MODERN MOTORCYCLE TECHNOLOGY

Third Edition

Edward Abdo

MODERN MOTORCYCLE TECHNOLOGY

Third Edition

Edward Abdo

CENGAGE Learning®

Australia • Brazil • Mexico • Singapore • United Kingdom • United States

Modern Motorcycle Technology, Third Edition
Edward Abdo

SVP, GM Skills & Global Product Management: Dawn Gerrain

Product Director: Matthew Seeley

Product Team Manager: Erin Brennan

Senior Director, Development: Marah Bellegarde

Senior Product Development Manager: Larry Main

Senior Content Developer: Meaghan Tomaso

Product Assistant: Maria Garguilo

Vice President, Marketing Services: Jennifer Ann Baker

Marketing Director: Michele McTighe

Senior Production Director: Wendy Troeger

Production Director: Andrew Crouth

Senior Content Project Manager: Cheri Plasse

Senior Art Director: Benjamin Gleeksman

Cover image(s):

1. © Shannon Kirk
2. © ManoAfrica/istockphoto.com
3. © styleTTT/istockphoto.com
4. © saicie/istockphoto.com
5. © stockphotomania/Shutterstock

Library of Congress Control Number: 201595851

ISBN: 978-1-3054-9745-0

Cengage Learning
20 Channel Center Street
Boston, MA 02210
USA

Cengage Learning is a leading provider of customized learning solutions with employees residing in nearly 40 different countries and sales in more than 125 countries around the world. Find your local representative at **www.cengage.com.**

Cengage Learning products are represented in Canada by Nelson Education, Ltd.

To learn more about Cengage Learning, visit **www.cengage.com**

Purchase any of our products at your local college store or at our preferred online store **www.cengagebrain.com**

Printed in the United States of America.

Print Number: 01 Print Year: 2015

Contents

Preface

Modern Motorcycle Technology (MMT) is designed to meet the basic needs of students and individuals interested in the subject of motorcycle and all-terrain vehicle (ATV) repair and also by helping instructors present information that will aid in students' learning experience. The subject matter is intended to help students become more qualified candidates for dealers looking for well-prepared, entry-level technicians.

MMT has been written to make learning enjoyable; the easy-to-read and easy-to-understand chapters and the great number of illustrations will assist visual learners with content comprehension. The book consists of 20 chapters, and starts with the history of the motorcycle and ends with information about troubleshooting various conditions found on any motorcycle. Because of the similarity of the technologies used, the servicing of ATVs is automatically included in the text.

MMT can be used not only for pre-entry–level technicians but also as a reference manual for practicing technicians. Motorcycle technicians are currently sought after and will continue to be in demand in the future as technology advances in the manufacturing of modern motorcycle and ATV products. In today's world, technicians who have an education prior to working in the field are becoming more desirable to hiring dealerships.

I have been in the motorcycle industry on "all sides of the fence." I have been a rider and a racer most of my life, as well as a customer, technician, service manager, motorcycle trade school technical instructor, chief instructor, curriculum developer, manufacturer's service representative, and head of a technical training department tasked to ensure that over 4,000 technicians are up to date with technologies and technical instruction and am now the owner of a successful motorcycle and ATV shop. I have had a passion for motorcycles since my first mini-bike back in the 1960s, and I have a unique outlook on my job. I love doing what I do! This is something that everyone should strive for, as there is nothing more rewarding.

—Ed Abdo

New To This Edition

The third edition of *Modern Motorcycle Technology* (MMT) has been updated throughout and includes new content on the latest motorcycle models and technology from today's top manufacturers. This new edition features additional material on key topics such as fuel management systems, suspension systems, and electrical systems. It also provides an expanded suite of separately available supplementary teaching and learning tools—including a hands-on Student Skill Guide and electronic instructor resources available on a companion website and CD-ROM. MMT is a valuable resource for anyone seeking the knowledge and skills to succeed in today's motorcycle technology field.

Acknowledgments

Many people were instrumental in making this book a reality. There were numerous reviews from those in the motorcycle industry; the suggestions were excellent and helped to make this a better textbook. There are also other people who helped make this book possible whom I would like to acknowledge: Bernie Thompson, Jeff Percival, Andy Parks, Kirk Nussbaum, Bill Kish, Adam Miller, Shawn Moen, and the staff from PowerSport Institute were all very helpful with the addition of material in several chapters of this edition as well as assisting with the updated pictures found within the pages to follow. The staff from Motorcycle Mechanics Institute were also very instrumental in providing updated material for this book. A special thanks to Shannon Kirk for taking the action photos which includes my son used on the covers of this textbook. The late George Decker, who many years ago saw something in me that made him think that I could be a technician, hired me for my first job in this industry and became my mentor. There are three others who were all key in helping shape my instructional career: Art Ridgway, unknowingly to both of us at the time, showed me that teaching

what you have learned to others is not only self-satisfying but also rewarding in ways far exceeding my imagination. Art's passion to help others learn inspired me to want to teach others what I have learned over the years. Larry Barrington helped me prove to myself that I could get up in front of a large group of students and actually teach! Larry had a way of making me feel at ease in my early stages of teaching when I was questioning my abilities as an instructor. Doug McIntyre taught me more about myself than any other person I have ever had the pleasure to work with. His willingness to listen and help me through my problems when trying to sort through instructional design issues will always be remembered. Next, my wife Bonnie and son Nick (shown as #268 in the action pictures used on the covers of this book!) for their endless love. The two of them find ways to inspire me every day. There were many more people who have helped me along the way in this great ride of a career, but the page is now getting long, so I will just say thank you all! It is an honor to give back to an industry that has done so much for me. Without all the support I have been fortunate to obtain throughout my life, you would not be reading this.

Reviewers

The author and publisher would like to thank the following reviewers for their valuable input during the development of the first and second editions of MMT:

Larry Barrington
Universal Technical Institute
Phoenix, AZ

Michael Baugus
Central Tech
Drumright, OK

Dan Clark
Fullerton, CA

Shane Conley
Western Iowa Technical Community College
Sioux City, IA

Tony DeBoeuf
Linn State Technical College
Linn, MO

Richard Deuschle
Motorcycle Mechanics Institute
Phoenix, AZ

Paul Fahey
ATI
Burleson, TX

Jason Finlay
Linn State Technical College
Linn, MO

Wayne Hightower
ATI
North Richland Hills, TX

Greg Hodges
Wyotech—Daytona Campus
Ormond Beach, FL

Roy King
Centennial College
Toronto, Canada

William W. Kish
PowerSport Institute
Cleveland, OH

Anthony V. Lambiase
Universal Technical Institute
Phoenix, AZ

Ray Luther
ATI
Joshua, TX

Adam Miller
PowerSport Institute
Cleveland, OH

Shawn Moen
PowerSport Institute
Cleveland, OH

Kara Moon
Universal Technical Institute
Phoenix, AZ

Robert Monroig
Lake Washington Technical College
Woodinville, WA

Terry A. Muncy, Jr.
Motorcycle Mechanics Institute
Orlando, FL

David Norman
Northern Georgia Technical College
Clarkesville, GA

Kirk Nussbaum
PowerSport Institute
Cleveland, OH

Ryan J. Pagan
Wyotech—Daytona Campus
Ormond Beach, FL

Andy Parks
PowerSport Institute
Cleveland, OH

Jeffrey Percival
PowerSport Institute
Cleveland, OH

John Pfingstag
Universal Technical Institute
Phoenix, AZ

Michael Ross
Motorcycle Mechanics Institute
Phoenix, AZ

Michael Sachs
DeKalb Technical College
Clarkston, GA

Bernie Thompson
PowerSport Institute
Cleveland, OH

Supplements

Student Skill Guide: This workbook is designed to provide students with activities centered around diagnostic and repair procedures commonly performed on the modern motorcycle. Each chapter contains questions and activities to reinforce the content in the respective core text chapter. The Skill Guide also contains many job sheets that allow students to put the theory to work in the shop with illustrated, step-by-step guided lab activities.

Instructor Resources: The Instructor Resources will help make classroom time more efficient and engaging with tools like chapter presentations in PowerPoint for each text chapter; an Image Gallery of photos and illustrations from the book; chapter tests powered by Cognero for use as exams, quizzes, or homework assignments; and the end-of-chapter questions available as Word files. An Answer Key is also provided for the end-of-chapter questions.

To access these Instructor Resources online, go to login.cengagebrain.com, and create an account or log into your existing account.

CHAPTER 1

Introduction to Modern Motorcycle Technology

Learning Objectives

When you have completed the study of this chapter and its laboratory activities, you should be able to:

- Understand a brief history of the motorcycle and the motorcycle industry
- Describe different types of motorcycles
- List some of the many motorcycle industry job opportunities

Key Terms

Advertising and marketing specialists
All-terrain vehicles (ATVs)
Custom cruiser
Customer service representatives
Direct drive system
District parts managers
District sales managers
District service managers
Dual-purpose motorcycles
Electric vehicle (EV)
Entry-level motorcycle technicians
Franchised dealerships
General manager
Hot-rod cruisers
Lot attendant
Motocross
Motorcycle
Motorcycle repair instructors
Motorcycle technician
Motor scooters
Multipurpose utility vehicles (MUVs)
Off-road motorcycles
Parts department
Parts technician
Quality control specialists
Race team support technicians
Research and development engineers
Road racing
Sales department
Service department
Service manager
Service technical training instructors
Service writer
Setup technician
Sport motorcycles
Sport-touring motorcycles
Standard street motorcycles
Street motorcycles
Technical advisors
Technical illustrators
Technical writer
Three-wheelers
Touring motorcycles
Universal Japanese Motorcycles (UJM)

INTRODUCTION

Motorcycles have a long history that dates over 100 years, and the motorcycle industry has continued to grow at a tremendous rate with peak yearly unit sales of new motorcycles reaching over 1 million from 2003 through 2008 and all-terrain vehicle (ATV) unit sales surpassing 800,000. Over the past few years, the economic condition of the marketplace has seen a reduction of new sales through 2015, although the market has recovered every year since the bottoming of the market in 2010. Servicing these machines is different in many ways than in the past. Over the years, constant breakthroughs in engine, chassis, and electronic technology have greatly changed how motorcycles and ATVs are developed and marketed to the consumer. Because of this, trained motorcycle technicians are in high demand throughout the country.

A BRIEF HISTORY OF THE MOTORCYCLE

According to *Merriam-Webster's Collegiate Dictionary*, the word **motorcycle** is defined as "a 2-wheeled automotive vehicle having one or two saddles." Of course, motorcycles are a bit more complex than that simple explanation.

In fact, motorcycles are a direct descendant of the bicycle. The early bicycle (actually called a velocipede, a bicycle with its pedals located on the front wheel) (Figure 1-1) appeared in the early 1860s and was also known as a "boneshaker," both for its jarring ride and for its tendency to toss the riders when riding on cobblestone roadways.

Since its invention, the motorcycle has been considered to be more than just a bike with an engine attached. Riding a motorcycle gives people a completely different perspective of the world around them as compared to driving in an automobile. Riding on the open road or along a trail is a feeling like no other. Furthermore, no matter which type or brand of motorcycle they have, all riders share a common bond between them. They are virtually all motorcycle enthusiasts and truly love to ride.

Courtesy Transportation Collections, Division of Work & Industry, National Museum of American History, Smithsonian Institution

Figure 1-1 The motorcycle is a direct descendant of the early bicycle, which was actually called a velocipede because of the placement of the pedals on the front wheel.

It could be argued that writing a book about the history of the motorcycle could easily take up more space than this entire textbook provides. Throughout the years, there have been literally thousands of different motorcycle manufacturers around the world. Therefore, we will briefly discuss only a few of the many highlights of the motorcycle's vast history.

The Birth of the Motorcycle

There are many different opinions pertaining to who exactly invented the first motorcycle, but using the definition by *Merriam-Webster*, it could be Sylvester H. Roper of Roxbury, Massachusetts. He built a steam-powered machine in 1869 (Figure 1-2) that could be considered to be the *first* motorcycle.

Roper's machine was considered to be quite remarkable, as it looked very similar to bicycles of that era but utilized a small vertical steam boiler under the seat. The boiler supplied two pistons that powered a crank-drive system to the rear wheel. The throttle was controlled by twisting the handlebar forward and back. The Roper machine had the first known—albeit a primitive version—use of the twist grip control. The twist grip throttle control was reinvented a couple of times over the years,

Courtesy Transportation Collections, Division of Work & Industry, National Museum of American History, Smithsonian Institution.

Figure 1-2 This could be considered the very first motorcycle, but since it was powered by the use of a steam engine, it can be debated that it was not a motorcycle. This machine was created by Sylvester H. Roper of Roxbury, Massachusetts, in 1869.

Courtesy Softeis, published under the terms of the GNU Free Documentation License . http://en.wikipedia.org/wiki/File:Daimler-1-motorcycle-1.jpg

Figure 1-3 This is a replica of what many historians consider to be the first motorcycle to be powered by an internal combustion engine. A gentleman by the name of Gottlieb Daimler created it in 1885.

finally by the Indian Motorcycle Company—after this Roper design—and is still in use on today's motorcycles. Roper built more versions of his steam-powered motorcycle, and in 1896, at the age of 73, he showed up at a bicycle track near Harvard with a modified version of one of his designs. He was clocked at an unbelievable 40 miles per hour, and while slowing down, the bike went into a wobble, throwing Roper off the bike. Sadly, he died in this accident. Later, however, an autopsy is reported to have shown that Roper died of a heart attack and did not die from the fall.

Even though the Roper machine was designed years before, most historians credit Gottlieb Daimler with the invention of the motorcycle in 1885, as it was the first motorcycle in recorded history with an engine powered by petroleum (Figure 1-3). Daimler designed an engine and mounted it into a wooden-framed contraption in 1885.

As mentioned, the Roper machine is considered by most to be the first motorcycle even though it actually had four wheels. Historians overlook the two outrigger-type stabilizer wheels and consider this machine to be the grandfather to the motorcycle. Daimler's young son Paul was the first to give this machine a test ride. Daimler's machine had no pedals. Instead, the power was supplied only by the simple four-stroke engine design. Daimler later went on to build early automobiles. He left it to bicycle builders to further develop the motorcycle.

In 1892, Alex Millet invented a five-cylinder motorcycle and was the first to utilize pneumatic tires (Figure 1-4). The Millet-designed machine used a complex rotary engine built within the rear wheel. The cylinders rotated with the rear wheel, while the crankshaft was actually incorporated into the rear axle.

