing the sites of several similar manufacturers, using your favorite search engine. Several websites are available to help find suitable products. Two common collections of vendor catalogs are the Sweets™ product catalogs and The Bluebook Building & Construction Network®. Both are websites that contain links to thousands of vendors related to a wide variety of building products. Sites such as these are especially helpful when a product is desired but the manufacturer is unknown. In addition to gathering information from specific manufacturers, the technician is expected to apply basic information from books such as *Architectural Graphics* or *Time-Saver Standards* to specific items within each project. These books will be useful in determining basic sizes of general features from all areas of the AEC world.

The senior technician is expected to be familiar with the building codes that govern the project and to maintain legal building standards. You may work with the many city and state building departments that govern your work. This will require you to research the codes that govern the building industry.

To advance as a senior CAD technician and be a good team leader, you will also need to develop skills that promote a sense of success among your teammates. Although it is against the law to discriminate on the basis of race, color, religion, gender, sexual orientation, age, marital status, or disability, moving beyond the law and creating a friendly and productive work environment is a critical skill for a team leader.

EMPLOYMENT OPPORTUNITIES

Firms of all sizes hire experienced CAD technicians to help complete drawing projects. Some opportunities still exist for converting hand-drawn details and drawings to AutoCAD. In addition to jobs in architectural and engineering offices, many architectural equipment suppliers such as heating, air-conditioning, electrical, and plumbing companies employ CAD technicians. Construction subcontractors hire CAD technicians to create their shop drawings. Firms that manufacture the actual construction components such as trusses, steel, and concrete beams also employ drafters to produce the needed drawings to manufacture their components. Due to their computer skills and construction knowledge, CAD technicians are often hired as sales representatives by many firms. Utility companies such as cable television, telephone, water, and gas companies all employ large numbers of CAD technicians to draw maps of individual routes of service. City, county, state, and federal agencies also hire large numbers of CAD technicians to update municipal records and projects such as parcel and subdivision maps, sewer layouts, and roadway projects. Figure 1.3 shows an example of a sewer drawing prepared by a CAD technician working for a city sanitation department. Information about CAD drafting opportunities in related construction trades can be obtained from the American Design Drafting Association. This organization includes members who work in areas such as heating and air-conditioning, plumbing, and electrical design. Contact the American Design Drafting Association for further information at

American Design Drafting Association
P.O. Box 11937
Columbia, SC 29211
803-771-0008
Website: www.adda.org

Designer

In some states a designer is a drafter who, by experience or state certification, is allowed to design multifamily and small commercial projects. The size of the project is dictated by the state. State laws vary on the types of buildings a designer may assume responsibility for without the supervision of an architect or engineer. In some areas of the country, anyone can decide that he or she is a building designer. In most states a designer working with commercial projects is required to work under the direct supervision of a licensed architect or engineer.

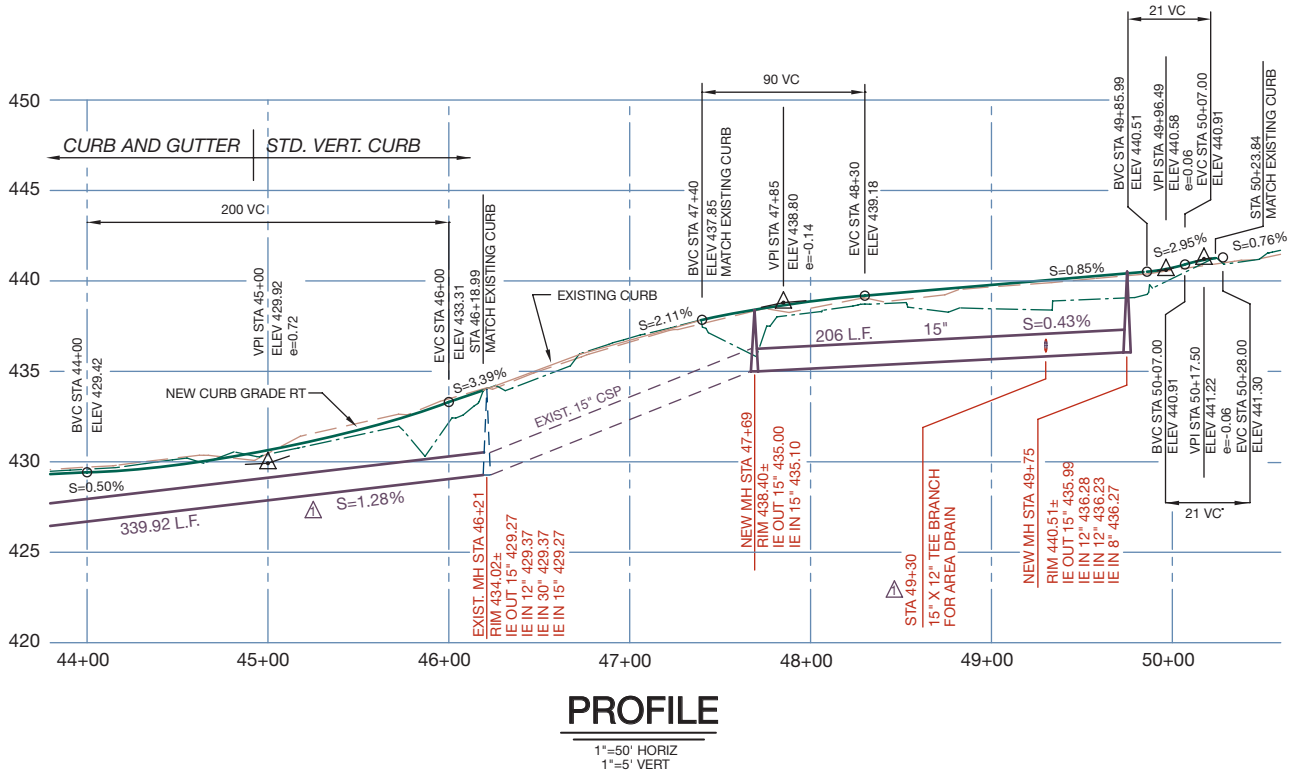


FIGURE 1.3 Many federal, state, county, and city agencies employ CAD drafters to complete required drawings. This profile drawing was completed by a CAD technician employed by a city sanitation department. *Courtesy of Oregon City*

Because of increasing liability problems, many states now require any person using the title *designer* to be licensed. The American Institute of Building Design (AIBD) now oversees designers in 40 states throughout the United States. Contact the AIBD for further information at

American Institute of Building Design
P.O. Box 1148
Pacific Palisades, CA 64057
Website: www.aibd.org

Interior Designer

Interior designers work with the architect to optimize and harmonize the interior design of structures. In addition to health and safety concerns, interior designers help plan how a space will be used, the amount of light that will be required, acoustics, seating, storage, and work areas. The elements of interior design include the consideration of how the visual, tactile, and auditory senses of the occupants will be impacted. An interior designer

GOING GREEN

A green or sustainable building is a structure that is designed, built, renovated, operated, or reused in an ecological and resource-efficient manner. Green buildings are designed to meet certain objectives such as protecting the health of the occupants; using energy, water, and other resources more efficiently; and reducing the overall impact to the environment. As a senior CAD technician, or with each of the following design positions to be described, you will be expected to provide input regarding materials and construction methods. Much of your time will also be spent investigating the use of environmentally friendly products suitable for each specific project. This will require good use of the Internet, good research skills, and a thorough understanding of the project to determine a product's compatibility with the project. As a new technician, one of your main responsibilities will be to become familiar with the *International Energy Conservation Code* and the *International Green Construction Code* and how these codes affect the projects you work on. Each will be introduced in Chapter 4.

must have an aesthetic, practical, and technical appreciation for how people use and respond to these elements, and how the elements interact with one another.

Designers must also be knowledgeable about the many types and characteristics of furnishings, accessories, and ornaments used in creating interiors. Furniture, lighting, carpeting and floor covering, paint and wall covering, glass, wrought metal, fixtures, art, and artifacts are just some of the many items and materials designers select from. In addition, they must be familiar with the various styles of design, art, and architecture and their history.

NOTE:

Becoming a student member of a professional association of drafters, designers, architects, or an engineer is an excellent way of getting to know design professionals. It's also a good way to become known. Contacts that you will make at these professional organizations will help you gain insight into the design world, provide information about issues affecting local design and building industries, and introduce you to possible employers.

EDUCATIONAL REQUIREMENTS

Although a college degree is currently not a requirement, the trend among employers and in states that have licensing requirements is to require a degree from an accredited institution. This can range from training in a two-year program to earn an associate's degree or certificate, to a four- or five-year program leading to a bachelor's (BA, BS, BFA) or master's (MA, MS, MFA) degree. The option chosen may depend on the licensing requirements in your state and whether you have completed a degree in another field.

In the United States, interior designers are registered by title. People cannot represent themselves using the title *interior designer* or *registered interior designer* unless they have met the requirements for education, experience, and examination as set forth in the statutes established by the National Council for Interior Design Qualification (NCIDQ). Candidates who apply to take the NCIDQ examination must demonstrate an acceptable level of professional work experience and completion of related course work. The minimum examination requirements include two years of formal interior design experience and four years of full-time work experience in the practice of interior design. Passage of the examination is required in 20 jurisdictions in the United States and 8 provinces in Canada that regulate the profession of interior design. For further information about careers in the field of interior design, contact

American Society of Interior Designers (ASID)
202-546-3480
Website: www.asid.org
International Interior Design Association
Website: www.iida.org

Architect

An **architect** is a person who is licensed by individual states to design and supervise the construction of structures. Although a few work full-time in the design or supervision of residential projects, most work in multifamily and commercial design because of the design challenges, job security, pay, and fringe benefits. Figure 1.4 shows a project designed by an architect. An architect is responsible for the design of a structure, from the preliminary drawings through the construction process, and must be able to coordinate the desires and limitations of the client, the financial restraints of the project, the physical setting of the project, and the structural elements of the material to be used.

Use of the title *architect* is legally restricted by each state. In order to be a licensed architect, a person must obtain a master's degree from an accredited school of architecture, complete three years of work experience for a licensed architect, and then pass the state test to demonstrate competency in several areas related to architectural practice. In some states, an architect's license can be obtained by gaining practical experience under the direct supervision of an architect and then passing the written exams. The length of time varies with each state, but typically five to eight years of work experience under the direct supervision of an architect are required before the state examinations may be taken.

EDUCATIONAL REQUIREMENTS

Because of the wide range of areas in which an architect must be competent, the educational requirements are very diverse. High school and two-year college students can prepare for a degree program by taking classes in fine arts, math, science, and social science. Many two-year drafting programs offer drafting classes that can be used for credit in four- or five-year architectural programs. A student planning

FIGURE 1.4 Architects are licensed professionals who work on a wide variety of structures. The Burj Al Arab hotel in Dubai, UAE, is world famous for its unique design by Tom Wright of Atkins. *© Paul Souders/Corbis.*

to transfer to a four-year program should verify with the new college which classes can be transferred. Preparation to enter a degree program in architecture should include the following:

- Fine arts classes such as drawing, sketching, design, and art, along with architectural history, will help the future architect develop an understanding of the cultural significance of structures and help transform ideas into reality.
- Math and science, including algebra, geometry, trigonometry, and physics, will provide a stable base for the advanced structural classes that will be required.
- Sociology, psychology, cultural anthropology, and classes dealing with human environments will help develop an understanding of the people who will use the structure.
- Literature and philosophy courses will help prepare students to read, write, and think clearly about abstract concepts.

In addition to formal study, students should discuss with local architects the opportunities and possible disadvantages that may await them in pursuing the study and practice of architecture.

Areas of Study The study of architecture is not limited to the design of buildings. Although the architectural curriculum typically is highly structured for the first two years of study, students begin to specialize in an area of interest during the third year of the program. Students may branch from architecture into related fields such as urban planning, interior architecture, and landscape architecture.

- *Urban planners* study the relationship among the components within a city.
- *Interior architects* work specifically with the interior of a structure to ensure that all aspects of the building will be functional.
- *Landscape architects* specialize in relating the exterior of a structure to the environment.

EMPLOYMENT OPPORTUNITIES

An architect performs the tasks of many professionals, including designer, artist, project manager, and construction supervisor.

The American Institute of Architects (AIA) lists several common positions that architects fill including:

Technical staff—CAD operators; drafters; consulting engineers such as mechanical, electrical, and structural engineers; landscape architects; interior designers.

Intern—Unlicensed architectural graduate with less than three years of experience. Common responsibilities include developing design and technical solutions under the supervision of an architect.

Architect I—Licensed architect with three to five years of experience. The job description typically includes responsibility for a specific portion of a project within the parameters set by a supervisor.

Architect II—Licensed architect with six to eight years of experience. The job description typically includes responsibility for the daily design and technical development of a project.

Architect III—Licensed architect with 8 to 10 years of experience. The job description typically includes responsibility for the management of major projects.

Manager—Licensed architect with more than ten years of experience. Job duties include management of several projects, project teams, client contacts, project scheduling, and budgeting.

Associate—Senior management architect, but not an owner in the firm. This person is responsible for major departments and their functions.

Principal—Owner or partner in an architectural firm.

The work of an architect is not limited to the design of structures. Architects are often employed by local and state governments to work as urban planners, planning whole areas rather than a single structure. Some architects, such as interior planners, lighting specialists, or audio experts, specialize in specific areas of design. Contact the AIA for more information about the role of an architect at

American Institute of Architects
1735 New York Avenue, NW
Washington, DC 20006
Website: www.aia.org

Contact the following organizations for related information about specialties in the field of architecture at

American Society of Landscape Architects, Inc.
636 Eye Street, NW
Washington, DC 20001-3736
202-898-2444
Website: www.asla.org

American Society of Interior Design
Website: www.asid.org

Engineer

The title **engineer** encompasses a wide variety of professions. Structural, electrical, mechanical, and civil engineers are typically involved in the design of a structure. **Structural engineers** are licensed professionals who specialize in the design of the structural skeleton of a structure. Teams of engineers coordinating with the architectural team designed the Bahrain World Trade Center shown in Figure 1.5.

