Welcome 4-H Leaders!

Welcome to the “Discovering Small Engines” project. There is lots of information, fun facts, and hands on activities that covers how a small engine works. This guide provides you with project meeting plans (Skill Builders) that include a skills list, background information, activity suggestions, and ways to know if your members have learned the skills identified. In short, all the information and tools necessary to make this project a rewarding one for you and your members.

In this project, members will examine, by learning to do by doing, how a small engine operates and how the operator can maintain the machine to keep it running smoothly. The Leader Guide is written with the expectation that the project leader(s) will have a working knowledge about how small gasoline engines work. If not, you may need to do some pre-work / research on the activities, or recruit assistance for certain sections.

Be sure to try out activities, demonstrations or hands on work ahead of time to ensure you have an understanding of each Skill Builder - this also allows for any adjustments should an activity not work for you or if any equipment or supplies are unavailable.

The 3D’s of Learning - Each Skill Builder has three sections of learning called “Dream it!”, “Do it!” and “Dig it!”. Below is a description of each.

Dream it! Plan for Success - this gives members a chance to help plan their activities. A skills checklist, background information, important words, and activating questions are included in the Member Manual so they will be able to think about the topic and activity and decide how they will approach it. The Leader Guide contains in-depth background information on the topics, material lists, suggestions, time requirements for activities, and activating, acquiring, and applying questions to engage member’s thinking through each step of the learning process.

Do it! Hands on learning - this is where members are engaged in the activity planned / discussed in the Dream it! Section. Here members are doing the activities and leaders are observing, recording, and providing feedback on how well they are doing. Allow as much individual practice as required; you are assessing the progress and understanding of individual members.

Dig it! What did you learn? - this simply means that members and leaders need to ‘dig into their learning’. For the learning cycle to be completed, both need to reflect on how things went and how well they did. For members, this involves self-assessment, giving feedback, creating meaning from their experiences, and thinking about what they would do differently next time. Once this is done they will be in a good position to apply what they have learned to the next experience.

The sequence of project meetings and specific skills building outcomes for members in this project are on the chart on the following page.

Table of Contents

<table>
<thead>
<tr>
<th>Table of Contents</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Project Summary</td>
<td>2</td>
</tr>
<tr>
<td>Skill Builder 1: Intro to Small Engines &amp; Engine Safety</td>
<td>5</td>
</tr>
<tr>
<td>Skill Builder 2: Two &amp; Four Stroke Engines</td>
<td>13</td>
</tr>
<tr>
<td>Skill Builder 3: Oil Maintenance</td>
<td>24</td>
</tr>
<tr>
<td>Skill Builder 4: Spark Plug &amp; Air Filter Maintenance</td>
<td>30</td>
</tr>
<tr>
<td>Skill Builder 5: Engine Disassembly</td>
<td>41</td>
</tr>
<tr>
<td>Skill Builder 6: Maintaining a Small Engine</td>
<td>44</td>
</tr>
<tr>
<td>Showcase Challenge</td>
<td>49</td>
</tr>
<tr>
<td>Portfolio Page</td>
<td>51</td>
</tr>
</tbody>
</table>

- Draft 2009 -
To complete this project, you must:

- Complete the activities in each Builder OR a similar activity that focuses on the same skills, as you and your members may plan other activities.
- Plan and complete the Showcase Challenge.
- Complete the Portfolio Page.
- Participate in your club’s Achievement (See the inside back cover for more information about 4-H Achievements).