Although short-lived due to poor design, the first motorcycle built for sale (over 200 were sold) was the Hildebrand & Wolf Mueller (Figure 1-5) in Munich in 1894. This motorcycle utilized a water-cooled twin-cylinder engine that had a **direct drive system,** meaning that the wheels were directly attached to the engine and, therefore, would always

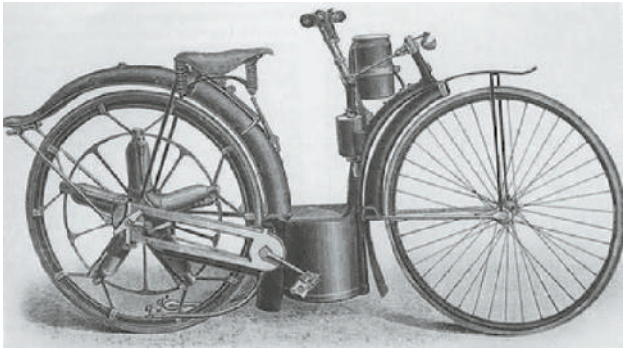

Figure 1-4 In 1892, Alex Millet of France built the first motorcycle with pneumatic tires. The engine was actually a part of the rear wheel and had five cylinders.

Courtesy Stahlkocher, published under the terms of the GNU Free Documentation License. http://en.wikipedia.org/wiki/File:Hildebrand-Wolfm%C3%BCller.jpg

Figure 1-5 The German company of Hildebrand & Wolf Mueller designed the first motorcycle that was produced for sale to the public. Design issues made this machine very hard to ride, and therefore it had a very short life.

be in motion if the engine were running. This made riding this motorcycle design difficult.

In 1895, the French firm of DeDion-Buton designed an engine that would allow motorcycle mass production to become a reality. The DeDion-Buton engine (Figure 1-6) design was a small high-revving four-stroke single using the first battery and coil-type ignition on such a small engine.

The engine was lubricated using a total loss system that dripped oil into the crankcase via a metering valve; the oil then sloshed around the internals to lubricate the moving components before burning or being pumped out onto the ground through a breather tube. While many of these engines were used, the engine design was copied by two very notable manufacturers in the United States: Indian and Harley-Davidson.

In 1900, two men, George Hendee and Carl Hedstrom, formed a partnership to manufacture a "motor-driven bicycle for the everyday use of the general public" in Springfield, Massachusetts, the Hendee Manufacturing Company. Hedstrom designed a motorcycle that debuted in 1901. A single-cylinder 1.75-horsepower engine that was copied from the DeDion-Buton engine gave the machine the ability to travel at speeds close to 25 miles per hour (Figure 1-7). The real secret to this design, however, was its chain drive, which was

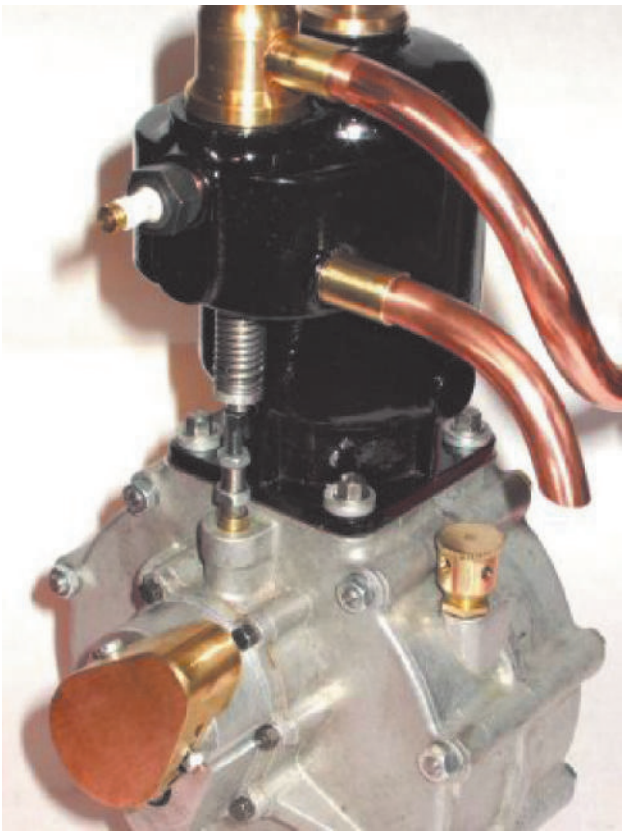

Figure 1-6 The French company of DeDion-Bouton built the first internal combustion engine that was mass-produced for usage specifically in a motorcycle.

Courtesy Transportation Collections, Division of Work & Industry, National Museum of American History, Smithsonian Institution

Figure 1-7 The first Indian motorcycle was produced in 1902 and was very similar in design to a bicycle.

superior to the belt-driven machines around at that time.

The partners picked the name "Indian" for their motorcycles, thus starting what was to become the largest production motorcycle company in the United States. Indian was a leader in early

Figure 1-8 Similar in looks to the first Indian motorcycles, this 1905 Indian was called a "camelback" due to the shape and location of the fuel tank.

Figure 1-9 Over the years, many have attempted to bring back the Indian motorcycle, but the last true Indian was produced in 1953. This photo is of a 1940 Four, which could be considered the Cadillac of motorcycles in its day. They were smooth and flexible—at home trickling through traffic or cruising down the highway. These particular Indians were very popular with law enforcement agencies.

motorcycle design, registering patents on components that are still used today on modern motorcycles. The 1905 model was called a "camelback" due to the shape and location of the fuel tank (Figure 1-8). Indians were well constructed and often over-engineered. The company went on to build a V-Twin motorcycle with two- and three-speed gearboxes and further refined it with a swing arm rear suspension. In 1914, the world's first motorcycle with an electric start and a full electrical system was introduced to the industry. The Hendee Special propelled Indian to be the largest motorcycle manufacturer in the world, producing over 20,000 bikes per year prior to World War I. One Indian motorcycle that was very popular with police departments was the Indian Four (Figure 1-9). While there have been a few attempts to revive the motorcycle brand Indian, the last true Indian motorcycle was the 1953 Indian Chief.

In 1903, 21-year-old William S. Harley and 20-year-old Arthur Davidson created for the public the first production Harley-Davidson motorcycle (Figure 1-10). The factory in which they worked was a 10- by 15-foot wooden shed with the words "Harley-Davidson Motor Company" crudely scrawled on the door (Figure 1-11).

Some of the earliest Harley-Davidson motorcycles were built with racing in mind. In 1908, Walter Davidson scored a perfect 1,000 points at the Federation of American Motorcyclists (FAM) 7th Annual Endurance and Reliability event. Then,

Photographs courtesy of the Harley-Davidson Motor Company Archives. Copyright H-D.

Figure 1-10 The first Harley-Davidson was produced in 1903.

Photographs courtesy of the Harley-Davidson Motor Company Archives. Copyright H-D.

Figure 1-11 An artist's rendition of the very first Harley-Davidson factory. The building was in fact a 10- × 15-foot woodshed.

Photographs courtesy of the Harley-Davidson Motor Company Archives. Copyright H-D.

Figure 1-12 The first V-Twin built by Harley-Davidson had 7 horsepower and was built in 1909.

Figure 1-14 Harley-Davidson celebrated 100 years of manufacturing motorcycles in 2003.

only three days later, he set the FAM economy record at over 188 miles per gallon.

The first Harley-Davidson V-Twin was built in 1909; it had a displacement of 49.5 cubic inches and boasted 7 horsepower (Figure 1-12). It was not until 1914 that the company formally entered into the motorcycle racing scene, but team Harley-Davidson was nicknamed the "Wrecking Crew" because of their dominance in the sport. In the 1920s, board track racing was very popular, and Harley-Davidson dominated that sport (Figure 1-13). During World War I, nearly half of all Harley-Davidsons built were used by the U.S. military, and by the end of the war, it was estimated that the U.S. Army used approximately 20,000 motorcycles, with the majority being Harley-Davidsons. By the year 1920, Harley-Davidson became the largest motorcycle manufacturer in the entire world with over 2,000 dealers located in 67 countries.

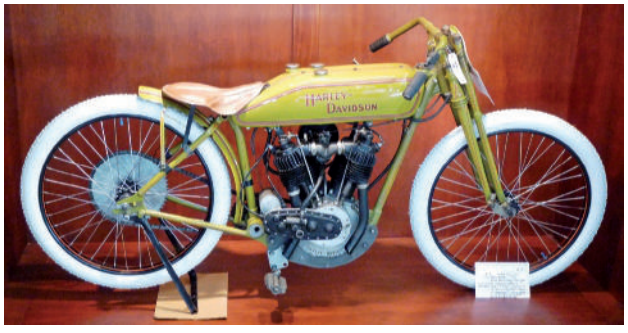

Figure 1-13 This 1923 board track racer was found in a chicken coop and restored to this pristine condition. It is currently ridden in exhibition races within the United States and has been clocked at over 75 miles per hour. Bikes such as this one dominated motorcycle racing in the 1920s.

This dominance lasted until the 1950s, when the British motorcycle industry came to full bloom. Today, the Harley-Davidson brand is an American icon, and their products appeal to many different types of riders. The only "true" American motorcycle manufacturer still in existence from the early days, the Harley-Davidson Motor Company celebrated its centennial in 2003 (Figure 1-14).

British Motorcycles

While British motorcycle production began in the early 1900s, it was not until the 1950s that motorcycle brands such as Triumph (Figure 1-15) and

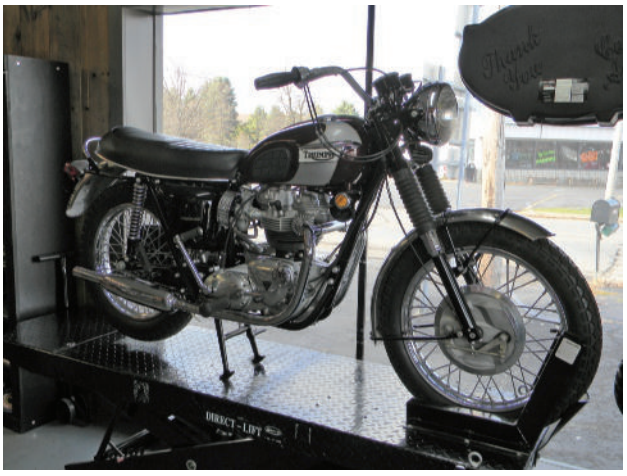

Figure 1-15 Triumph was a strong contender in the United States from the 1950s up until the early 1970s. The company's downfall was its failure to change its products to align itself with the changing trends of the marketplace. This 1970 Bonneville was one of the last strong attempts to bring up market share, but in the end it failed to keep the company going.

Birmingham Small Arms, better known as BSA (Figure 1-16), were brought to the forefront of the U.S. motorcycle industry. Britain's motorcycle industry dominance was at its peak in 1959. Happy with their success, these companies felt somewhat invincible and failed to take note of emerging trends or to replace their aging designs. Most of the engineers and company executives came from prewar days and paid attention only to the glory days of the 1930s but unfortunately failed to look into the future. BSA merged with the Norton Villers Triumph, and the last BSA was produced in 1973. Triumph is the only British brand to make any successful attempts to reenter the motorcycle marketplace in the United States over the years.

European competition from Germany included the company BMW (Figure 1-17), which made a rapid recovery from postwar times, and the Italian companies Ducati (Figure 1-18) and MV Agusta (Figure 1-19). They began to intrude on market share with their desire to build more stylish machines. The final blow to the British motorcycle industry came from the Japanese as the U.S. and European markets began to import less expensive and more reliable machines. The Japanese motorcycles showed more innovation and engineering development, and the British companies were too slow to react to this competition.

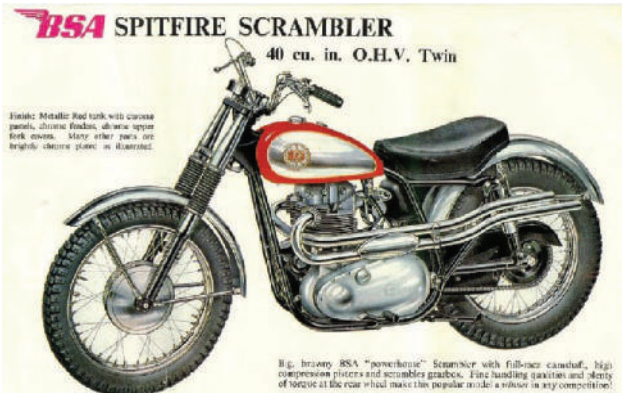

Figure 1-16 This vintage magazine advertisement of a BSA Spitfire Scrambler helped the British manufacturer create a strong consumer base with its power and looks.

Courtesy of BMW of North America

Figure 1-17 German manufacturer BMW came back after World War II quickly to build very stylish (for the time) and reliable machines.

Figure 1-18 The Italian firm of Ducati has always been regarded to have motorcycles that could be considered just as much art as functional. Machines such as this helped to capsize the British motorcycle dominance of the 1960s.

Courtesy of Motorcycle Hall of Fame Museum Collection

Figure 1-19 MV Agusta was another strong manufacturer that built motorcycles that the public wanted and therefore helped to reduce the British motorcycle dominance.

Japanese Motorcycles

The motorcycle industry throughout the world saw its biggest change in the early 1960s, when a company from Japan, headed by Sochirio Honda, changed the way people looked at motorcycling. The Honda C100 Cub (Figure 1-20) was by far the most successful entry-level motorcycle, and in the United States the company utilized the ever-popular slogan "You meet the nicest people on a Honda." The cub alone has continued to sell over a half a million units per year every year since its

Figure 1-20 The Honda Cub was first built in the late 1950s but dominated the market in the 1960s. The 60-millionth (60,000,000) Cub was built in the spring of 2008, making it the number one single motorcycle model ever produced by any motorcycle manufacturer in the world.

inception. The 60-millionth (60,000,000) Cub was built in 2008, making it the number one single motorcycle model ever produced by any motorcycle manufacturer in the world. To this day, almost 5 million more units are built each year for sale in countries around the globe.

In 1969, Honda introduced its CB750 (Figure 1-21), which not only boasted a four-cylinder overhead camshaft design that could reach speeds of 120 miles per hour but also included an electric start, front disc brakes, and a level of sophistication that was unheard of at the time. Honda also invented the all-terrain vehicle with its ATC90 in 1970 (Figure 1-22).

Figure 1-21 The 1969 CB750 Honda brought a level of sophistication to the motorcycle industry that started the modern-day motorcycle.

Figure 1-22 Honda created the ATC90 in 1970, which started the ATV revolution that has led to unit sales well over 700,000 yearly.

Figure 1-23 The Yamaha YM1 was a 305cc two-stroke that was produced from 1964 to 1966. It had an oil injection system to mix the oil with the gasoline and could reach speeds over 100 miles per hour.