Electrical engineers work with architects and structural engineers and are responsible for the design of lighting, power supply, and communications systems. This includes supervision of the design and installation of specific lighting fixtures, telephone services, and requirements for computer networking.

Mechanical engineers are responsible for the sizing and layout of the heating, ventilation, and air-conditioning systems (HVAC) and details similar to those shown in Figure 1.6. This involves working with the project architect, who determines the number of occupants and the heating and cooling loads, and designing the route that conditioned air will take

FIGURE 1.5 Once the architectural team has designed a structure, the engineering team is responsible for determining the loads that a structure must resist and ensuring that those loads are transferred to the foundation and into the supporting ground. Engineers working on this structure in Manama, Bahrain, not only had to plan for the normal loads of a structure, but they also had to design the structure in such a way that the twin 50-story towers would support the three wind turbines that are used to help supply energy for the structure.
© Yoshio Tomii/The Image Bank/Getty Images.

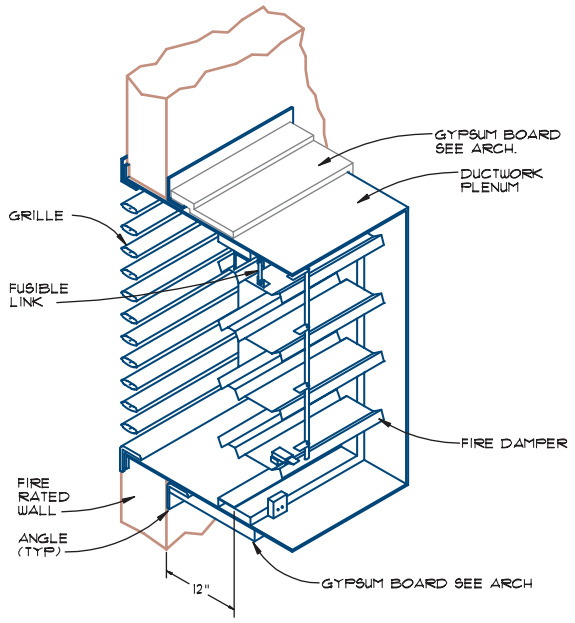


FIGURE 1.6 Mechanical engineers are responsible for the design of the HVAC system and all required drawings and details. *Courtesy of Tereasa Jefferis/Manfull Curtis*

through the building. The mechanical engineer also plans the size and locations of plumbing lines for fresh and wastewater as well as lines for other liquids or gases that might be required for specific occupancies.

Civil engineers are responsible for the design and supervision of a wide variety of construction projects such as subdivision plans, as well as grading and utility plans for construction projects such as buildings, highways, bridges, sanitation facilities, and water treatment plants. Civil engineers are often directly employed by construction companies to oversee the construction of large projects and to verify that the specifications of the design architects and engineers have been carried out.

EDUCATIONAL REQUIREMENTS

A license is required to function as an engineer. The license can be applied for after several years of practical experience, or after obtaining a bachelor's degree and three years of practical experience. Success in any of the engineering fields requires a high degree of proficiency in math and science, including courses in physics, mechanics, print reading and architecture, mathematics, and material sciences. Similar to the requirements for becoming an architect, engineers are required to complete five years of education at an approved college or university, followed by successful completion of a state-administered examination. Certification can also be accomplished by training under a licensed engineer and then successfully completing the examination. Contact these organizations for additional information about the field of engineering at

American Society of Civil Engineers® (ASCE)
1801 Alexander Bell Drive
Reston, VA 20191-4400
800-548-2723
Website: www.asce.org

American Consulting Engineers Council (ACEC)
1015 15th Street, NW, Suite 802
Washington, DC 20005
202-347-7474
Website: www.acec.org

American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE)
1791 Tullie Circle NE
Atlanta, GA 30329-2305
800-527-4723
Website: www.ashrae.org

Illuminating Engineering Society of North America© (IESNA)
120 Wall Street, 17th Floor
New York, NY 10005
212-248-5000
Website: www.iesna.org

Related Jobs in AEC Fields

In addition to the drawing and design aspects of construction drawings, a drafting background can lead to several other careers such as illustrator, model maker, specifications writer, and inspector. A drafting background can also be useful in careers such as sales representative, contractor, and estimator. Although these jobs do not require drafting as a job requirement, knowledge of drafting fundamentals will help in the performance of job requirements.

Illustrator

Commercial drawing requires the use of a rendering such as that seen in Figure 1.7. Many drafters, designers, and architects have the basic skills to draw architectural renderings, but very few have the expertise to make this type of drawing rapidly. Most **illustrators** have a background in art. By combining artistic talent with a basic understanding of architectural principles, an illustrator is able to produce drawings that show a proposed structure realistically.

FIGURE 1.7 Drawings are often prepared by an architectural illustrator to help convey design concepts. *Courtesy Dean K. Smith, Kenneth D. Smith Architect, & Associates, Inc.*

Presentation drawings range from traditional renderings created with graphite, ink, colored pencils, or watercolors to computer-generated renderings. Many firms are now adopting the use of AutoCAD's solid modeling programs and third-party software to create computer-generated renderings. Drawings created in 3D allow the viewpoint to be altered, providing a realistic look at the structure from any vantage point. Illustrators also use virtual reality to represent how a structure will blend with its environment and to allow clients to walk through proposed buildings and see how components can be arranged. Chapter 3 will explore additional methods of creating 3D drawings. For more information, contact

American Society of Architectural Illustrators (ASAI)
1022 Tait Street
Oceanside, CA 92054
760-453-2544
Website: www.asai.org

Model Maker

In addition to presentation drawings, many architectural firms use models of building projects to help convey design concepts. Models similar to the one in Figure 1.8 are often used for public presentations to groups such as zoning commissions, citizens' advisory committees, and other regulatory commissions. Model makers need basic drafting skills to interpret the working drawings so that the model can be an accurate representation of the proposed structure. Model makers are employed by large architectural firms, or by companies that specialize in making models for architects, or by municipalities. For more information, use your favorite search engine to look for architectural models or contact the Association of Professional Model Makers (APMM) at

Association of Professional Model Makers (APMM)
P.O. Box 165
Collinsville, CT 06019
887-663-2766
Website: www.modelmakers.org
E-mail: info@modelmakers.org

Specifications Writer

Most architectural and engineering firms have an internal staff that specializes in written documentation that is needed to build a structure. Specifications are used to clearly convey the intentions of the owner, the architectural team, and each consultant to be involved with the project to those responsible for constructing and maintaining the project. Written specifications provide a method of supplementing the working drawings regarding the level of quality to be used for materials and the labor and methods to be used to install each material. The construction drawings and

FIGURE 1.8 Models are used for public displays to convey design ideas. *© Photo Researchers/Getty Images.*

written specifications must be compatible for bidding and building accuracy, and they must be clear to avoid misinterpretation. The drawings visually define the relationships of materials, products, and systems within the structure by showing the location and size of each element. Specifications provide information regarding the quality of materials and workmanship, methods of installation, the desired performance at completion, and how performance is to be measured.

An understanding of basic drafting principles, a mastery of grammar and basic English, keyboarding, word processing, and spreadsheet skills are all essential for a specifications writer. The specifications writer also must be able to communicate clearly, including having the ability to translate technical information into usable information for the various trades that will use the specs while maintaining the information in a format that will hold up in a court of law. Taking classes in grammar, English composition, and technical writing at the high school and community college levels can help develop these skills. A thorough understanding of the Construction Specifications Institute's (CSI) chapter format, which will be introduced in Chapter 14, is also required.

Construction Estimators

Construction estimators work in most large AEC firms to develop the cost information that companies need to bid on construction contracts and to decide on the profitability of proposed new projects. Estimators collect and analyze data on all of the factors that can affect costs, such as materials, labor, location, duration of the project, and special machinery requirements, including computer hardware and software. Job duties vary widely depending on the type and size of the project. On a large construction project the estimating process begins with the decision to submit a bid.

Construction estimators are sometimes employed by the project's architect, engineering firm, or owner to help establish a budget, to manage and control project costs, and to track actual costs relative to bid specifications as the project develops. During construction, estimators may manage the cost of change orders and negotiate and settle any extra costs or mitigate potential claims. Estimators may also be called upon as expert witnesses on cost in construction dispute cases.

To prepare for a career as a construction estimator, students need

- a background in architectural design and construction or a degree in construction management, building science, or construction science;
- experience in construction gained through professional practice, internships, or cooperative education programs;
- an understanding of construction materials, costs, and construction procedures;
- an aptitude for mathematics and the ability to analyze, compare, and interpret detailed information;
- to be proficient with computers and have skills in programming, familiarity with cost estimating, and building information modeling (BIM) software;
- to maintain a database of information related to all phases of the construction project;
- to be aware, evaluate, and incorporate OSHA and EPA regulations that are relevant to the construction project; and
- to have the supervision skills to oversee inspections and compliance with government and OSHA regulations.

Plans Examiner and Construction Inspector

Municipalities require that the plans and the construction process be inspected to ensure that the required codes have been met. The primary responsibility of the **plans examiner** is to review the working drawings, written specifications, and all calculations to ensure they comply with the appropriate codes. Once the plan review has been completed the plans examiner will return the drawings to the design plan for additional corrections or determine the fees for a building permit, and then approve building permit applications. The plans examiner must also respond to questions from engineers, developers, property owners, and architects regarding adopted codes.

A plans examiner must be licensed by the state or by the ICC to certify minimum understanding of the construction process and common engineering practices. Most states require a degree in architecture or engineering for a state or city inspector or plans examiner. Most architectural and engineering firms also require job inspection as part of their design process to ensure that contractors have rigidly followed the plans and specifications. This also ensures that conflicts between the numerous firms involved in the construction process can be resolved to the benefit of the client. An inspector or job supervisor is not required to be a licensed architect or engineer, but a thorough understanding of the drawings and the construction process is essential.

The construction that results from the plans must also be inspected. Depending on the size of the building department, the plans examiner may also serve as the building **inspector**. In large building departments, one group inspects plans and another inspects construction. A **construction inspector** must have an exceptionally good understanding of codes limitations, print reading, and construction methods as well as the ability to work well with people. Each of these skills has its roots in a beginning drafting class.

Jobs in Construction

Many CAD technicians are employed directly by construction companies. The benefits of this type of position have already been discussed. In addition to drafting work, these CAD technicians typically work part-time in the field. Many CAD technicians give up their jobs for one of the high-paying positions in the construction industry. The ease of interpreting plans as a result of a background in drafting is a great benefit to any construction worker. If you decide to use your CAD training to enter an area of construction, you must be properly trained in using the tools and chemicals that you might encounter. Classes in building science and construction technology are available at both the high school and community college levels to provide proper training on how to use and maintain power tools safely and efficiently. This training goes far beyond using basic tools such as hammers, saws, and other common tools associated with varied areas of construction to include instruction in proper use, maintenance, and certification of heavy equipment often found on construction sites. Although not required at the residential level, most construction jobs at the commercial level require union certification with training that will

- certify your ability to safely operate tools, machinery, and equipment related to the area of construction you're entering;
- train and certify your ability to properly maintain and repair tools, machinery, and equipment related to the area of construction you're entering;
- provide training to recognize, identify, and properly use tools, machinery, and equipment related to the area of construction you're entering; and
- provide training to identify, inspect, and develop rejection criteria.

Also take at least one class that deals with how to safely handle chemicals that may be found at construction sites. Understanding how to safely mix compatible chemicals and which chemicals are incompatible will help eliminate costly job accidents and increase company profits.

Professional Perspective

No matter which of these careers you choose to enter, at some point you must apply for your first job in the field. You'll also be required to visit professional designers to complete many of the exercises throughout this text. Whether you're visiting or applying for a job, make an appointment, show up on time, and dress and act professionally. Appropriate dress for an interview includes dressing as if you were already working at the firm. Remember, companies establish dress codes to allow employees to work comfortably and be free from sexual harassment. The formality of the dress code is usually related to the amount of interaction the employee will have with clients or design consultants.

For smaller firms, casual wear includes jeans, slacks, and a dress shirt or blouse. Clothes that you would wear for recreation, hanging out, or exercise classes such as T-shirts, tank tops, shorts, and sandals should be saved for casual Friday once you're employed. Clothing that reveals too much cleavage, your back, chest, feet, stomach, or your underwear is not appropriate for a place of business, even in a business casual setting.

As the size of the firm increases, the dress code requirements typically become more formal. Midsize firms usually require employees to dress in "business casual," meaning no jeans, Bermuda shorts, bib overalls, or other comfortable clothes. Appropriate slacks that require a crease, dress shirts, sweaters, and polo-type shirts are appropriate for men working at midsize firms. For women, casual dresses such as summer dresses, skirt and blouse combinations, or pantsuits are common attire. Skirts and dresses should be long enough to allow you to sit comfortably in public. Sundresses, spaghetti-strap dresses, and mini-skirts or tight-fitting dresses that tend to ride up are inappropriate for work situations. Many larger design firms require men to wear ties and women to wear suits. Larger firms typically include their dress codes on their websites.

MAJOR CONSIDERATIONS OF GREEN DESIGN

Reduce, reuse, recycle! No matter what area of the design or construction field you enter, an important aspect of your career will be a building mind-set that revolves around these three words. Whether it is called *earth-friendly, green, ecological,* or *sustainable* construction, the concept is to build and maintain a structure in a manner that will use energy efficiently, that uses materials that have a low impact on the environment, and that contributes to a healthier workplace.

One of the leaders in the development of sustainable construction is the Leadership in Energy and Environmental Design Green Building Rating System, referred to as LEED. **LEED** is a rating system used to evaluate key areas of building projects, such as:

- Sustainable sites
- Water efficiency
- Indoor environmental quality
- Energy and atmosphere
- Material and resources
- Innovation and the design process

Developed by the U.S. Green Building Council (USGBS), LEED has been the leading standard for environmental design and construction for over a decade in the United States and internationally. In 2012, the International Code Council published the *International Green Construction Code* (*IgCC*), which establishes minimum standards for environmental design and construction. The LEED certification process will continue to provide important guidelines in areas that do not adopt the *IgCC*, or for those who want to exceed minimum standards. Chapter 4 will explore the *IgCC* and other codes that impact environmental designs, and environmental information related to specific materials will be explored throughout the text. As a new CAD technician, you may not be making the decisions on how to increase the sustainability of a structure, but in order to advance in an office, you must understand key green issues.

