

# USDA Forest Service National Sawyer Training: Developing Thinking Sawyers



## Student Guide: Prework

**USDA Forest Service National Sawyer Training:  
Developing Thinking Sawyers**  
Module 2.1: Chain Saw Basics, Maintenance, and Operation

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**Module 2.1: Chain Saw Basics, Maintenance, and Operation**

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## Module 2.1: Chain Saw Basics, Maintenance, and Operation

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### Module 2.1: Chain Saw Basics, Maintenance, and Operation

#### Overview

Module 2.1 covers how chain saws work, their components, how they operate, and the correct way to fuel and start a chain saw. This prework packet introduces chain saws and chain saw maintenance. The instructor will explain chain saw operation during class and will provide you time to practice what you've learned.

#### Prework Topics

- Chain Saw Basics
- Chain Saw Operations
- Chain Saw Maintenance
- Fueling a Chain Saw
- Starting Procedures
- Required Equipment
- Troubleshooting

#### Objectives

When you complete the full module during training, you will be able to:

- Identify the parts of a chain saw.
- Perform a five-point safety check.
- Discuss fueling safety procedures.
- Start a chain saw.
- Describe reactive forces.
- List the guidelines for transporting a chain saw.

#### Chain Saw Basics

##### Selecting a Chain Saw

Many different types of power saws are available on the market today, including gas-powered carbureted, gas-powered computer-tuned, and battery-powered. When selecting the right tool for the job, you should also consider powerhead size, bar length, your skill level, and the specific task at hand.

Personal fitness and strength are other considerations; these factors can dramatically affect your ability to handle, hold, and manipulate a chain saw. Bigger is not always better. Over time, handling even a 12-pound chain saw can become physically challenging. As fatigue sets in, your risk of injury greatly increases.

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## Module 2.1: Chain Saw Basics, Maintenance, and Operation

### Chain Saw Components

When you first purchase or receive a chain saw, become familiar with the make and model and the location of the components (figures 2.1.1 and 2.1.2).

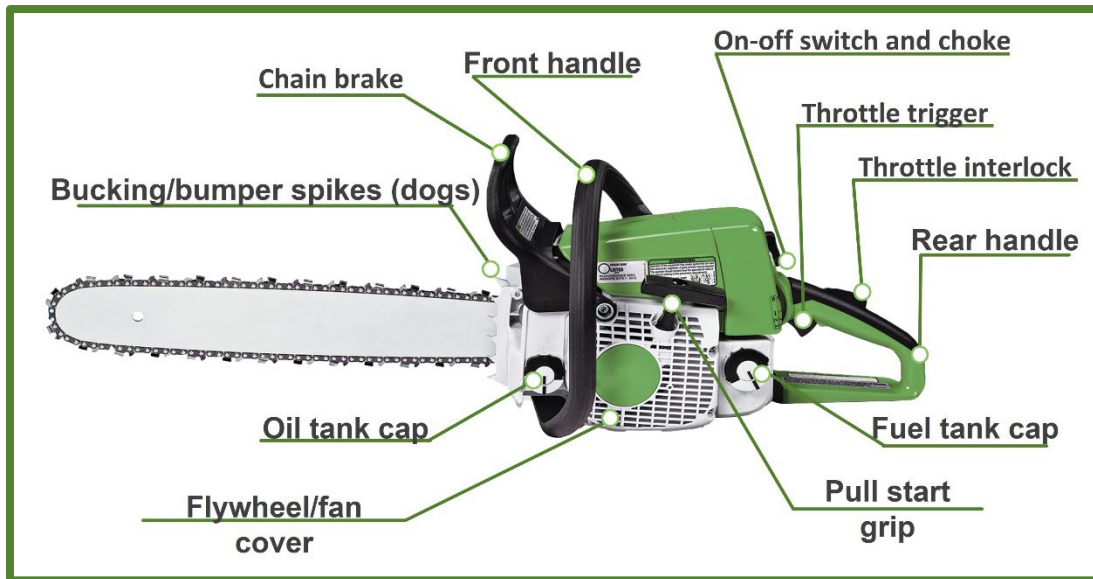


Figure 2.1.1—Chain saw components.

