



# CORE

## Introduction to Basic Construction Skills

SIXTH EDITION



  
CONSTRUCTION  
ESSENTIALS

# CORE

## Introduction to Basic Construction Skills

**SIXTH EDITION**





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*Printer/Binder:* LSC Communications

*Cover Printer:* LSC Communications

*Text Fonts:* Palatino LT Pro and Helvetica Neue

**Cover Image**

*Cover photo provided by Haskell*

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ScoutAutomatedPrintCode



*Paperback*

ISBN-10: 0-13-748334-1

ISBN-13: 978-0-13-748334-1

*Hardcover*

ISBN-10: 0-13-748335-X

ISBN-13: 978-0-13-748335-8

# PREFACE

## To the Trainee

Welcome to the world of construction! You are joining the eight million Americans who have chosen a career in this lucrative field. Construction is one of the nation's largest industries, offering excellent opportunities for high earnings, career advancement, and business ownership.

People with many different talents and educational backgrounds—skilled craftspersons, managers, supervisors, and superintendents—find job opportunities in construction and related fields. As you will learn throughout your training, many other industries depend upon the work you will do in construction. From houses and office buildings to factories, roads, and bridges—everything begins with construction.

## New with *Core: Introduction to Basic Construction Skills*

NCCER and Pearson are pleased to present the sixth edition of *Core: Introduction to Basic Construction Skills*. This full-color textbook includes ten modules for building foundational skills in construction. NCCER has added QR codes to videos exploring the different types of jobs available in the industry.

This edition of *Core* features a brand new module called *Build Your Future in Construction*. This new introductory module explores the various careers available in the construction industry and introduces trainees to what it might be like to work on a construction site.

We are also excited to present a significant expansion to the training on construction drawings and construction math. This edition includes some to-scale drawings in the *Introduction to Construction Drawings* module, as well as updated prints throughout to illustrate the parts and pieces of drawings with which trainees must familiarize themselves.

Both the *Introduction to Hand Tools* and *Introduction to Power Tools* modules have been significantly updated to include a variety of new tools, including many power tools that are battery operated.

All 10 modules have updated learning objectives and performance tasks, in-line with the best practices in education.

*Core* remains aligned with OSHA's 10-hour program. This means that instructors who are OSHA 500 Certified are able to issue 10-hour OSHA cards to their students who successfully complete the program.

Our website, [www.nccer.org](http://www.nccer.org), has information on the latest product releases and training.

Your feedback is welcome. You may email your comments to [curriculum@nccer.org](mailto:curriculum@nccer.org) or send general comments and inquiries to [info@nccer.org](mailto:info@nccer.org).

## NCCER Standardized Curricula

NCCER is a not-for-profit 501(c)(3) education foundation established in 1996 by the world's largest and most progressive construction companies and national construction associations. It was founded to address the severe workforce shortage facing the industry and to develop a standardized training process and curricula. Today, NCCER is supported by hundreds of leading construction and maintenance companies, manufacturers, and national associations. The NCCER Standardized Curricula was developed by NCCER in partnership with Pearson, the world's largest educational publisher.

Some features of the NCCER Standardized Curricula are as follows:

- An industry-proven record of success
- Curricula developed by the industry, for the industry
- National standardization providing portability of learned job skills and educational credits
- Compliance with the Office of Apprenticeship requirements for related classroom training (CFR 29:29)
- Well-illustrated, up-to-date, and practical information

NCCER also maintains the NCCER Registry, which provides transcripts, certificates, and wallet cards to individuals who have successfully completed a level of training within a craft in NCCER's Curricula. *Training programs must be delivered by an NCCER Accredited Training Sponsor in order to receive these credentials.*



## Online Badges

Show off your industry-recognized credentials online with NCCER's digital badges!


NCCER is now providing online credentials. Transform your knowledge, skills, and achievements into badges which you can share across social media platforms, send to your network, and add to your resume. For more information, visit [www.nccer.org](http://www.nccer.org).

## Cover Image

Norwegian Cruise Line (NCL), one of the largest cruise lines in the world, set a bold vision to provide its guests with the finest global cruise terminal in the industry. Located at Port of Miami, the new terminal would be delivered on an ambitious schedule by a joint venture of two peer companies, NV2A Group and Haskell, in collaboration with renowned architect Bermello Ajamil & Partners (BA). NV2A-Haskell, rather than subcontractors, accepted the unprecedented liability of not requiring field dimensioning. This confidence came from digital modeling and saved over six months on the project schedule. The 3D model gave NV2A-Haskell absolute confidence that the tolerances would be such that all glass would fit, and in fact, it did. The facility was completed in summer 2020. For more information, visit [www.haskell.com](http://www.haskell.com).

# CORE FEATURES

Content is organized and presented in a functional structure that allows trainees to access the information where they need it.



MODULE 00109

Source: Courtesy of Terex Aerial Work Platforms

### Objectives

Successful completion of this module prepares you to do the following:

1. Identify the basic concepts of material handling and common safety precautions.
  - a. Describe the basic concepts of material handling and manual lifting.
  - b. Identify common material handling safety precautions.
  - c. Identify and describe how to tie knots commonly used in material handling.
2. Identify various types of material handling equipment and describe how they are used.
  - a. Identify non-motorized material handling equipment and describe how they are used.
  - b. Identify motorized material handling equipment and describe how they are used.

### Performance Tasks

Under supervision, you should be able to do the following:

1. Demonstrate safe manual lifting techniques.
2. Demonstrate how to tie two of the following common knots:
  - Square
  - Bowline
  - Half hitch
  - Clove hitch

### Overview

Lifting, stacking, transporting, and unloading materials such as brick, pipe, and various supplies are routine tasks on a job site. Whether performing these tasks manually or with the aid of specialized equipment, workers must follow basic safety guidelines to keep themselves and their co-workers safe. This module provides guidelines for using the appropriate PPE for the material being handled and using proper procedures and techniques to carry out the job.

### Industry Recognized Credentials

If you are training through an NCCER-accredited sponsor, you may be eligible for credentials from NCCER's Registry. The ID number for this module is 00109. Note that this module may have been used in other NCCER curricula and may apply to other level completions. Contact NCCER's Registry at 888.622.3720 or go to [www.nccer.org](http://www.nccer.org) for more information.

Trainees can navigate Core using color coded tabs on the upper right hand corner.

The Objectives list the skills and knowledge trainees need in order to complete the module successfully.

The Performance Tasks give you an opportunity to apply your knowledge to real-world tasks.

Section Openers provide a visual organizational structure for the information. Objectives and Performance Tasks are broken out for each section.

### 1.0.0 Common Hand Tools

Performance Task	Objective
1. Inspect and demonstrate the safe and proper use of the following hand tools: <ul style="list-style-type: none"><li>• Hammers</li><li>• Demolition tools</li><li>• Chisels and punches</li><li>• Screwdrivers</li><li>• Adjustable wrenches</li><li>• Non-adjustable wrenches</li><li>• Sockets</li><li>• Pliers</li></ul>	<p>Name common hand tools and state how to use them.</p> <ol style="list-style-type: none"><li>a. Identify various hammers and demolition tools and explain how to use them.</li><li>b. Describe chisels and punches and how they are used.</li><li>c. Match screwdrivers to the appropriate hardware.</li><li>d. Differentiate between non-adjustable, adjustable, and socket wrenches.</li><li>e. Describe various types of pliers and explain how they are used.</li></ol>

Construction craftworkers require a combination of knowledge and practical skills to be successful. While there are many things that can be done with hands alone, every craft must use hand tools to get the job done. How craftworkers handle and care for their tools often demonstrates their level of skill and respect for the craft.

Many unique hand tools are used across the crafts—far too many to present in a single module. You will likely be required to use hand tools in the early

### 1.1.2 Drywall Hammer

A **drywall hammer** (Figure 5) is used for driving nails in drywall, also referred to as **sheet rock**. Instead of claws, the opposite end of the hammer is shaped like a small hatchet.

Drywall hammers are lighter than normal hammers, generally weighing 12–14 oz (340–397 g). This light weight helps prevent deep indentations into the drywall. The nailing face is more rounded than other hammers as well, for the same reason. The hatchet-like tail of the hammer was originally used by plasterers to cut **lath**. However, it is equally valuable for drywall work. It can cut through small woodwork, and the U-shaped area is used to help grab and carry drywall sheets.

**Drywall:** A large, flat board made of layers of fiberboard and gypsum used primarily for wall construction and finishing. Drywall, also known as **sheet rock** and **wallboard**, is typically manufactured in 4' x 8' panels and readily accepts paint.

**Lath:** A thin, flat strip of wood used to form latticework or a foundation for wall plaster.

Trade Terms appear on the page adjacent to the text where they are first presented.

Step-by-step math equations help make the concepts clear and easy to grasp.

### 1.2.0 Adding and Subtracting Whole Numbers

**Sum:** The result of an addition problem. For example, in the problem 7 + 8 = 15, 15 is the sum.

To add means to combine the values of two or more numbers together into one **sum** or total. To add whole numbers, perform the following steps:

$\begin{array}{r} 723 \\ + 84 \\ \hline \end{array}$	<b>Step 1</b> Line up the digits in the top and bottom numbers by place value columns.
$\begin{array}{r} 723 \\ + 84 \\ \hline 7 \end{array}$	<b>Step 2</b> Beginning at the right side, add the numbers in the ones column (3 and 4) together first.
$\begin{array}{r} 1 \\ 723 \\ + 84 \\ \hline 07 \end{array}$	<b>Step 3</b> Continue adding the digits in each column, moving from right to left, one column at a time. In this example, adding the 2 and 8 in the tens column gives 10. This requires carrying the 1 from the tens column over to the next column on the left. To do so, place the 0 in the tens column and carry the 1 over to the top of the hundreds column as shown. Always add the carried-over number to the rest of the digits in that column.
$\begin{array}{r} 1 \\ 723 \\ + 84 \\ \hline 807 \end{array}$	<b>Step 4</b> Add the 7 already in the hundreds column to the 1 carried over. The resulting sum is 807.

QR codes link trainees directly to videos that highlight current content.