Section 2 of this text will examine common framing methods found in commercial construction. Environmentally friendly framing is not just a matter of selecting green materials; once selected, these green products must be used in a manner that will reduce the environmental impact of the structure. Products that are not considered green can be used in a structure, but they must benefit the building owner and the occupants in a manner that contributes to its sustainability. Creating an environmentally friendly structure requires the matching of materials to a specific design and site that minimizes the effect on that site. Five questions should be considered that will affect the selection of materials to make a sustainable structure.

1. Can products be selected that are made from environmentally friendly materials?
2. Can products be selected because of what they do not contain?
3. Will the products to be used reduce the environmental impact during construction?
4. Will the products to be used reduce the environmental impact of operating the building?
5. Will the products to be used contribute to a safe, healthy indoor environment?

Environmentally Friendly Materials

One of the major considerations that affect framing materials is the selection of products and construction materials that are made from environmentally friendly components. The materials used to produce a building product, and where those materials came from, are key determinants in labeling a product a green building material. Points to consider in selecting building materials include products that can be salvaged, products with recycled content, certified green quick-growth products, agricultural waste materials, and products that require minimal processing.

SALVAGED PRODUCTS

A major goal of sustainable construction is to reuse a product whenever possible instead of producing a new one. Common salvaged materials used in buildings include bricks, millwork, framing lumber, plumbing fixtures, and period hardware. Each of these materials is sold on a local or regional basis by salvage yards. Depending on the occupancy rating of a structure, this may not be possible on larger commercial projects.

PRODUCTS WITH RECYCLED CONTENT

Recycled content is an important feature of many green products because materials are more likely to be diverted from landfills. Industrial by-products such as iron-ore slag can be used to make mineral wool insulation, fly ash can be used to make concrete, and PVC pipe scraps can be used to make shingles.

(*continued*)

CERTIFIED WOOD PRODUCTS

Third-party forest certification, based on standards developed by the Forest Stewardship Council® (FSC), will help ensure that wood products come from well-managed forests. Wood products must go through a certification process to carry an FSC stamp. Manufactured wood products can meet the FSC certification requirements with less than 100% certified wood content.

QUICK GROWTH AND WASTE BY-PRODUCTS

The use of quick-growth products for framing materials allows old- and second-growth trees to remain in the forest. Rapidly renewable materials are made with wood from tree farms with a harvest rotation of approximately 10 years to make products such as LVL, OSB, and laminated beams. Interior finish products are also produced from agricultural crops or their waste products. Examples of green products made from agricultural crops include linoleum, form-release agents made from plant oils, natural paints, textile fabrics made from coir and jute, cork, organic cotton, wool, and sisal. Building products can also be produced from agricultural waste products made from straw (the stems left after harvesting cereal grain), rice hulls, and citrus oil. These products can be used to improve the interior environment and create an ecologically friendly structure.

Engineered lumber products are an example of a green building product. Engineered lumber products are made by turning small pieces of wood into framing members. Structural engineered members are made from fast-growing tree species grown on tree farms specifically for the purpose of being used to make structural materials. Depending on the product to be made, sawdust, wood scraps, small pieces of lumber, or whole pieces of sawn lumber can be joined by adhesives applied under heat and pressure to produce engineered building products. Common engineered products found throughout a structure include laminated veneered lumber, oriented strand board, engineered studs, I-joists, and laminated beams. Production of engineered framing products offers three benefits: (1) efficient use of each log that enters the mill, (2) predictable, superior structural quality, and (3) reduced construction waste at the job site. See Chapter 8 for additional information.

MINIMALLY PROCESSED PRODUCTS

Products that are minimally processed can be green because of low-energy use and low risk of chemical releases during manufacture. These can include wood products, agricultural or nonagricultural plant products, and mineral products such as natural stone and slate shingles.

Removing Materials to Become Earth Friendly

Some building products are considered green, not because of their content, but because they allow material savings elsewhere, or they are better alternatives to conventional products containing harmful chemicals. Chemicals that deplete the ozone, CCA wood preservative, polyvinyl chloride (PVC), and polycarbonate are products that should be avoided in a structure, but products with these chemicals may be considered earth friendly because the products have significant environmental benefits. Some examples include drywall clips that allow the elimination of corner studs, engineered lumber that reduces lumber waste, the piers for a joist floor system that minimizes concrete use compared to a post-and-beam system, and concrete pigments that eliminate the need for conventional finish flooring by using the concrete slabs as the finished floor.

Reducing the Impact of Construction

Some building products produce their environmental benefits by avoiding pollution or other environmental impacts during construction. Products that reduce the impacts of new construction include various erosion-control products, foundation products that eliminate the need for excavation, and exterior stains that result in lower volatile organic compound (VOC) emissions into the atmosphere. The greatest impact from construction can come from careful design that creates a home that suits the site and a foundation system that requires minimal excavation. See Chapter 15 for methods of reducing site impact during construction.

REDUCING THE IMPACT AFTER CONSTRUCTION

The ongoing environmental impact that results from operating a structure will far outweigh the impact associated with the construction phase. It is important during the design phase to select components that will reduce heating and cooling loads and conserve energy, select fixtures and equipment that conserve water, choose materials with exceptional durability or low-maintenance requirements, select products that prevent pollution or reduce waste, and specify products that reduce or eliminate pesticide treatments.

REDUCING ENERGY DEMANDS

Structurally insulated panels (SIPs), insulated concrete forms (ICFs), autoclaved aerated concrete (AAC) blocks, and high-performance windows are examples of materials that can be used during construction to reduce HVAC loads over the life of the structure. Other energy-consuming equipment such as water heaters, furnaces, and basic office equipment should be carefully selected for their ability to conserve energy after construction. Most office equipment is now rated by Energy Star™ standards that have been adopted nationally. Energy Star is a government-backed program designed to help consumers obtain energy efficiency. Using compact fluorescent

(*continued*)

lamps and occupancy or day lighting control equipment can save additional energy. Installing efficient equipment as the structure is constructed will reduce energy needs over the life of the structure.

RENEWABLE ENERGY

Equipment that uses renewable energy rather than fossil fuels and conventional electricity is highly beneficial from an environmental standpoint. Examples for smaller projects include solar water heaters and photovoltaic systems. Natural gas fuel cells or cells that use other fossil fuels such as a hydrogen source are considered green because emissions are lower than that of the combustion-based equipment they replace.

CONSERVING WATER

All toilets are required to meet the federal water efficiency standards. Other systems, such as the reuse of gray water and rainwater storage systems, also contribute to making a structure earth friendly.

REDUCING MAINTENANCE

Products that reduce maintenance make a structure environmentally attractive because those products need to be replaced less frequently, or their maintenance has very low impact. Sometimes, durability is a contributing factor to the green designation but not enough to distinguish the product as green on its own. Included in this category are such products as fiber-cement siding, fiberglass windows, slate shingles, and vitrified clay waste pipes.

PREVENTING POLLUTION

Methods of controlling substances from entering the environment contribute to making a structure earth friendly. Alternative wastewater disposal systems reduce groundwater pollution by decomposing organic wastes more effectively. Porous paving products and vegetated roofing systems result in less storm water runoff and thereby reduce surface water pollution. Providing convenient recycling centers within the structure allows the occupants to safely store recyclables for collection.

ELIMINATING PESTICIDE TREATMENTS

Although they may be needed to increase livability in smaller wood-framed structures, periodic pesticide treatment around buildings can be a significant health and environmental hazard. The use of products such as termite barriers, borate-treated building products, and bait systems that eliminate the need for pesticide application all contribute to a sustainable structure.

Contributing to the Environment

Product selection has a significant effect on the quality of the interior environment. Green building products that help ensure a healthy interior living space can be separated into several categories including products that don't release pollutants, products that block the spread of indoor contaminants, and products that warn occupants of health hazards.

NONPOLLUTING PRODUCTS

One of the dangers of modern construction is the ability to make a structure practically airtight. This in itself is not a problem, but the adhesives in most products can be harmful when constant air changes are not provided. Products that don't release significant pollutants into a structure contribute to an earth-friendly home. Interior products that contribute to improving the interior environment include zero- and low-VOC paints, caulks, and adhesives, as well as products with very low emissions, such as nonformaldehyde manufactured wood products.

BLOCKING, REMOVING, AND WARNING OF CONTAMINANTS

Certain materials and products are green because they prevent contaminants from entering the interior environment. Linoleum is available that helps control microbial growth. Coated duct board is available that helps control mold growth, and products are available for blocking the entry of mold-laden air into a duct system. Other products can help remove pollutants from the shoes of people entering the structure. Each of these types of products can help provide an earth-friendly interior environment.

Once contaminants have entered the structure, several products are available to warn the occupants. Examples of warning systems include carbon monoxide (CO) detectors and lead paint test kits. Once occupants are aware of environmental dangers, several products are available to remove the contaminants. Ventilation products, filters, radon mitigation equipment, and other equipment can remove pollutants or introduce fresh air.

@ADDITIONAL RESOURCES

The following websites can be used as a resource to help you keep current with changes in building industry.

ADDRESS	COMPANY/ ORGANIZATION
www.acec.org	American Consulting Engineers Council
www.aceee.org	American Council for Energy Efficient Economy

www.aiaonline.com	American Institute of Architects
www.asai.org	American Society of Architectural Illustrators
www.asce.org	American Society of Civil Engineers
www.ashrae.org	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
www.asid.org	American Society of Interior Designers
www.asla.org	American Society of Landscape Architects
www.aspenational.com	American Society of Professional Engineers
www.aeinstitute.org	Architectural Engineering Institute
www.usace.army.mil	Army Corp of Engineers
www.awa-la.org	Association for Women in Architecture
www.modelmakers.org	Association of Model Makers
www.athenasmi.ca	Athena Sustainable Materials Institute
www.buildinggreen.com	Building Green Inc.
www.crbt.org	Center for Resourceful Building Technology
www.corrim.org	Consortium for Research of Renewable Industrial Materials
www.thebluebook.com	Construction Information Network
www.csinet.org	Construction Specifications Institute
www.eere.energy.gov	Department of Energy Integrated Building for Energy Efficiency
www.dbia.org	Design-Build Institute of America
www.enercept.com	Enercept, Inc. (SIPs)
www.eeba.org	Energy and Environmental Building Association
www.energydesign resources.com	Energy Design Resources
www.energystar.gov	Energy Star (appliance energy standards)
www.ei.org	Engineering Information
www.iesna.org	Illuminating Engineering Society of North America
www.greenbuilder.com	Greenbuilder
www.thegbi.org	Green Building Initiative
www.greenguard.org	Green Guard Environmental Institute
www.buildinggreen.com	GreenSpec
www.ieee.org	Institute of Electrical and Electronics Engineers
www.iccsafe.org	International Code Council (ICC)
www.leedonline.com	LEED Online (USGBC)
www.noma.net	National Organization of Minority Architects
www.nsbe.org	National Society of Black Engineers
www.nspe.org	National Society of Professional Engineers
www.naima.org	North American Insulation Manufacturers Association
www.raic.org	Royal Architectural Institute of Canada
www.scscertified.com	Scientific Certification Systems
www.sara-national.org	Society of American Registered Architects
www.oneshpe.org	Society of Hispanic Professional Engineers
www.same.org	Society of Military Engineers
www.housingzone.com	Sustainable Buildings Industry Council
www.sweetsconstruction.com	Sweets
www.usgbc.org	U.S. Green Building Council
www.wbdg.org	Whole Building Design Guide
www.beconstructive.com	Wood Promotion Network

CHAPTER 1 TEST

Professional Careers and Commercial CAD Drafting Test

NOTE:

The answers to some questions may not be contained in this chapter and will require you to do additional research using the Internet. Use your favorite search engine to search for specific professional companies, or general categories of information.

@QUESTIONS

1-1 List the main job responsibilities of a senior CAD drafter.

1-2 List several skills or assets needed to become a senior CAD drafter.

1-3 List and describe nine careers in which CAD drafting could be helpful.

1-4 List three duties a junior CAD technician might perform.

1-5 Why would a student in an architecture program need to take classes in social science?

1-6 List the websites of five architectural or engineering associations in your area.

1-7 Why are engineering students required to have such a strong understanding of math?

1-8 Explain the term *VOC* and explain how it relates to construction.

1-9 Why are engineered lumber products considered earth friendly?

1-10 Contact one member of the AIBD, AIA, or ASCE and determine specific requirements for education, employment, and advancement in your area.

1-11 What is the difference between a commercial structure and an industrial building?

1-12 A structure is to be built with a four-level apartment complex over ground-level retail space. Would the apartments be considered residential or commercial space? Explain your answer.

1-13 Why do commercial projects offer more chances for employment than residential projects?

1-14 List three key steps to ensure a safe visit to a construction site.

1-15 Which skill is more important at a job—speed or quality?

1-16 List five skills that can help you correctly identify and complete an assignment.

1-17 Why do companies have rules of ethics?

1-18 Other than building codes, list four common sources of information for CAD technicians.

1-19 List three common drawing programs that are common to architectural and engineering firms.

1-20 Why does a CAD technician need good English and grammar skills?

1-21 Contact your state's branch of the AIA and list the requirements for becoming an architect in your state.

1-22 Visit the "Information for Consumers" section of the AIA website and list the three areas of information found under "Commercial."

1-23 List the benefits of using an architect, as described in the "Institutional" area of the AIA website.

1-24 Visit the National Society of Professional Engineers website and briefly describe three current news items that are listed.

1-25 Use a search engine to list and describe a minimum of five websites for structural engineers.

1-26 Use the Internet to search for your state's employment office and find at least five different terms that are used to describe employment opportunities in an architectural or engineering firm.