- **Bucking/bumper spikes (dogs):** Used to help hold the saw steady against wood.
- **Chain brake:** Stops the chain's motion.
- **Front handle:** Used to hold and balance the saw.
- **On/off switch:** Turns the saw on and off.
- **Throttle trigger:** Controls the speed of the engine.
- **Throttle interlock:** Prevents the throttle from engaging unless the interlock is depressed on the handle.
- **Rear handle:** Used to hold the saw.
- **Fuel tank cap:** Provides access to the fuel tank and seals the tank to prevent spillage.
- **Pull-start grip:** A rubber or plastic handle attached to the starter pull rope.
- **Flywheel cover:** Covers the flywheel and holds the recoil starter.
- **Oil tank cap:** Provides access to the oil tank and seals the tank to prevent spillage.

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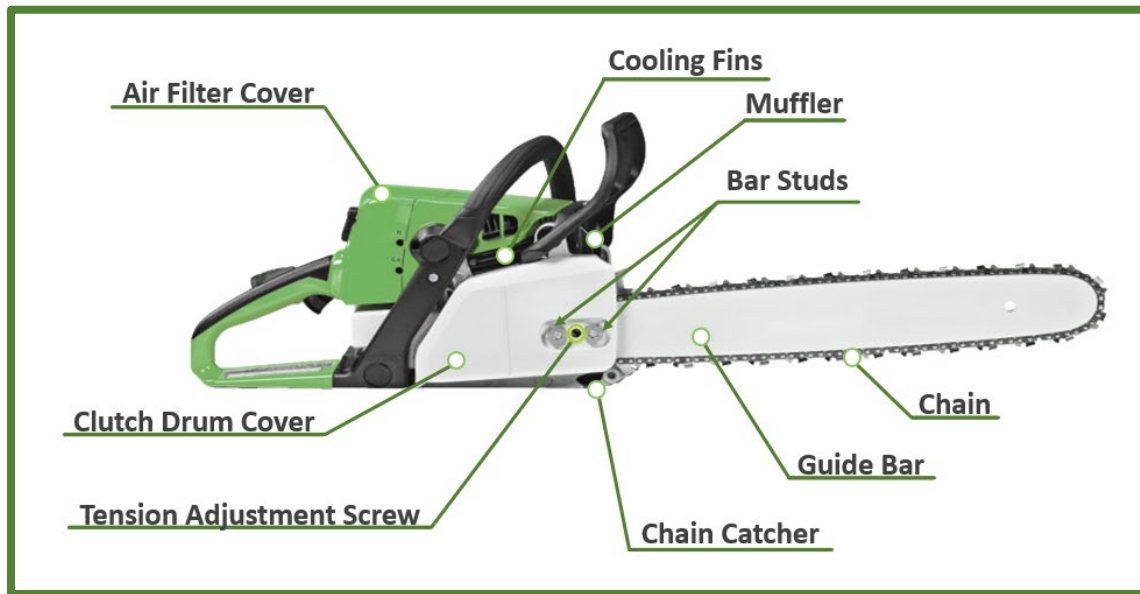


Figure 2.1.2—Chain saw components, continued.

- **Air filter cover:** Stops dirt, dust, and sawdust from entering the air filter, thereby protecting the carburetor.
- **Cooling fins:** Provides cooling to the motor cylinder.
- **Muffler:** Reduces exhaust noise.
- **Bar studs:** Hold the bar in place.
- **Chain catcher:** Prevents the chain from contacting the sawyer in the event of a broken or thrown chain.
- **Tension adjustment screw:** Moves the guide bar to maintain proper tension on the saw chain.
- **Clutch drum cover:** Covers the sprocket and clutch.
- **Clutch drum (under the cover):** Couples the engine to the chain sprocket when you accelerate the engine above idle speed.