With its advanced technology and willingness to consistently strive to improve, Japan had shown to the world that it was a power to be noticed in the motorcycle industry, and Japanese manufacturers Yamaha (Figure 1-23), Suzuki (Figure 1-24), and Kawasaki (Figure 1-25) soon joined Honda to dominate the motorcycle industry.

TYPES OF MOTORCYCLES AND ATVs

Motorcycles are available in a wide variety of models and sizes. The model that consumers purchase depends primarily on their intended use and personal choice of how they will ride. However, all motorcycles have basic similarities (Figure 1-26). They all contain the following common components:

- Engine
- Electrical system

Figure 1-24 The Suzuki GT550 was a big hit in the United States when it was imported in the 1970s. The GT had a six-speed transmission and was very fast in its day and came in different engine displacements.

Figure 1-25 The Kawasaki Mach III was a 500cc triple-cylinder motorcycle that defined power when it was introduced in 1969.

- Fuel system
- Tires and wheels
- Drive train
- Handlebars with controls
- Brakes
- Seat
- Frame
- Suspension systems

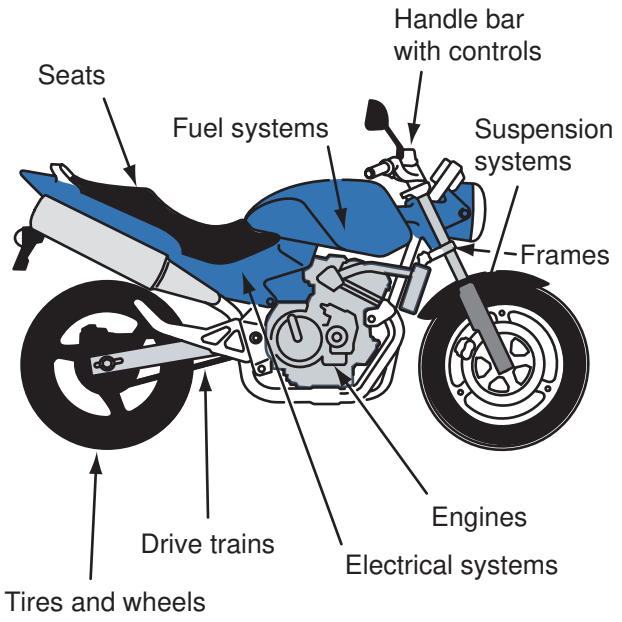

Figure 1-26 All motorcycles have basic similarities and contain common components.

These components form systems that must work together to provide a dependable and safe means of transportation. Each system performs a specific function. For example, the fuel system supplies the correct ratio of air-to-fuel mixture for proper engine operation. The ignition system provides timed electrical sparks to ignite the air-and-fuel mixture in the engine's internal combustion chamber(s). The drive train mechanism transfers the energy from the engine to the drive wheel. The brakes stop the motorcycle quickly and safely. Finally, the frame and suspension system absorb vibration and shock to give the rider a smooth, comfortable ride over varying road surfaces.

Because of the numerous applications and uses, motorcycles are divided into categories by use. Each category is then subdivided by engine displacement.

Engine displacement is a size measurement given in cubic centimeters (cc). For example, a 1,000cc engine has 1,000 cubic centimeters of volume. If it is a four-cylinder engine, then each cylinder has 250cc of volume. If it is a two-cylinder engine, then each cylinder has 500cc of volume. We'll cover exactly how this measurement is calculated in another chapter.

Motorcycles are classified as:

- Street
- Dual-purpose
- Off-road

All-terrain vehicles (better known as ATVs) are classified as:

- Three-wheelers
- Four-wheelers

Let's look at the different classifications of motorcycles and ATVs.

Street Motorcycles

Street motorcycles are available in a wide variety of designs and sizes. As the name implies, street motorcycles are designed for use on paved roadways. The **standard street motorcycle** has an upright riding position (Figure 1-27).

Japanese manufacturers initially designed today's standard street motorcycles in the late 1960s and early 1970s. They picked up the designation of **Universal Japanese Motorcycle (UJM)** after millions were built and sold. Although the current crop of standard street motorcycles is derived from the UJM version, early models of a very similar style were available from American manufacturers long before the UJM models were first imported here. These early American versions of the street motorcycles were customized by their owners into a unique class of vehicles known as custom cruisers. The standard street motorcycle is still very popular. It is available in a variety of different engine and chassis sizes to fit almost anyone's needs. The standard street motorcycle is often thought of as entry level in motorcycling circles, although many experienced riders purchase them for their daily use.

Figure 1-27 The standard style motorcycle has an upright riding position and is very popular with both beginner and experienced riders.

Figure 1-28 Custom cruisers are very popular and were designed originally by individuals based on the standard-style motorcycle.

A variation of the standard street motorcycle is the **custom cruiser** (Figure 1-28). The custom cruiser design began as a set of modifications to production models of the standard street motorcycle. Custom cruisers started to evolve when riders began to customize their standard street motorcycles. It was this customizing, which began in the United States that focused on modifying handlebar and seat design. The motorcycle manufacturers recognized the growing popularity of the customized models and started building factory versions. These manufactured custom cruisers have grown into one of the largest and most popular sales offerings of the motorcycle industry. A major difference between standard street models and custom cruisers is the riding position.

Standard street models are ridden in the upright position, and custom cruisers have a laid-back riding position. Custom cruisers come in a variety of sizes and feature many different looks. **Hot-rod cruisers** are another spin-off of the standard street motorcycle (Figure 1-29) and are similar to custom cruisers. The riding position of hot-rod cruisers is slightly forward-leaning. Hot-rod cruisers are equipped with large, powerful engines. Manufacturers have redesigned the chassis and suspension systems on the hot-rod cruisers to accommodate the larger engines and the increased power common with this class of motorcycle.

Figure 1-29 Hot-rod cruisers are more powerful versions of the custom cruiser and also have a more forward riding position.

From a performance standpoint, **sport motorcycles** (Figure 1-30) are by far the fastest, best-stopping, and best-handling members of the street-type motorcycles available to the public. They are available in a wide variety of sizes and power options. Many sport motorcycles are used in **road racing** (Figure 1-31), where racing is done on closed-course, street circuits.

As the name suggests, **touring motorcycles** are large, well-equipped units designed for long-distance touring travel (Figure 1-32). Many are equipped with standard and optional features, such as satellite, AM/FM, and CB radios; CD players; and even cruise control. Most touring motorcycles come equipped with large fairing units (windshields and wraparound side panels) to protect riders from the elements. They're also equipped with large weatherproof saddlebags to carry and protect luggage.

Figure 1-30 If it's speed you're after, then a sport motorcycle may be just what you're looking for, as they are the fastest and best-handling two-wheeled machines on the road.

Figure 1-31 Sport motorcycles are often used in high-speed, closed-course road racing as seen here.

Figure 1-32 Touring motorcycles are chock-full of luxury items like radios, CD players, and even heated seats and hand grips. This Honda Gold Wing even comes with a GPS navigation system.

Sport-touring motorcycles (Figure 1-33) are designed for touring without some of the frills of the pure touring version. Options such as radios and cruise control are not part of the sport-touring motorcycle design. Sport-touring motorcycles

Figure 1-33 Sport-touring motorcycles are a combination sport bike and touring machine. They combine comfort with long-distance capabilities that allow two-up riding all day long while handling well at higher speeds when it is desired to do so.

Figure 1-34 A typical small 50cc scooter is shown here.

Figure 1-35 Scooters come in many sizes up to this 650cc model, which is more than capable of riding on any highway, not to mention outperforming many full-sized motorcycles as well!

have high-performance engines, handle very well at high speeds, and provide a comfortable riding position (which is a must for long trips).

Motor scooters are another member of the street category of motorcycles. They're offered with engine displacements from 50cc (Figure 1-34) to 650cc (Figure 1-35). Because of their relatively small design, they are very economical to operate and easy to park or store. The characteristics of the typical motor scooter make them excellent for daily, short-distance urban or suburban commuting. They can be equipped with saddlebags to provide limited space for carrying small parcels, books, and briefcases, while some offer under-seat storage as well.

Dual-purpose motorcycles are exactly what the name suggests (Figure 1-36). They have been

Figure 1-36 Dual-purpose motorcycles perform well on both paved highways and dirt roads. These machines are often ridden on trails as well.

designed and manufactured to perform well both on and off paved highways. Dual-purpose motorcycles share mechanical characteristics with both street motorcycles and off-road motorcycles. These motorcycles are great for riders who might desire to take the conventional route to work or school and then choose to take the road less traveled on the return trip, using trails or fire roads instead of paved highways. Dual-purpose motorcycles are equipped with more shock-absorbing suspension systems than standard street motorcycles to handle off-road conditions.

They also have special tires for improved traction when riding on the various types of road (pavement and dirt) surfaces. Dual-purpose motorcycles are becoming more popular with individuals who appreciate their versatility. Because of this growing popularity, an increasing number of specialized dual-purpose riding events, meets, and contests are held each year. These events are designed to test the versatility of the dual-purpose motorcycles and the skills and handling techniques of the riders.

Off-Road Motorcycles

As the name implies, this category of motorcycles is specifically designed for off-road use. **Off-road motorcycles** (Figure 1-37) are built to handle rough terrain. The frames, suspension systems, and wheels are considerably stronger than those found on standard street motorcycles. Off-road motorcycles are often used in extreme terrains, such as deserts and mountain trails. Another use for off-road motorcycles that you may be familiar with is

Courtesy of Yamaha Motor Corporation, USA

Figure 1-37 This is an example of a typical off-road motorcycle. Most off-road bikes today come with four-stroke engines.

Figure 1-38 A typical motocross motorcycle is shown here.

motocross (Figure 1-38). Motocross is defined as a motorcycle race on a tight, closed course over terrain that includes sharp turns, hills, mud, and water.

Because of their special use, off-road motorcycles have little need for lights; consequently, the majority of models, if they have them at all, are equipped with small headlights and taillights. Certain special events require lights, but this is the exception rather than the rule. Off-road motorcycles are available in a wide variety of sizes from small to large and powerful. They are offered with both two-stroke engines and four-stroke engines. The engine sizes vary from 50cc (Figure 1-39) to over 600cc (Figure 1-40).

All-Terrain Vehicles

All-terrain vehicles (ATVs) are a separate branch of the motorcycle family tree. ATVs are available in a variety of sizes and styles. They can be equipped

Figure 1-39 This photo shows an example of a small 50cc off-road motorcycle that has a four-stroke engine to power it. These little bikes are very popular with children who are just getting into riding motorcycles.

Copyright by American Honda Motor Co., Inc. and reprinted with permission

Figure 1-40 This is an example of a large 650cc four-stroke, off-road motorcycle.

with either two-stroke or four-stroke engines ranging from 50cc to over 700cc.

The following are two subclasses of ATVs:

- Three-wheel tricycle-style machines commonly referred to as *three-wheelers*.
- Four-wheel models commonly referred to as *four-wheelers*.

Four-wheelers are further divided into two-wheel-drive and four-wheel-drive models. ATVs are versatile. They can be used for pleasure, such

as off-road and backcountry touring and camping (Figure 1-41), for trail riding, for racing on closed-course tracks (Figure 1-42), or for work and utility purposes (Figure 1-43). There are design differences to support the different uses. An ATV model designed for pleasure is not well suited for either racing or work. Similarly, a racing model is not designed for work.

As mentioned earlier, ATVs have been produced as both three-wheelers and four-wheelers.

Figure 1-41 This is an example of a recreational ATV that can be used for multiple purposes, such as off-road and backcountry touring and camping.

Figure 1-42 This example of a sport ATV is very popular and designed to be ridden on trails and on off-road race tracks. Note the distance between the wheels and fenders for suspension clearance.

Figure 1-43 This ATV is used for utility purposes, such as hunting and fishing. Note the camouflage color scheme.

Figure 1-44 Three-wheeler ATVs are no longer in production by any major manufacturer, but there are still thousands in use.

Although thousands are still in use, **three-wheelers** (Figure 1-44) are no longer in production. Some people feel that they have a tendency to be unstable, especially on rough and uneven terrain. For safety reasons, they have been discontinued. Owners of three-wheelers have been alerted to use caution when operating this type of ATV.

Multipurpose Utility Vehicles

Virtually all of the manufacturers that built ATVs also have **multipurpose utility vehicles (MUVs)** in their lineup of products. MUVs are commonly known as side-by-sides (SXS) but can also be called utility task vehicle (UTV), recreational off-highway vehicle (ROV), or all material transporter (AMT). MUVs are now outselling ATVs in many

Figure 1-45 MUVs come in many shapes and sizes, as can be seen here. They are very popular to the point that they now outsell ATVs in many markets!

markets around North America, and although larger in size than a typical ATV, they allow for a larger load capacity, and because most allow for multiple passengers, they are becoming more popular as time goes on (Figure 1-45).

Electric Vehicles

Today, you can now find electric-powered motorcycles, scooters, ATVs, and MUVs from a variety of manufacturers (Figure 1-46). The power output on an **electric vehicle (EV)** is amazing and smooth. As battery technology continues to progress with more power, less weight, greater longevity between charges, and lower cost to manufacture, EVs will become more and more popular with the public.

MOTORCYCLE INDUSTRY OPPORTUNITIES

The final section of this chapter introduces you to the opportunities available in the motorcycle industry. Upon completing their training, many students obtain their first job as **entry-level motorcycle technicians** at **franchised dealerships.** A franchised dealership is authorized to sell a particular motorcycle company's products and services in a particular area. There are many positions available at a motorcycle dealership for individuals with a motorcycle repair background. Even if you are not interested in a motorcycle career at this time, this section will give you an idea of what the motorcycle industry is all about. To obtain a better understanding of the positions available at a motorcycle dealership, we will start by taking a closer look at the dealership.

Dealership Opportunities

A motorcycle dealership (Figure 1-47) is an excellent place to begin a motorcycle or ATV repair career. Often, prospective employees must be willing to start at an entry-level position and work their way up the ladder.

Figure 1-46 An all-electric powered motorcycle can be seen here with its bodywork off as well as on. As you can see, the machines look rather complex once all of its bodywork is removed. While they are complex, they are quite efficient.

Figure 1-47 Motorcycle dealerships come in all different sizes. This dealership sells multiple brands of bikes.