1-27 Use the Internet to research job availability for CAD technicians, architects, and structural engineers in your local area and state. Visit the website for the U.S. Bureau of Labor Statistics or another similar state or federal agency and research the predictions for employment in these three professions. Report on areas that may be in demand and areas that are in decline using proper grammar and writing skills to report your findings.

1-28 Contact three different design firms of varied sizes in your area and schedule an appointment. Visit each office to discuss job opportunities, areas in the AEC field that may be in decline, pay scale, minimum educational requirements, and job advancement possibilities. After visiting these firms use proper grammar and writing skills to write a report on your findings.

1-29 Schedule an appointment and visit a design professional to discuss methods of advancing in that career. With the help of an employment counselor, make and implement an educational plan to help you meet your goals. Review your plan at the end of each term or semester.

1-30 Visit the Occupational Safety and Health Administration website and read and report on two sections of the *Construction Industry Digest* that would apply to construction in your area of interest.

1-31 Visit the website of a large architectural design firm in your area and get a copy of its dress code. Make an appointment with the HR department to discuss the purpose for the code, problems they've had with it in the past, and problems they are hoping to avoid. Use proper grammar and writing skills to write a report on your findings.

1-32 Visit the website of a large architectural design firm in your area and get a copy of its code of ethics that they expect their employees to adhere to. Make a list of at least five behaviors you can incorporate into your behavior as a new employee to ensure ethical behavior and explain how having those behaviors can lead to job advancement or how not having them could lead to dismissal.

1-33 Visit the website of a large international architectural or engineering firm and research job options within that firm. Report on your findings including the types of projects the firm handles, employment options, minimum employment requirements, and travel options.

1-34 Join a student branch of the AIBD, AIA, ICC, or other similar professional group approved by your instructor. Attend and report on the meetings you attended.

1-35 Use the Internet to research key elements that should be included on a resume. Using a word processing program, develop a resume that you can use to seek employment. Be sure to indicate factors showing that you are reliable and dependable and document your educational and work history. Keep track of your projects as you progress through your program and develop a portfolio suitable for use as you begin your employment search. Also keep a log of the major skills that you've acquired as well as varied software that you used for each class. Throughout your educational journey, have instructors write letters of recommendation for you.

Chapter 2

The CAD Technician's Role in Office Practice and Procedure

KEY TERMS

Architectural drawings
Calculations
Discipline designators
Drawing coordination
Electrical drawings
Externally referenced drawings
Mechanical drawings
National CAD Standards®
Plumbing drawings
Preliminary drawings
Sheet sequence designators
Sheet type designators
Shop drawings
Structural drawings

The office that you work in, the size of the staff, and the type of project being drawn will all affect the role of the CAD technician. This chapter explores common roles of a drafter and common types of drawings included in a set of plans. Because most graduates of two-year technical and junior college programs work for architectural and engineering firms, these will be the only types of drawings explored in this text. This chapter will explore:

- Common office procedures you're likely to encounter as a new technician
- The types of drawings you're likely to encounter in an architect's or a structural engineer's office
- Common drawing set organization
- Using the engineer's calculations, vendor catalogs, and codes
- Common drawing page layout and project coordination

Common Office Practice

The design of a structure starts with the selection of the design team. The client typically selects the architectural firm based on several common reasons. The reputation of the design firm is typically of utmost importance. The relationship with previous clients and the ability to meet the design requirements in a timely and economical manner are key elements in any designer's reputation. Previous experience with projects similar to the structure to be designed is also an important consideration. Although many large firms work with a variety of structures and materials, some smaller architectural firms are very specialized in the type of structures they design. For instance, some firms work primarily with educational structures. Some firms work only with specific materials such as concrete tilt-up structures like the one seen in Figure 2.1 or with rigid steel frames. Recommendations from a realtor, builder, or previous client, as well as marketing, also play an important part in the selection of an architectural firm.

Once selected, the architectural team can provide valuable assistance to the client in the selection of the construction site and in the refinement of the design criteria. With an understanding of the basic design requirements, analysis of the potential site based on access, climate, and zoning laws can begin. Chapters 4 and 5 will provide further information on how building codes and accessibility standards affect the design process. Other areas such as the shape of the potential job site, availability of utilities, topography, soil conditions, drainage patterns, and proposed building materials also must be considered in the initial stages of design. With a specific site purchased, design studies can be done to determine the best possible merging of the client's desires with the limitations of the site and the financial constraints of the project.

The Role of the CAD Technician

The experience of the CAD drafter, the number of CAD drafters assigned to a project, and the complexity of the project will dictate when the CAD technician

FIGURE 2.1 Most firms specialize is designing certain types of structures, such as schools, churches, or high-rise structures. Other firms specialize in working with specific materials such as steel frame structures or concrete tilt-up structures similar to this manufacturing headquarters. *Courtesy Ginger M. Smith, Kenneth D. Smith Architect, & Associates, Inc.*

will become involved in the project. The CAD technician may be brought into the project at a very early stage to set up sheet templates to meet specific needs of the projects. As the template is established, drafters need to be sure to use established scaling values. See Chapter 3 for common construction drawing scales. Typically, a CAD drafter will become involved in the completion of the **preliminary drawings** that make up the design presentation. This includes work on the site plan, floor plan, elevations, and sections so that the key elements of the design can be presented to the client. One of the first needs of the designer is a layout of the site. Working with drawings provided by a civil engineer, the architectural team can start the preliminary site plan using the methods described in Chapter 15. On simpler projects the technician may need to draw the lot boundary and other items such as the street and curb.

After the designer has developed a concept site plan, floor plan, and exterior elevations, the technician may be directed to clean up the drawings. This work might include developing a site or building section, calculating areas, numbering parking spaces, or adding text such as room names, reference grid lines, and dimensions. The technician may also be asked to assist in preparing presentation drawings by adding color, texture, and foliage to the various drawings. These drawings will be used to present and explain the project to the client, control committees, planning commissions, lenders, and other similar groups.

DESIGN DEVELOPMENT

The next step for the technician will probably be to further refine the drawings to work out drawing conflicts, and to get preliminary input from consultants to make sure that the necessary space has been provided for their needs. This is a time to carefully review the project again to make sure that the project still complies with code requirements. One major item that should be checked is the exit

path, which will be described in Chapter 4. Another item to review is the requirements for firewalls for occupancy or area separation. Once these reviews have been done, background drawings required by consultants need to be prepared. Consultants for the project may include a civil engineer, a landscape architect, an electrical engineer, a mechanical engineer, and a structural engineer. These consultants will add to the drawings created by the architectural technician or incorporate the technician's drawings into their projects. This basic design information from the consultants will then be returned to the architect so that any necessary adjustments can be made.

CONSTRUCTION DOCUMENTS

Once all the adjustments have been incorporated into the preliminary drawings, the technician begins the biggest job, preparing the working drawings. Most likely the first thing to be done is issuing new base sheets to the consultants. Getting the revised base sheets out to the consultants first will allow them to be developing their drawings while the technician is completing the **architectural drawings**. The aim here is to have the consultants' drawings completed simultaneously while staff members at the architect's office complete the architectural drawings. Drawings are typically dispersed to consultants as **externally referenced drawings** (XREFs), which are automatically updated each time the drawing is opened.

After the consultants' drawings have been distributed, the technician can continue developing all of the architectural working drawing sheets. During this process, changes may develop that impact the information that has been sent to the consultants. It is very important to keep communication lines open, informing the consultants of these changes and distributing new base sheets, if necessary, if XREFs are not used. Information may also flow the other way. The consultants may need updates to be made to the base drawings to make their system work. The mechanical engineer may need a shaft added to adequately distribute the heating, ventilation, air-conditioning (HVAC); the structural engineer may need to add a sheer wall or column. This information will need to be incorporated into the drawings and distributed to the other consultants. The use of external referenced drawings can greatly aid in this communication. Chapter 3 will introduce the use of building information modeling (BIM) that can also be utilized to increase the accuracy of drawings and ease communication between the architectural team and project consultants.

Depending on the size and complexity of the project, a structural engineering firm will work in conjunction with the architectural firm to analyze the forces that will be imposed on the structure. Chapter 13 introduces common structural considerations affecting the design of a structure. The structural engineer might provide calculations, framing plans, structural elevations and sections, and details for the architectural firm to use to complete the project or might provide a complete set of **structural drawings** to accompany the architectural drawings. In either case, CAD technicians will be required to ensure that materials required to meet all of the mathematical calculations of the engineer have been incorporated into the drawings. CAD drafters will also be required to incorporate information supplied by several other firms including mechanical, electrical, plumbing, lighting, and interior design firms.

PERMIT AND BIDDING STAGES

Once the working drawings have been completed and the consultants' drawings have been received, the drawings are assembled, printed, and submitted to the building department. The building department will check the drawings and will frequently require corrections to be done. The technician will make these corrections under the direction of the project coordinator so the project can be resubmitted to the building department. Once the corrections have been completed and the drawings rechecked by the building department, a building permit can be issued.

At some time during this process, the plans will be issued to contractors so that they can prepare a bid for the project. It is normal for the plans to be issued prior to the building department completing their plan check. When changes and corrections are made to the plans it will be necessary to inform the bidding contractors of those changes so that they can make appropriate price adjustments to their bid.

CONSTRUCTION PHASE

After the contractors have turned in their bids, one of them will be selected as the general contractor to build the project. The building permit will not normally be issued until the general contractor has been named. During the construction process, the general contractor will normally submit shop drawings to the architect's office. **Shop drawings** are

prepared by subcontractors and show a level of detail beyond that which is in the working drawings. The technician may be asked to check the shop drawings to see if they are in general compliance with the working drawings. During the construction process, unanticipated conditions may arise that necessitate changes to the working drawings. The technician may be asked to prepare the drawings for these changes.

Types of Drawings

Commercial projects often contain five major types of drawings.

- *Procurement drawings* are issued for bidding or negotiating before an agreement is signed.
- *Contract drawings* describe the work required to complete the project.
- *Resource drawings* show existing conditions or new work not included in the project.
- *Addenda drawings and modification drawings*—Both types of drawings are known as supplemental drawings. Addenda drawings are used to amend the work during the bidding process but prior to the awarding of the contract. Modification drawings are used to alter or revise an element of the working drawings after the drawings have been released for construction.

The majority of the information that is provided in Sections 3 and 4 is devoted to preparing contract drawings.

Drawing Organization

Commercial drawing sets often include more than 100 sheets of 24" × 36" or 30" × 42" drawings. Because of the size and scope of most commercial projects, drawings are arranged by subsets of related information. Based on the United States **National CAD Standards®** V-6 (NCS), these common **discipline designators**, and their order within the drawing set, include:

G—General
H—Hazardous Materials
V—Survey Mapping
B—Geotechnical
C—Civil
L—Landscape
S—Structural
A—Architectural
I—Interiors
Q—Equipment
F—Fire Protection
P—Plumbing
D—Process
M—Mechanical
E—Electrical
W—Distributed Energy
T—Telecommunications
R—Resource
X—Other Disciplines
Z—Contractor/Shop Drawings
O—Operations

The letter that precedes each subset name will be used in the page numbering system to reference the subset. The NCS refers to this letter as the **sheet type designator**. Page numbering will be introduced later in this chapter. Not all of these subsets will be required for each project, and some projects may require additional subsets depending on the scope, size, and complexity of the project. The most common discipline designators and their order in the completed drawing set include:

C—Civil
S—Structural
A—Architectural
I—Interiors
P—Plumbing
M—Mechanical
E—Electrical

Separate consulting firms that are coordinated by the architectural firm usually prepare these drawings. On smaller projects, the architectural team may prepare these drawings based on recommendations from consulting firms.

NOTE:

Even though the NCS recommends that structural drawings be placed before the architectural drawings, in order to help better understand the design process, the architectural drawings will precede the structural drawings in Sections 3 and 4 of this text.

Drawing Set Organization

Regardless of the source of origination, CAD drafters will be employed to develop each type of drawing. The first page of most commercial plans is a title page, which contains a table of contents similar to the one seen in Figure 2.2. Other items that should be placed on the title page include:

- The name and contact information of the project owner
- The name, logo, and contact information for the project architect and each consulting firm responsible for some aspect of the plans
- A rendering or a photograph (for franchise structures) of the project
- A list of abbreviations, project data, a location map, and general notes relevant to the entire project

DRAWING SET PAGE DESIGNATORS

For a very simple project that will be completely drawn by the architectural team, drawings within the project can be numbered in successive order using a designator such as A-1, A-2, A-3. Most projects require a more thorough system of sheet designators. Common sheet designators that are used in combination with the discipline designator for a structure include:

0—General information such as symbols, legends, and notes specific to the subset

1—Plan views (horizontal views)

2—Elevations (vertical views)

3—Sections

4—Large-scale views such as plans, elevations, stair sections, or sections that are not details

5—Details

6—Schedules and diagrams

7—User-defined sheets that do not fall into other categories such as typical detail sheets

8—User-defined sheets that do not fall into other categories

9—3D drawings including isometric perspectives and photographs

Using these sheet designators, the page number for a sheet of details developed by the architectural team would have the prefix A-5. The **sheet sequence designator** then follows the discipline designator and sheet type designator.