### Not Shown

- **Chain sprocket:** The toothed wheel that drives the saw chain. Sprockets come in different styles and sizes (e.g., rim sprocket, spur sprocket).
- **Oiler adjustment screw:** Adjusts the amount of oil dispensed to the bar and chain.
- **Choke:** Used for starting a cold saw.
- **Fuel filter:** Prevents dirt and other contaminants from entering the saw's carburetor.
- **Spark plug:** Ignites fuel in the cylinder.
- **Decompression valve:** Reduces pressure in the cylinder head to enable easier starting.
- **Directional marks (gunning sights):** Used for aiming the undercut and backcut.



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### Guide Bars

Guide bars (figure 2.1.3) come in a variety of sizes. You must select the proper-sized bar for the powerhead and the job. Let's first become familiar with the types of guide bars.

#### Types of Guide Bars

- **Roller tip:** The bar tip has a roller sprocket for reduced friction and wear.
- **Lightweight:** These bars have aluminum inserts that reduce some weight. The weight difference is most noticeable on longer bars (note that the inserts can make these bars less rigid).



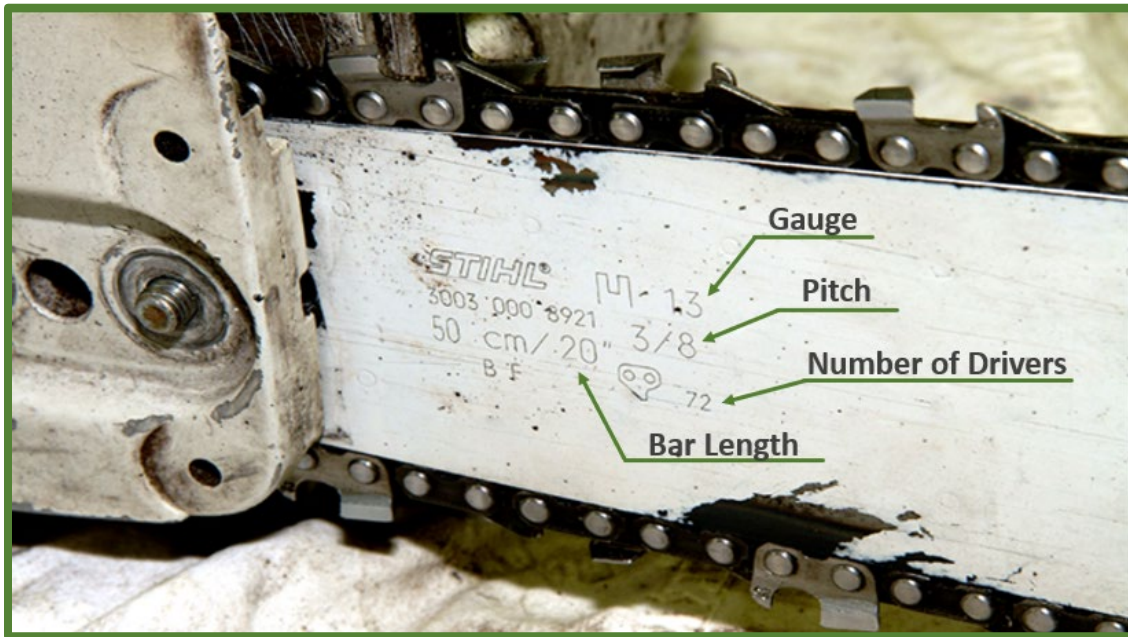
**Figure 2.1.3—Guide bar types.**

#### Guide Bar Markings

Not all chains fit every bar. Not all bars fit every chain saw. You should understand and use the right bar and chain combinations. It is important that the **gauge and pitch** of the saw chain, guide bar, and sprocket all match. Figure 2.1.4 provides an example of guide bar markings.