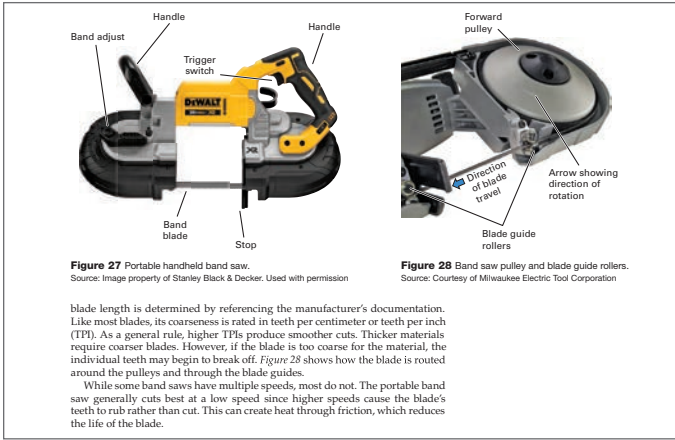
### SUCCESS STORIES: Credentials Matter: Start Building Your Career Today



Scan this code using the camera on your phone or mobile device to view this video.

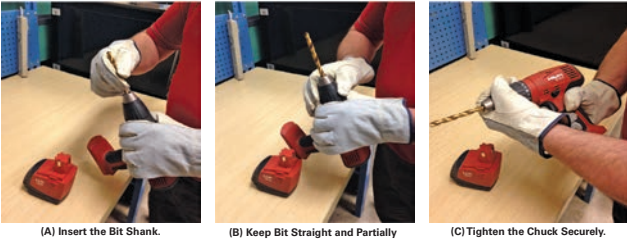
Important information is highlighted, illustrated, and presented to facilitate learning.

Placement of images near the text description and details such as callouts and labels help trainees absorb information.



**Preparing Drills with Keyless Chucks**  
Most cordless drills use a keyless chuck. While the steps for preparing a cordless drill are similar, there are some small differences. Follow the steps below when preparing to use drills with keyless chucks:

- Step 1** Disconnect the drill from its power source by removing the battery pack before loading a bit.
- Step 2** As shown in (Figure 7A), open the chuck by turning it counterclockwise until the jaws are wide enough to insert the bit shank.
- Step 3** Insert the bit shank into the chuck opening (Figure 7B). Keeping the bit centered in the opening, turn the chuck by hand until the jaws grip the bit shank.
- Step 4** Tighten the chuck securely with your hand so that the bit does not move (Figure 7C). You are now ready to use the cordless drill.



**Figure 7** Loading the bit on a keyless chuck.  
Source: Clenbro Corporation

New boxes highlight safety and other important information for trainees. Warning boxes stress potentially dangerous situations, while Caution boxes alert trainees to dangers that may cause damage to equipment. Notes boxes provide additional information on a topic.

**WARNING!**

A portable band saw always cuts in the direction of the user. For that reason, workers must be especially careful to avoid injury when using this type of saw. Always wear appropriate PPE and stay focused on the work.

**CAUTION**

Never assume anything. It never hurts to ask questions, but disaster can result if you don't ask. For example, do not assume that an electrical power source is turned off. First ask whether the power is turned off, then check it yourself to be completely safe.

**NOTE**

This training alone does not provide any level of certification in the use of fall arrest or fall restraint equipment. Trainees should not assume that the knowledge gained in this module is sufficient to certify them to use fall arrest equipment in the field.

**Did You Know?**

Louis Henry Sullivan, an American architect in the late 19th century, created a new style of architecture that resulted in buildings that were tall but still considered beautiful, a unique concept at the time. Called the "Father of Skyscrapers," he is most known for his design of the Wainwright Building in St. Louis.

These boxed features provide additional information that enhances the text.

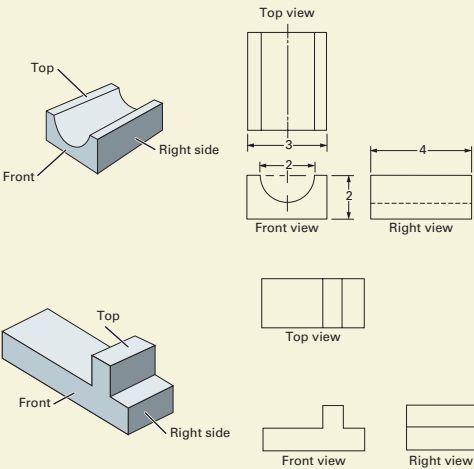
**Around the World**

**GOST**

While OSHA serves to protect workers by setting safety standards in the United States, other systems are used internationally. One such set of technical standards used on a regional basis is known as GOST. GOST standards are more far-reaching than OSHA standards, as they cover a much broader range of topics than worker safety alone. The first set of GOST standards were published in 1968 as state standards for the former Soviet Union. After the Soviet Union was dismantled, GOST became a regional standard used by many previous members of the Soviet Union. Although countries may also have some standards of their own, countries such as Belarus, Moldova, Armenia, and Ukraine continue to use GOST standards as well. The standards are no longer administered by Russia, however. Today, the standards are administered by the Euro-Asian Council for Standardization, Metrology and Certification (EASC).

**Orthographic Drawings**

Orthographic drawings are used for elevation drawings. They show straight-on views of the different sides of an object with dimensions that are proportional to the actual physical dimensions. In orthographic drawings, the designer draws lines that are scaled-down representations of real dimensions. Every 12 inches, for example, may be represented by 1/4 inch on the drawing. Similarly, in an example using metric measurements with a ratio of 1:2, every 30 millimeters may be represented by 15 millimeters on the drawing.



**Going Green**

**Biodiesel**

Cranes and other equipment used in rigging operations consume lots of fuel—just like all the other pieces of equipment at a typical job site. Most large trucks and construction equipment run on diesel fuel. These vehicles and machines could go green and use biodiesel instead. Biodiesel is a plant oil based fuel made from soybeans, canola, and other waste vegetable oils. It is even possible to make biodiesel from recycled frying oil from restaurants. Biodiesel is considered a green fuel since it is made using renewable resources and waste products. Biodiesel can be combined with regular diesel at any ratio or be run completely on its own. This means any combination of biodiesel and regular petroleum diesel can be used or switched back and forth as needed.

But what benefits does biodiesel have over traditional fuels?

- It's environmentally friendly. Biodiesel is sustainable and a much more efficient use of our resources than diesel.

- It's non-toxic. Biodiesel reduces health risks such as asthma and water pollution linked with petroleum diesel.
  - It produces lower greenhouse gas emissions. Biodiesel is almost carbon-neutral, contributing very little to global warming.
  - It can improve engine life. Biodiesel provides excellent lubricity and can significantly reduce wear and tear on your engine.
- Think about the environmental impact that would occur if every vehicle and piece of equipment at every job site were converted to biodiesel. The use of biodiesel also continues to increase in Europe, where Germany produces the majority of these fuels. However, even tiny countries such as Malta and Cyprus have some level of production.

Going Green looks at ways to preserve the environment, save energy, and make good choices regarding the health of the planet.



Review questions at the end of each section and module allow trainees to measure their progress.

### 1.0.0 Section Review

- The person primarily responsible for your safety is \_\_\_\_\_.
  - your foreman
  - your instructor
  - yourself
  - your employer
- The color commonly used for informational signs is \_\_\_\_\_.
  - green
  - red
  - yellow
  - blue
- The SDS for any chemical used at a job site must be available \_\_\_\_\_.
  - at the job site
  - online
  - at the contractor's office
  - at the nearest hospital

### Module 00101 Review Questions

- The four leading causes of death in the construction industry include electrical hazards, struck-by hazards, caught-in or caught-between hazards, and \_\_\_\_\_.
  - vehicular incidents
  - falls
  - radiation exposure
  - chemical burns
- A sign that has a white background with a green panel with white lettering is a \_\_\_\_\_.
  - general information sign
  - safety instruction sign
  - caution sign
  - danger sign
- To properly dispose of oily rags, they must be \_\_\_\_\_.
  - stored in a container designed for the purpose
  - washed thoroughly and returned to use
  - taken outdoors and thrown into a dumpster
  - burned at the end of the shift
- Keeping your work area clean and free of scraps or spills is referred to as \_\_\_\_\_.
  - managing
  - organizing
  - housekeeping
  - stacking and storing

## NCCERconnect

This interactive online course is a unique web-based supplement that provides a range of visual, auditory, and interactive elements to enhance training. Also included is a full eText. Visit [www.nccerconnect.com](http://www.nccerconnect.com) for more information!

1.0.0 Basic Rigging Equipment


### Regulations and Site Procedures

The information in this module is intended as a general guide. The techniques shown here are not the only methods that can be used to perform a lift. Many techniques can be safely used to rig and lift different loads.

Some of the techniques for certain kinds of rigging and lifting are spelled out in requirements issued by federal government agencies. Some will be provided at the job site, where written site procedures that address any special conditions that affect lifting procedures on that site can be found. Questions about any of these procedures should be directed to the supervisor at the site.

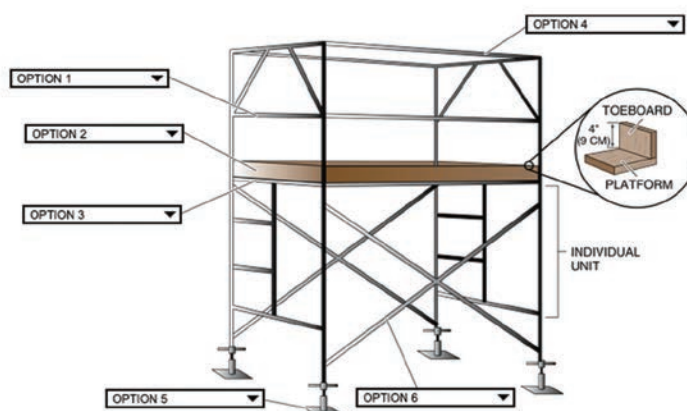
- They are flexible. They mold themselves to the shape of the load (Figure 5-10).
- They are very elastic, and they stretch under a load much more than wire rope. This stretching allows synthetic slings to absorb shocks and to cushion the load.
- Loads suspended in synthetic web slings are less likely to twist than those in wire rope or chain slings.

Watch: Opportunities in Construction



Source: Hingman, Inc.

### Typical Manufactured Scaffold



Instructions: Select the correct label from the dropdown option. Then click Submit.



## ACKNOWLEDGMENTS

This curriculum was revised as a result of the vision and leadership of the following sponsors:

MCTA	Knox School District
Haskell	River Valley Technical Center
ABC San Diego	TIC – The Industrial Company
Pittsburg State University	Industrial Management & Training
Stanley Black & Decker/DeWalt	Institute Inc.
Sundt	

This curriculum would not exist without the dedication and unselfish energy of those volunteers who served on the Authoring Team. A sincere thanks is extended to the following:

Mark Bonda	Heidi Pratt
Ryan Camer	Fernando Sanchez
Jason Decker	John Stronkowski
Josh Garland	Chad Sutton
Harold Heintz	Tim Thompson
Erin Hunter	Darry Welker
Jon Jones	

A final note: This book is the result of a collaborative effort involving the production, editorial, and development staff at Pearson Education, Inc., and NCCER. Thanks to all of the dedicated people involved in the many stages of this project.