Most franchised and independent dealerships have the following three main departments:

- Sales department
- Parts department
- Service department

Before we discuss the service department, let's first take a look at the other two departments. It is possible that your entry job may be in the sales or parts department. You can gain valuable experience in these departments as well. The ability to get along with people is a key requirement for working in any area of a motorcycle dealership. This is particularly true in the **sales department** (Figure 1-48), where products are displayed and sold. As a skilled salesperson, you must also be able to discuss the technical features of the different motorcycle models with customers. An education in motorcycle repair provides you with a definite advantage as a member of the sales staff. If you possess the ability to deal directly with people, the sales department is an excellent place to learn

Figure 1-48 This is an example of a large motorcycle sales department.

how a motorcycle dealership operates. The sales area provides valuable exposure to business-related activities. The experience can be very beneficial, especially if you plan to run your own business someday.

The **parts department** (Figure 1-49) is also a great place to use your people skills. Parts departments sell repair parts and accessories. As a member of the parts department, you will have constant contact with retail customers, the sales department, and the service department. You will be dealing directly with customers, both in person and on the telephone. The parts department is more closely related to the service department than to the sales department, especially if you work as a **parts technician.** A parts technician is responsible for supplying the service department technicians with the parts that they need to complete their service and repair work.

The third department within a motorcycle dealership is the **service department** (Figure 1-50), where motorcycles are brought in for maintenance and repairs. A small shop may have a service department that employs only one or two technicians. A medium-sized shop might employ three or four technicians plus a service manager. It's not unusual to find a significant number of employees in the service department of a large motorcycle dealership.

Larger motorcycle dealerships typically employ the following personnel in the service department:

- Lot attendants
- Setup technicians (motorcycle assemblers)

Figure 1-49 An example of a parts department is shown here.

Figure 1-50 Service departments come in many different sizes, depending on the overall store capacity.

- Motorcycle technicians
- Service writers
- Service managers

If you get a job in a motorcycle dealership service department but not as a technician, you may be employed as a **lot attendant.** A lot attendant is usually responsible for cleaning up the display and shop areas; rearranging, cleaning, and detailing motorcycles; picking up and delivering motorcycles and supplies; and performing other related tasks. If you start out as a lot attendant, the dealership management will have a chance to evaluate your job performance before assigning you additional responsibilities.

A **setup technician** (also known as a *motorcycle assembler*) is a step closer to becoming a motorcycle technician. The setup technician position requires certain mechanical skills. The setup technician uncrates and assembles all the new motorcycles received at a dealership (Figure 1-51). The setup activity often includes the initial service of the motorcycle (oil, gas, adjustments, and other important safety checks).

The **motorcycle technician** is frequently considered the backbone of the service department. It is not unusual to find motorcycle technicians who started in sales, in the parts department, as lot attendants, or as setup technicians and worked their way up. As a motorcycle technician, you will need a technical background, factory training (which the dealership can arrange for you), tools, and usually some prior mechanical experience.

Figure 1-51 Motorcycles and ATVs (shown here) must be uncrated and assembled prior to selling. A setup technician will normally handle this duty.

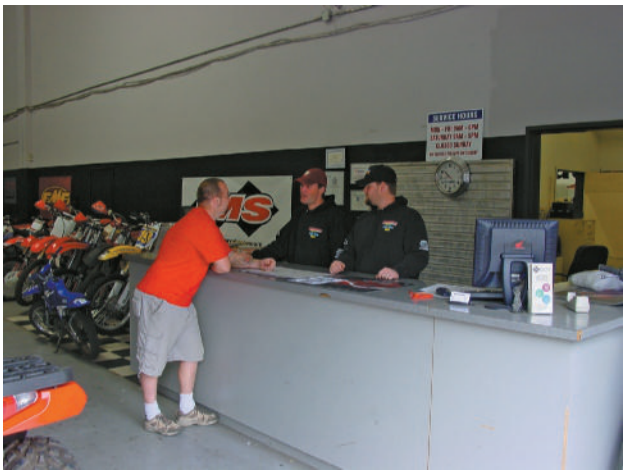

Figure 1-52 The service writer and service manager work directly with customers on a daily basis.

Some of the job assignments and responsibilities of a motorcycle technician include the following:

- Warranty service
- Preventive and scheduled maintenance
- General repair activities
- Staying current with new products, accessories, and service procedures
- Maintaining accurate repair records
- Alerting the service manager to actual or potential problems

In addition to the direct repair activity involvement of the motorcycle technician, there are other related positions available in most service departments for those who wish to try other assignments in the motorcycle service career field.

Another key employee in the service department is the **service writer** (Figure 1-52). The service writer is responsible for writing the repair orders for service work, should be technically trained, and should have a complete understanding of the service process. When writing a repair order, the service writer must obtain detailed failure information from the customer, verify the customer's input, and then provide the customer with an estimate of the services that might be required to correct the problem. In most dealerships, the service writer creates the repair orders, which are then distributed to the motorcycle technicians. The service writer also has a hand in job scheduling, ensuring that the repair process flows smoothly.

The **service manager** (Figure 1-52) holds the highest position in the service department. Most service managers are responsible for the following:

- Customer transactions
- Warranty claims
- Product update and information publications
- Technician training
- Employee hiring and dismissal
- Equipment needs
- Building maintenance
- Service policy changes
- Service files and records

Service managers usually have an extensive service background and prior management experience, including the following:

- Technical training
- Factory service school training
- Lot attendant experience
- Setup and assembly experience
- Motorcycle repair experience
- Customer relations skills
- Management experience

The service manager has the overall responsibility for the service department and must see that everything in the service department is well organized, that all necessary parts are in stock, and that

the service work is performed correctly and completed on time. The service manager must handle all customer complaints and any technical questions from both customers and technicians. The service manager needs an extensive amount of motorcycle repair experience and excellent management skills.

Finally, the top position in many motorcycle dealerships is the **general manager.** The general manager has the overall responsibility for the sales, parts, and service departments and oversees the day-to-day operations of the entire business. A general manager is likely to have had experience in all the other departments.

Other Industry Opportunities

Some individuals with motorcycle repair backgrounds (e.g., motorcycle technicians and service managers) have found challenging career opportunities as **motorcycle repair instructors** at the vocational school level. To be a motorcycle repair instructor, you must meet certain requirements. These requirements vary by locality and institution. For example, in some states, a technical instructor must be certified. To be certified in California, for instance, a technician can apply for teaching credentials if he or she is qualified in one of the following ways: seven years' experience in the trade or five years' experience in the trade plus two years of college (with a major in the specific trade). Because of the growing popularity of motorcycles and ATVs for sport and utility purposes, more motorcycle technical trade schools are opening every year. The demand for qualified motorcycle repair instructors is growing especially at the postsecondary school level. There are also teaching positions in most motorcycle manufacturer training schools.

Before seriously considering a career as a motorcycle repair instructor, be sure that you enjoy explaining the details of how something works, that you feel comfortable working directly with groups of people, and that you have an abundance of patience. The pay and benefits for the instructor position are usually good, but to most instructors, the most satisfying reward is watching the students develop the ability to apply their newly acquired knowledge.

If you enjoy motorcycle repair theory more than you enjoy actually repairing motorcycles, it is quite possible that you would enjoy a career as a **technical writer.** Technical writers wrote most everything that you have ever read about motorcycle repair. Technical writers in the motorcycle industry are constantly in demand, especially if they are skilled at transforming technical ideas and concepts into everyday language.

Most technical writers have the following:

- Technical training
- Higher education (college)
- Writing experience

Technical illustrators, who work closely with technical writers, create most motorcycle photographs and illustrations contained in service manuals, sales brochures, and other printed matter. Although technical illustrators create most of the illustrations, in certain cases the technical writers themselves create the illustrations. At the very least, technical writers should be able to define the illustrations or photographs needed to support the text that they have developed and to verify that the completed illustrations support the text. There is usually a close working relationship between technical writers and the technical illustrators to develop the finished printed material. Most technical illustrators usually have the following:

- Technical training
- Some writing experience
- Photographic experience
- Technical illustration and layout experience

These are just a couple of the many possible opportunities in the area of motorcycle training, distribution, and manufacturing. Companies in the motorcycle distribution and manufacturing industry offer numerous other career opportunities as well. Although the complete list is long and varied, here is a list of these positions with a brief explanation of what the position entails:

Technical advisors assist dealer technicians with problems over the phone.

District service managers work with a group of dealers with technical-related issues within a predetermined area.

District sales managers work very much like district service managers but instead handle sales-related items.

District parts managers assist dealers with parts-related problems.

Service technical training instructors facilitate training to technicians in the same manner as motorcycle repair instructors previously mentioned.

Customer service representatives assist customers over the phone with a variety of wishes and concerns.

Quality control specialists work closely with the manufacturing engineers to ensure that the products are of the highest quality possible.

Research and development engineers help in the actual creation of the products.

Race team support technicians travel extensively and work on the factory race machines.

Advertising and marketing specialists help in selling the products to the greatest number of customers as possible.

Most motorcycle manufacturing company employees enjoy competitive salaries and generous company benefits. Before seriously being considered for a career with a motorcycle manufacturer, you will need most of the following:

- Related mechanical experience
- Employment at a dealership
- Technical training
- Factory service school training in motorcycle repair
- Higher education (college or vocational school)

We have explored several career opportunity options for someone who has the necessary skills and training in motorcycle repair. What about the person who wants to be self-employed? Are the days of the independent service technician over? Not at all! With adequate financial backing, a person with the proper skills and background could start any type of related business, including a full motorcycle dealership, a parts and accessories store, or a major service and repair business. It is possible for a trained motorcycle or ATV repair technician to start a small repair and service business with little available capital. Many of today's thriving repair and service businesses started out in the back of a garage. If self-employment is your goal, you might start out by using that spare space in your garage! Some countries, such as Canada, require special licensing before the level of motorcycle technician is achieved through an apprenticeship program as well as a final national level exam that must be taken and passed.

These are just some of the possibilities that await you in the exciting and challenging field of motorcycle and ATV repair. As you have discovered in this section, a wide range of career opportunities are available to qualified individuals.

Summary

- The motorcycle industry is growing at a tremendous rate, and the need for trained technicians is growing rapidly.
- The history of the motorcycle dates back to the mid-1800s.
- The first two major motorcycle manufacturers in the United States were Indian and Harley-Davidson.
- British motorcycle sales were at their highest in the late 1950s.
- Japanese motorcycles came to the forefront of the industry in the 1960s.
- There are four basic motorcycle classifications: street, dual-purpose, off-road, and ATV.
- All motorcycles have basic similarities.
- There are numerous opportunities within the motorcycle industry, not only at the dealership level but also at the manufacturer and distributor levels.

Chapter 1 Review Questions

1. Name the five positions mentioned in this chapter available in a motorcycle service department.
2. Name the three main departments in a motorcycle dealership.
3. List three things that a service writer must do when working with a customer.
4. List the three basic classifications of motorcycles.
5. Although thousands are still being used today, what type of ATV is no longer in production by any major manufacturer?
6. Which motorcycle is often used for road racing?
   a. Hot-rod cruiser
   b. Standard
   c. Sport
   d. Sport touring
7. What does “UJM” stand for?
8. The first motorcycle in recorded history using an internal combustion engine was built by:
   a. Alex Millet
   b. Gottlieb Daimler
   c. William Davidson
   d. Sylvester Roper
9. The Hendee Manufacturing Company changed its name to _____ after designing its first motorcycle in 1901.
10. In what year was the first Harley-Davidson V-Twin built?
11. In what year did Harley-Davidson celebrate its 100-year anniversary?
12. In 1914, the world’s first motorcycle with electric start and a full electrical system was introduced to the industry. What brand of motorcycle was this?
13. Which motorcycle usually has little to no lighting capabilities?
14. Which motorcycle is often equipped with a radio and even cruise control?
   a. Cruiser
   b. Sport touring
   c. Touring
   d. Standard
15. Which motorcycle industry professional works with a group of dealers with technical-related issues within a predetermined area?
   a. District sales managers
   b. District service managers
   c. Technical writers
   d. Quality control specialists

CHAPTER 2

Safety First

Learning Objectives

When you have completed the study of this chapter and its laboratory activities, you should be able to:

- Understand the importance of safety and accident prevention in a motorcycle shop environment
- Explain the basic principles of personal safety
- Explain the procedures and precautions for safety when using tools and equipment
- Explain what should be done to maintain a safe working area in a service shop environment
- Describe the purpose of the laws concerning hazardous wastes and materials, including right-to-know laws
- Describe your rights as an employee and/or student to have a safe place to work

Key Terms

Alternating current (AC)
Carbon dioxide (CO_2)
Carbon monoxide (CO)
Class A fires
Class B fires
Class C fires
Class D fires
Conductors
Contact dermatitis
Direct current (DC)
Earplugs
Eczema
Fire extinguishers
Fire triangle
Goggles
Halon
Hazard Communication Standard
Headset
Material handling
Material safety data sheets (MSDS)
Metatarsal guards
Motorcycle Safety Foundation (MSF)
National Electrical Code® *(NEC®)*
National Fire Protection Association (NFPA)
National Safety Council (NSC)
Occupational Safety and Health Administration (OSHA)
PASS
Personal protective equipment (PPE)
Power tools
Respirators
Safety glasses

INTRODUCTION

Most people are concerned with safety in and around their homes. They strive to protect their families from accidents and injuries. But accidents in the workplace are often much more severe than home accidents, because workplaces contain many more potential hazards than the average home. Working on motorcycles can be fun and rewarding, but if the proper precautions are not followed, it can be dangerous as well.

THE SAFETY ATTITUDE

Safety is more than just the absence of accidents. *Safety is an attitude* that helps you prevent injuries to yourself and others. Safe working practices should be a way of life. They should be as instinctive as putting on your seat belt or looking both ways before you cross the street. Safety is not a matter of good luck or bad luck. It is a predetermined set of mental exercises, including the following:

- Planning to work safely
- Recognizing potential safety hazards and eliminating hazards
- Following proper safety procedures at all times, particularly in your workplace

You should be aware that the **Occupational Safety and Health Administration (OSHA)** is the federal agency that publishes safety standards for business and industry. The OSHA regulations affect every business that has employees and sells its products or services. OSHA requires every employer to provide employees with safe workplaces that are free from recognized hazards. For reasons of brevity concerning the legal aspects of OSHA, it is the federal government's law enforcer for industrial-safety matters. Employers are motivated to adopt and use safe working procedures through OSHA's strict enforcement of the regulations. Safety violators receive harsh penalties and fines. You can find a complete list of OSHA's proven safety methods, practices, and regulations in one convenient resource called the Code of Federal Regulations. Even if you are a one-person operation, you should understand and follow OSHA's safety guidelines for your own protection. In a motorcycle service department, the safety matters of primary concern are the following:

- Fire safety
- Chemical safety
- Basic electrical safety
- Ventilation of exhaust gases
- Safe operation of engines and equipment
- Good housekeeping practices
- Safe handling of heavy objects and materials
- Proper use of personal protective equipment
- Using Tools Safely
- Safe riding practices

Now that we've provided you with a quick list of the safety topics and areas that OSHA's regulations cover, let's look at these important safety items one at a time.