<table>
<thead>
<tr>
<th>Members will be able to...</th>
<th>Activities</th>
<th>Page</th>
</tr>
</thead>
</table>
| Skill Builder 1 Intro to Small Engines & Engine Safety  
  - Identify the different types of small engines  
  - Explain the basic safety rules when working with engines  
  - Identify and describe tools used to maintain small engines | Intro to Engines  
  Safety at Work | 8  
  9 |
| Skill Builder 2 Two & Four Stroke Engines  
  - Explain how 2 and 4 stroke engines work  
  - Demonstrate how a piston and crankshaft work  
  - Identify the advantages and disadvantages of 2 and 4 stroke engines | Model Piston/Crankshaft  
  Difference Between 2 & 4 Stroke Engines | 18  
  19 |
| Skill Builder 3 Oil Maintenance  
  - Explain the importance of maintenance on small engines  
  - Explain the purpose of motor oil  
  - Perform an oil change | Work on Your Oil Burner | 26 |
| Skill Builder 4 Spark Plug & Air Filter Maintenance  
  - Describe the components of a spark plug and air filter and describe how they work  
  - Gap a sparkplug  
  - Clean and care for an air filter | Gapping a Spark Plug  
  Air Filter Check List | 34  
  35 |
| Skill Builder 5 Engine Disassembly  
  - Identify all small engine parts  
  - Take apart a small engine using the correct tools | Ripping it Apart | 42 |
| Skill Builder 6 Maintaining a Small Engine  
  - Make a maintenance check list  
  - Provide needed maintenance on a small engine  
  - Properly store a machine at end of season | Maintaining & Storing My Machine | 45 |

When members successfully complete the builders, they will showcase what they have learned.

| Portfolio & Showcase | My Portfolio Page  
  Showcase Challenge | 49  
  51 |
Showcase Challenge and My Portfolio Page

At the end of the members’ section are the “Showcase Challenge” and “My Portfolio Page”. The Showcase Challenge page gets members to think about their accomplishments and explain or demonstrate how they were successful. There are a number of suggestions along with planning information to help them decide how they will best “showcase” their learning to friends, family, community members and/or fellow 4-H members.

Record keeping is an important part of every 4-H project. “My Portfolio Page” is a graphic organizer used to keep track of members’ 4-H experiences. As each member learns skills, the evidence of learning (through participation and completion of the various activities) is recorded on the page. When the Portfolio Page has been completed and confirmed by the leader, then it becomes a record of the member’s completion of the project and participation in other 4-H activities beyond the project.

4-H leader assessment of members will happen throughout the project as you assess the progress and understanding of individual members. You need to observe the members doing the skill and record what you see and hear. Your feedback should be positive and descriptive (not just “well done”). Share that feedback with members frequently so they can put your suggestions into action. How you choose to observe and record is up to you. Some methods are to create checklists, videos and notes while encouraging discussions, peer observations and questions. Recognize that members may improve over the course of a builder and that records should be updated to reflect when they demonstrated their best learning. You are discussing how well members are meeting the skills checklists that are at the beginning of each of the project books, in each Builder and on the Portfolio Page.

Projects promote technical, communication, meeting management, and leadership skills, as well as community involvement and real-world experiences. In addition to the specific skills members are to learn in each builder, the following general learning goals for members are important: Following instructions - Working with others - Using supplies safely - Using the key words - Improving with practice - Respecting timelines.

4-H Project Series Skill Development Levels

Each project topic series contains three levels of skill development: explore, discover, and master.

Explore - each project series has is one project outlining the fundamentals. All members will be expected to complete the Explore level project before moving into the Discover level projects. It introduces the basic skills and terms needed by members for subsequent projects in that series.

Discover - each project series has several project options and members are encouraged to take as many as they would like. At this level, members practice topic specific techniques and gain theme related skills through specialized builders.

Master - multiple project options encourage members to specialize in a topic. They may branch out and take advantage of community options such as cooking for a canteen or participating in a food drive. The Leader’s role is look for opportunities for their members to have more authentic experiences by: working with other mentors, partnering with outside agencies, participating in exchanges, entering competitions, etc. Projects at this level may include the “Partner-a-Project” whereby pre-approved courses will allow members to advance their skills, while applying their learning to the 4-H program.
4-H LEADER TIPS FOR SUCCESS!