## NCCER PARTNERS

To see a full list of NCCER Partners, please visit [www.nccer.org/about-us/partners](http://www.nccer.org/about-us/partners).

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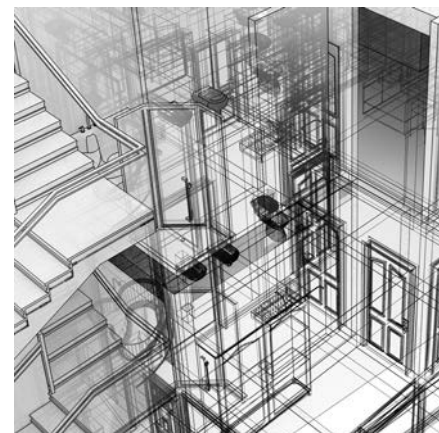
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# CORE

## Introduction to Basic Construction Skills



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# Build Your Future in Construction

Source: Smileus/123RF

## Objectives

Successful completion of this module prepares you to do the following:

1. Describe the construction industry.
  - a. Define construction and summarize the current and future outlook for jobs.
  - b. Identify some of construction's more prominent contributions in history.
2. Explain the benefits of a construction career.
  - a. Recognize and describe how construction careers make a difference in the community.
  - b. Describe the financial and professional benefits of pursuing a construction career.
3. Describe the typical career path for craft professionals.
  - a. Describe industry sectors and the progression path for construction careers.
  - b. Identify different construction careers and the types of skills they require.
4. Identify ways to pursue a career in the construction industry.
  - a. Explain the benefits of career and technical education programs.
  - b. Describe the advantages of craft training programs and their relationship with apprenticeships.
  - c. Summarize the path to a construction career through community colleges and universities.

## Performance Task

This is a knowledge-based module. There are no performance tasks.

## Overview

Construction is an exciting, well-paying industry that offers an abundance of career opportunities. With a growing need for individuals who are ready to learn while getting paid, it provides a great fit for people of all backgrounds, skills, and strengths. Carpenter, pipefitter, welder, electrician, and crane operator are just a few of the construction professions in high demand. This module will help you understand the state of the industry, the job opportunities that currently exist, and the training options that will lead you on a path to your new construction career.



### Industry Recognized Credentials

If you are training through an NCCER-accredited sponsor, you may be eligible for credentials from NCCER's Registry. The ID number for this module is 00100. Note that this module may have been used in other NCCER curricula and may apply to other level completions. Contact NCCER's Registry at 1.888.622.3720 or go to [www.nccer.org](http://www.nccer.org) for more information.



	1.0.0 Overview of the Construction Industry	
<b>Performance Tasks</b>  There are no performance tasks in this section.	<b>Objective</b>  Describe the construction industry. a. Define construction and summarize the current and future outlook for jobs.  b. Identify some of construction's more prominent contributions in history.	

When you think of construction, what images come to mind? If you are like many people, you might imagine someone hammering a nail or driving a bulldozer. While these are important activities within a specific construction trade, the opportunities within the entire industry are much broader than you may imagine. The construction industry employs millions of skilled individuals working in trades that offer rewarding jobs, excellent benefits, and great opportunities to have a positive impact on society and the world. Whatever your skills or interests, construction has a place for everyone.

1.1.0 What Is Construction?

At its most basic level, the term *construction* means to build. As an industry, construction includes the creation of residential and commercial buildings, roads, bridges, dams, industrial facilities, and more. It also includes lesser-known activities related to designing, managing, planning, repairing, maintaining, and even demolishing these structures.

Construction is both an art and a science and involves individuals skilled in a particular **craft/trade**. While **craft professionals** must rely on their technical knowledge, they often combine it with creativity and artistic skills. Creativity can mean many things, from using an artistic eye to looking at problems in an original way. It takes imagination to look at a job site or a piece of wood and know how to transform it into a finished product.

Think about the work performed by carpenters, welders, and masons. In most cases, it is critical that the products they build are structurally sound. In many instances, they are also visually appealing. If you have ever admired a building, a stained-glass window, a bridge (*Figure 1*), or even someone’s renovated kitchen, then you understand the value of construction and the different trades. The term *trade* is a general way of referring to one of the many construction specialties or crafts. From skyscrapers to small homes, highways to pipelines, and



**Figure 1** The Golden Gate Bridge.  
Source: Travel Stock/Shutterstock

**Craft/trade:** A general term referring to one of the many construction specialties.

**Craft professionals:** A trained and skilled individual who designs and builds things. Craft professionals conform to the technical and ethical standards of their trade.



**Figure 2** Craft professionals impact all parts of society.

Source: Icon Sportswire/Getty Images

power lines to ocean liners, everything in society was built by individuals using a wide variety of materials, tools, and skills.

Finding a way to follow one's passion in construction is easy. Restoring historic structures, like the Statue of Liberty or the United States Capitol, is its own exciting specialization of the construction field. Even building a professional football stadium (Figure 2) or basketball arena takes hundreds of trade professionals with a wide variety of expertise. Imagine the pride in creating lasting structures used by thousands of individuals and the opportunity to say you helped build it.

### 1.1.1 State of the Industry

The construction industry is currently thriving. According to the Associated General Contractors of America (AGC), the industry builds over \$1.3 trillion in structures per year and includes over 700,000 construction companies that employ more than 7 million total employees. In fact, construction contributed over \$887 billion to the US economy in 2019 alone, which equates to about 4 percent of the total value of all goods and services produced in the US.

Despite recent challenges in the overall US economy, the construction market is steadily growing. In addition to continued private spending, more construction growth is projected because of future plans to invest in the country's aging **infrastructure**. These are the transportation, water, electrical, and telecommunications systems that allow countries to operate.

### 1.1.2 Growing Demand for Skilled Craft Professionals

Opportunities abound for individuals entering the construction field. In fact, there simply are not enough skilled craft professionals to meet the industry's existing or anticipated demands in the coming years. Studies show that 80 percent of construction companies intend to hire more people over the next few years to meet the growing needs of the market. Many companies have encountered difficulties filling these positions and employee shortages are now a top concern.

Since experienced professionals are leaving the industry and fewer new employees are replacing them, there is a significant workforce shortage and a high demand for talented craft professionals. In fact, construction companies are trying to hire and train individuals immediately for the projected future growth in construction. For those seeking to enter the construction industry, this means there are great jobs available and they can earn a good income while they are being trained (Figure 3).

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**Infrastructure:** The transportation, water, electrical, and telecommunications systems that allow communities and countries to operate.





**Figure 3** The construction industry offers many opportunities to today's craft professionals.

Source: Mr Twister/Shutterstock

There are several reasons for this growing labor shortage. By 2030, an estimated 40 percent of the current construction workforce is expected to retire. Baby Boomers, the portion of the US population that is nearing or past retirement age, currently make up a large portion of the construction workforce. This group of highly experienced craft professionals have built their careers for decades and now hold leadership positions. They will leave behind a large gap in the number of people needed to perform the work in many of the trades.

At the same time, fewer young people are entering into construction. Instead, many individuals over the past few decades have opted to earn a degree at a four-year university. According to the website *Statista*, in 2018, 34 percent of men and 35 percent of women in the US had received at least four years of college education. In 1968, these numbers were much lower. Only 13 percent of men and 8 percent of women had attended a four-year college. So, in just 50 years, college enrollment has nearly tripled. With a continued national emphasis on attending college, many young people are simply unaware of the abundant construction career opportunities.

### 1.1.3 Common Construction Industry Myths

Despite its essential role in keeping the world's infrastructure running smoothly, the current construction industry is widely misunderstood. These misconceptions may prevent some people from pursuing careers in construction. The following list of myths about construction explains why they are not true.

#### **Myth: People in Construction Are Unskilled**

Construction is often mistakenly thrown into the category of unskilled labor; that is, work that can be performed without any special training or knowledge. This misconception likely stems from the fact that a person does not need a college degree to get a construction job. In reality, craft professionals perform extremely detailed, specialized work that requires a high level of expertise gained through years of training, both in the classroom and on the job. Many professionals must also earn specialized licenses, credentials, and/or certifications that prove their expertise.

#### **Myth: Construction Employees Make Minimum Wage**

According to a 2018 survey by *U.S. News & World Report*, the lowest-paid 25 percent of the construction workforce made almost double the minimum wage amount,

### Success Story: Holley Thomas

Holley Thomas became interested in welding in 2007 while earning a degree in robotics from Central Alabama Community College. She discovered that not only did she have a great talent for welding, but she also loved the craft. She was recruited by KBR, a global engineering and construction firm, as part of their outreach and engagement with the college's technical programs.

Over the next 11 years, Thomas took advantage of KBR's training offerings and grew as an experienced craftsperson. She started as a welder, worked her way into supervision, and moved into a quality inspector role. She is the first woman welder to have taken top honors (gold) in welding at the Associated Builders and Contractors (ABC) National Craft Championship in 2010. In 2015, Thomas won the ABC's National Craft Professional of the Year award.

Thomas shares, "Being a skilled craft professional, and furthermore a female in the industry, helps me leave a great legacy. I've been able to show other women in the industry that you can start from the bottom and work your way up to where I am today."

over \$28,520 per year. The highest 25 percent of employees made almost double that amount. The average annual salary is over \$40,000 and rising. Salaries do not include overtime or bonus pay, which means potential incomes are even higher.

### Myth: Construction Is Not for Women

For most of history, men dominated the world of construction. Now, greater focus on refined skills and knowledge of specific crafts means that the most successful and best-paid construction professionals are those who can do the best work, regardless of gender.

According to the National Association of Women in Construction (NAWIC), 1.1 million women work in construction industry jobs that include field, office, and management positions. With women making up only 10 percent of the construction workforce (*Figure 4*), many construction companies see this underrepresented demographic as an opportunity to fill important job vacancies.

In addition, women are paid more equally in construction than in many other industries. The US Bureau of Labor Statistics (BLS) reports that women earn more than 99 cents for every dollar a man earns in construction jobs, compared to the US average of 81 cents.