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**Figure 2.1.4—Guide bar markings.**

### Markings

Guide bar markings include:

- **Gauge:** A measurement of the thickness of the drive link. It corresponds to the groove in the bar.
  - The bar gauge and chain gauge must match. The most common gauges are .050-inch, .058-inch, and .063-inch.
- **Pitch:** A measurement between rivets.
  - To determine pitch, measure the distance between three rivets and divide by 2.
  - The most common pitches are .325-inch,  $\frac{3}{8}$ -inch, and .404-inch.
  - The pitch of the drive sprocket must match the pitch of the bar nose sprocket.
- **Number of drivers:** The length of the bar dictates the number of drivers necessary on a chain.
- **Bar Length:** Indicates the length of the bar.

### Owner's Manual

The chain saw owner's manual is a critical document that every chain saw operator must be familiar with. **Do not throw it away.**

The document contains important information that is unique to each chain saw, such as:

- Assembly
- Fuel handling
- Maintenance intervals

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- Parts and controls
- Safety precautions
- Starting and stopping procedures
- Technical data

### Chain Saw Operations

#### Five-Point Safety Check

Safety is paramount when operating any power tool, but especially when operating a chain saw. A simple five-point inspection of your chain saw ensures that all parts are in working order and will help prevent injury during use (figure 2.1.5).

The five inspection points for the safety check are:

1. Activate the chain brake to ensure that it locks and unlocks the chain properly.
2. Squeeze the trigger to ensure it is locked. Squeeze the trigger again while pressing the interlock to ensure it unlocks.
3. Confirm the chain catch pin is present.
4. Check that the antivibration system and fasteners are tight.
5. Check that the spark arrester screen is present.

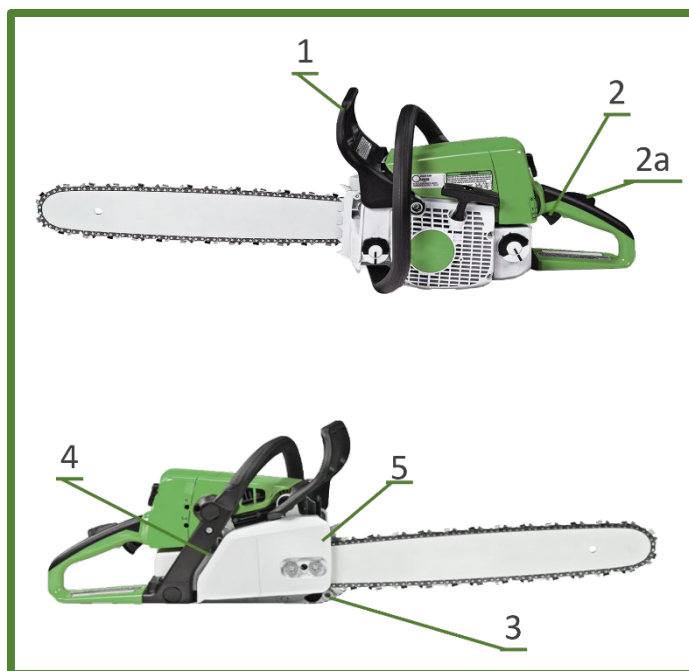


Figure 2.1.5—Five-point safety check.

### Chain Saw Maintenance

#### Maintenance

A properly maintained saw improves performance, reduces downtime, requires less effort to operate, reduces fatigue, and minimizes operator risk.

The goal is not to create chain saw mechanics but to educate you on basic daily saw maintenance to keep your saw performing safely and as designed.

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There are three major systems on a chain saw that you must maintain:

- **Safety system:** includes the chain brake, chain catcher, throttle interlock, antivibration system, and handlebars.
- **Powerhead system:** includes the air filter, carburetor, fuel tank, fuel filter, spark arrester, spark plug, fan housing, flywheel fins, cylinder cooling fins, and decompression valve.
- **Bar and chain system:** includes the guide bar, oilway, and chain tensioner, adjusting oil flow, chain components, rim, and drum.