♦ To complete, members **must** complete all the activities referred to on the “Project Completion Requirements” page OR alternate idea for an activity that would teach the same skill or an age appropriate variation. If activity substitutions are used, be sure to have the member make note in their manuals.

♦ Dependent on time available at each meeting, group size and abilities of group members, you may wish to break the Builders into more than one project meeting.

♦ The internet has lots of interesting websites and educational activities. You may choose to use a search engine to explore the options available. We do not endorse any website or the safety or functionality of any products they may sell. Information/products will be used at your own discretion. Other suggested resources are the engine owner’s manual, libraries, local small engine dealers, local small engine repair shops, schools, and small engine manufacturers (write or call).

♦ Safety is a number one priority. Care has been taken to create safe, age appropriate activities throughout this manual. As leaders, it is important for you to emphasize safety rules and manage or adapt activities in a manner that will safely match your members abilities. Ensure members have a good understanding of safe working and handling practices when using tools, that they use the appropriate safety equipment when necessary, and that appropriate supervision is provided. A quality experience needs to be a safe experience.

♦ The multiple intelligences theory teaches us that people learn in at least 8 different ways. All individuals will be stronger in some ways of “intelligences” and weaker in others. It follows that the more ways we teach, the more members we will reach. Throughout this project, you will find a mix of writing, reading, hands-on work, artwork, self-evaluation, group discussion and math calculations. Teaching projects using a broad blend will help increase the learning potential of all members.

♦ Projects are designed to teach many skills, such as an understanding of the science behind how machines work. However, the 4-H member is always more important than the subject matter. Stress cooperation in the activities where possible to develop teamwork and cooperation skills. These are valuable skills that will assist them in a number of settings. Ensure the work is completed in a manner that members feel good about themselves and their efforts. This can be done by assigning appropriate tasks or roles based on member’s individual abilities. Modelling and expecting supportive behaviour (i.e. no “put-downs”) amongst members, or by other adults, also contributes to a positive experience.

♦ There will be opportunity for experimentation and applying skills that members have learned throughout this project. Experimenting can be frustrating, but learning through trial and error is an important life skill. Explain to members that it is alright to either go onto the next builder or do the builder again if they need the practice. Help the members work through their challenges until they are satisfied with the quality of their designs. Creating inventive 4-H members will be very rewarding.

♦ Celebrating success is an important but sometimes overlooked part of our lives. We encourage you to use the final section to empower the members by celebrating all they have learned in a fun manner. Anything that you do to add to the spirit of fun and the sense of accomplishment of each member will likely be remembered as the highlight of their 4-H year.

**Have fun and thanks for your belief in young people!**
Skill Builder 1: Intro To Small Engines & Engine Safety

Skills Checklist:
- Identify the different types of small engines
- Explain the basic safety rules when working with engines
- Identify and describe tools used to maintain small engines

Dream it!

Background for Leaders

Types of Engines

An internal combustion engine is an engine that works by burning fuel inside the engine, unlike a steam engine that burns fuel outside the engine. The most common engine type is gasoline powered; others are those that run on diesel, hydrogen, methane, and propane. There are different kinds of internal combustion engines: Four stroke engines, diesel engines, gas turbine engines, rotary engines and two-stroke engines. Each of them has advantages and disadvantages.

There at least 100 million small engines now being used in the United States and Canada. There are 6 million purchased each year. Small gasoline engine sizes range from 1/2 to 15 horsepower. Major manufactures include:
- Briggs and Stratton
- Tecumseh
- Honda
- Kohler

The word stroke in the world of engine mechanics is each upward or downward movement of a piston within the cylinder. A 4 stroke or 4-cycle motor has 4 strokes between the spark plug firing. On a 2 stroke or 2 cycle motor, the spark fires at the top of each stroke (down-up-fire, down-up-fire).