### Myth: Construction Does Not Use Technology

Construction has embraced technology and invested in it. According to the website [techcrunch.com](http://techcrunch.com), funding in US-based construction technologies increased



**Figure 4** Construction opportunities abound for men and women.

Source: Jhorrocks/E+/Getty Images



**Figure 5** Many construction professionals use technology on the job.

Source: AzmanL/E+/Getty Images

by about 320 percent in recent years and is expected to increase even more. Examples of technology used in construction include:

- *Computers, mobile apps, and IoT devices* — Allow workers to share data, collaborate, and communicate more quickly (Figure 5). Examples of IoT devices include smartphones, tablets, residential and commercial sensors, and many other items.
- *Drones* — Survey job sites and identify potential hazards in risky or hard-to-see areas.
- *Robots* — Lift and move heavy objects on job sites.
- *Simulators* — Create realistic sensations of heights, stress, and hazards, allowing trainees and craft professionals to experience what it feels like to operate equipment and practice safety procedures before actually doing so on the job.
- *Software* — Create and update construction designs easily and seamlessly.

### Myth: Construction Is Dangerous

Jobs involving heavy machinery, power tools, and large components have inherent risks. But the construction world has made great strides to create a safer and healthier work environment for craft professionals. Working in construction is safer than ever before due to many factors:

- *Higher government safety standards* — Since the formation of the **Occupational Safety and Health Administration (OSHA)** in 1971, construction injuries have dropped significantly. The mission of OSHA is to establish and enforce safe working conditions for the US workforce. Protective equipment requirements and dedicated safety managers on job sites are two of the most influential reasons for safer work environments.
- *More emphasis on safety in training* — Many injuries can be avoided if craft professionals are well-trained and understand the proper procedures. Modern construction programs place a significant focus on teaching safe practices in the workplace.
- *Improved technology* — Digital technology has enabled construction companies to work more safely and efficiently. For example, drones allow construction crews to more easily spot potential hazards and to monitor work sites remotely.
- *Safety matters in winning bids* — A construction company's safety records are a major factor in winning bids and being selected for projects.

### Occupational Safety and Health

**Administration (OSHA):** An agency of the US Department of Labor with the mission to establish and enforce safe working conditions for the US workforce.

### Did You Know?

President Nixon played an important role in the history of construction by signing the Occupational Safety and Health Act in 1970, which established the government agency called OSHA.





**Figure 6** Solar panels at Walt Disney World Resort.

Source: Engdao Wichitpunya/123RF

### Myth: Construction Is Bad for the Environment

The construction industry is leading the charge on **sustainability**—the practice of minimizing negative impacts to Earth’s climate and natural environment. Today, construction companies are attempting to reduce impacts on the environment by recycling materials, installing renewable energy sources, and using **green construction**, which involves creating structures that adhere to sustainability principles. In 1993, the US Green Building Council (USGBC) was created with a mission to promote sustainability-focused practices in the building industry. The council created the green building rating system known as Leadership in Energy and Environmental Design (LEED), which has become an international standard for certifying environmentally sound buildings.

Examples of construction practices that are good for the environment include:

- Preassembly of structures off site, which allows for more material reuse
- Wind power technologies, which use wind to generate energy
- Solar panels, which harness sunlight to provide energy
- Water reclamation

An example of green construction in use is the Walt Disney World Resort in Orlando, Florida, which recently installed a solar panel facility on 270 acres of land that will reduce annual emissions of greenhouse gas by more than 50,000 tons (*Figure 6*).

## 1.2.0 History of Construction

Construction had its start thousands of years ago. History is documented through the built environment—think about the architectural wonders like the Great Pyramid of Giza in Egypt, the Great Wall of China (*Figure 7*), or Machu Picchu in Peru. It’s easy to forget that human beings created these amazing structures. Imagine the many aspects of work that were required to bring these structures to completion; the design, planning, transporting of heavy materials, building, and so much more, all without the tools and technology available today.

Construction began by necessity, with humans building personal shelters using their hands or simple hand tools. Over time, people gained expertise in certain tasks to become specialists such as carpenters, bricklayers, and blacksmiths, allowing societies to build more complex structures. As steam-powered machinery came about in the 19th century, more advanced structures could be built, and could be built much faster.

With technology advancements that came with the Information Age, computer systems have revolutionized construction faster than in any other time period.

**Sustainability:** The practice of minimizing negative impacts to Earth’s climate and natural environment.

**Green construction:** Construction practices that involve the creation of structures that adhere to sustainability principles.

### Did You Know?

American sculptor, inventor, and businessperson Pat Billings invented the product Geobond®, an indestructible plaster product that was patented in 1997. The most significant characteristic of Geobond® products is that they are extremely resistant to heat, able to withstand temperatures reaching over 2,000°F. Not even a rocket engine can burn the product.



**Figure 8** The Burj Khalifa in Dubai is the tallest building in the world.

Source: Iain Masterton/Alamy Stock Photo

#### Personal protective equipment (PPE):

Equipment or clothing designed to prevent or reduce injuries.

**Computer-aided design (CAD):** The use of computers to digitally sketch construction designs, allowing other people to see how aspects of a structure would look and work together when built.

**Building information modeling (BIM):** A process in which software reads computer files containing building data to create a virtual picture of a facility before it is built. BIM objects represent many dimensions of construction, and allow builders to adjust the plans prior to beginning actual construction.



**Figure 7** Construction on the Great Wall of China began around 700 BC.

Source: Aphotostory/Shutterstock

Improvements in accuracy, consistency, speed, and complexity of construction exist today in ways never even imagined just 50 years ago. Construction has evolved into a high-tech business. Innovative individuals who tried new ideas, invented new products and processes, and manufactured easy-to-use materials have helped transform construction into a much more efficient and technology-driven business.

### 1.2.1 Famous Construction Examples

All the famous and iconic man-made structures around the world would not be here today without the skilled people who built them. Consider these feats of construction that were groundbreaking at the time they were built:

- *Eiffel Tower, in Paris, France* — Made of wrought iron in the late 1800s, it is still the second tallest building in France.
- *Empire State Building, in New York, NY* — The world's tallest building upon its completion in 1931.
- *Golden Gate Bridge, in San Francisco, CA* — The longest suspension bridge in the world upon its completion in 1937.
- *Hoover Dam, on the Nevada/Arizona border* — A dam built with a workforce that peaked at more than 5,000 people in 1934.
- *Burj Khalifa, in Dubai, United Arab Emirates* — A skyscraper completed in 2009, it is still the tallest artificial structure in the world at 2,722 feet (*Figure 8*).

### 1.2.2 Important Construction Innovations and Inventions

It is hard to imagine the world without inventions that make construction projects work more efficiently. The following are just a few examples of the construction industry's important innovations and inventions:

- **Personal protective equipment (PPE)** — This equipment or clothing is designed to prevent or reduce injuries on a job site. Examples include hard hats, safety glasses, face shields, safety-toed footwear, gloves, and earplugs (*Figure 9*).
- **Computer-aided design (CAD)** — Before this invention in the 1960s, construction designs had to be drawn on paper by hand, using a tedious and time-consuming process. With CAD, users employ a more automated approach to sketching two-dimensional or three-dimensional designs, allowing other people to more clearly see how aspects of a structure would look and work together when built.
- **Building information modeling (BIM)** — In this process, software reads computer files containing information to get virtual pictures of the construction





**Figure 9** Craft professionals wear PPE to stay safe on the job.

Source: Xavierarnau/E+/Getty Images

of a facility before it is built. BIM objects represent many dimensions of construction such as time, cost, operation, and safety to simulate the construction process and anticipate any issues that may arise. As a result, schedules, site layouts, and other details can be adjusted for the best outcome, long before the physical building begins.

- **Virtual reality (VR)** — Like CAD and BIM, virtual reality takes what used to be paper drawings and information and allows users to visualize a structure before it is created. VR provides a 3D model of a construction site and allows users to directly immerse themselves into the virtual space. VR enables multiple people to envision the final product, feel what it is like to be in the space, and identify any issues before work begins.

### Did You Know?

The first CAD system was developed in the 1960s by an American computer scientist named Ivan Sutherland. The system, called Sketchpad, was the first of its kind to store information and drawings and allow the user to alter designs digitally. This invention also laid the groundwork for building information modeling (BIM) and virtual reality (VR).

**Virtual reality (VR):** Provides a 3D model of a construction site and allows users to directly immerse themselves into the virtual space. VR enables multiple people to envision the final product, feel what it is like to be in the space, and identify any issues before work begins.

## 1.0.0 Section Review

1. A major reason for the projected shortage of trained craft professionals is \_\_\_\_\_.
  - a. construction salaries are too low
  - b. technology has eliminated many construction careers
  - c. demand for construction projects is declining
  - d. the retirement of Baby Boomers
2. For every dollar made by men in construction, women make approximately \_\_\_\_\_.
  - a. 50 cents
  - b. 68 cents
  - c. 87 cents
  - d. 99 cents
3. During the 19th century, many structures could be built faster due to the invention of \_\_\_\_\_.
  - a. hand tools
  - b. steam-powered machinery
  - c. self-healing concrete
  - d. virtual reality

## 2.0.0 Benefits of a Career in Construction

### Performance Tasks

There are no performance tasks in this section.

### Objective

Explain the benefits of a construction career.

- a. Recognize and describe how construction careers make a difference in the community.

- b. Describe the financial and professional benefits of pursuing a construction career.

When you choose a career in construction, you are choosing an industry that has a lasting impact on people and communities. At the same time, it provides an opportunity to combine knowledge, skills, and artistic expression. There are limitless opportunities for career mobility and advancement, plus the financial benefits that come from an industry filled with high-paying occupations. With so many specialties from which to choose, the benefits of a career in construction are many.

## 2.1.0 Making a Difference

In many ways, the state of a society's infrastructure depends on the skills and expertise of craft professionals. The end result of their work is what allows society to function and thrive. In short, craft professionals make a lasting difference in the world.

Craft professionals who work in construction take pride in being part of something greater than their individual contributions. They understand that it often takes the skills of many individuals working together to achieve great things.

### 2.1.1 Providing Essential Services

When you wake up and flip the light switch on, that switch is connected to wires that ultimately lead to a power plant that is miles away that craft professionals built and maintain. When you turn on the faucet and clean water flows, that water comes through pipes that connect to a water station miles away that craft professionals built and maintain. The roads you drive on and the buildings in the schools you attend were all built by craft professionals. These services and structures are only possible because of skilled individuals who used their talents to install the components and systems that make activities like these a regular part of our daily lives.

During natural disasters or other catastrophes, craft professionals often act as first responders. Hurricanes, tornados, floods, and earthquakes can create destruction that interrupts many essential services. Restoring essential services and rebuilding structures in a timely manner are critical to minimizing the impact of these emergencies. Examples of essential services include restoring utilities such as water and electricity and rebuilding residential structures that may have been destroyed in a disaster.

### 2.1.2 Working to Help the Environment

The current construction workforce has become increasingly focused on minimizing environmental impacts of construction. As a result, the construction industry is changing, and the professionals who work in the industry are making positive differences for the environment. In addition to employing different building techniques, they are actually installing devices and systems that help businesses and homeowners conserve energy, reduce environmental impacts, and save money.