INDEX OF DRAWINGS

T1 — TITLE SHEET, SITE DEMOLITION & SURVEY

CIVIL

C1 — SITE UTILITIES
C2 — EROSION CONTROL PLAN & DETAILS
C3 — PUBLIC UTILITY PLAN
C4 — UTILITY DETAILS

LANDSCAPE

L1 — IRRIGATION SYSTEM PLAN & LEGEND
L2 — IRRIGATION SYSTEM DETAILS & NOTES
L3 — PLANTING PLAN, DETAILS & LEGEND

STRUCTURAL

S1 — FOUNDATION PLAN
S2 — FOUNDATION DETAILS
S3 — SECOND FLOOR FRAMING PLAN
S4 — ROOF FRAMING PLAN
S5 — DETAILS
S6 — DETAILS

ARCHITECTURAL

A1 — SITE PLAN & DETAILS
A2 — GRADING PLAN & DETAILS
A3 — FIRST FLOOR PLAN, SCHEDULES & DETAILS
A4 — SECOND FLOOR PLAN, SCHEDULES & DET.
A5 — ENLARGED PLANS, INTERIOR ELEV. & DET.
A6 — EXTERIOR ELEVATIONS & DETAILS
A7 — BUILDING & WALL SECTIONS & DETAILS
A8 — ROOF PLAN & DETAILS
A9 — DETAILS
A10 — REFLECTED CEILING PLAN & DETAILS

MECHANICAL

M1 — FIRST FLOOR PLUMBING PLAN, LEGEND
M2 — SECOND FLOOR PLUMBING PLAN, NOTE
M3 — DETAILS, SCHEDULES
M4 — FIRST FLOOR H.V.A.C PLAN, LEGENDS
M5 — SECOND FLOOR H.V.A.C. PLAN
M6 — ROOF MOUNTED H.V.A.C. EQUIP. PLAN
M7 — H.V.A.C. DETAILS, SCHEDULES

ELECTRICAL

E1 — NOTES, LEGEND, RISER
E2 — FIRST FLOOR LIGHTING PLAN
E3 — SECOND FLOOR LIGHTING PLAN
E4 — FIRST FLOOR POWER PLAN
E5 — SECOND FLOOR POWER PLAN
E6 — ROOF MOUNTED EQUIP. POWER PLAN
E7 — DETAILS, SCHEDULES
E8 — FIRST FLR. COMMUNICATIONS PLAN, LEGEND
E9 — SECOND FLOOR COMMUNICATIONS PLAN
E10 — H.V.A.C. DETAILS, SCHEDULES

FOOD SERVICE

FS1 — EQUIPMENT PLAN, SCHEDULES
FS2 — PLUMBING PLAN, MECHANICAL PLAN
FS3 — EQUIPMENT, DETAILS,

FIGURE 2.2 The title page, the first sheet of each project, typically contains a table of contents to help print readers use the drawings effectively. *Architects Barrentine, Bates & Lee, AIA*

The sheet sequence number consists of a two-digit number starting with 01 and proceeding to 99. Using a two-digit number will aid in electronic file sorting and facility management databases. Numbers are usually placed sequentially, but occasionally a number may be omitted to allow for a future page

to be inserted into the drawing set. This numbering system would be used for each subset throughout the project.

A modified version of this system is often used for plan sheets. The categories remain the same, but instead of using a single digit, a number based on 100 is used. Floor plans for a three-level structure would be numbered:

A-101—First floor plan (ground level)

A-102—Second floor plan

A-103—Third floor plan

With this expanded system, 1 represents a floor plan, and the 01 represents the first floor. These numbers are also used throughout each of the subsets to aid in coordination. Sheet **A-102** would contain the architectural floor plan for the second level; sheet **S-102** would contain the second structural framing plan; **M-102** would contain the mechanical plan for the second level, and **E-102** would contain the electrical plan for the second level.

Civil Drawings

Drawings that are related to the construction site typically follow the title page. Each drawing is numbered in successive order starting with **C-1** (Civil) or **L-1** (Landscape). Figure 2.3 shows an example of a commercial site plan. Depending on the complexity of the project and the site, the site drawings might include an existing site plan, a proposed site plan, a grading plan, a utility plan, an irrigation or a sprinkler plan, and a landscape plan. Each of these drawings will be introduced in Chapter 15.

Architectural Drawings

The architectural drawings are placed in the working drawings in the subset represented by the letter A. The architectural drawings are the drawings that describe the size and shape of a structure. They are prepared by or are under the direct supervision of an architect. Common architectural drawings for a commercial project include floor plans, enlarged floor plans, elevations, wall sections, roof plan, reflected ceiling plan, interior elevations, finish schedules, and interior details. Each type of architectural drawing will be introduced in Section 3.

Structural Drawings

As their name implies, these are the drawings used to construct the skeleton of the structure. Engineers or CAD drafters working directly under the supervision of the engineer prepare these drawings. Structural drawings will be discussed in Section 4 and are placed in the working drawings in the subset represented by the letter S. Structural drawings include the framing plans, foundation plan, and related sections and details. Figure 2.4 shows an example of a framing plan drawn by CAD drafters working in an engineering firm.

Cabinet and Fixture Drawings

On structures with few cabinets, the interior details and elevations similar to Figure 2.5 are part of the architectural drawings. On structures such as a restaurant or a medical facility that will contain a magnitude of specialty cabinet (or trim) drawings, these drawings will be in their own section and be in successive order starting with I-1 (for Interiors). This section will also include details covering interior trim and specialized equipment as well as cabinets. Figure 2.6 shows an example of interior drawings for a commercial kitchen.

Electrical Drawings

The **electrical drawings** include the electrical plans, lighting plans, equipment plans, and related schedules and details needed to completely specify the electrical requirements of the structure. For simple projects, CAD technicians working for the architectural firm might complete the electrical drawings. CAD technicians working under the direct supervision of a licensed electrical engineer typically prepare the electrical drawings for larger projects. These drawings will be successively arranged starting with drawing E-1 or E-101. The preparation of electrical drawings and details for commercial plans will not be discussed in this text.

Mechanical Drawings

The drawings that are used to show the movement of air throughout the structure make up the **mechanical drawing** portion of a project. These drawings will be successively arranged starting with **M-1** or **M-101**. Several schedules and details are also typically very instrumental to these drawings. The preparation of mechanical drawings and details will not be discussed in this text.

Plumbing Drawings

The **plumbing drawings** are used to show how fresh water and wastewater will be routed throughout the structure. Plumbing drawings, schedules, and details are successively arranged starting with page **P-1** or **P-101**. The preparation of plumbing drawings and details will not be discussed in this text.

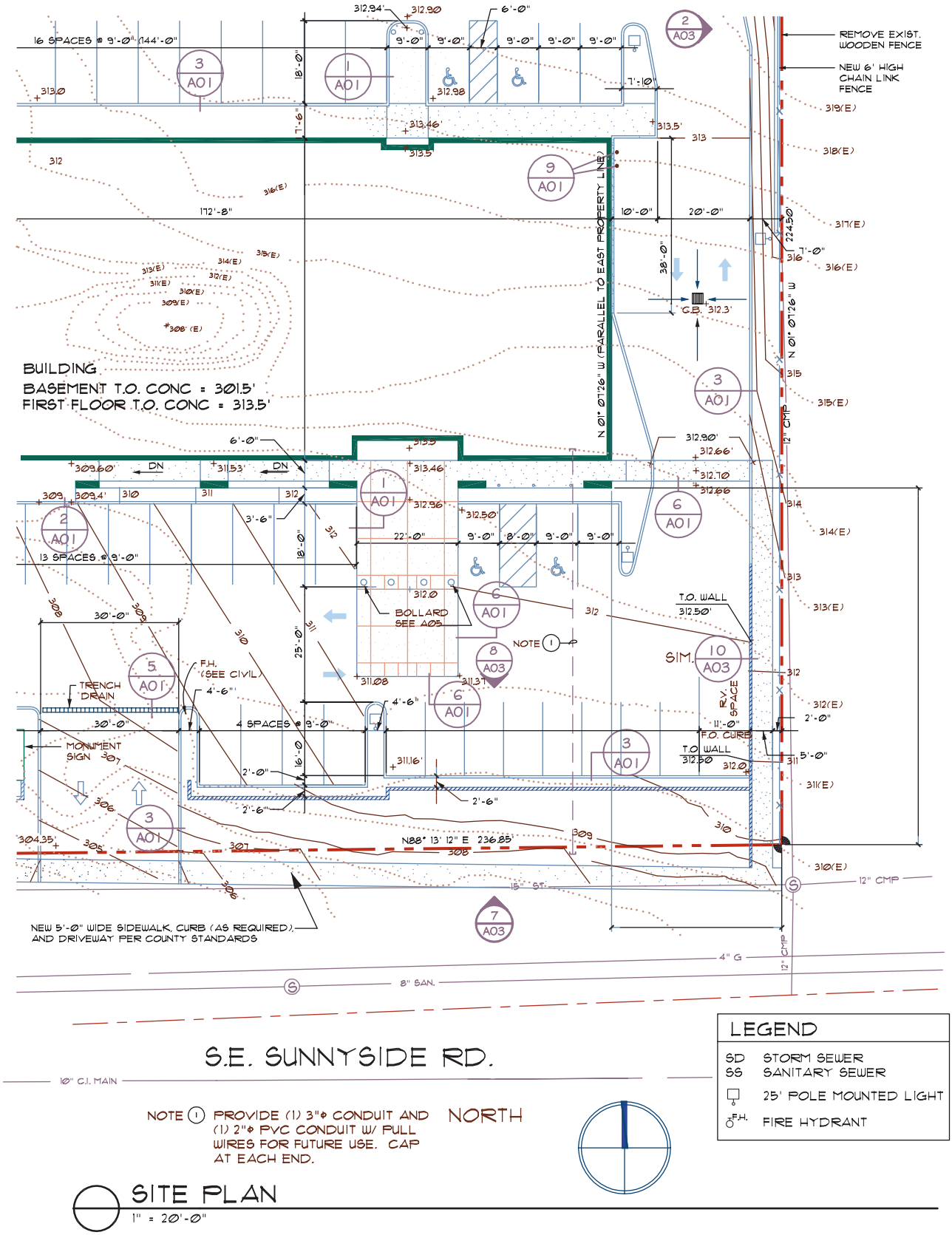


FIGURE 2.3 A commercial site plan can be completed by a CAD technician working for an architect or a civil engineer. *Courtesy Peck, Smiley, Ettlin Architects.*

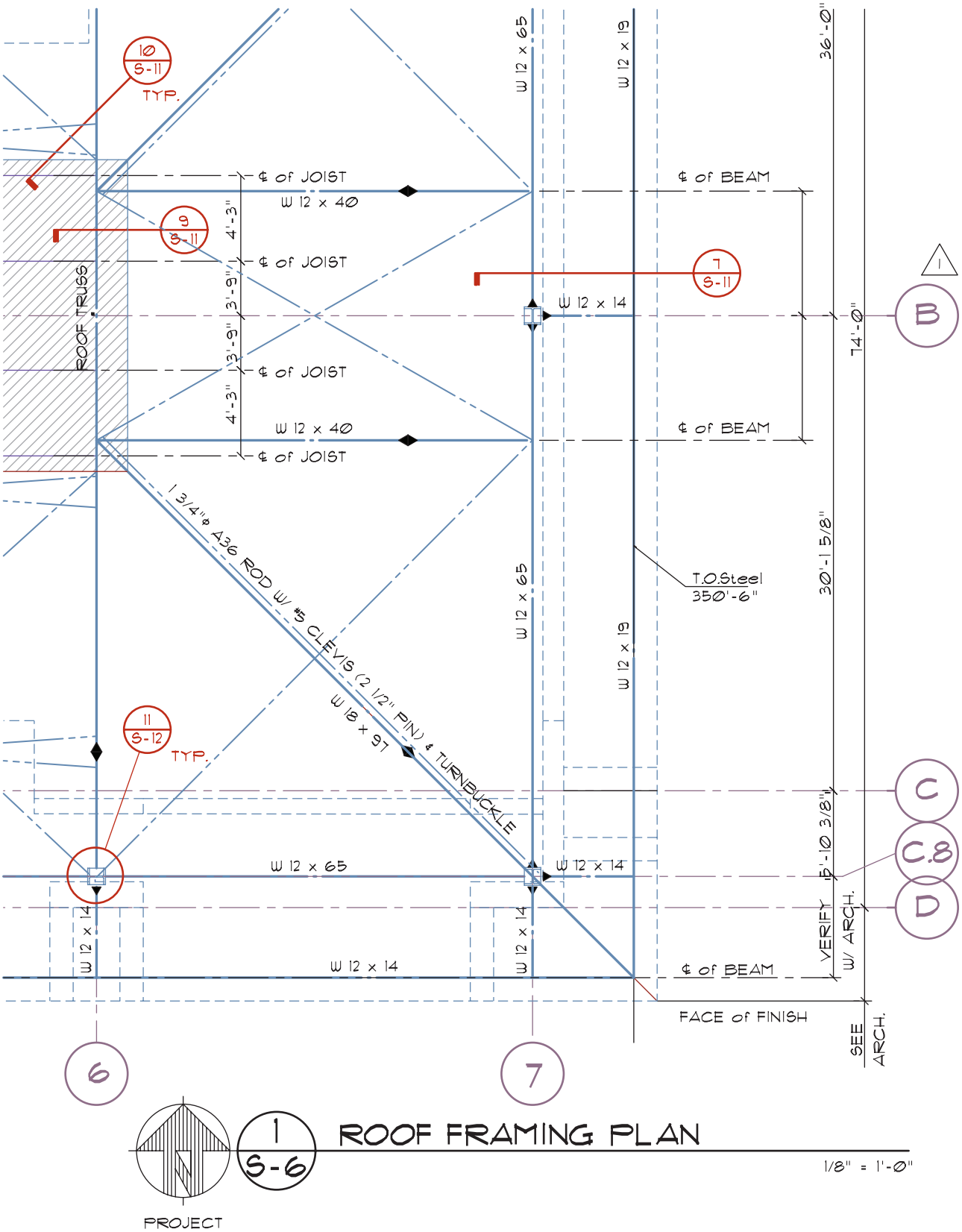


FIGURE 2.4 The structural drawings show how to construct the skeleton of a structure. *Courtesy VLMK Consulting Engineers*