History of engines

Today's internal combustion engine is a marvel of technology. But amazingly, after more than 100 years the basic process has not changed.

The brief history of the internal combustion engine that can be shared with members:

1680: Dutch physicist, Christian Huygens designed (but never built) an internal combustion engine that was to be fuelled with gunpowder.
1790s: Two Englishmen were the first to file patents for the "spark-ignited engine": John Barber on October 31, 1791 and Robert Street on May 7, 1794.
1859: Etiene Lenoir of Belgium developed the first internal combustion engine
1862: Lenoir built the first automobile. He adapted his engine to run on liquid fuel. With his vehicle a 6-mile (10-kilometre) trip required two to three hours.
1870: Austrian engineer Siegfried Marcus put an internal combustion engine on a simple handcart. This appliance was designed for liquid combustibles and made him the first man propelling a vehicle by means of gasoline.
**1876**: Nikolaus August Otto invented and later patented the first successful four-stroke internal combustion engine, known as the "Otto cycle".

**1885**: Gottlieb Daimler invented what is often thought of as the prototype of the modern gas engine - with a vertical cylinder, and with gasoline injected through a carburetor (patented in 1887). Daimler first built a two-wheeled vehicle the "Reitwagen" (Riding Carriage) with this engine and a year later built the world's first four-wheeled motor vehicle.

**1886**: On January 29, Karl Benz received the first patent (DRP No. 37435) for a gas-fuelled car.

**1889**: Daimler built an improved four-stroke engine with mushroom-shaped valves and two V-slant cylinders.

**1892**: German engineer Rudolph Diesel built the diesel engine. The diesel engine is designed heavier and more powerful than gasoline engines and uses oil as fuel.

All of these inventors as well as many others made important improvements in the evolution of the internal combustion engine.

**Engine Safety**

Small engines are used in many different situations. Sometimes people become careless when working with them. These machines can be very dangerous and people are hurt by them every day.

Strategies and tips for an accident free engine experience:

- A tool or machine should be used only after it has been discussed and demonstrated by the leader.
- Safety glasses must be worn when using power machinery or when there is a chance of eye injury.
- Things can get tangled and cause serious injury. When you are working on small engines, be sure to avoid:
  - Jewellery
  - Loose clothing
  - Long hair
- Stop the engine and remove the spark plug wire before doing any kind of maintenance
- Safe use of gasoline
  - Do not use as a solvent
  - Store away from fire
  - Do not fill the tank while the engine is running
  - Gasoline fumes may be ignited by a hot muffler
- All running engines must have the exhaust ventilated outside because exhaust fumes contain carbon monoxide, a deadly poison that is colorless and odourless.
- Read the equipment manual prior to first time equipment operation.
- Keep equipment in perfect operating condition with all guards in place.
- Basics of shop safety
  - Using the right tool for the job avoids injuring yourself or damaging the tool.
  - Keeping the floor neat is important to avoid the chance of slipping or tripping.
  - Compressed air should never be used to clean dirt and dust from your clothing.
Tools needed for small engines (display for members to see)

- Socket wrenches (good quality) - for small engine work, a 3/8" ratchet and a set of sockets from 1/4" to 1" as well as a special spark plug socket.
- Screwdrivers – a variety (straight and Philips are essential).
- Oil filter wrench
- Pliers - Needle-nose and utility.
- Wire cutters and strippers
  - Hammer (ball peen)
  - Rubber mallet
  - Funnel, drain pan, plastic milk jug for used oil
  - Old rags, cotton swabs, paper towels, etc. - for cleaning. An old but soft paint brush for getting dust and dirt out of various places.
  - Wood blocks for propping things up or securing the blade or flywheel when loosening or tightening.
  - Torque wrench – for measuring and controlling the amount of torque or turning force to be exerted on nuts and bolts. Find one that will work with your 3/8" sockets.
  - Feeler gauge - a set of precise thickness strips or wires for setting spark plug and point gaps. The .020" and .030" sizes are good for basic maintenance.
  - Flywheel puller (build or buy). If purchased, it should be one specifically designed for your model of engine.
  - Carburetor cleaner - this comes in a spray can. It is as flammable as gasoline, toxic, and will eat plastics and painted surfaces. Therefore, use only in a well-ventilated area or outdoors and take precautions.
  - A tube of thread-lock - for locking, sealing, and protecting the threads of screws and bolts.
  - A tube of anti-seize compound like graphite grease – keeps metal lubricated at high temperatures