## 2.2.0 Construction Career Benefits and Opportunities

Construction careers can provide competitive salaries, a debt-free start, and financial security. With the sizeable shortage of construction professionals, the increasing demand for craft professionals has resulted in rising salaries and enticing benefits designed to attract talented individuals.

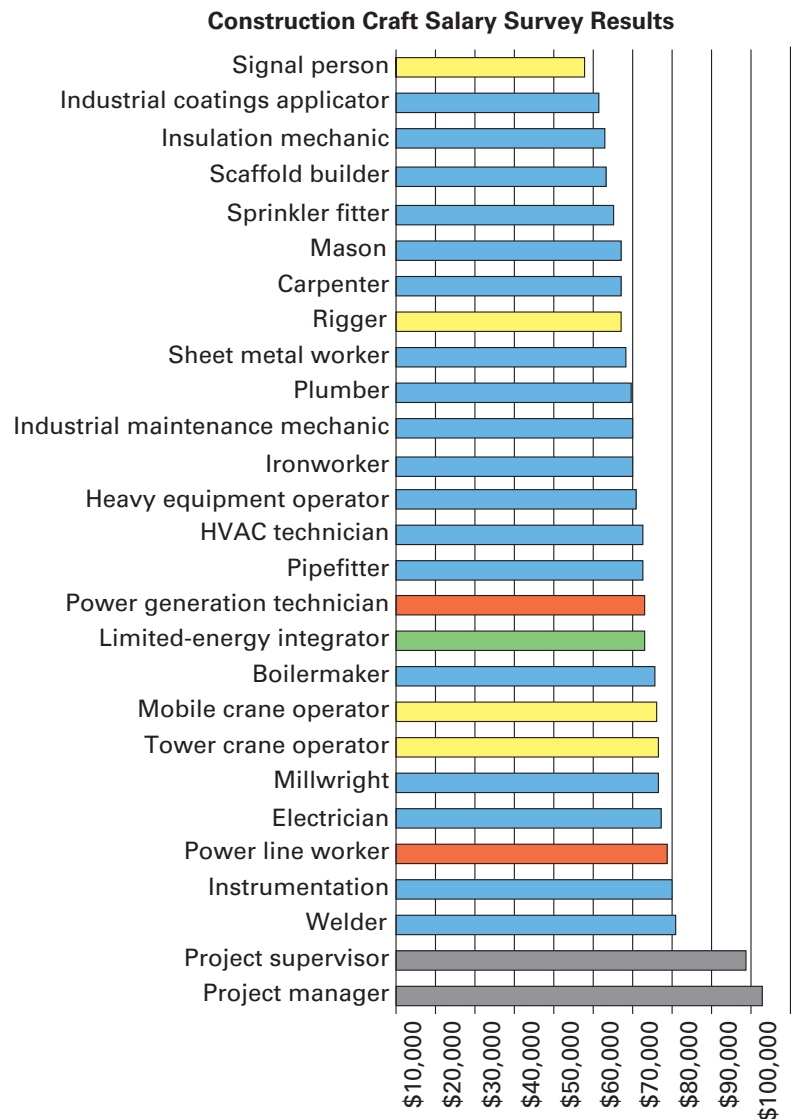
### 2.2.1 Competitive Salaries

Salaries for craft professionals are extremely competitive. Every other year, NCCER releases construction craft salary survey results based on the national average of base salaries for skilled craft professionals. The survey represents more than 350,000 industrial and commercial construction employees from across the US. Results for some of the construction trades are shown in *Figure 10*. Construction salaries for all of the crafts included in this survey range from \$47,000 to \$92,000. The salaries shown do not include overtime, bonuses, or other incentives. When these are combined, the overall benefits of construction jobs are even higher.

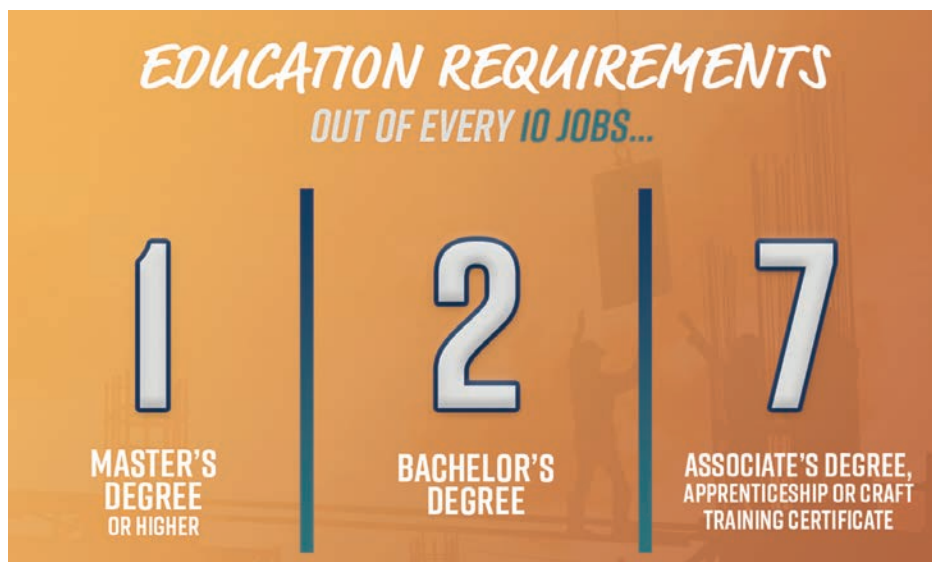
### 2.2.2 Starting Out Debt-Free

College tuition costs and student loans are the second-highest source of debt in the United States. In fact, college tuition debt is second only to mortgage debt. *Forbes* reports that the total amount of student debt is over \$1.5 trillion, which is equivalent to the value of about 500 National Football League franchises.

College tuition costs continue to rise at a fast rate. While some aspiring craft professionals may choose to obtain a bachelor's degree—particularly if they want to become civil engineers, project managers, or architects—the majority of construction careers do not require a degree. In fact, 7 out of every 10 jobs in the US economy require less than a four-year degree (*Figure 11*).



**Figure 10** NCCER construction craft salary survey results.



**Figure 11** Education and construction career requirements.



Skilled craft training is available through technical schools, community colleges, associations, or contractor programs. These programs are shorter and far less expensive per year than the cost of attending a university.

With craft training programs (*Figure 12*), trainees learn both on the job and in the classroom under the instruction of experienced craft professionals. Craft training typically follows an **Earn as You Learn** model, which allows trainees to earn wages for their work in the field with pay increases as their skills advance. In addition, many construction companies will cover any additional education costs, allowing trainees to complete the training program debt-free and with a growing bank account.

In fact, successful completion of an **apprenticeship/craft training** program provides immediate marketability and acquisition of highly valuable skills—all while earning an income as you are being trained. This type of training makes it possible to avoid the high costs of attending a university. On the other hand, despite spending several years and considerable funds to earn a college diploma, university graduates often end up working in jobs unrelated to their degree. A study by the Federal Reserve Bank of New York found that only 27 percent of graduates work in a field related to their major.

**Earn as You Learn:** An approach to education that pays trainees wages for work completed as part of an on-the-job learning (OJL) program.

**Apprenticeship/craft training:** A program in which you gain valuable skills on the job under the instruction of more experienced professionals, often making money as you obtain training.

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### 2.2.3 Career Advancement and Mobility

Construction careers typically offer clear paths to advancement and craft professionals have excellent opportunities to progress in their careers. Many construction jobs begin with individuals learning how to use their tools. As they become proficient and develop their expertise, they can obtain additional licenses and certifications to increase their chances for promotion.

In addition to core craft skills, working in construction often requires leadership skills such as good communication, teamwork, and decision-making (*Figure 13*). These critical leadership skills allow advancement from trainee to craft professional to higher managerial and executive roles. Some craft professionals ultimately gain the knowledge and skills necessary for starting their own businesses and leading their own teams of employees.

During the development of their skills, these same individuals are often given the opportunity to travel or relocate to different areas because the skills they possess are in such high demand. Excellent construction jobs exist in cities and states all across the US and the world, meaning that skilled craft professionals are free to travel or move to locations as the demand allows. In some cases, companies even send their employees to construction sites in foreign countries.



**Figure 12** Craft training provides on-the-job learning (OJL).  
Source: Sturti/E+/Getty Images



**Figure 13** Leadership skills help you advance in construction.  
Source: kzenon/istock/Getty Images

### Success Story: Boyd Worsham, from Builder to President/CEO

As a boy growing up, Boyd Worsham always liked to build things. The carpentry program at his high school solidified his desire to enter the construction industry. He was inspired by his carpentry teacher, who taught not only skills in carpentry but also responsibility and how to be employable. His teacher introduced Boyd to a job opening as a carpentry helper, which he started in 1980, right out of high school.

As he developed his skills over the next 38 years, Worsham worked his way up, first as a journeyman carpenter, then carpenter foreman, assistant superintendent, superintendent, and, finally, to vice president of construction support for The Haskell Company. Haskell is a leader in design-build project delivery. At Haskell, he was involved in major projects throughout the US. Haskell even paid for Worsham to obtain his Master of Business Administration from Jacksonville University, located in Jacksonville, Florida. Although he did not have a bachelor's degree, his 25 years of industry experience was counted in place of a degree. Ultimately, in September 2020, Worsham was appointed president and chief executive officer of NCCER, an international education foundation for the construction industry.



Source: Courtesy of Boyd Worsham

## 2.0.0 Section Review

- During disasters, craft professionals are considered first responders because they perform work to restore essential services and structures.
  - True
  - False
- A major benefit of craft training is that \_\_\_\_\_.
  - you have no financial responsibilities until you finish training
  - you are able to earn while you learn
  - you eventually make enough to pay off your training debt
  - you have your apprenticeship after one year of training
- One reason construction careers provide craft professionals with mobility is \_\_\_\_\_.
  - subcontractors often give company automobiles to employees
  - most craft professionals must travel due to the lack of work
  - their skills are often in demand everywhere
  - most good contractors demand that their employees travel long distances

## 3.0.0 Construction Craft Careers

### Objective

Describe the typical career path for craft professionals.

- Describe industry sectors and the progression path for construction careers.

- Identify different construction careers and the types of skills they require.

### Performance Tasks

There are no performance tasks in this section.

Skilled construction professionals are part of a growing industry that offers a wide array of career opportunities. While some people still hold an outdated view that lumps all construction jobs together, today's reality is much different. The construction industry offers many career paths and specializations. In fact, the National Center for Construction Education and Research (NCCER) offers specialized training programs for more than

45 construction crafts. This means individuals can choose from a large variety of construction jobs, many of which offer tremendous earning potential and great opportunity for advancement.