You should do a daily visual inspection of these various components on the saw to reduce downtime:

- Remove, clean, and replace the air filter.
- Remove the bar and chain.
  - Inspect the chain.
  - Clean the bar channel groove, oil ports, bar sprocket, and drive sprocket.
  - Properly engage and disengage the chain brake.

Maintaining a sharp chain is critically important and will help improve your safety, reduce physical fatigue, and lessen the wear of the bar and powerhead. Pay attention to the amount of sawdust you generate; this is a great indicator of a dull chain (sawdust) or a sharp chain (woodchips).

### Transporting Basics

Basic guidelines for transporting a chain saw and fuel include:

- Never transport a chain saw or fuel in the passenger compartment or in an enclosed vehicle.
- Cover the bar with a sheath during transport to prevent damage to the saw cutter tooth or other property.
- When you transport a chain saw over your shoulder, you must use a sheath that covers the bumper spikes (dogs) and muffler. This will greatly decrease the risk of serious physical harm. A sturdy shoulder pad is also recommended.
- When transporting by aircraft or watercraft, follow the aircraft personnel or pilot's instructions.
- When transporting by pack stock, follow the packer's instructions.

### Fueling a Chain Saw

Chain saws are two-cycle motors that require a fuel-oil mixture, most often mixed at a 50-to-1 ratio (50 parts gas to 1 part two-cycle oil). Follow the manufacturer's recommendations, as they may vary.

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### Mixing Fuel

To mix fuel for a chain saw:

1. Add the correct amount of two-cycle engine oil to the fuel container.
2. Add the correct amount of gasoline to the fuel container to obtain the correct fuel-to-oil ratio.
3. Cap the fuel container and shake the mixture for 20 to 30 seconds to ensure proper blending.

#### Notes:

- Use the fuel-oil mixture within 30 days of mixing.
- Commercially produced, premixed fuel may also be available and has a longer shelf life. Refer to manufacturer guidance on shelf life.

You should always fuel the chain saw on bare ground and at least 20 feet from any ignition source. Allow the chain saw to cool before refueling.

### Fueling a Chain Saw

To fuel a chain saw:

1. Wipe away accumulated sawdust and dirt from the gas and oil filler caps.
2. After filling, replace the fuel cap and wipe up any spillage.
3. Remove the oil cap and fill with bar oil.
4. Replace the oil cap and wipe up spillage.
5. Move at least 10 feet away from the fill site before you start the chain saw.

While the order you use to refill the fuel and oil tanks on your saw is not critical, make it a habit of performing the task the same way each time to prevent filling the tank with the wrong fluid.

### Fuel Geysers

#### What is a fuel geysers?

A **fuel geysers** is the forceful expulsion of liquid and vapor fuel from the fuel tank caused by the rapid depressurization of the tank (figure 2.1.6). Heat and agitation cause the pressure increase. A delayed fuel geysers can occur after opening the fuel container.

#### What do I need to know to protect myself?

Fuel geysers can occur anytime fuel, heat, and pressure combine in fuel transport containers or small, gasoline-powered engines, such as chain saws, leaf blowers, and portable pumps.

Fuel geysers have resulted in injury when sprayed fuel and vapor have ignited.



Figure 2.1.6—Fuel geysers warning poster.

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Along with the fueling procedures listed above, take the following precautions when fuel, heat, and pressure are present (these steps may prevent significant burns in the event of fuel spray):

- Always assume fuel tanks and fuel containers are pressurized.
- Always check fuel levels before opening the fuel tank or filler cap; more than half a tank may geysers.
- Cover the cap with a rag to contain potential fuel geysers.
- Be extra vigilant when equipment is running poorly and the fuel level is above half a tank.
- Do not use fuel older than 1 month.