FIRE SAFETY

A major safety consideration in the motorcycle repair business is fire prevention. Many fires occur in private garages every year, and a significant number of these are started by the mishandling of gasoline, such as storing gasoline in unapproved containers or failing to clean up gasoline spills. Gasoline is the fuel for all current modern motorcycle engines. Because gasoline is one of the most flammable liquids, fire is a serious threat in any motorcycle service area.

Gasoline is not the only flammable liquid used in the service department: oils, lubricants, paints, cleaning solvents, and other chemicals can also create a fire hazard when improperly handled. Despite the fire risk, a service department can be run safely. By following basic safety practices, the

danger of fire can be greatly reduced, if not eliminated entirely.

The **National Fire Protection Association (NFPA)** is the largest and most influential national group dedicated to fire prevention and protection. Its mission is to safeguard people, property, and the environment from fires. The NFPA also publishes the ***National Electrical Code® (NEC®).*** The *NEC®* is the national standard for all residential and industrial electrical installations in the United States and Canada. When you start planning a fire safety program for your business, check with the NFPA. They can provide useful hints and detailed support information.

The Fire Triangle

There are three conditions that must be present for a fire to start. These conditions are grouped together to form the **fire triangle.** The three components of the fire triangle are as follows:

- Fuel (such as wood or gasoline)
- Oxygen
- An ignition source (such as a spark)

After a fire starts, the supply of fuel and oxygen must stay at certain levels to sustain the fire. To extinguish a fire, you must remove at least one of these two legs of the fire triangle. You can put out a fire by removing the fuel source or removing the oxygen.

When analyzing fire prevention, you must always be aware of the ignition sources that could start a fire in your work area. When we consider ignition sources, most of us think of open flames, sparks, stoves, and matches. However, there are several other dangerous, but less obvious, ignition sources.

For example, a common but often overlooked source of ignition is the engine exhaust. A motorcycle's exhaust system becomes hot during operation. This heat remains in the exhaust system for a period of time after the vehicle's engine has been turned off. Therefore, if a vehicle's engine is still warm when you begin to make repairs, you must take extra precautions to prevent fires.

Another highly possible source of ignition is cigarette smoking. Smoking-related ignitions are a leading cause of fires. Sparks from lit cigarettes, heat from discarded cigarette butts, and the open flames of lighters and matches can all start fires in flammable and combustible materials. Therefore, smoking should be strictly controlled in a motorcycle service department. Smoking and nonsmoking areas should be posted with distinct, easily recognizable symbols. Smoking areas should be equipped with adequate receptacles to provide for the safe disposal of smoking materials. Smoking is prohibited in many service departments, and smokers must go to a designated outside smoking area.

Spontaneous combustion is another potential source of ignition that you should recognize. In spontaneous combustion fires, the heat for ignition is created by a chemical reaction in combustible materials. One common type of spontaneous combustion occurs when oil- or solvent-soaked rags or papers are discarded in a trashcan. The decomposition of the oil or solvent often produces enough heat to ignite the rags or papers. To prevent spontaneous combustion, all oil- or solvent-contaminated rags and papers should be discarded only in designated, fireproof metal safety receptacles. Routine trash material should not be discarded in these special receptacles.

The Four Fire Classes

Let us take a closer look at the different types of fires. The NFPA classifies fires in four categories, or classes: Classes A, B, C, and D (Figure 2-1). Each of these four fire classes is defined by, and associated with, a different type of fuel source.

Class A fires involve the burning of wood, paper, cardboard, fabrics, and other similar fibrous materials. These materials ignite easily, burn rapidly, and produce large quantities of heat during burning. Some examples of Class A combustible materials that are commonly found in workplaces include the following:

- Paper business forms
- Company files or records
- Cleaning and polishing cloths
- Work aprons
- Dust covers
- Work area partitions

Class A fires can be extinguished with water, CO_2 (carbon dioxide), or dry chemical agents. These agents extinguish the fire by quickly cooling

	CLASS OF FIRE	TYPICAL FUEL INVOLVED	TYPE OF EXTINGUISHER
Class A Fires (green)	**For Ordinary Combustibles** Put out a Class A fire by lowering its temperature or by coating the burning combustibles.	Wood Paper Cloth Rubber Plastics Rubbish Upholstery	Water*[1] Foam* Multipurpose dry chemical[4]
Class B Fires (red)	**For Flammable Liquids** Put out a Class B fire by smothering it. Use an extinguisher that gives a blanketing, flame-interrupting effect; cover whole flaming liquid surface.	Gasoline Oil Grease Paint Lighter fluid	Foam* Carbon dioxide[5] Halogenated agent[6] Standard dry chemical[2] Purple K dry chemical[3] Multipurpose dry chemical[4]
Class C Fires (blue)	**For Electrical Equipment** Put out a Class C fire by shutting off power as quickly as possible and by always using a nonconducting extinguishing agent to prevent electric shock.	Motors Appliances Wiring Fuse boxes Switchboards	Carbon dioxide[5] Halogenated agent[6] Standard dry chemical[2] Purple K dry chemical[3] Multipurpose dry chemical[4]
Class D Fires (yellow)	**For Combustible Metals** Put out a Class D fire or metal chips, turnings, or shavings by smothering or coating with a specifically designed extinguishing agent.	Aluminum Magnesium Potassium Sodium Titanium Zirconium	Dry chemical extinguishers and dry powder compounds only

*Cartridge-operated water, foam, and soda-acid types of extinguishers are no longer manufactured. These extinguishers should be removed from service when they become due for their next hydrostatic pressure test.

Notes: (1) Freezes in low temperatures unless treated with antifreeze solution, usually weighs over 20 pounds, and is heavier than any other extinguisher mentioned.
(2) Also called ordinary or regular dry chemical (solution bicarbonate).
(3) Has the greatest initial fire-stopping power of the extinguishers mentioned for Class B fires. Be sure to clean residue immediately after using the extinguisher so sprayed surfaces will not be damaged (potassium bicarbonate).
(4) The only extinguishers that fight Class A, B, and C fires. However, they should not be used on fires in liquefied fat or oil of appreciable depth. Be sure to clean residue immediately after using the extinguisher so sprayed surfaces will not be damaged (ammonium phosphates).
(5) Use with caution in unventilated, confined spaces.
(6) May cause injury to the operator if the extinguishing agent (a gas) or the gases produced when the agent is applied to a fire are inhaled.

Figure 2-1 The symbols in this table are placed on fire extinguishers to indicate the types of fires that they are designed to be used on.

the burning material and lowering the temperature in the combustion zone. The symbol used to identify Class A extinguishing equipment is the letter "A" inside a green triangle.

Class B fires involve flammable liquids, gases, and other chemicals. Because many flammable and combustible liquids and solvents are used in a motorcycle service department, special care should be given to their handling, use, and storage. Some common flammable liquids include gasoline, cleaning solvents, oils, greases, turpentine, oil-based paints, and lacquers. Common flammable gases include natural gas, propane, and acetylene.

Fires involving flammable liquids produce tremendous quantities of heat. Water is an ineffective extinguishing agent for a Class B fire. The heat from

a burning flammable liquid will boil the water that is applied to the fire, turning the water into steam before it can do much good. Most importantly, almost all flammable liquids are lighter than water. The liquids float on top of the water and continue burning. This is a very dangerous situation that can cause a flammable liquid fire to spread very rapidly. The best way to extinguish a Class B fire is to smother it, removing its source of oxygen. Foams, dry chemicals, and CO_2 are the best extinguishing agents to use on a Class B fire. The symbol used to identify Class B extinguishing equipment is the letter "B" inside a red square. If you routinely keep gasoline (even in small amounts) in your workplace, you should have at least one Class B fire extinguisher in the area. You can also smother a small Class B fire with a blanket or noncombustible container. Use this method only if you can do so without risking personal injury. You should always remember that flammable liquid fires have a tendency to flare up very rapidly.

Class C fires involve live electrical equipment such as electrical boxes, panels, circuits, appliances, power tools, machine wiring, junction boxes, wall switches, and wall outlets. Some form of short circuit or overloaded circuit usually causes electrical fires. Examples of these causes include the following:

- Loose contacts or terminals
- Frayed wire insulation
- Improper installations
- Defective equipment
- Overloaded circuits

Electrical system overloads and short circuits can produce arcs, sparks, and heat. This type of electrical problem can ignite nearby combustible materials, for example, wire insulation, plastic components, and wall insulation or paneling. Water is a good conductor of electricity, and if it is applied to an electrical fire, the person holding the extinguisher could be severely shocked or electrocuted. **Carbon dioxide (CO_2)** is the most widely used extinguishing agent because it is nonconductive, it penetrates around electric equipment well, it is effective, and it leaves no residue that would have to be cleaned up afterward. Dry chemicals produce a residue that can damage electric equipment.

Halon is another extinguishing agent that is effective on all classes of fire, especially Class C. It is stored as a liquid under high pressure and is released on a fire as an oxygen-depleting (smothering) gas. Although Halon is very effective, it is not readily available. Halon is a fluorocarbon compound that is classified as an ozone-depleting substance. The usage of Halon is restricted by law for environmental reasons. The symbol used to identify Class C extinguishing equipment is the letter "C" inside a blue circle.

Class D fires involve combustible metals such as magnesium, titanium, zirconium, sodium, lithium, and potassium. Flakes and fine particles of these metals can be ignited at relatively low temperatures. Metal particles are often produced by cutting or grinding operations. If cutting or grinding is done in the typical motorcycle repair shop, it is usually confined to a designated area that is uncluttered and well ventilated. The larger exposure to Class D fires is found in a *back-of-the-garage* type of operation, where space is limited and conditions might favor the start of this type of fire. You should be aware of Class D fires and how to react to them.

Dry powder compounds and *dry chemical extinguishers* are the two primary methods to extinguish Class D fires. Dry powder compounds are completely different than dry chemical extinguishers. They are usually scooped directly onto a fire. Dry chemical extinguishers apply the dry chemical charge under pressure. The symbol used to identify Class D extinguishing equipment is the letter "D" inside a yellow star.

The most important reason for introducing you to the four classes of fires is to inform you of what to do and what not to do in a fire emergency. Your reaction to a fire could mean the difference between a minor incident and a major loss of property, with possible injury or death. Knowledge of the fire classes is also important when you're assessing your work area for fire hazards. Basically, most fires are preventable. It is important to remember that fire prevention is not just a slogan. Awareness, common sense, and good work habits go a long way toward preventing fires.

Based on the nature of your work environment, the two types of fires most likely to occur in a motorcycle service department are Class A and Class B fires. But don't be negligent about the possibility of a Class C or Class D fire occurring also. Know what to do for all fire classes.

Using a Fire Extinguisher

Fire extinguishers (Figure 2-2) must be properly used to be effective on a fire. You should become familiar with the various extinguishers installed at your facility before a fire starts. This familiarization step is important for the following reasons:

- To operate a fire extinguisher safely and efficiently, you should know how to use it. You will lose valuable fire-fighting time if you have to stop and read instructions. Be prepared!
- You could injure yourself or others by using an extinguisher improperly.
- An average fire extinguisher discharges all its contents in only 12 to 60 seconds. You need to make the best use of all the extinguisher contents.

To be effective, portable fire extinguishers must be readily available in a fire emergency. Extinguishers must be installed close to all potential fire hazards (Figure 2-3). The extinguishers must contain the proper type of extinguishing agent for those hazards, and they must be large enough to protect the designated area. The fire hazards existing in a shop must be identified and evaluated, to verify that the proper numbers and types of fire extinguishers are installed at the correct locations.

Figure 2-2 Examples of different types and sizes of fire extinguishers are shown here.

Figure 2-3 Be sure to know the locations and types of fire extinguishers available in the shop.

Take the following steps before you attempt to extinguish any fire:

1. Evaluate the size of the fire. A fire in its beginning stages is called an *incipient fire*. A fire is classified as incipient (start-up) if it covers an area no larger than 2 to 4 feet square, has flames less than 2 feet in height, and produces low levels of smoke. Fire extinguishers can be effective for extinguishing or suppressing this size of fire. But it is not safe to use a fire extinguisher after a fire passes beyond the incipient stage. The length of time that a fire remains in the incipient stage is usually quite brief. If the fire goes beyond the start-up stage, the only course of action is to evacuate the building or facility and call the fire department.
2. Locate the exits and the escape routes you will need in an emergency evacuation. To prevent yourself from becoming trapped in a serious situation, keep the locations of the exits in mind as you fight the fire.
3. Determine which way the flames are moving, and approach the fire from the opposite direction. The flaming side of the fire radiates too much heat, and the fire could overtake you before you have a chance to escape. By attacking the fire from the opposite side, you will be safer; you will also be able to get closer to the combustion zone of the fire.

When you have taken these preliminary steps, you are ready to use an extinguisher. To operate this type of extinguisher, perform the following:

- Remove the extinguisher from the wall.
- Grasp the handle of the extinguisher and pull out the safety pin.
- Free the hose and aim the nozzle at the fire.
- Squeeze the handle.
- Move the nozzle in a sweeping motion to distribute the extinguishing agent.

Here's a little hint. You can use the acronym **PASS** to help you remember how to operate a fire extinguisher. The letters in PASS stand for *Pull* (the safety pin), *Aim*, *Squeeze,* and *Sweep.*

Always direct the stream of extinguishing agent at the base of the flames. This is the fire's combustion zone. Cooling this area will extinguish the fire more quickly. Sweep the stream from side to side and work your way around the fire until it is completely extinguished. You should remember to never turn your back on a fire until you are absolutely sure that it is completely extinguished. Heat remaining inside of partially burned materials can reignite the fire when you are not looking. This could trap you. Portable fire extinguishers should be given a complete maintenance check annually. Maintenance may include recharging or pressure testing the extinguisher. Most fire extinguishers require pressure testing every five years. You should also inspect all fire extinguishers at least once monthly and answer the following:

- Is the extinguisher in its designated place close to possible fire hazards?
- Is the extinguisher clearly visible?
- Is access to the extinguisher free from all obstacles and obstructions?
- Is the extinguisher fully charged?

It is also a good idea (in some localities it is the law) to install battery-operated smoke detectors and carbon-monoxide detectors in all buildings. Remember that smoke detectors require some maintenance. Check the detectors and their batteries routinely to ensure that they are in proper working order. Replace batteries yearly, and replace all detectors that show any signs of malfunction or incorrect operation.