### 3.1.0 Construction Industry Sectors

**Sector:** A category of construction distinguished by specific types of work, materials, equipment, and skills. The four sectors of construction are residential, commercial, industrial, and heavy civil/infrastructure.

The construction industry comprises four primary sectors. Each **sector** includes specific types of construction, materials, equipment, and skills. The four sectors are:

- **Residential** — Includes design, construction, and maintenance of single-family homes, multi-family homes such as apartment buildings, public housing developments, and even separate garages and sheds.
- **Commercial** — Includes design, construction, and maintenance of schools, government buildings, medical facilities, hotels, sports arenas and stadiums, shopping centers, and large office buildings.
- **Industrial** — Includes construction of public works such as manufacturing plants, oil refineries, electrical generating plants, chemical processing plants, and large mills.
- **Heavy civil/infrastructure** — Often referred to as horizontal construction, this sector includes professionals who build bridges, roadways, airports, tunnels, and dams.

Each construction sector has its own approach to initiating and paying for projects, selecting the required equipment, and ensuring its workforce is adequately trained and prepared for the job.

Although each sector and construction craft has specific requirements for skills and training, the progression path for construction careers is usually the same as the one shown in *Figure 14*.

A **contractor** oversees many parts of a construction project, including resource management, budgeting, code adherence, quality assurance, and construction materials. A contractor typically works directly with the construction **project owner** or the owner's representative. The project owner is the initiator of the project and usually finances the building endeavor. A contractor hires a **subcontractor/specialty contractor** to complete specific construction tasks. In most cases, subcontractors employ craft professionals with expertise and skills that can be used across multiple construction sectors. For example, while some craft professionals are responsible for tasks related to erecting a structure, others are involved in installing and maintaining electrical, communication, HVAC, and plumbing systems.

Many construction professionals start their careers working for a subcontractor and may continue there or move up to become general contractors. As they refine their skills and develop their leadership capabilities, they may be promoted to **crew leader** or superintendent, or even progress to higher senior management positions. The crew leader, sometimes called the *foreman*, manages a team or crew of craft professionals assigned to work on a construction project (*Figure 15*). A **site superintendent** manages day-to-day activities on a construction site and supervises work performed by the subcontractors. A superintendent can be a craft professional who has been a crew leader and has completed the necessary supervisory training, or he or she can be a person who graduated from a university construction management program. On the other hand, a **project manager** plans, schedules, and executes projects within a set budget, but is not always on the construction site. A project manager typically holds a university degree.

As in many other industries, opportunities for advancement in construction are directly related to workers' skill level, their continued willingness to grow and develop, and the quality of their work.

**Contractor:** Oversees many parts of a construction project, including resource management, budgeting, code adherence, quality assurance, and construction materials.

**Project owner:** The initiator of the project who usually finances the building endeavor.

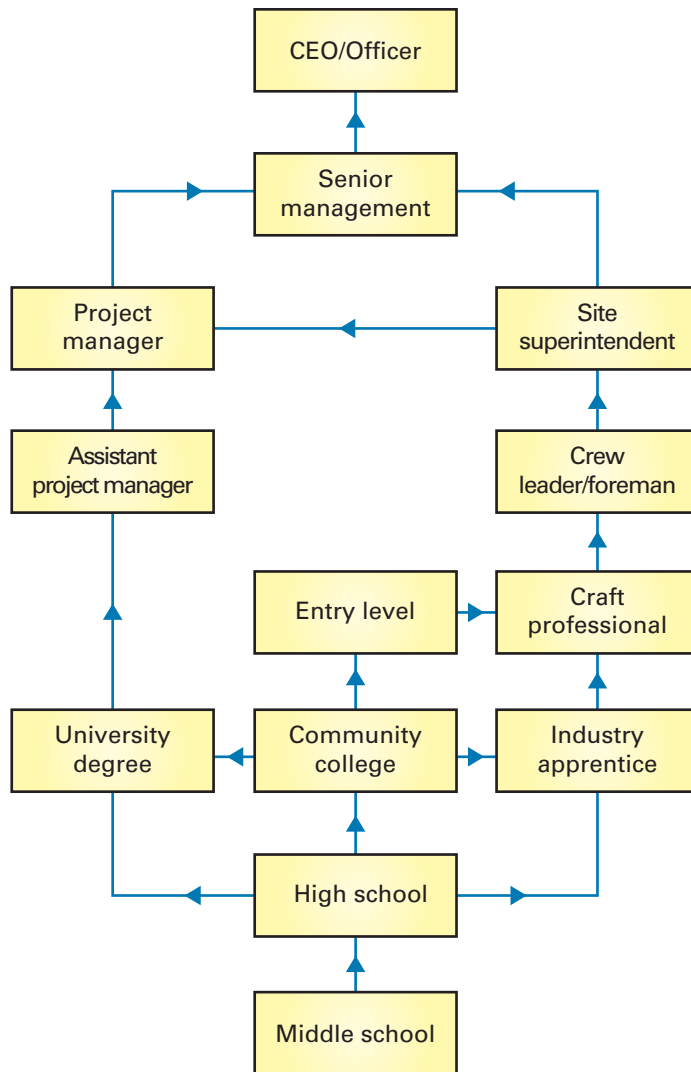
**Subcontractor/specialty contractor:** Typically employs craft professionals who have specialized skills needed to complete a particular part of the construction project (e.g. HVAC, electrical, plumbing).

**Crew leader:** Also called *foreman*, this supervisory role oversees a crew of craft professionals. It is the crew leader's job to make sure that work is completed correctly and on time. Crew leaders are responsible for the safety and work of those under them.

**Site superintendent:** Manages day-to-day activities on a construction site and supervises work performed by the subcontractors.

**Project manager:** Oversees the planning and delivery of construction projects on time and within budget.





**Figure 14** Career path for construction careers.



**Figure 15** Construction project team.

### 3.2.0 Types of Construction Careers

One of the biggest benefits of pursuing a construction career is the variety of available jobs. Depending on your personal interests, professional goals, and desire to learn, construction offers great opportunities for practically everyone willing to learn and develop their skills.

Another benefit is the earning potential offered by many of the construction careers. Salary ranges differ based on specific construction career paths and an individual's skill level, quality of work, region, and desire to succeed. Other factors include ongoing classroom education and craft-specific training and certifications.

While performing the role of construction project manager or civil engineer requires a college education, most construction careers require only a high school diploma or equivalent to get started. Formal training programs are generally offered through technical schools, community colleges, and construction-oriented training organizations, and many use the NCCER curricula. An image of NCCER is shown in *Figure 16*. Most NCCER programs are designed to provide multiple levels of training, allowing a trainee to learn and obtain craft credentials in stages.

The following sections describe several popular construction careers, providing information related to each career path's responsibilities, salary potential, needed skills, and job outlook.

#### 3.2.1 Carpenter

Carpenters construct, repair, and install building frameworks and structures made from wood and other materials (*Figure 17*). Carpenters are involved in many kinds of construction from the restoration of historic buildings to the construction of homes, commercial buildings, and more.

Examples of carpentry specializations include:

- *Rough carpenter* — Does the framing, formwork, and other structural work.
- *Finish carpenter* — Puts finishing touches on structures after they are almost fully built. Most of the visible wood inside of homes and buildings is placed there by finish carpenters. Typical jobs for a finish carpenter include window and door trim, crown molding, bookshelves, baseboards, and wooden stairways.

**SUCCESS STORIES:** SkillsUSA 2018  
Carpentry Competition Highlights



Scan this code using the camera on your phone or mobile device to view this video.



**Figure 16** National Center for Construction Education and Research.





**Figure 17** Carpenters build both large and small structures.

Source: Stevecoleimages/E+/Getty Images

### Salary

The average salary for a carpenter is approximately \$57,000 per year. The top 10 percent of carpenters earn more than \$84,690.

### Job Growth Estimates

The demand for carpenters in the US is expected to remain the same, with about 90,000 new openings per year expected through the next decade.

### Skills

To be successful, a carpenter should possess the following traits or skills:

- Physically fit
- Sense of balance
- Good eye-hand coordination
- Detail oriented
- Ability to read blueprints and follow instructions for installing certain products
- Basic math skills (to calculate sizes and amounts of materials accurately)
- Good problem-solving skills

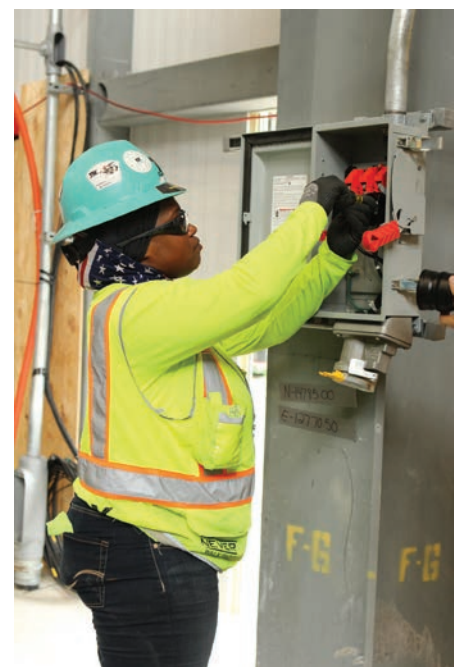
### Specific Qualifications

In some cases, carpenters are expected to earn an apprenticeship, which requires a specific number of hours on the job and in the classroom. NCCER offers a four-year carpentry training course that can be used to fulfill the classroom instruction requirement of an apprenticeship.

## 3.2.2 Electrician

Electricians install and maintain the electrical and power systems for homes, businesses, and factories (*Figure 18*). In large factories, electricians usually do maintenance work that is more complex. These kinds of electricians may repair motors, transformers, generators, and electronic controllers on machine tools and industrial robots. They also advise management regarding electrical hazards.

Another related electrical career is focused more on installation and maintenance of low-voltage electronic cables and devices. Some of the systems



**Figure 18** Electricians install and maintain high-voltage power systems.

installed by these professionals include audio and video, security, fire protection, residential and commercial building networks, CCTV, and access control systems. These electronics professionals are known as limited-energy integrators or electronic systems technicians.

### Salary

The average salary for an electrician is approximately \$67,000 per year. The top 10 percent of electricians earn more than \$96,580.

### Job Growth Estimates

The demand for electricians in the US is expected to grow by almost 10 percent during the next decade, which equates to almost 80,000 new openings per year over the same time period.