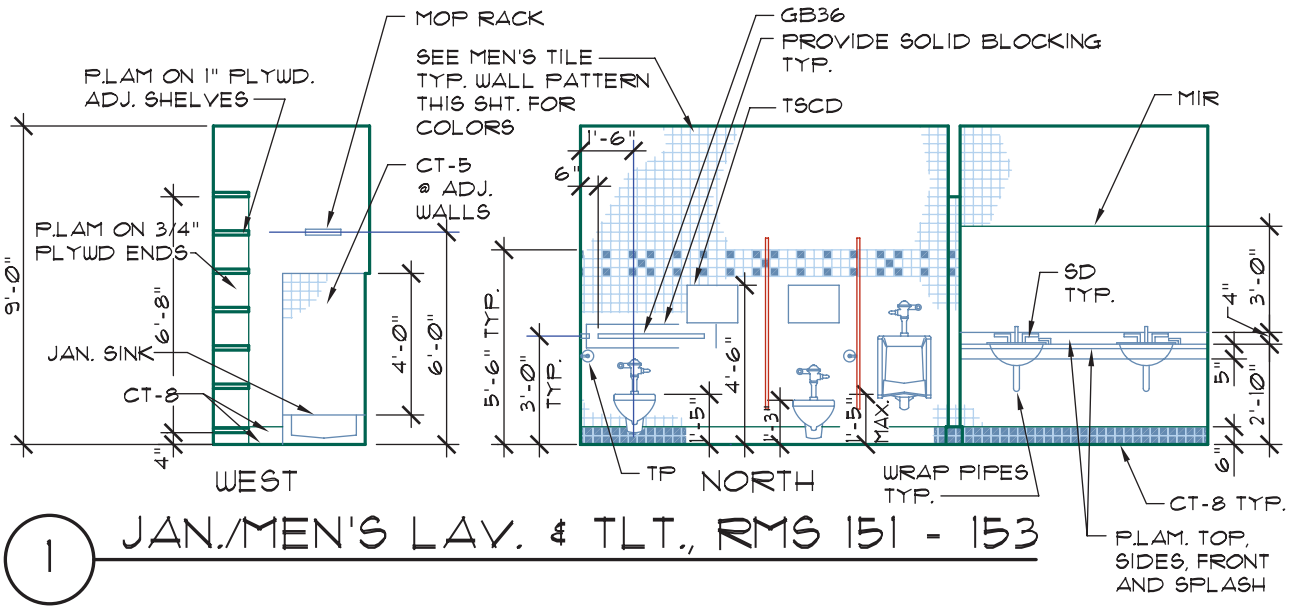
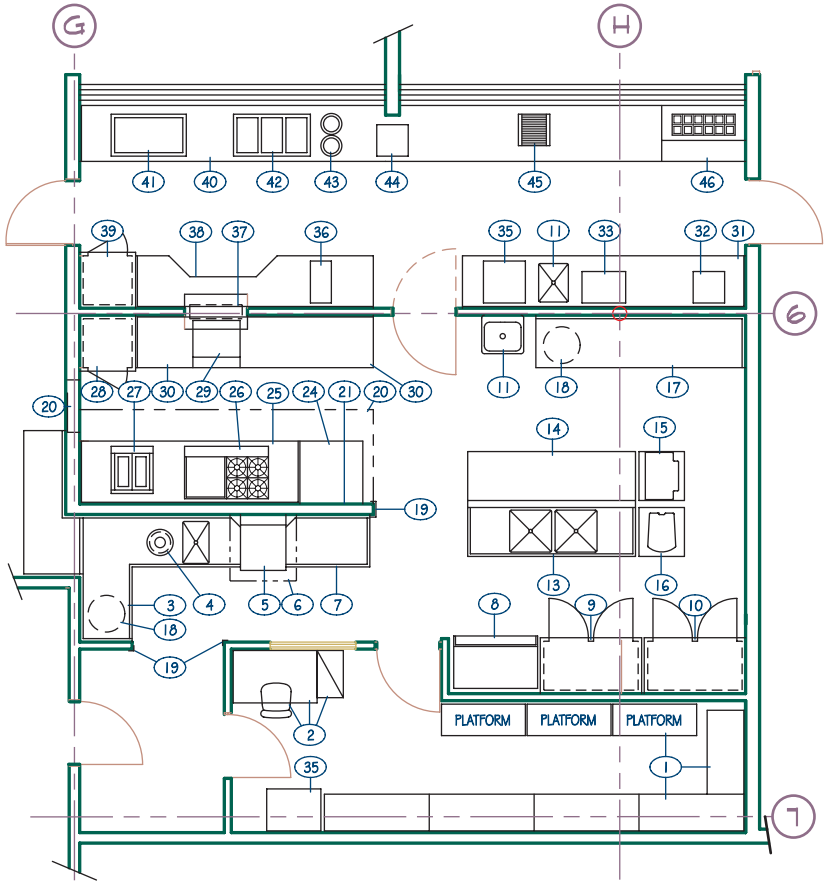


FIGURE 2.5 Cabinet drawings and interior elevations are drawn by the architectural team. *Courtesy Goodwill Industries of the Columbia Willmette/Michael & Kuhns Architects, P.C.*



EQUIPMENT SCHEDULE

ITEM	DESCRIPTION	QTY.	REMARKS:
1	DRY STORAGE SHELVING	LOT	
2	DESK & CHAIR	LOT	BY OWNER
3	SOILED DISHTABLE W/PASS-THRU	1	EXIST/MODIFY/REINSTALL
4	DISPOSER	1	EXISTING/REINSTALL
5	DISHWASHER	1	
6	DISHWASHER CANOPY HOOD	1	
7	CLEAN DISHTABLE	1	
8	ICE MACHINE	1	EXISTING½REINSTALL
9	REFRIGERATOR	1	
10	FREEZER	1	EXIST./MODIFY/REINSTALL
11	HAND SINKS	2	REQUIRE. BY DIVISION 15
12	SPARE NUMBER	---	
13	VEGETABLE PREP SINKS	1	EXISTING½REINSTALL
14	WORK TABLE	1	
15	SLICER W/MOBILE CART	1	EXISTING½NEW
16	20-QUART MIXER W/MOBILE CART	1	EXISTING½NEW
17	WORK TABLE	1	
18	WASTE RECEPTACLES	2	
19	CORNER & CHANNEL GUARDS	LOT	
20	CANOPY HOOD W/FIRE PROT. SYS.	LOT	
21	STAINLESS STEEL WALL FLASHING	LOT	
22	SPARE NUMBER	---	
23	SPARE NUMBER	---	
24	CONVECTION OVEN	1	
25	COOKING COUNTER	1	
26	GRIDDLE/OPEN BURNERS	1	
27	FRYER	1	
28	COOKS REFRIGERATOR	1	
29	SANDWICH REFRIGERATOR	1	
30	COOKS TABLES	LOT	
31	BEVERAGE COUNTER	1	
32	COFFEE MAKER	1	BY PURVEYOR
33	MILK DISPENSER	1	EXISTING½REINSTALL
34	SPARE NUMBER	---	
35	CARBONATED BEVERAGE SYSTEM	1	BY PURVEYOR
36	FOOD WARMER	1	
37	PASS-THRU SHELF	1	
38	BACK-UP COUNTER	1	
39	REFRIGERATOR	1	
40	SERVING COUNTER	1	
41	ICED DISPLAY PAN	1	
42	HOT FOOD UNIT	1	
43	SOUP WARMERS	2	
44	CASH REGISTER	1	BY OWNER
45	HOT DOG GRILL/BUN WARMER	1	
46	SANDWICH REFRIGERATOR	1	

FIGURE 2.6 Drawings to describe special equipment in a structure are often drawn by drafters employed by a consulting firm. *Courtesy Halliday Associates, Inc.*

Working with Calculations

With so many different types of drawings and so many different firms contributing to the structure, an inexperienced drafter could easily get lost in the developmental process of a structure. To ensure that all required information is incorporated in the drawings, architects and engineers typically provide a set of **calculations** and sketches for the drawing team to use in order to complete the plans. The calculations for the structural drawings are required to be signed by an architect or engineer and must be submitted to the building department with the completed drawings in order for a building permit to be obtained.

Figure 2.7 shows a portion of one page of an engineer's calculations. Typically, calculations are divided into three sections that include a problem statement, mathematical solution, and the material to be used to meet the imposed stress. In Figure 2.7, the engineer is determining the size of two intersecting beams, and how they will be connected. Although it is important that the drafter understand basic structural principles to advance in the field, the technician is not expected, or allowed, to do structural calculations. Sections 3 and 4 will introduce concepts the drafter should be familiar with to complete structural drawings. The CAD drafter's role is to be sure that the third portion of the calculations—the solution—is correctly placed on the drawings and to draw the connecting detail.

Although the layout of the calculations can take many forms, usually the loads are determined from the top of the structure to the foundation. This allows loads to be accumulated as formulas are completed for the upper levels and used to solve problems at lower levels. Figure 2.8 shows the framing detail that was created to comply with the engineer's design. Notice that some information in Figure 2.8 was not specified by the engineer's sketch. As a drafter gains experience and knowledge of the construction industry, the drafter is expected to be able to complete the detail. Depending on the engineer and the experience of the drafting team, the calculations may or may not contain sketches. When an engineer is specifying a common construction method to a

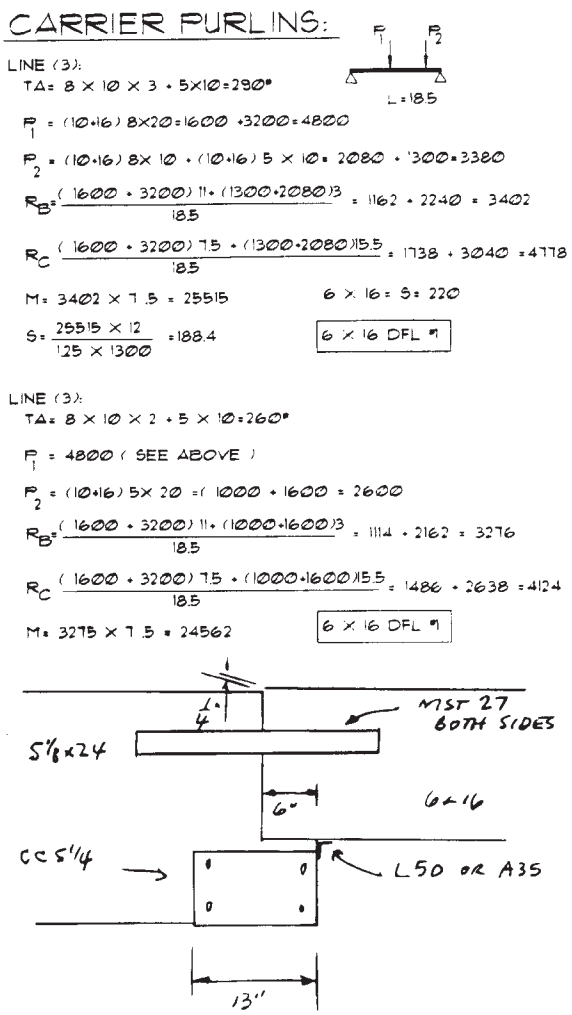


FIGURE 2.7 The engineer's calculations provide the mathematical proof that components in the structure will resist all loads and stresses. *Courtesy Dean K. Smith, Kenneth D. Smith Architect, & Associates, Inc.*

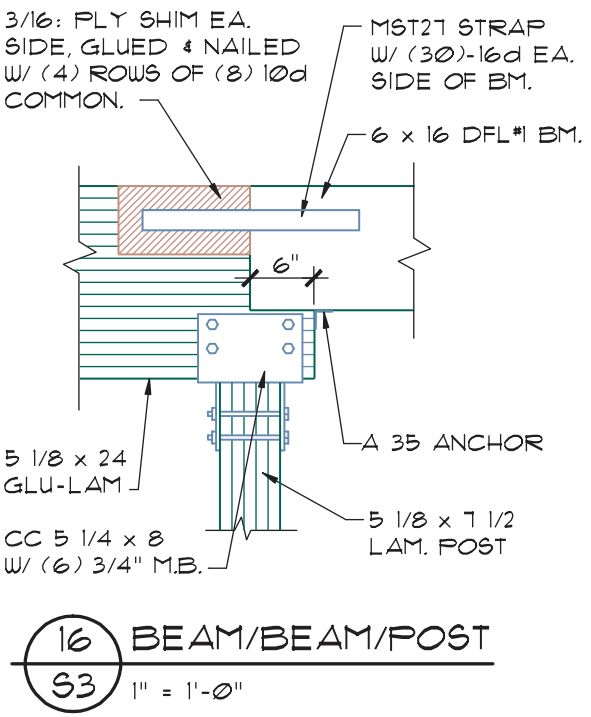


FIGURE 2.8 A framing detail based on the calculations shown in Figure 2.7. *Courtesy Ginger M. Smith, Kenneth D. Smith Architect, & Associates, Inc.*

skilled team, usually a sketch will not be provided. Chapter 6 provides an introduction to drawing common construction details.

Using Vendor Materials

Closely related to the use of the engineer's calculations is the use of vendor catalogs. Common sources of building materials include the Internet, Sweets® Network, and *Architects' First Source for Products*®. The World Wide Web is an excellent source for obtaining materials related to every phase of construction. *Sweets* is a collection of vendor catalogs that is available in Internet download formats. Information is listed using the numbering system of *MasterFormat*®, published by the Construction Specifications Institute®, which will be discussed in Chapter 14. *Architects' First Source* is an index of materials with a short listing of the product descriptions and performance features. Book and website options are available. Yellowpages.com is also an excellent source of local suppliers. Most firms will gladly supply written specifications or construction details as electronic downloads or on CD-ROM to help ensure the use of their products.

As seen in Figure 2.7, the engineer has specified a particular column cap to be used. Notice that no information is supplied about the cap other than the manufacturer and the model number. The drafter is expected to be able to research a specific product and completely specify the product on the working drawings. Figure 2.9 shows a sample listing from the Simpson Strong-Tie® brochure for standard column caps. The sizes and bolting for the required connector can be obtained from the company's website or from its display in Sweets catalogs.

Working with Codes

In addition to using calculations and vendor materials, a CAD technician will also be required to have a working knowledge of the building code that governs the municipality where the structure will be built. Chapter 4 introduces basic code considerations for design and construction. Building codes address two general categories in the design of a structure. To ensure public safety, most aspects of a code relate directly to either fire protection or the ability of a material or portion of a structure to resist collapsing under the loads that will be resisted.