The following are some important fire evacuation procedures that you should commit to memory. Never take fire safety lightly. It is recommended that you practice these procedures in regularly scheduled exercises or fire drills.

- Get out fast. Believe the alarm when you hear it. Do not waste time trying to verify that there is a fire or trying to gather things before you leave.
- Stay low to the floor to avoid smoke and toxic gases. The clearest air is found near the floor. So crawl if necessary! Cover your mouth and nose with a damp cloth, if available, to help you breathe.
- Do not open a closed door without feeling the door's surface first. If you open a door with flames on the other side, the fire could backdraft and severely burn you. Use the back of your hand (to avoid burning your palms) when you test for heat. If the door feels warm on your side, the temperature is probably far above the safety level on the other side. Do not open the door; use an alternate escape route!
- Never enter a burning building. This could be a fatal mistake! Professional firefighters are equipped with special protective equipment and breathing devices that allow them to enter burning buildings. They are also trained in search and rescue techniques. Leave these tasks to the professionals.
- If your clothing catches fire, do not panic! Stop, drop to the ground, and roll around to smother the flames. If a coworker's clothing catches fire, quickly wrap the person in a blanket or rug to smother the flames. Assist the person with the *stop, drop, and roll* maneuver if a rug or blanket is not handy.

HAZARDOUS CHEMICALS

Question: Do you work with or near any hazardous chemicals? Before you answer too quickly, continue reading!

Many people are unaware that some everyday materials and products in their work areas are indeed hazardous chemicals. Materials such as paints, oils, lubricants, cleaners, degreasers, solvents, and gasoline are all potentially hazardous

chemicals. Labels on chemical containers normally list the names of the chemicals and any hazards associated with them. The labels also highlight health hazards that the chemicals present, including eye and skin contact irritation characteristics, breathing and inhalation dangers, and accidental swallowing or ingestion warnings. Many labels also include first-aid procedures to administer for these hazards, the name and address of the chemical manufacturer or importer, and specific ingredients of the hazardous chemical compounds. Some chemicals can cause a variety of serious health problems (or even death) if you are exposed to them.

For example, some chemicals can produce gases and vapors that are poisonous when inhaled. Other chemicals are highly flammable or explosive when exposed to sparks or open flames. And still other chemicals can cause temporary or permanent blindness if they get splashed in the eyes. Everyone should take the potential hazards of chemicals seriously. The intent here is not to scare you; it is to alert you to possible dangers so that you will give chemicals the respect they deserve.

Most chemicals in the workplace are not life-threatening but can cause minor injuries or illnesses. If you work with chemicals in your service department, always follow the safety precautions on the chemical's label and protect yourself with gloves and safety goggles. A common problem that chemicals can cause is a skin inflammation called **contact dermatitis** or **eczema.** Contact dermatitis usually starts as redness in the area of chemical contact or exposure and may progress into blistering, scaling, and cracking of the skin surface. People who regularly expose their hands to materials such as detergents, cleaners, degreasers, oil, and gasoline are susceptible to dermatitis. Although contact dermatitis is not a life-threatening condition, it is very uncomfortable and could lead to more serious health complications such as infections. Contact dermatitis is much easier to prevent than it is to cure, so it is important to wear industrial rubber gloves whenever you are using chemicals that could come in contact with your skin. Exposing the skin to stronger chemicals can cause more serious injuries. For instance, exposure to acids and strong bases can cause immediate, very painful burns to the skin.

The batteries used in all types of motorcycles and ATVs contain strong and dangerous acids. The sulfuric acid found in batteries is a particularly dangerous acid you should be aware of. It can eat through clothing or burn your skin. And more importantly, it can easily cause blindness if splashed in the eyes. Be aware that storage batteries give off dangerously explosive hydrogen gas when they are being charged. Always use extreme caution when handling, storing, replacing, charging, or adding distilled water to storage batteries. Follow these safety guidelines when handling batteries:

- Keep batteries upright to prevent the acid from spilling or leaking.
- Always wear gloves, an apron, and safety goggles when handling batteries to protect your skin and eyes.
- Charge batteries in a well-ventilated location to prevent the buildup of hydrogen gas.

Right-to-Know Laws

An important part of a safe work environment is knowledge of potential hazards. Right-to-know laws protect every employee in a motorcycle dealership. These laws were placed in effect when OSHA's **Hazard Communication Standard** was published back in 1983. This was originally intended for chemical companies and manufacturers that require employees to handle potentially hazardous materials in the workplace. Since then, most states have enacted their own right-to-know laws, and these laws now apply to all companies that use or sell potentially hazardous chemicals or materials. The general intent of right-to-know laws is to ensure that employers provide a safe working place for their employees when hazardous materials are involved. Specifically, there are three areas of employer responsibility.

First and foremost, all employees must be trained about their rights under the legislation, the nature of the hazardous chemicals around them, and the contents of the labels on the chemicals. All the information on each chemical must be posted in **material safety data sheets (MSDSs)** and must be easily accessible to every employee (Figure 2-4). The manufacturer of the chemical must give these sheets to its customers if it

Figure 2-4 Right-to-know laws were created to protect employees' rights and give them access to all information regarding potentially hazardous materials in the workplace.

is requested to do so (Figure 2-5). The sheets detail the chemical composition and precautionary information for all products that can present a health or safety risk.

ELECTRICAL SAFETY

We tend to take electricity for granted, so we often lose sight of its potential to cause serious injury or death. The main hazards of electricity are electrical shocks and burns. Electrical shocks and burns usually result from the following:

- Faulty power tools or equipment
- A disorderly and untidy work environment
- Human error (the misuse of an electrical device)

Even if you do not work with electrical equipment on a routine basis, you should be aware of how shocks can occur. Generally, you must be in contact or in proximity with a conductor or a conductive surface. **Conductors** are normally metallic materials that readily pass or conduct electricity. If you are in proximity to a conductor and you contact a source of electricity, the electricity can pass through your body to the conductive material and then to the ground. In such a situation, your body acts like a switch, closing the electric circuit. The sensation that you feel is an electrical shock. The shock may range from mild to severe depending on the circumstances and the source of the electricity. If you are lucky, you may experience only a brief unpleasant sensation. If you are unlucky, you could be seriously injured, or worse!

There are two types of electric-power sources: **alternating current (AC)** and **direct current (DC).** Alternating current flows in alternating cycles and is used to run lighting circuits and appliances in most households and workplaces. Direct current is continuous and steady. It is found in batteries and battery-powered electrical systems such as motorcycle electrical systems.

Each type of electrical source has its own set of hazard characteristics. The alternating current found in the typical repair facility can be very hazardous if the path of the shock is from one hand to the other. This puts your heart in line with the AC flow and can cause fibrillation (erratic, nonrhythmic heartbeat). An AC shock causes the muscles to contract and relax with the alternating current cycles. This allows you to withdraw the body contact point (normally a hand) from the source of the shock when the muscles relax.

The direct current found in the typical motorcycle shop can present a more serious hazard than alternating current because a DC shock causes the muscles to contract and freeze. There are no alternating cycles with direct current; consequently, the muscles do not relax like they will with an AC shock. This makes it very difficult to let go of the shock contact point, extending the time that you are subjected to the danger of the shock. You can incur severe burns, or worse, from a DC shock.

Always keep your work area clean and orderly to prevent electrical accidents. Keep floors clean and dry, because a wet or damp floor will make anyone standing on it more conductive to electricity. All portable electrical equipment (machines that have plugs and cords) should be inspected before each use to ensure that the equipment, cord, and plug are in good condition. If you feel the slightest tingle or shock while using electrical equipment, stop using it immediately! That slight tingle is an indication that there is a fault in the equipment's electrical wiring or ground circuit.

Avoid wearing conductive metals such as rings, watches, and chains when working with electricity. These metal objects significantly increase your

HEXANE
==========
MSDS Safety Information
==========
Ingredients
==========
Name: HEXANE (N_HEXANE)
% Wt: >97
OSHA PEL: 500 PPM
ACGIH TLV: 50 PPM
EPA Rpt Qty: 1 LB
DOT Rpt Qty: 1 LB
==========
Health Hazards Data
==========
LD50 LC50 Mixture: LD50:(ORAL,RAT) 28.7 KG/MG
Route Of Entry Inds _ Inhalation: YES
Skin: YES
Ingestion: YES
Carcinogenicity Inds _ NTP: NO
IARC: NO
OSHA: NO
Effects of Exposure: ACUTE:INHALATION AND INGESTION ARE HARMFUL AND MAY BE FATAL. INHALATION AND INGESTION MAY CAUSE HEADACHE, NAUSEA, VOMITING, DIZZINESS, IRRITATION OF RESPIRATORY TRACT, GASTROINTESTINAL IRRITATION AND UNCONSCIOUSNESS. CONTACT W/SKIN AND EYES MAY CAUSE IRRITATION. PROLONGED SKIN MAY RESULT IN DERMATITIS (EFTS OF OVEREXP)
Signs And Symptions Of Overexposure: HLTH HAZ:CHRONIC:MAY INCLUDE CENTRAL NERVOUS SYSTEM DEPRESSION.
Medical Cond Aggravated By Exposure: NONE IDENTIFIED.
First Aid: CALL A PHYSICIAN. INGEST:DO NOT INDUCE VOMITING. INHAL:REMOVE TO FRESH AIR. IF NOT BREATHING, GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN. EYES:IMMED FLUSH W/PLENTY OF WATER FOR AT LEAST 15 MINS. SKIN:IMMED FLUSH W/PLENTY OF WATER FOR AT LEAST 15 MINS WHILE REMOVING CONTAMD CLTHG & SHOES. WASH CLOTHING BEFORE REUSE.
==========
Handling and Disposal
==========
Spill Release Procedures: WEAR NIOSH/MSHA SCBA & FULL PROT CLTHG. SHUT OFF IGNIT SOURCES:NO FLAMES, SMKNG/FLAMES IN AREA. STOP LEAK IF YOU CAN DO SO W/OUT HARM. USE WATER SPRAY TO REDUCE VAPS. TAKE UP W/SAND OR OTHER NON-COMBUST MATL & PLACE INTO CNTNR FOR LATER (SU PDAT)
Neutralizing Agent: NONE SPECIFIED BY MANUFACTURER.
Waste Disposal Methods: DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE AND LOCAL ENVIRONMENTAL REGULATIONS. EPA HAZARDOUS WASTE NUMBER:D001 (IGNITABLE WASTE).
Handling And Storage Precautions: BOND AND GROUND CONTAINERS WHEN TRANSFERRING LIQUID. KEEP CONTAINER TIGHTLY CLOSED.
Other Precautions: USE GENERAL OR LOCAL EXHAUST VENTILATION TO MEET TLV REQUIREMENTS. STORAGE COLOR CODE RED (FLAMMABLE).
==========
Fire and Explosion Hazard Information
==========
Flash Point Method: CC
Flash Point Text: _9F,_23C
Lower Limits: 1.2%
Upper Limits: 77.7%
Extinguishing Media: USE ALCOHOL FOAM, DRY CHEMICAL OR CARBON DIOXIDE. (WATER MAY BE INEFFECTIVE).
Fire Fighting Procedures: USE NIOSH/MSHA APPROVED SCBA & FULL PROTECTIVE EQUIPMENT (FP N).
Unusual Fire/Explosion Hazard: VAP MAY FORM ALONG SURFS TO DIST IGNIT SOURCES & FLASH BACK. CONT W/STRONG OXIDIZERS MAY CAUSE FIRE. TOX GASES PRDCED MAY INCL:CARBON MONOXIDE, CARBON DIOXIDE.
==========

Figure 2-5 Material safety data sheets are an important part of working in a motorcycle dealership and should be readily available. They contain important information to let you know the dangers—if any—of working with chemicals.

risk of being shocked. You can increase your resistance to electrical shock by wearing rubber gloves, standing on an insulating rubber mat, and using tools with insulated handles.

EXHAUST GAS SAFETY

When an engine is running, it creates exhaust gases that are hazardous if inhaled. The most dangerous of these gases is **carbon monoxide (CO).** Carbon monoxide is a by-product of burning hydrocarbon fuels. It is often present in garages and around heating equipment. It is colorless, odorless, and tasteless, so you cannot detect when it is present. When inhaled, carbon monoxide passes into the bloodstream and prevents red blood cells from carrying oxygen. As a result, the body suffocates from the lack of oxygen to the brain. Even small amounts of carbon monoxide can make you very ill. Adequate ventilation is necessary to prevent the buildup of dangerous carbon monoxide fumes. Also, carbon monoxide detectors should be installed in your work area. These devices are similar in appearance to smoke detectors and can be purchased at most hardware or discount stores. These detectors sound an alarm when a predetermined level of carbon monoxide is sensed in the air. They do not detect smoke and cannot be substituted for smoke detectors. Each type of device has its own function. Always follow these precautions when operating an engine:

- Never operate an engine in an enclosed area. Make sure that your workshop has proper ventilation. Use exhaust pipe extensions to direct the exhaust gases to the outside. OSHA can provide detailed information about ventilation safety requirements for buildings and work areas.
- When you are operating an engine (even if your shop is well ventilated), avoid breathing in the fumes.
- Never operate an engine too close to a residential building. Exhaust gases could seep in and jeopardize the well-being of those inside.

SAFE OPERATION OF EQUIPMENT

All motorcycles and ATVs have moving parts that can be potentially hazardous. The careless operation of these vehicles when they are in for service can cause serious injuries and damage your workshop and your tools. To avoid accidents, follow these safety guidelines:

- Read the manufacturer's instruction manual carefully before operating any unfamiliar equipment.
- Never start a vehicle unless the transmission has been shifted into neutral.
- Turn off the ignition system before you start working to prevent the engine from starting accidentally while you're working on it.
- Keep your hands, fingers, and sleeves clear of all hazardous moving parts.
- Keep visitors and customers (especially children) away from all risk areas and post appropriate signs to warn customers of hazards.
- Remember that the exhaust system gets very hot during operation. Keep your hands, feet, and loose clothing away from the exhaust components whenever the exhaust system is hot.

GOOD HOUSEKEEPING PRACTICES

Now that we've discussed some of the hazards that may be present in a motorcycle service department, let's look at some of the things that can be done to prevent accidents. One of the most important considerations of any accident prevention and safety program is good housekeeping. Good housekeeping is more than just cleaning up. Housekeeping is a reflection on your organization and your work habits. A neat, well-organized work area provides the environment for good inventory control of parts and materials. A tidy work environment provides the basis for proper waste disposal. Your neatness can prevent parts, tools, work records, and other important items from being lost in the clutter and thrown out with the trash. Finally, a neat work area is less likely to contribute to accidents. The following are some specific rules related to good housekeeping:

- Keep your workbenches and your work areas clean and organized at all times. You should clean your work area at least daily, preferably after each job is completed. If a job spans several days, clean up at the end of each day. Do not allow combustible debris such as paper, cardboard, string, or rags to accumulate on or

Figure 2-6 Always store flammable liquids in a cool, dry area away from ignition sources.