**SUCCESS STORIES:** *Discover Success:  
Following in Footsteps*



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### Skills

To be successful, an electrician should possess the following traits or skills:

- Physically fit
- Good color vision (to recognize electrical wires by color)
- Detail-oriented
- Good math skills
- Good problem-solving skills
- Customer service skills
- Skilled with hands

### Specific Qualifications

Credentials needed by electricians vary by state. In most states, they must be licensed. To earn a license, an electrician must pass a test with questions related to national, state, and local codes. These codes are in place to ensure safe installation of electrical wiring and equipment.

Electricians are generally required to take continuing education courses related to safety, code changes, and product training in order to maintain their licenses. To work in a specialty area, electricians are often required to obtain additional training.

### 3.2.3 Welder

Welders join metals together using a high-intensity electrical arc at temperatures between 6,000°F and 10,000°F. By joining metal together, welders create a variety of structures, including buildings, ships, bridges, automobiles, and other smaller items. They also cut steel using oxyfuel, air carbon-arc, or plasma-arc equipment. A strong focus on precision and safety is key for success in this craft. Examples of welding specializations include:

- *Pipe welder* — As the name implies, pipe welders construct and repair sections of pipe and related components (*Figure 19*).
- *Stainless steel welder* — Uses either TIG welding, spot welding, or MIG welding to join stainless steel metals. The method used typically depends on the qualities of the stainless steel being welded.
- *Weld inspector* — Assures the quality of existing welds by using high-tech testing methods.
- *Underwater welder* — While wearing full underwater diving gear, this professional performs different types of welding using a power source supplied through cables and hoses connected to welding equipment.
- *Robotic welder* — Programs robots and computer-controlled machines to perform welding.

#### Did You Know?

Two men of the 19th century are credited with making significant advancements in the welding field. French engineer Auguste de Meritens was the first to use heat from electricity to weld together lead plates. Around the same time, Russian inventor Nikolay Benardos discovered a similar method of welding using carbon rods.



**Figure 19** Pipe welders join sections of pipe.

Source: Imantsu/istock/Getty Images

### Salary

The average salary of a pipe welder is approximately \$69,000. Structural welders make an average salary of approximately \$56,160. When other advanced specialty welding salaries are combined, the average salary of an experienced welder rises to \$71,067.

### Job Growth Estimates

The demand for welders in the US is expected to grow by about 3 percent during the next decade. As the nation's infrastructure ages, the expertise of welders will be needed to rebuild roads, bridges, and buildings. Aspiring welders have more opportunities if they are open to traveling or relocating to work on what are often short-term projects.

### Skills

To be successful, a welder should possess the following traits or skills:

- Detail-oriented
- Hand-eye coordination
- Physically fit
- Strength in reading two- and three-dimensional drawings
- Basic understanding of electricity

### Specific Qualifications

Some welding positions require a general welding certification. The American Welding Society (AWS) offers the Certified Welder credential. To become a specialist, a welder must obtain a certificate focused on a particular area, such as pipe welding. Underwater welders must also have a diver's certification.

### 3.2.4 Pipefitter

Pipefitters install, assemble, fabricate, maintain, and repair mechanical piping systems. They work with many kinds of pipe in manufacturing, commercial, and industrial settings such as chemical plants, oil refineries, food processing plants, and paper mills. They work with piping systems that carry water, gases, liquid chemicals, solids, and fuels (*Figure 20*). Pipefitters need to have a good understanding of blueprints, basic math, welding, pipe bending, fittings, and valves.

**SUCCESS STORIES:** *Discover Success:  
Earn More Through Welding Jobs*



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**Figure 20** Pipefitters connect and repair pipe in a variety of industrial settings.

**SUCCESS STORIES:** *Discover Success:  
Family Means Everything*



*Scan this code using the  
camera on your phone  
or mobile device to view  
this video.*

### Salary

The average salary for a pipefitter is approximately \$63,000 per year. The top 10 percent of pipefitters earn more than \$97,170 annually.

### Job Growth Estimates

The demand for pipefitters in the US is expected to grow approximately 4 percent in the next decade, which works out to approximately 50,000 new openings per year.

### Skills

To be successful, a pipefitter should possess the following traits or skills:

- Mechanical abilities
- Physical fitness
- Problem-solving skills
- Mathematical skills, particularly in geometry
- Ability to measure, cut, thread, and assemble pipe
- Ability to sketch piping systems

### Specific Qualifications

Pipefitters typically go through a four-year craft training or apprenticeship program to become a journey-level fitter. Several states require pipefitters to be licensed when working on gas lines.

### 3.2.5 Heavy Equipment Operator

Heavy equipment operators drive and control heavy construction equipment to move construction materials, dirt, and other heavy objects at construction sites, large mills, mining operations, and distribution centers. On large construction



**Figure 21** Heavy equipment operators drive large construction machinery.

Source: Ewg3D/istock/Getty Images

sites, heavy equipment may be used to clear, grade, and lift equipment prior to and during the construction of roads, buildings, bridges, airports, and power generation facilities.

Examples of heavy equipment include backhoes, bulldozers, dump trucks, forklifts, and excavators. Almost all operators choose to specialize in one or more of these types of equipment (*Figure 21*).

### Salary

The average salary for a heavy equipment operator is approximately \$61,000 per year. In a recent survey, the top 10 percent of people in this career earned more than \$84,650. Professionals operating more complex equipment typically get paid higher salaries.

### Job Growth Estimates

The demand for heavy equipment operators in the US is expected to grow by about 4 percent in the next decade. Metropolitan areas usually offer the most job opportunities, and operators trained to work on multiple types of equipment typically have the best opportunities.

### Skills

To be successful, a heavy equipment operator should possess the following traits or skills:

- Physical strength
- Good sense of balance
- Hand-eye-foot coordination
- Mechanical skills

### Specific Qualifications

Several OSHA standards apply to operating different types of heavy equipment. OSHA's 1910.178(l)(3) standard requires operators of powered industrial trucks (forklifts) to be licensed or certified. When operators are tasked with hauling their own equipment between job sites, they may also be required to obtain a commercial driver's license.

**SUCCESS STORIES:** *James Snyder:*  
*I Built This*



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### 3.2.6 Crane Operator

Crane operators use state-of-the-art machinery to hoist heavy construction materials above and around a job site. Joysticks, levers, and pedals allow operators to control the equipment. Professional crane operators are regularly tasked with using trigonometry and physics equations to calculate maximum load size based on the configuration of the crane and load.

There are many different types of cranes, including tower cranes that are seen high in the sky over tall buildings in cities around the world. Tower crane operators frequently control equipment that remains in place but grows taller as the building progresses upward. In some cases, cranes can rise many stories above their original starting point (*Figure 22*).

#### Salary

The average salary for a tower or mobile crane operator is approximately \$66,000 per year. In a recent survey, the top 10 percent of people in this career earned more than \$91,840.

#### Job Growth Estimates

The demand for crane operators in the US is expected to grow by about 8 percent in the next decade, which is above the average growth for all occupations. Metropolitan areas usually have the largest need for crane operators and pay the highest salaries. Because crane operators have unique skills, job prospects are extremely good for this profession.

#### Skills

To be successful, a crane operator should possess the following traits or skills:

- Endurance
- Agility
- Physical coordination
- Good sense of balance
- Ability to judge distance
- Hand-eye-foot coordination
- Good math skills
- Comfortable with technology



**Figure 22** Crane operators hoist heavy materials off the ground.

Source: Hxdyl/istock/Getty Images

### Specific Qualifications

According to OSHA standard 1926.1400(a), crane operators must be certified or licensed, with the type of certification based on the type or capacity of the crane. Licensing usually consists of a combination of written exams and physical tests in which individuals must demonstrate safe operating practices.

### 3.2.7 Ironworker

Ironworkers place and install iron or steel beams, columns, and other construction materials to form and reinforce structures. Contrary to the name, ironworkers primarily work with steel and are often referred to as *structural ironworkers*. These professionals primarily build structural frameworks that support large construction (Figure 23).

### Salary

The average salary for an ironworker is approximately \$60,000 per year. In a recent survey, the top 10 percent of people in this career earned more than \$89,790.

### Job Growth Estimates

The demand for ironworkers in the US is expected to grow by about 5 percent in the next decade. Because of the ongoing need to repair aging highways and bridges, an ironworker's skills should remain in high demand for years to come.

### Skills

To be successful, an ironworker should possess the following traits or skills:

- Physical fitness
- Agility
- Good sense of balance
- Hand-eye coordination
- Ability to work at heights
- Mechanical skills
- Math skills
- Problem-solving skills

### Specific Qualifications

Ironworkers with a welding certification often have more job prospects.

### 3.2.8 HVAC Technician

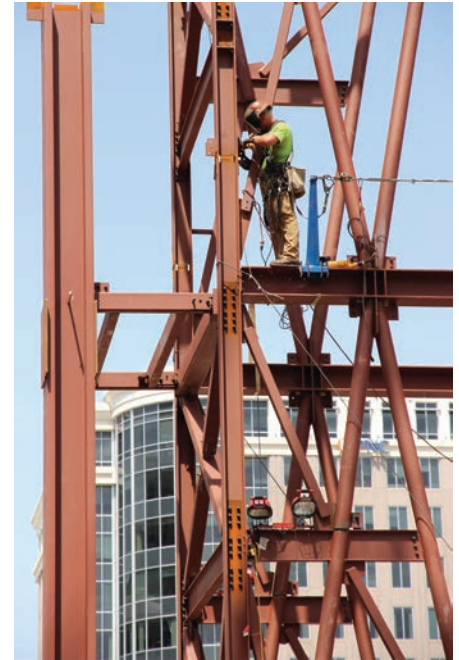
HVAC technicians install, maintain, and repair heating, ventilation, and air conditioning systems. HVAC work includes both mechanical and electronic systems such as motors, pumps, fans, thermostats, and computerized switches that control systems in residential, commercial, and industrial structures (Figure 24). Technicians can also specialize in specific equipment, such as water-based heating systems, or commercial refrigeration.

### Salary

The average salary for an HVAC technician is approximately \$62,000 per year. In a recent survey, the top 10 percent of people in this career earned more than \$77,920.

### Job Growth Estimates

Demand for HVAC technicians in the US is expected to grow by about 4 percent over the next decade. Increased opportunities exist for technicians willing to move to higher-growth areas.



**Figure 23** Ironworkers build steel structural frameworks.

**SUCCESS STORIES:** *Discover Success:  
Looking for Something Different*



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**Figure 24** HVAC technicians install and repair air conditioning systems.