If the equipment is running poorly or you suspect vapor lock:

- Do not open the fuel cap. Relieving the pressure does not alleviate a **vapor lock**.
- Check the fuel level through the tank or use the bar oil level to gauge the fuel level.
- If the fuel level is more than half full, **do not** open the tank.
- Allow the equipment to thoroughly cool. This could take 45 minutes or more.
- Restart the equipment when it is cool.

It's **your** job to protect yourself and others. Know how to handle your equipment to avoid fuel geysers anytime fuel, heat, and pressure are present.

### Starting Procedures

Before you try to start a chain saw for the first time, it is important to understand its basic components and how they work. It is also important to understand the engineered safety features of the saw you are handling. Take extra care each time you start a chain saw: in order to do so, you must release one hand to pull the starter cord, which compromises your grip and some of the control that two-handed operation normally provides.

Consult your owner's manual for the correct choke and switch settings for your saw.

### General Guidelines

**Note:** Consult your owner's manual for the correct starting/stopping procedure for the make and model of your chain saw.

The following factors remain true no matter which of the three methods you use to start a chain saw:

- Wear all required PPE.
- **Always engage the chain brake** before attempting to start a chain saw.
- **Never drop start** a chain saw.
- Maintain a firm grip.
- Engage the choke when starting a cold saw.



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- Pull the starter handle with your right hand and pull out the starter cord slowly until you feel resistance (as the starter pawls engage), then pull firmly and rapidly until the engine starts.
- Once the saw **pops**, open the choke.
- Give the starter rope short, brisk pulls until the saw starts.

### Ways to Support the Chain Saw

The three acceptable methods for supporting a chain saw when starting it are on the ground, between your legs, or firmly supported by a stump, log, or branch.

On the ground (figure 2.1.7):

1. **Set the chain brake.**
2. Place the saw on firm ground in an open area.
3. Grip the front handlebar firmly.
4. Place the toe of your right foot into the rear handle or place your knee on top of the powerhead.
5. Give the starter rope a firm, brisk pull.



**Figure 2.1.7—Starting a chain saw on the ground.**

Between the legs (figure 2.1.8):

1. **Set the chain brake.**
2. Place your left hand on the front handlebar.
3. Place the upper portion of the rear handlebar at the back of your right leg. Move your left leg over to firmly hold the saw against your right leg.
4. Give the starter rope a firm, brisk pull with your right hand.



**Figure 2.1.8—Starting a chain saw between the legs.**

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Firmly supported by a stump, log, or branch (figure 2.1.9):

1. **Set the chain brake.**
2. Place the bar of the saw over the available wood support.
3. Grip the rear handlebar.
4. Give the starter rope a firm, brisk pull.



**Figure 2.1.9—Starting a chain saw supported by a log.**

### Required Equipment

When operating a chain saw, required equipment includes:

- A chain saw bar wrench
- A chain file
- An approved safety container for chain saw fuel and bar oil
- Proper wedges for the specific sawing project or activity
- A 3- to 5-pound single-bit ax (minimum handle length 20 inches) or a commercially made pounder
- A bar cover that adequately covers the chain and bumper spikes (dogs) when you carry the chain saw on your shoulder or a cover that is adequate for carrying the chain saw at your side

### Recommended extra equipment:

- Spare sprocket
- Extra chain
- Spare spark plug
- Filing guide
- Raker file/depth gauge file
- E-clip/sprocket retaining clip
- Bearings and bearing grease
- Extra bar nuts
- Various nut drivers
- Tuning screwdriver



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- Extra pull cord
- Tachometer
- Bar groove cleaning tool

### Ax Selection

An ax is a required tool for chain saw operations. It is invaluable when properly selected and maintained (figure 2.1.10). Choose a single-bit ax head weighing 3 to 5 pounds and select a handle based on your height (table 2.1.1).

### Selecting an Ax for Chain Saw Operations

Table 2.1.1—Height-to-handle ratio

Person's height	Appropriate handle length
5'5"	27"
5'7"	29"
5'9"	30"
5'11"	31"
6'1"	32"
6'8"	36"



Figure 2.1.10—Selecting an ax.