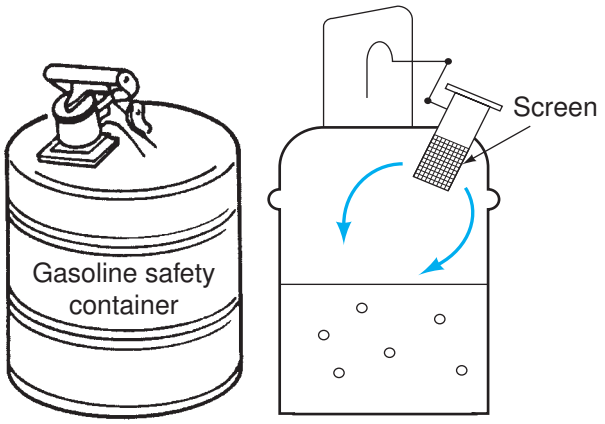

Figure 2-7 Flammable liquids should be stored in safety-approved containers. This gasoline container keeps the fumes from escaping while in storage.

under the bench. If you must use combustible materials or flammable liquids, use only the quantity needed to complete the task and immediately return the remainder to its proper storage area. Clean up any spilled materials from floors and benches immediately. Sweep the floors every day to eliminate the buildup of dirt, dust, and other litter.

- Store flammable liquids such as gasoline and solvents in approved safety cabinets and in cool, dry areas away from ignition sources (Figure 2-6). Avoid storing flammable liquids or other chemicals in direct sunlight, heat, or humidity. Ensure that the storage area is well ventilated to prevent the buildup of potentially explosive fumes. Check all storage areas frequently for rusted containers, corroded caps or lids, and leaking containers.
- Label all flammable liquids and other hazardous materials properly. If a substance is transferred from its original container, the second container must also be properly labeled. Use portable safety cans for transporting small quantities of flammable liquids (Figure 2-7). These cans are fire-resistant and have self-closing lids. Never leave cans of flammable liquids lying around when they are not in use.
- Small amounts of flammable liquids sometimes leak or spill from machines and equipment. Place drip pans under leaking engines and vehicles to prevent the floor from becoming slippery. Drip pans should be noncombustible and should be large enough to contain any anticipated spill. If a vehicle has a persistent leak, place an absorbent, noncombustible material in the pan to soak up the liquid. Empty the drip pans regularly and dispose of the oil-soaked compounds. Oil-soaked materials are *hazardous waste* that must be disposed of properly. Do not include hazardous waste with normal trash.
- Proper garbage disposal (Figure 2-8) is another important concern for motorcycle service departments. Discard dry combustibles on a regular basis and never allow them to accumulate. Place combustibles in metal containers with lids. Lids help to contain and snuff out any fire that might start inside of the

Figure 2-8 Place oily rags and other combustible waste in an approved container.

containers. When you empty the smaller containers, store the accumulated waste in a large metal refuse bin with a lid. These refuse bins should be located in a remote area away from heat sources.

- It is a good housekeeping practice to separate clean combustible wastes from dirty combustible wastes. Examples of dirty combustibles include papers, rags, and work clothes that are soaked with oil, grease, or solvents. These contaminated materials are more flammable than clean materials. Place all contaminated materials in separate metal containers with tight-fitting lids. Do you remember our earlier discussion in the fire safety section about spontaneous combustion? This is a good example of the use of a special discard container for disposing of contaminated material. Have oily rags and work clothes laundered by a professional industrial cleaning service. It is important to note that used liquids contaminated with dirt, grease, oils, solvents, or degreasers are classified as hazardous wastes and must be disposed of accordingly. Never empty such liquids into a sink or dump them on the ground. Federal, state, and local laws regulate the handling and disposal of hazardous wastes. Always follow authorized procedures when disposing of waste liquids.

HANDLING HEAVY OBJECTS AND MATERIALS

Material handling (moving materials from one place to another) is a concern for all occupations because this task has serious hazards associated with it. Every workplace requires some form of material handling. In a motorcycle service department, you may be required to remove or lift complete engine assemblies, packages of supplies, or pieces of equipment. Poor material-handling techniques and practices can lead to a variety of injuries including back injuries, twisted or sprained muscles and joints, hand injuries, and foot injuries. Improper material-handling procedures can also result in damaged equipment, tools, and facilities. Because they happen so frequently, back injuries are the most costly of all injuries in terms of medical costs and lost work time. Back injuries are often the result of poor material handling and improper lifting. Most back injuries occur when workers either do not know, or choose to ignore, the proper lifting techniques (Figure 2-9). Back injuries can also result from preexisting back problems that are worsened by lifting. Some workers know how to lift heavy items correctly but ignore proper techniques in order to get the job done faster. To prevent injuries, always use the following lifting techniques:

- Be sure that the weight of the load is not beyond your capacity to lift. Usually, loads of more than 50 pounds require the assistance of a second person.
- Check that the path of travel from pick-up to drop-off is clear of obstacles.

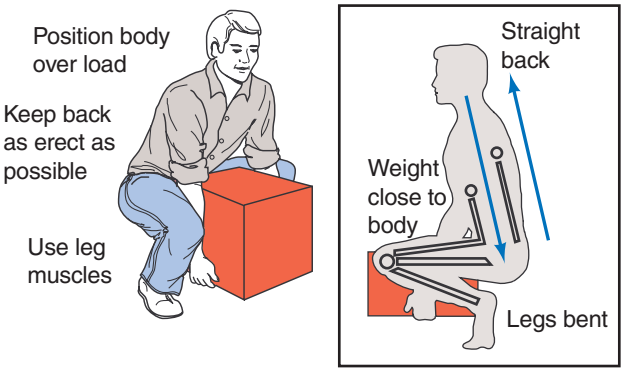

Figure 2-9 Always lift heavy loads using your leg muscles rather than your back muscles and get close to the object to make lifting easier.

- Get a good grip on the item to be lifted. If needed, wear gloves to improve your grip.
- Stand close to the load you are going to lift.
- Bend from the knees (squat) when lifting and setting down a load. Bending from the waist places more strain on the lower back.
- Lift with a smooth, controlled motion.
- Do not twist from the waist to place the load after lifting it. Instead, turn your entire body to set a load in place.
- Use caution when placing a load above chest height or below knee height. You put more strain on the lower back in those positions.

The following are some other suggestions to prevent back injury when lifting materials:

- Use hoists, hand trucks, carts, or dollies to lift or move heavy items. These lifting devices free you from heavy lifting and protect you from injury.
- Wear a back support belt to protect the back muscles.
- Always get help to move loads that are heavy or awkward in size or shape.
- Stretch your back and arm muscles before lifting. Stretching warms up the muscles and helps prevent muscle strains, pulls, and tears.
- Keep your back and stomach muscles in good shape. A lack of good muscle tone could contribute to a severe lifting-related injury.

USING PERSONAL PROTECTIVE EQUIPMENT (PPE)

To protect yourself from injuries in the workplace, use **personal protective equipment (PPE)** when appropriate. PPE includes items such as dust masks, safety glasses, gloves, and special footwear (Figure 2-10). Remember that any task can be hazardous, even if the equipment is operated properly and all safety procedures are followed. Always wear PPE wherever the potential for injury exists. The type of PPE you need varies depending on the tasks you perform.

Protecting Your Eyes and Face

Protective **safety glasses** and **goggles** (Figure 2-11) are available in a wide variety of styles to meet specific needs. Safety glasses with side shields

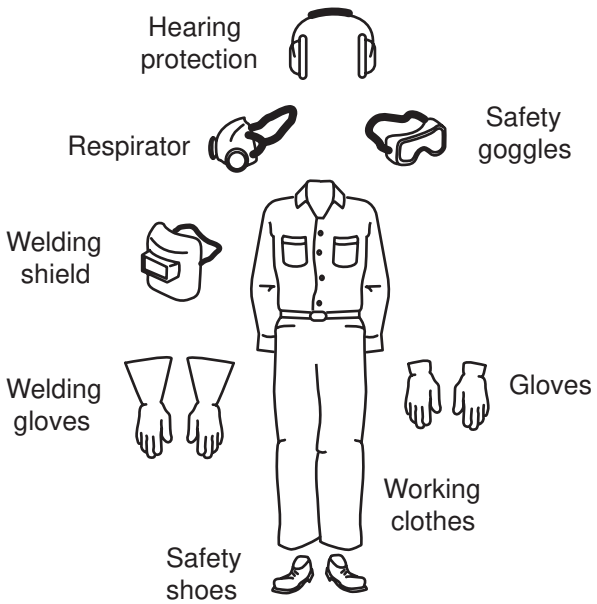

Figure 2-10 Always wear the appropriate personal protective equipment when working in a shop environment.

provide more protection from impact and flying particles. Most safety glasses and goggles may be worn alone or over a worker's own prescription eyeglasses.

Splash goggles protect the eyes from dust, particles, and chemicals. They may contain ventilation holes to provide air circulation. Welding glasses have tinted or darkened lenses to protect the eyes from the bright flashes of welding arcs. A face shield is a cap-like device that holds a clear plastic shield over the face. The face shield protects the entire face from chemical splashes and flying particles.

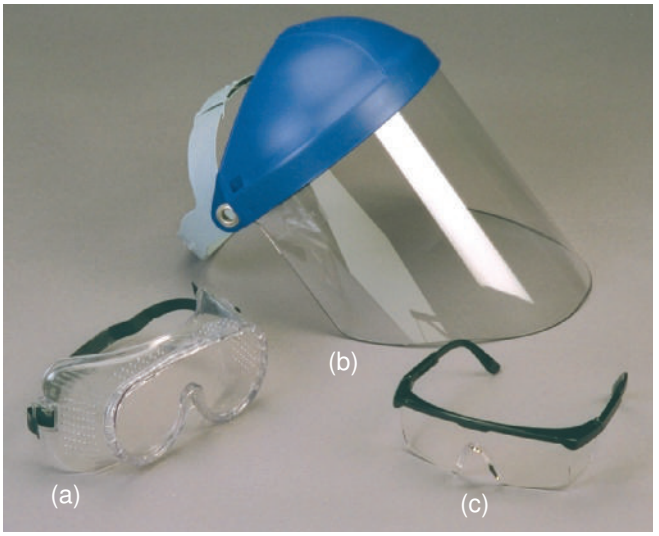

Figure 2-11 These eye protectors all have specific uses: (a) splash goggles, (b) face shield, and (c) safety glasses.

Figure 2-12 Eye-wash stations are available in properly equipped motorcycle service shops. If you need to use an eye-wash station, you should follow up with a visit to a doctor to ensure no permanent damage to the eyes has occurred.

Many people wear contact lenses as a replacement for glasses. Contact lens wearers must determine when it is appropriate for them to wear their contacts based on their working environment. Wearing contact lenses is not recommended if the workplace has significant amounts of flying dirt or dust particles, or if chemical fumes are present. Remember that the only function of contact lenses is to correct your vision. They do not provide any eye protection from dust, impact, or splashes. You must still wear eye protection devices such as goggles or face shields over your eyes whenever your activity warrants such protection.

Sometimes, even with the best safety practices, people somehow get foreign objects in their eyes. Many shops have eye-wash stations or safety showers (Figure 2-12) that should be used whenever you or someone else has been sprayed or splashed with a chemical such as battery acid, fuel, or cleaning solvent. Have someone contact a doctor and get immediate medical attention under these conditions as well.

Protecting Your Lungs

Respiratory-protection devices can prevent you from inhaling harmful dusts, gases, or vapors. Any employee whose work environment exposes them to chemical fumes, dust, or any other

Figure 2-13 Whenever there is a danger of breathing harmful fumes, always use a high-quality respiratory breathing protector.

irritants in the air should wear the appropriate respiratory protection. A typical dust mask is a small, fabric-like filter with straps that slip over the face to cover the nose and mouth. Dust masks are designed to shield the mouth and nose from dust particles. They do not filter out vapors, fumes, or gases.

Respirators (Figure 2-13) are more substantial devices than masks. Firefighters use a form of respirator device when they are called upon to enter a burning building. Respirators are made of heavy plastic, metal, and safety glass. The firefighter's version is nonflammable and insulates the user from the high temperatures of a fire. All respirators have their own oxygen supply. Because the person using the respirator does not breathe any of the smoke, fumes, vapors, or toxic gases that might be present in the air, the respirator provides the best respiratory protection available.

Protecting Your Hearing

Question: How can you tell that you are in a high-noise area without using a sound-level meter? If another worker is standing three feet away and you cannot have a conversation unless you shout, the work area is too noisy. Hearing protection should always be worn in areas with a high noise level. If you work eight hours a day in a high-noise environment without wearing hearing protection, you will most likely experience a hearing loss over a period of years. If the noise level is extreme, you

Figure 2-14 Protect yourself from permanent hearing damage from excessive noise by using high-quality headsets when you are working in high noise areas.

Figure 2-15 A typical pair of disposable earplugs with a small storage container is shown here. In a motorcycle shop environment these may be all that is needed to help protect your hearing in most cases.

may suffer a hearing loss more quickly. You should always wear **earplugs** or a **headset** (Figure 2-14) in noisy areas or when using noisy tools.

Remember, there is no cure for noise-induced hearing loss. The prevention of excessive noise exposure is the only way to avoid hearing damage. Some earplugs are disposable (Figure 2-15), meant to be used once and thrown away. Others are intended to be cleaned and used repeatedly. A professional hearing specialist should individually fit preformed or molded plugs.

Proper Work Attire

When working in a shop atmosphere, remove bracelets, necklaces, watches, and other jewelry. These can be caught in drive systems or possibly cause electrical shock if placed across an electric circuit. To maintain a professional appearance, many shops have uniforms for their employees to wear when at work. These uniforms will include long pants and button-up shirts. Never wear shorts while working in a service shop as there will be no protection to your legs from hot surfaces such as an exhaust system.

Protecting Your Feet and Legs

Foot injuries are associated with material handling. These injuries usually occur when heavy materials or tools are dropped. To prevent foot injuries, it is a good idea to wear steel-toed safety shoes or boots. Various types of steel-toed safety shoes are available to provide different levels of protection. You can also attach **metatarsal guards** (special covers that go over the instep of boots) to your shoes to protect your feet. Open-toed shoes or sneakers are not considered appropriate footwear.