The first concern of building codes, fire resistance, is broken down into three general areas: (1) the tendency of a material to fail by combustion, (2) the tendency of a material to lose its strength once a fire has broken out, and (3) methods of fire containment. You will be introduced to basic code requirements as you progress throughout this text.

The second major concern of the building code is the ability of the materials and the structure as a whole to resist loads. Building codes typically use either the working stress method or the factored load method to ensure the safety of a structure. Each method deals with the resistance of loads from stress on materials and the predetermined ability of a material to resist stress. Chapter 13 will provide an introduction to forces that affect the design of a structure. Subsequent chapters will explain how these stresses are resisted throughout a structure.

Although the architect or engineer will complete the majority of work with codes, it is important for the drafter to have a basic understanding of the code. The architect will determine the size, height, and type of materials to be used in construction, based on a thorough knowledge of the code. The drafter will need an understanding of the code to comprehend many of the components that will be added to a drawing. This will require knowledge of basic code layout and, specifically, an understanding of the chapters dealing with basic building requirements based on a specific type of construction.

Drawing Placement

Just as you should develop an outline before writing a research paper, thought should be given to the drawings needed to describe a construction project. The drawing layout must be one of the first things considered in planning a project. General office practice is to plan the drawing requirements and placement prior to starting the working drawings. The general order of a set of drawings was introduced earlier in this chapter. As the drawing layout is being planned, the placement on the page should be carefully considered. Great care must be taken, however, when several drawings will be placed on the same sheet. The architect, engineer, or project coordinator will typically provide new CAD technicians with a sketch of the intended page layout along with individual sketches of each drawing to be placed on the page. These sketches of the proposed project are similar to an outline that is developed for a written project. The sketches

These products are available with additional corrosion protection. Additional products on this page may also be available with this option, check with Simpson for details.

Model No. (CC shown ECC/ECCU similar)	Beam Width	Dimensions						Fasteners					Allowable Loads					Code Ref.	CCO Model No. (No Legs)	ECCO Model No. (No Legs)
		W_1	W_2	L			H_1	Size	Beam			Post	Down		Uplift					
				CC	ECC	ECCU			CC	ECC	ECCU		CC	ECC/ ECCU	CC		ECCU			
															133	160	133/160			
CC3¼-4	3⅛	3¼	3⅝	11	7½	9½	6½	⅝	4	2	4	2	16980	6125	3035	3640	1010	20, 142	CCO3¼	ECCO3¼
CC3¼-6	3⅛	3¼	5½	11	7½	9½	6½	⅝	4	2	4	2	19250	9625	3035	3640	1010			
CC44	4x	3⅝	3⅝	7	5½	6½	4	⅝	2	1	2	2	15310	7655	1220	1465	205		CCO4	ECCO4
CC46	4x	3⅝	5½	11	8½	9½	6½	⅝	4	2	4	2	24060	12030	2330	2800	740		CCO4/6	ECCO4/6
CC48	4x	3⅝	7½	11	8½	9½	6½	⅝	4	2	4	2	24060	16405	2330	2800	740	170		
CC5¼-4	5⅛	5¼	3⅝	13	9½	10½	8	¾	4	2	4	2	26635	10045	6305	7530	2735	20, 80, 142	CCO5¼	ECCO5¼
CC5¼-6	5⅛	5¼	5½	13	9½	10½	8	¾	4	2	4	2	28190	15785	6275	7530	2735			
CC5¼-8	5⅛	5¼	7½	13	9½	10½	8	¾	4	2	4	2	37310	21525	6275	7530	2735			
CC64	6x	5½	3⅝	11	7½	9½	6½	⅝	4	2	4	2	28586	12030	3365	4040	1165		CCO6	ECCO6
CC66	6x	5½	5½	11	7½	9½	6½	⅝	4	2	4	2	30250	18905	3365	4040	1165			
CC68	6x	5½	7½	11	9½	9½	6½	⅝	4	2	4	2	37810	25780	3365	4040	1165			ECCO68
CC6-7⅛	6x	5½	7⅛	11	9½	9½	6½	⅝	4	2	4	2	37810	24060	3365	4040	1165	170		
CC7⅛-4	7	7⅛	3⅝	13	10½	10½	8	¾	4	2	4	2	34736	18375	6260	7510	4855		CCO7⅛	ECCO7⅛
CC7⅛-6	7	7⅛	5½	13	10½	10½	8	¾	4	2	4	2	58500	28875	6320	7585	4855			
CC7⅛-7⅛	7	7⅛	7⅛	13	10½	10½	8	¾	4	2	4	2	57750	36750	6320	7585	4855			
CC7⅛-8	7	7⅛	7½	13	10½	10½	8	¾	4	2	4	2	52500	36750	6320	7585	4855			
CC74	6¾	6⅞	3⅝	13	10½	10½	8	¾	4	2	4	2	33490	13230	6270	7525	3605		CCO7	ECCO7
CC76	6¾	6⅞	5½	13	10½	10½	8	¾	4	2	4	2	37125	20790	6270	7525	3605			
CC77	6¾	6⅞	6⅞	13	10½	10½	8	¾	4	2	4	2	49140	25515	6270	7525	3605			
CC78	6¾	6⅞	7½	13	10½	10½	8	¾	4	2	4	2	49140	28350	6270	7525	3605			
CC86	8x	7½	5½	13	10½	10½	8	¾	4	2	4	2	41250	23100	6200	7440	2625	20, 80, 142	CCO8	ECCO8
CC88	8x	7½	7½	13	10½	10½	8	¾	4	2	4	2	54600	31500	6200	7440	2625			
CC96	8¾	8⅞	5½	13	10½	10½	8	¾	4	4	4	2	48125	26950	6260	7515	4670		CCO9	ECCO9
CC98	8¾	8⅞	7½	13	10½	10½	8	¾	4	4	4	2	63700	36750	6260	7515	4670			
CC106	10x	9½	5½	13	10½	10½	8	¾	4	4	4	2	52250	29260	6260	7515	3325		CCO10	ECCO10

1. Post sides are assumed to lie in the same vertical plane as the beam sides.
2. Loads may not be increased for short-term loading.
3. Downloads are determined using $F_{c\perp}$ equal to: 560 psi for glulam sizes and CC86, CC88 and CC106; 750 psi for 7⅛" size; 625 psi for all others; reduce where end grain bearing or buckling capacity of the column, or other criteria are limiting.
4. Uplift loads have been increased for earthquake or wind load durations with no further increase allowed; reduce where other load durations govern. Uplift loads are limited by the beam shear capacity per 2005 NDS except CC76, CC78, and CC96 through CC106.
5. Beam splices with CC's must be detailed by the Designer to transfer tension loads between spliced members by means other than the column cap.
6. CC uplift loads do not apply to splice conditions.
7. Beam depth must be greater than H_1.
8. Structural composite lumber columns have sides that show either the wide face or the edges of the lumber strands/veneers. Values in the tables reflect installation into the wide face.
9. For 5¼" engineered lumber, use CC 6X or ECC 6X models.

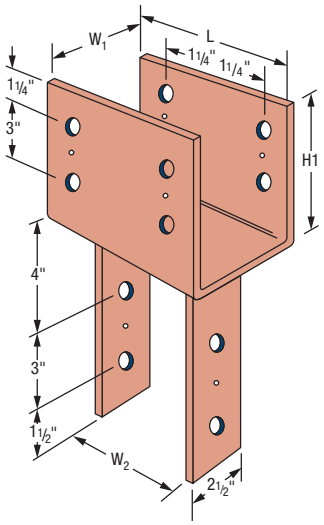


FIGURE 2.9 CAD drafters are often required to consult vendor catalogs to find needed information to complete drawings. This and other information about Simpson products can be obtained from the strongtie.com website. *Simpson Strong-Tie Co. Inc.*

provide a tentative layout for the placement of each plan, elevation, section, schedule, and detail that is anticipated.

When all drawings are complete and printed, they will be assembled into a set and bound along the left margin. The larger the sheets used, the more likely that drawings, notes, or parts of drawings placed on the left side of the sheet will not be seen. Whenever only one drawing is to be placed on a sheet, it should be placed near the right margin, leaving any blank space on the left (or binding) side. This same guideline should be used if smaller drawings, such as details, are to be placed with a large drawing. Placing the details on the left could cost the print reader needless time in skimming the drawings because the details might not be seen. Details placed on the right side can be clearly seen while the reader thumbs through the drawing. It is true that the print reader should be careful when examining a set of drawings; however, anything the drafter can do to improve communication should be done.

Another consideration in placing details is to place them as close as possible to where they occur, still being careful that small drawings will not be lost. The layout in Figure 2.10 places the detail close to its source and in a location where it can't be hidden by other pages. Wherever possible on symmetrical drawings, place the detail symbol where the right side can be seen.

When positioning drawings together, it is important that the limits of each drawing not interfere with its neighboring drawing. Lettering from one drawing should not be intertwined with a neighboring drawing. Some offices share text between two drawings, as seen in Figure 2.11. Text that relates only to the drawing on the right should be separated to avoid confusion. Other offices use a layout similar to Figure 2.12, which places details in neat rows with no shared text. Another option is to use a grid system similar to Figure 2.13. All boxes do not need to be the same size, but the box edges must align. Care must be taken to number the detail grids in an orderly manner. Order can vary, with the numbering of details starting in any one of the corners, but the same order of progression should be used throughout the project. Text assigned to details' symbols will be further discussed as the drawings are being coordinated.

Keep in mind that there is no one correct way to arrange details. When entire sheets will be filled with details, it is important to have a logical order to their arrangement. Figure 2.14 shows a section of a brick wall. Notice that three details are referenced to this section to completely explain this wall assembly. These details have been placed in an order that matches their arrangement within the section.

Another consideration in placing details throughout the drawing set is to place them in groups according to the labor force that will do the work. Roof drawings should not be mixed with concrete drawings because two completely different work crews will complete those jobs. If possible, place all concrete details with the foundation plan, or on a separate sheet following the foundation, and all roof details with the roof plan or very close to it. Chapters 3 and 6 will present additional information regarding details and their placement.

Project Coordination

Completion of the last drawing is no cause to celebrate. All working drawings must now be coordinated. The architectural office will arrange all of the architectural drawings and each consulting engineer will be responsible for the coordination of their drawings.

Consulting firms will provide electronic copies ready to be added to the project. **Drawing coordination** involves the placing of each page in its final order within the drawing set and assigning numbers to each page and detail. Project coordination is typically done working with a small paper copy of each sheet. Pages are usually arranged in the order presented earlier in this chapter. Although this order will vary for each office and from job to job, the placement of drawings in the subset should match the National CAD Standards as much as possible to aid the print readers.

Assigning Page Numbers

A space in the lower-right corner of the title block is generally reserved for the display of the page number. Two methods of page numbering have been introduced. As long as the drawings communicate effectively, they can be arranged in either order, based on office procedure. Generally, offices try to maintain a similar order for each of their jobs so that bidders and construction crews will have a sense of familiarity with their plans. Sheets that contain abbreviations or symbols should be placed very early in the drawing set.

Assigning Detail References

Once the page numbers have been assigned, details on each specific page can be numbered. Each detail should have a detail symbol that shows the detail number over the page number. A title is often placed near the detail symbol similar to the drawing shown in Figure 2.14. If the project manager has not assigned a title, determine a suitable title by asking the question "*Why did I draw this detail*?" No fair using an answer such as "*I was paid.*" The title should reflect the contents or the goal of the drawing. The text used for titles and detail numbers is usually between 1/8' and 1/4" high. A uniform height should be used throughout the entire project. Pages, details, and scales are usually placed in 1/8"-high text. One of two methods is typically used to assign detail numbers.

- Some offices assign consecutive numbers for each detail on a specific page, but begin with 1 for every page containing a detail, as shown in Figures 2.12 and 2.13.
- Other offices opt to begin numbering with detail 1 on page 1, and then to use consecutive numbering for all subsequent details through the end of the drawing set. This method eliminates having several details with a detail number of 1.