### Ax Uses in Chain Saw Operations:

- **Driving wedges:** A properly sized handle is an important consideration (see module 4, “Ax Basics, Maintenance, and Use” for more information about selecting a proper ax). A handle that fits the user properly allows for the most force and accuracy when swinging the ax. Too long a handle can make an accurate swing difficult, while too short a handle limits the driving force.
- **Removing bark:** A sharp and properly shaped ax can facilitate bark removal, in some cases more safely and faster than a chain saw, while also generating less bark dust (see module 4 for information about sharpening and shaping an ax).
- **Removing limbs:** You can remove small, brittle limbs with the pole of an ax. Larger limbs may only take a few blows from an ax used correctly.
- **Freeing a pinched bar:** Another chain saw may not be available to cut out a stuck saw. A sharp ax enables a sawyer to chop out the bar. **Note:** Be sure to remove the chain saw power head before chopping with the ax.

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**Troubleshooting**

Refer to table 2.1.2 for information about troubleshooting chain saw issues. **Remember to always consult the owner’s manual**—not all makes and models are the same.

**Table 2.1.2—Troubleshooting guide**

<b>Problem</b>	<b>Possible cause</b>	<b>Remedy</b>
<b>Saw won’t start</b>	Empty fuel tank	Without opening it, visually inspect the fuel tank. If it is empty, carefully remove the cap and fill the tank with fuel.
	Throttle control in wrong position	Inspect the throttle control lever to verify it’s in the correct position.
	Spark plug fouled	Remove, clean, and regap or replace the spark plug.
<b>Saw won’t start and a strong fuel smell is present</b>	Flooded condition	Depress fully and hold the throttle trigger. Pull the starter cord five to six times to clear excess fuel. Attempt a normal start. If the saw still won’t start, remove the air filter cover and repeat the process. <b>Note:</b> This process will not work on saws with computer-controlled carburetors (M-tronic, Auto-tune).
<b>Saw won’t continue running</b>	Water or dirt in fuel	Clean or replace the fuel filter and/or drain the tank if necessary.
	Fuel intake line kinked or partially plugged	Clean or untwist the fuel line and replace it if necessary.
	Dirty air filter	Remove and clean the air filter.
<b>Saw bogs down or is underpowered</b>	Chain is too tight	Readjust the chain tension.

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<b>Problem</b>	<b>Possible cause</b>	<b>Remedy</b>
	Dirty air filter	Remove and clean the air filter.
	Dirty fuel filter	Remove and clean the fuel filter.
<b>Chain won't cut</b>	Chain is on backward	Inspect the chain to ensure it is installed correctly.
	Depth gauges too high	File the depth gauges to the correct level.
<b>Chain won't spin</b>	Chain brake is engaged	Disengage the chain brake.
	Chain is too tight	Readjust the chain tension.
	A sprocket is misaligned, worn, or the wrong pitch	Inspect the sprocket and adjust or replace it if necessary.
<b>Chain produces powder instead of chips/dulls quickly</b>	Incorrectly sharpened feathered cutting edges	Refile cutters using light strokes with the correct file and angles.
	Depth gauges too high	File depth gauges to the correct level.
<b>Chain cuts crooked</b>	Bar rails damaged	Remove the chain and inspect the bar rails. Replace the bar if necessary.
	Most of the cutting teeth on one side are dulled	Sharpen the chain.
<b>Bar and chain overheating</b>	Lack of sufficient lubrication	Ensure oil is spraying from the bar tip by throttling the saw above the wood surface and visually inspecting it.
	Oil reservoir empty	Check the oil reservoir and fill it as needed.
	Oiler holes in bar are plugged	Remove the bar and clear the oiler holes.

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### Summary

In this prework packet, you learned about how chain saws work, their components, how they operate, and the correct way to fuel and start a chain saw.

This knowledge will help you to learn the material presented in Module 2.1 of the “Developing Thinking Sawyers” course.

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