Protecting Your Hands and Arms

Gloves, gauntlets, and sleeves protect the arms and hands from chemical splashes, heat, cuts, and tool-related injuries. In addition to standard leather and heavy-cotton construction, work gloves are also made from a variety of plastics and rubbers for use when working with solvents (Figure 2-16). Special gloves may also be designed to resist tears, cuts, and punctures. Gloves come in a variety of lengths to cover the hand, wrist, elbow, or entire arm, depending on the requirements of the job.

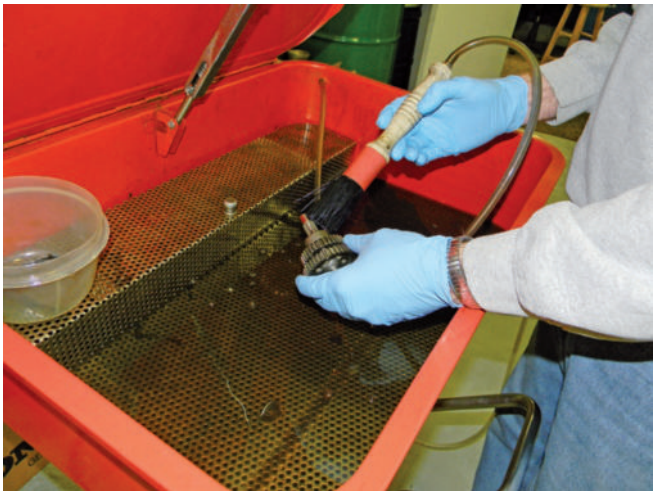

Figure 2-16 Rubber gloves will protect your hands when working with cleaning solvents.

USING TOOLS SAFELY

According to the **National Safety Council (NSC),** more than 500,000 disabling, work-related finger and hand injuries occurred in a recent one-year period. The careless use of simple hand tools such as screwdrivers, wrenches, and hammers was the cause of many of these injuries. The most common hand and finger injuries are impact injuries (bruises, sprains, and broken bones), cuts, and puncture wounds caused by the improper use of hand tools. Improper use means using the wrong tool for the job, holding or using the tool incorrectly, or using a damaged tool.

Using Hand Tools Safely

Motorcycle technicians use dozens of different hand tools daily. By giving your tools proper care, you will extend their useful life and also lessen the possibility of accidents and injuries. To keep your tools in top working condition and to prevent injuries to yourself and your fellow workers, observe the following safety precautions:

- Always use the right tool for a job. Do not try to substitute one tool for another.
- Inspect hand tools often for defects. If you find a defective tool, repair it or replace it.
- When using a tool, comply with the manufacturer's instructions. Follow the instructions for the tool's use and maintenance.
- Never toss a tool to someone. Hand tools should be passed from one person to another by hand.
- Keep all tools clean. Protect the tools from corrosion. Wipe them clean when you are finished using them. Lubricate all tools with moving parts to prevent wear and binding. Store tools in a dry and secure location.
- Keep the cutting edges on tools sharp. Sharp tools perform better and they save time.

Using Power Tools Safely

Power tools also have certain additional hazards associated with them. Common power tools that are used by a motorcycle technician include drills, power impact wrenches, and grinders. Electric power tools have three properties that contribute to their potential danger: electrical charge, high-speed movement, and momentum. The most important area of concern when using power tools is the electrical charge. To avoid an electrical shock when using an electric power tool, you must isolate and insulate yourself from the electric current by observing the following guidelines:

- Make sure that all electric power tools are properly grounded.
- Inspect electric power tools often for defective wiring. Visually inspect all power cords, plugs, and receptacles. Have qualified electricians replace all defective cords and plugs.
- Always unplug tools before replacing bits, blades, or grinder wheels.
- Never operate an electric power tool in a wet or damp area.
- Wear gloves to protect yourself from shocks. If you ever feel a shock or tingle when using a power tool, stop using it immediately.
- Use only extension cords that are rated to carry the current required by the power tool. An undersized extension cord can cause damage to the tool and can be a fire hazard if it overheats because of electrical overloads.

High-Speed Movement

High-speed movement is another area of concern when operating electric and air power tools. Avoid contact with any rotating tool parts because they could grab your hands, hair, or clothing. Keep all safety guards in their proper positions when operating power tools such as grinders and drills. When drilling metal, remember that friction from the high speed produces sharp, hot shavings that could cut or burn you. Also, note that if a drill becomes jammed in a piece of material, the momentum of its moving parts may cause it to spin out of control. To avoid being injured by a tool's momentum, remember the following guidelines:

- Hold all tools firmly. Pay attention to any sounds that may indicate that a tool is about to jam.
- Use only sharp cutting bits. A dull bit will frequently jam.

- Clamp or block all work pieces tightly to a firm work surface. Do not use your hands to hold the materials in position.
- Wear the appropriate personal protective equipment when operating power tools.
- Check tools for potential mechanical failure. For example, check for broken drill bits. In addition, check for faulty triggers and control switches that could cause unexpected start-ups and stops. Make sure the tools have all their guards in place.

SAFE RIDING PRACTICES

As a contributor to safe vehicle operating conditions, it is the motorcycle service technician's responsibility to verify that the set-up of each motorcycle and ATV is correct.

Each motorcycle manufacturer promotes riding safety by delivering a high-quality product. Quality ensures that the motorcycle or ATV has been designed with the rider's safety in mind. The motorcycle technician should always set up and service all vehicles with the same safety focus that the manufacturers used initially. Don't let a vehicle go out of the shop that you wouldn't be confident of riding yourself.

One of the most important elements of riding safety is the awareness and practice of safe riding habits. Riding safety also requires the proper riding apparel and a properly maintained and serviced motorcycle or ATV.

The clothing that you wear while riding a motorcycle or ATV should provide visibility and protection. Leather jackets provide the best protection for your upper body. Denim provides some protection for your legs, but leather provides the best protection. Leather chaps worn over denim provide excellent protection for your legs. You should also wear sturdy footwear and gloves. A helmet and proper eye protection are the most important elements of riding apparel. Your helmet should fit securely and you should fasten the chinstrap snugly. No matter how experienced you are as a rider, an accident could happen at any time—while you're riding for pleasure, or while you are test-riding a motorcycle or ATV in the parking lot. Proper riding apparel does not guarantee that you will be accident-free, but it will decrease the chances of serious or fatal injuries.

A good riding attitude is based on your understanding that a motorcycle or ATV is more vulnerable on the road or on the trail than a car or four-wheel-drive truck. Because motorcycles and ATVs are low-visibility vehicles and weigh less than nearly any other vehicle, the motorcyclist should be prepared to yield in all situations. Most car and truck operators have no real appreciation of how vulnerable motorcycles can be. They do not realize that stopping distances are different or that motorcycles are less stable on gravel surfaces. Their ignorance can get the motorcycle rider in serious trouble. Always remember that fact, and ride accordingly. Always keep the odds on your side through proper vehicle maintenance and safe riding habits. You can contact the **Motorcycle Safety Foundation (MSF)** at 800-446-9227 or view their site online at www.msf-usa.org. Also, any motorcycle dealer will have further information on learning how to ride safely.

Summary

- It is very important to understand the importance of safety and accident prevention in a motorcycle shop environment.
- You should know the basic principles of personal safety.
- There are procedures and precautions for safety when using tools and equipment.
- You must maintain a safe working area in a service shop environment.
- There are laws concerning hazardous wastes and materials including right-to-know laws.
- You have rights as an employee and/or student to have a safe place to work.

Chapter 2 Review Questions

1. List the three elements of the fire triangle.
2. True or False? A Class B fire involves live electrical equipment.
3. Name the federal agency that publishes and enforces safety standards for business and industry.
4. What are some of the key safety areas of primary concern in a motorcycle service department?
5. What type of fire is created by a chemical reaction with combustible materials?
6. Safety is an ___ that helps you prevent injuries to yourself and others.
7. What are two types of electrical power sources?
8. The letters PASS are used as a fire safety acronym. What do they stand for?
9. To prevent foot injuries, it is a good idea to wear what type of shoes?
10. When an engine is running, it creates exhaust gases that are hazardous if inhaled. Name the most dangerous of these gases.

CHAPTER 3 Tools

Learning Objectives

When you have completed the study of this chapter and its laboratory activities, you should be able to:

- Identify common hand, power, and special tools
- Know how to select the correct tool for a repair
- Understand advantages and disadvantages of various types of tools
- Identify and select the right measuring tool for different jobs
- Understand the importance of having an up-to-date service library

Key Terms

Adjustable (or crescent) wrenches
Air ratchet
Allen wrench
Angled or remote screwdrivers
Aviation snips
Ball peen hammer
Basic hand tools
Beam-type torque wrench
Bench grinder
Bench vise
Box-end wrenches
Breaker bar
C-clamps
Center punches
Chisels
Clamps
Click-type torque wrench
Combination and rib-joint pliers
Combination wrenches
Compression gauge
Cutting pliers
Dead blow hammers
Dealer Management System
Deep sockets
Dial indicator
Drill
Drill bit
Drill press
Engine control module (ECM)
Exhaust gas analyzer
Feeler gauges
Files
Flare-nut or line wrench
Flat chisel
Flat (or slot) tips
Flex handles
Fuel injection (FI)
Hacksaws
Hammers
Hex wrench
Hose clamp pliers
Impact screwdrivers
Locking or vise grip pliers
Mallet or soft-faced hammer
Metric
Micrometers
Multimeter

Needle-nose pliers
Offset screwdrivers
On-board diagnostics (OBD-II)
Open-end wrenches
Phillips screwdriver tips
Pin and straight shank punches
Plastic-faced hammers
Pliers
Power impact wrenches
Pozidrive tips
Precision measuring tools
Pullers
Punches
Rechargeable cordless drills
Reed & Prince tips
Retaining-ring pliers
Rubber hammers
SAE (Society of Automotive Engineers)
Screwdriver
Screw extractor
Service manuals
Sliding t-handles
Snips or shears
Socket wrenches
Specification manuals
Speed handles
Standard wrench
Starting or aligning punches
Stubby screwdrivers
Taps and dies
Test light
Timing light
Toolbox
Torque
Torque wrenches
Torx tips
Torx wrench
Vernier caliper
Vises
Wire stripper/crimper pliers
Wrenches

INTRODUCTION

Motorcycle and ATV technicians use virtually hundreds of different tools to perform a wide variety of repair activities. In addition to the standard hand and power tools that you are already familiar with, there are specialized and precision repair tools that will probably be new to you. The assortment of tools that you will use depends primarily on the types of vehicles you will encounter and the specific systems that you will be responsible for. As an example, if you specialize in electrical systems, you will need different tools than someone who specializes in internal engine repairs.

Skilled professionals, no matter what their trade or field, know how to use tools correctly and safely. Knowing exactly which tools to use for each task is essential for completing quality repair jobs quickly, safely, and efficiently. When you gain experience in the motorcycle and ATV repair field, you will acquire the skills to do jobs faster and more efficiently. A large part of this skills development will focus on your ability to use the tools of the trade correctly.

Motorcycle and ATV repair tools can be divided into the following groups:

- Basic hand tools
- Power tools
- Special tools

It would be virtually impossible for us to discuss every type of motorcycle and ATV repair tool in this chapter. For this reason, we will limit our discussion to the tools that you will use most often. You have probably used many of the standard hand tools that we will cover. But you may be totally unfamiliar with some of the specialized tools and measuring and testing instruments that we are going to introduce you to. We suggest that you take your time as you read about the various tools and instruments and familiarize yourself with their use.

BASIC HAND TOOLS

Basic hand tools are the common tools that are found in just about every workshop toolbox. Some of these basic hand tools include screwdrivers, hammers, pliers, wrenches, and socket sets. Because of the frequency of the use of these tools, most motorcycle repair technicians own a complete set of hand tools similar to the example shown in Figure 3-1. Most of the basic hand tools are undoubtedly familiar to you.

You have probably used them and may even own many of them. To be sure that you understand the proper use of these tools, we will take a brief look at each of them. Let us begin with the most commonly used hand tool, the wrench. The largest portion of your current tool collection probably consists of different types of wrenches.

Wrenches

Wrenches are used to tighten or loosen nut-and-bolt types of fasteners. As you probably know, wrenches come in a variety of sizes from very small to very large. The size of a wrench is determined by the width of the opening at the end of the wrench (Figure 3-2).

Metric and **SAE (Society of Automotive Engineers)** are the general classifications of the wrenches found in a motorcycle technician's toolbox. Metric wrenches are measured in millimeters, such as 10 mm, 11 mm, and 12 mm. SAE wrenches are measured in fractions of an inch, such as 1/2 inch, 9/16 inch, and 5/8 inch. As a rule of thumb, American-made motorcycles require SAE tools, and foreign-made (primarily Japanese) motorcycles require metric tools. More information on different measuring systems will be discussed in a later chapter of this textbook.

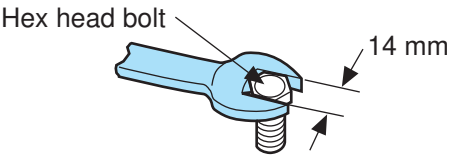

Figure 3-2 The size of a wrench is determined by the width of the opening at the end of the wrench.

- Wrenches are forged from strong, tempered steel. Each wrench size is designed to fit one particular-sized fastener. A common mistake when using wrenches is to use the wrong size (where the wrench "almost" fits). Using the wrong-size wrench can in many cases damage the fastener. It could also damage the wrench. In addition to varying sizes, wrenches are also available in different styles (Figures 3-3 and 3-4). The six most common styles are the following:
- Open-end wrench
- Box-end wrench
- Combination wrench
- Adjustable wrench
- Socket wrench
- Allen and Torx wrenches

Figure 3-1 This illustration shows a typical set of hand tools that a motorcycle technician would own. This assortment of tools could be used for many different applications and is not limited to motorcycle repair.

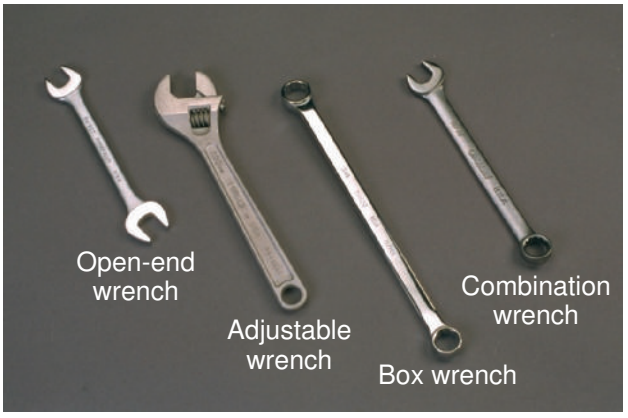

Figure 3-3 This illustration shows four different styles of wrenches.