Source: Sturti/E+/Getty Images

### Skills

To be successful, an HVAC technician should possess the following traits or skills:

- Good hand-eye coordination
- Mechanical aptitude
- Basic math skills
- Good problem-solving skills

**SUCCESS STORIES:** *No One Day Is the Same—Discover Success*



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### Specific Qualifications

Some states and localities require technicians to be licensed; others require technicians to be certified when working with different types of chemicals.

### 3.2.9 Project Manager

Project managers are essential to completing construction projects on time and on budget. Their duties include planning, coordinating, budgeting, and supervising projects from beginning to end. They typically prepare cost estimates, explain project contracts to other professionals, manage personnel, resolve project issues, and ensure that projects adhere to safety codes and regulations. Project managers usually spend most of their time on site, where they monitor projects and ensure construction activities stay on schedule (Figure 25).



**Figure 25** Project managers monitor project schedules and activities.

Source: Kali9/E+/Getty Images

### Salary

The average salary for a construction project manager is approximately \$92,000 per year. In a recent survey, the top 10 percent of people in this career earned more than \$164,790. Project managers may also earn bonuses based on their performance.

### Job Growth Estimates

The demand for construction project managers in the US is expected to grow by about 8 percent over the next decade, which is well above the average growth for all occupations. As construction processes and mobile technology become more sophisticated, the need for project managers who stay current with technological changes is expected to increase.

### Skills

To be successful, a project manager should possess the following traits or skills:

- Good oral and written communication skills
- Ability to make sound decisions
- Business acumen
- Ability to manage time and oversee multiple ongoing activities
- Strong customer service skills
- Good leadership skills

### Specific Qualifications

Unlike most construction careers, project managers typically need a bachelor's degree from an accredited college or university. Large construction companies tend to seek candidates who have a bachelor's degree in a construction-related field and direct construction experience.

Some states require construction project managers to be licensed. Additionally, certifications in construction management and project management can increase the chances of landing a project management job.

### 3.2.10 More Construction Careers

While some of the more popular construction careers have been highlighted, NCCER offers training on more than 45 crafts, and you can discover more about them on NCCER's Build Your Future website, [www.byf.org](http://www.byf.org). This site offers information about salaries by craft, career paths, labor demand by state, and much more.

## 3.0.0 Section Review

1. Which construction sector includes schools, government buildings, hotels, and shopping centers?
  - a. Residential
  - b. Commercial
  - c. Public
  - d. Industrial
2. The construction role that typically reports to the project owner is the \_\_\_\_\_.
  - a. superintendent
  - b. foreman
  - c. subcontractor
  - d. contractor
3. To start your career path in most construction crafts, you generally need a \_\_\_\_\_.
  - a. high school diploma or equivalent
  - b. bachelor's degree
  - c. master's degree
  - d. state permit



4. The construction craft professional regularly tasked with using trigonometry and physics equations to calculate maximum load sizes is the \_\_\_\_\_.
- a. heavy equipment operator
  - b. ironworker
  - c. crane operator
  - d. pipefitter

	4.0.0 Starting Your Construction Career
<b>Performance Tasks</b>  There are no performance tasks in this section.	<b>Objective</b>  Identify ways to pursue a career in the construction industry. <ul style="list-style-type: none"><li>a. Explain the benefits of career and technical education programs.</li><li>b. Describe the advantages of craft training programs and their relationship with apprenticeships.</li><li>c. Summarize the path to a construction career through community colleges and universities.</li></ul>

You have several training options to consider if you are interested in pursuing a construction career. If you are still in high school, you should find out if any local schools offer additional construction classes. You can also look for summer jobs with local contractors. The Internet is a great resource for learning about construction crafts while you earn your diploma.

After earning your high school diploma or equivalent, choose which training path works best for you. Available training options include:

- Technical school
- Apprenticeship program
- Community college or university
- Industry training program

Most craft professionals are taught through a combination of technical schools, on-the-job learning (OJL), craft training programs, and/or apprenticeships.

Career and technical education (CTE): Programs offered in high school and technical education centers that allow students to explore career options available in construction.

4.1.0 Career and Technical Education

**Career and technical education (CTE)** classes are generally offered at high schools and technical education centers. Some schools start earlier by offering middle school classes that teach introductory concepts in electronics, engineering, carpentry, or other construction-related crafts. In either case, students attending these programs have the opportunity to explore career options available for each of the construction crafts. In some cases, students attending high school CTE classes have the opportunity to develop their hands-on skills through construction competition events like SkillsUSA. School guidance counselors can provide information about which CTE courses are offered and how students can enroll.

CTE programs place an emphasis on career readiness and hands-on learning (Figure 26). These programs emphasize the following approaches:

- *Real-life application* — Being able to practice skills learned has been shown to increase students’ retention and understanding. For many students, being able to link traditional lessons directly to their future careers means they are more committed to succeeding in their education. Being able to do so in a low-pressure environment makes learning easier.



**Figure 26** CTE programs focus on hands-on learning.

- *Teaching nontechnical skills* — Having a combination of craft-specific technical skills along with other important but nontechnical skills increases a student's employability. Some of these nontechnical skills include effective communication, time management, attention to detail, critical thinking, and a customer service attitude.
- *Career exploration* — By learning about careers early on, and from teachers with industry experience (*Figure 27*), students can discover their own strengths and interests, find a career that fits their passions, and set a path to achieve their goals.

After completing CTE classes, students generally have the qualifications needed to progress to one of these next steps:

- Industry apprenticeship
- Community college
- University degree



**Figure 27** Students learn from industry experts in CTE programs.

Source: Istock/Getty Images

### Success Story: Construction in The Villages

A growing retirement community called The Villages is located in north central Florida. In 2017, The Villages Charter School (TVCS) added a construction management academy to introduce students to construction, one of the most prevalent career fields in their community.

Each year, Bruce Haberle, a construction teacher at the school, has his senior class help construct a home for Habitat for Humanity. This project gives students a platform to practice the skills they are learning with real-life applications like reading blueprints, working on a schedule, and keeping an efficient pace. In their senior year, students are able to see what a career in construction is really like. Most recently, students worked to construct a 1,200-square-foot, 3-bedroom, 2-bathroom home.

Haberle is still refining the program for his students but says he has three primary goals for his students: prepare them, get them in the industry, and set them up for success in their careers.

## 4.2.0 Craft Training and Apprenticeships

The craft training and apprenticeship approach enables students to learn skills from experienced construction professionals. Regardless of students' previous exposure in high school, many construction companies provide training themselves, either through in-house programs or by paying for trainees to attend classes at a local construction association or community college. Ultimately, craft training programs and apprenticeships are excellent opportunities to be paid while working on the job.

A craft training or apprenticeship program features a split between learning in the classroom (typically 20 percent of learning) and on the job (typically 80 percent of learning) (*Figure 28*). It usually takes two to four years and requires at least 2,000 hours of OJL and 144 hours of classroom instruction during each year of the apprenticeship. According to the US Department of Labor, there are five components to an apprenticeship that are also included in craft training:

- Business involvement
- Structured OJL
- Related instruction
- Rewards for skill gains
- Nationally recognized credentials



**Figure 28** Apprenticeships and craft training offer paid work while learning.

Craft training programs and apprenticeships offer many benefits, including full-time, paid work while learning skills on the job. This model of education not only gives trainees needed experience, but it keeps them from incurring high education debt. It also allows them to make valuable connections in the industry through relationships built with mentors.

You can find craft training programs and apprenticeships in your area in the following ways:

- Search the national apprenticeship database at [www.apprenticeship.gov](http://www.apprenticeship.gov).
- Contact local construction associations like Associated Builders and Contractors (ABC) as well as Associated General Contractors (AGC).
- Search online job boards or other social media job search sites.
- Reach out to local employers.
- Research information on websites for national construction organizations.

### 4.3.0 Community Colleges and Universities

More and more colleges and universities offer construction-related degree programs. These institutions offer a variety of construction-oriented academic degrees. Community colleges usually provide two-year programs and offer associate degrees, while four-year universities are more often used for bachelor's degrees and beyond.

#### 4.3.1 Community College

Community colleges often collaborate with contractors and construction companies by helping facilitate their training programs. Rather than teach employees in-house, these companies can send trainees to a community college. Doing so allows companies to fulfill the knowledge-based component of the program by taking advantage of the college's dedicated teaching staff and classroom facilities.

Earning an associate degree from a community college allows you to receive college credit as well as industry-recognized certifications and credentials upon graduation. Options for the next steps include:

- Industry apprenticeship
- Entry-level job
- University degree

#### 4.3.2 Four-Year Universities

An increased number of four-year universities offer degree programs in construction-related areas such as design, construction management, estimating, human resources, architecture, engineering, and safety (*Figure 29*).

Degrees signify formal academic achievement and offer in-depth learning. A bachelor's degree focuses on an area of study (called a "major") and typically requires at least 120 hours of credit work. Typical degree programs will consist of general education courses (science, math, history, and English) along with specific construction courses.

A big advantage of a college degree is that it may allow you to move up the construction career ladder more quickly after gaining initial experience in your craft. You may also be more qualified for higher-paying roles that involve decision-making responsibilities.

However, there are financial challenges related to obtaining a four-year degree. The tuition can be very expensive and it can be difficult to work a full-time job while attending classes. In addition, a college degree is not a guarantee that you will be offered a specific construction job, and unfortunately, unless you have on-the-job construction experience, you may still have to start your career in an entry-level position.

#### SUCCESS STORIES: *How Many Jobs Need a 4-Year Degree*



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#### Did You Know?

Louis Henry Sullivan, an American architect in the late 19th century, created a new style of architecture that resulted in buildings that were tall but still considered beautiful, a unique concept at the time. Called the "Father of Skyscrapers," he is most known for his design of the Wainwright Building in St. Louis.





**Figure 29** Many universities offer construction-related degrees.

Source: JanPietruszka/istock/Getty Images

## 4.0.0 Section Review

1. CTE programs place an emphasis on preparing students for construction careers through \_\_\_\_\_.
  - a. hands-on learning
  - b. lectures and quizzes
  - c. virtual lessons
  - d. group projects
2. Depending on the particular craft, an apprenticeship or craft training program can generally be completed within \_\_\_\_\_.
  - a. six months
  - b. two to four years
  - c. six to eight years
  - d. ten years
3. Earning a construction degree guarantees you will be offered a construction job upon graduation.
  - a. True
  - b. False

## Module 00100 Review Questions

1. What percentage of construction companies anticipate having to hire more people in the coming years to replace retiring craft professionals?
  - a. 60 percent
  - b. 70 percent
  - c. 80 percent
  - d. 90 percent
2. What percentage of construction field and office positions are currently filled by women?
  - a. 10 percent
  - b. 20 percent
  - c. 30 percent
  - d. 40 percent