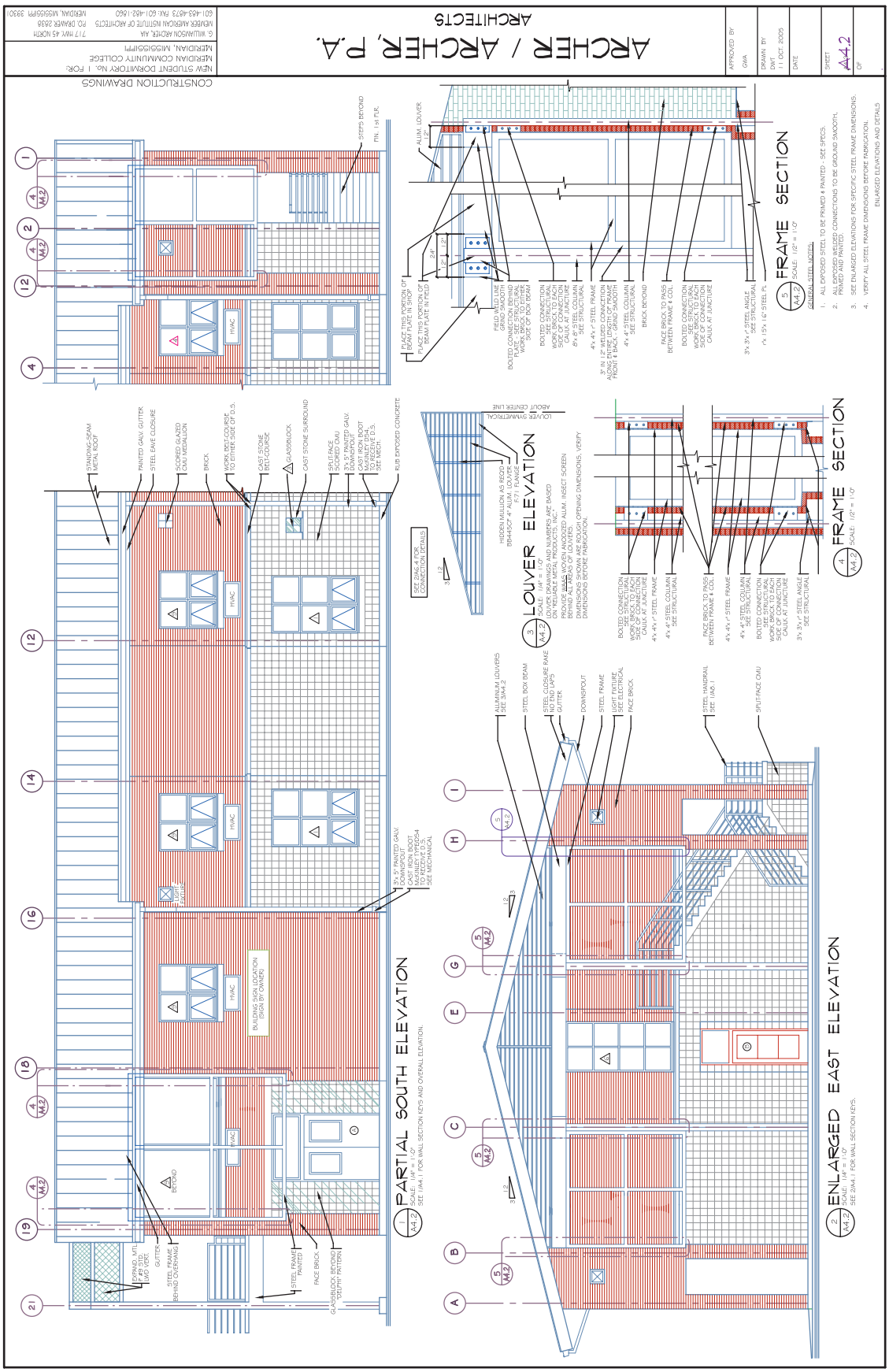


FIGURE 2.10 The smaller the detail, the more important that it will be placed on the right side of the page to avoid being ignored as pages are skimmed. Details should also be placed as close as possible to the drawing that they reference. *G. Williamson Archer AIA, Archer & Archer P.A.*

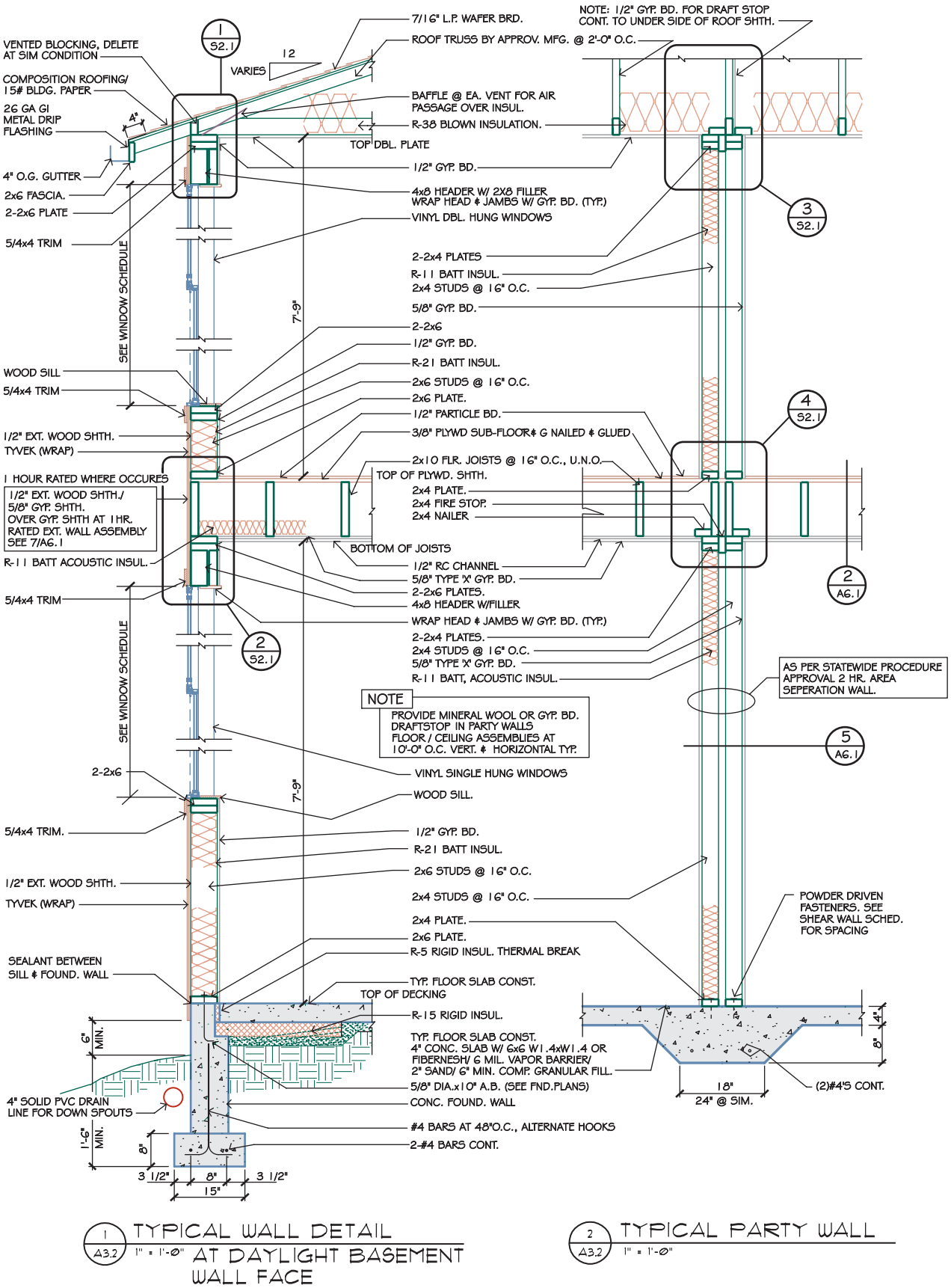


FIGURE 2.11 Text can be shared between two similar details to save space and drawing time. *Courtesy Scott R. Beck, Architect.*

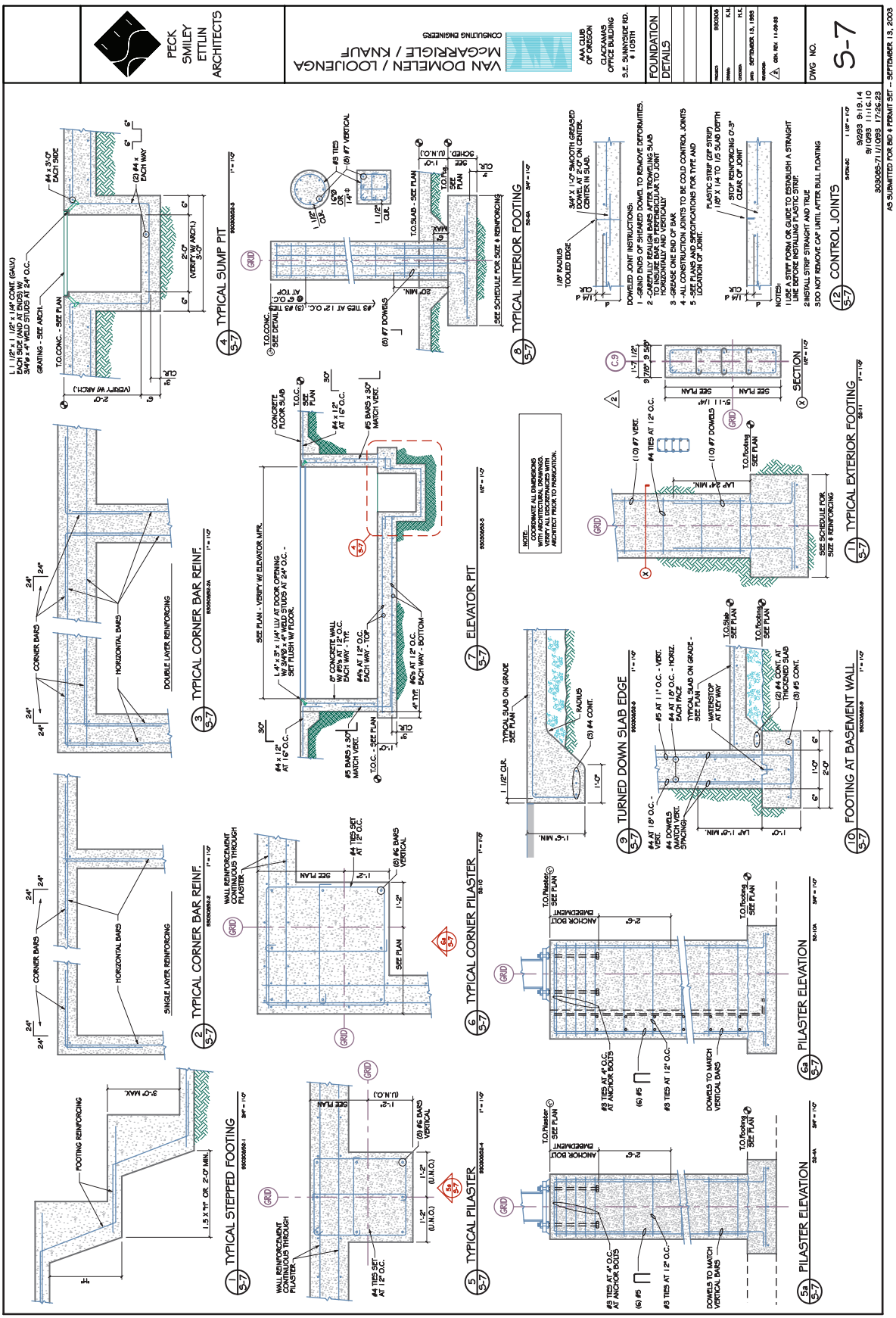


FIGURE 2.12 Careful placement of details and other small drawings is critical to good page clarity. *Courtesy YLMK Consulting Engineers*

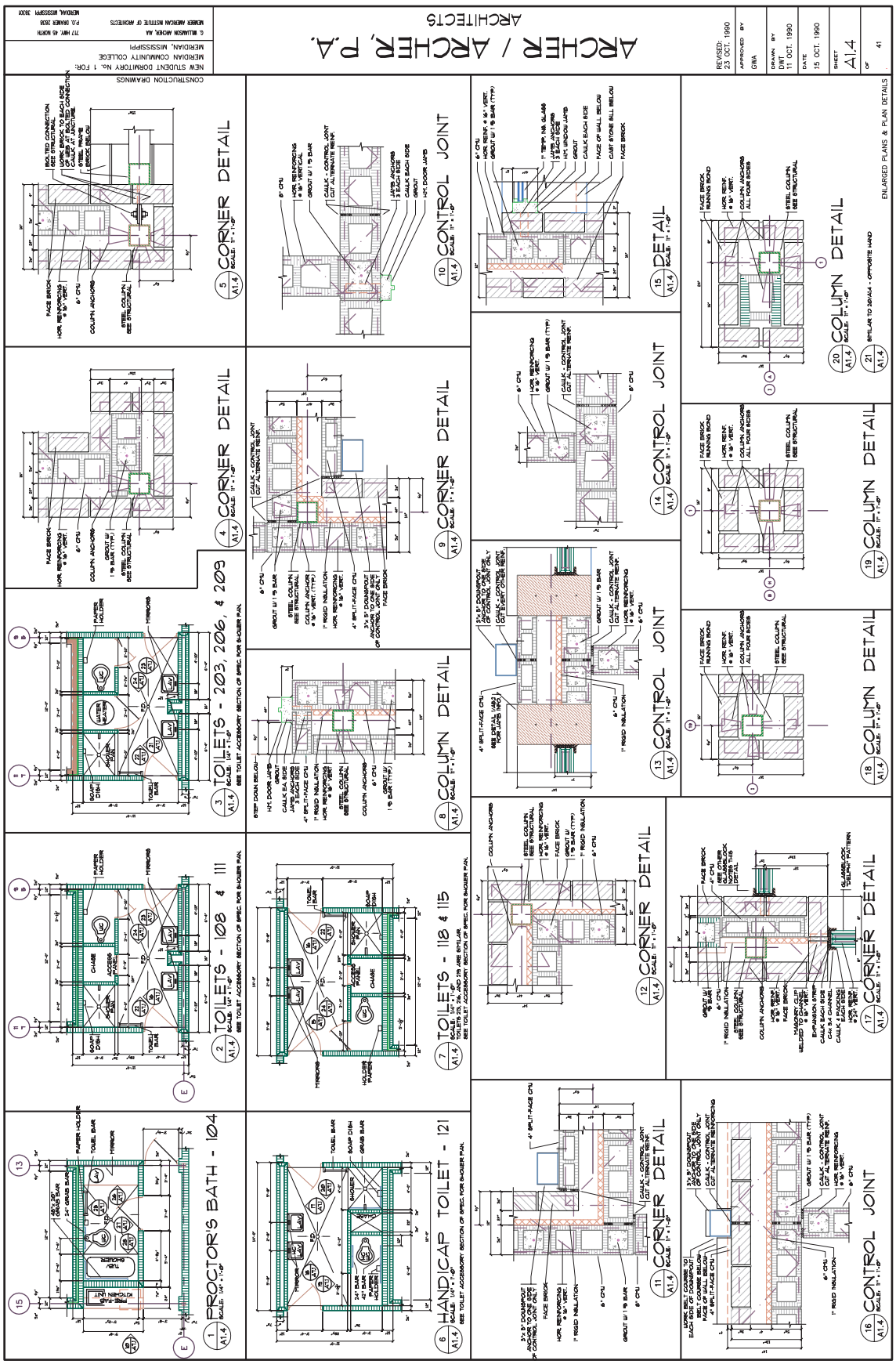


FIGURE 2.13 Many offices arrange details in neat rows and columns surrounded by a border to add clarity to each drawing. *G. Williamson Archer A.I.A., Archer & Archer P.A.*