Safety tips for using tools

- Pull on a wrench rather than push it. You can hurt yourself if it slips. If you must push, push with an open hand to avoid scrapped knuckles.
- Clean all tools. Greasy tools slip and cause accidents.
- Store tools carefully. Damaged tools are dangerous.
- Keep long hair, clothing, jewellery, and body parts away from equipment and tools.
- Use the right size tool for the job.
- Use the CORRECT tool for the job. (e.g. Do not use a screwdriver as a pry bar)

Resources/Handouts/References

- For more information on small engine safety: http://ohioline.osu.edu/aex-fact/192/pdf/0192_1_70.pdf
- For more background on internal combustion engines: http://www.calaged.org/ResourceFiles/Curriculum/advcluster/2851.txt
**Important Words**

Help members define the following words and look for members using this vocabulary in their discussions. Here are some examples of how to use the “important words” to increase the members understanding:

- Ask members to form a mental image of the new word.
- Have members describe (rather than define) the new word in terms of their experiences.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel</td>
<td>Something that is burned to provide power or heat.</td>
</tr>
<tr>
<td>Engine safety</td>
<td>Protection from, or not being exposed to, the risk of harm or injury while working with engines.</td>
</tr>
<tr>
<td>Stroke</td>
<td>The word stroke in the world of engine mechanics is each upward or downward movement of a piston within the cylinder.</td>
</tr>
<tr>
<td>Tool Safety</td>
<td>Protection from, or not being exposed to, the risk of harm or injury while working with tools.</td>
</tr>
<tr>
<td>Combustion</td>
<td>The burning of fuel in an engine to provide power.</td>
</tr>
</tbody>
</table>

**Age Considerations**

- 12 and up

**Thinking Ahead**

- What will you discuss with members? Gather observations that will help support your discussion.

**Preparing for Success**

- Ask members how they know they will be successful in this builder. Discuss what success looks like, sounds like, and feels like.

**Activating Strategies**

- Have members talk about the machines with engines they know of. What kind of engines are they?

**Intro to engines**

**Time required:** 30 minutes

**Equipment/Supplies**

- Pencil

**Instructions**

1. Lead a discussion or tour with the members on the different uses of engines around the farm and around the world. Discuss what types of engines (2 or 4 stroke) are best suited for what jobs.
2. Have members do the quiz “How Small Engines Work” from the Member Manual. If there is a question they do not know, tell them to leave it and fill in the answer when they have learned it. By the end of the project all questions should be answered.
How Do Small Engines Work?

Answers:

1. Stop switch  
2. Choke lever  
3. Air cleaner  
4. Fuel tank  
5. Spark plug  
6. Oil plug  
7. Carburetor  
8. Idle screw  
9. Power shaft  
10. Fuel line

Source: Alberta 4-H - Exploring 4-H Technology and Trade Module p. 217  
(http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/4h7895/$FILE/Exploring4H_TechnologyTrade.pdf)

- What kinds of machines use 2 stroke engines? Why?

Do it!

Safety at work

Time required: 30 minutes

Equipment/Supplies

- Pencil

Procedure:

1. Discuss with members the importance of safety when working with engines as well as basic shop safety. Make sure members read the “Safety with Engines” sheet in the Member Manual.
2. Have members do the “Safety at Work” quiz.
3. Review/discuss answers.

- Based on what you have learned, how will you organize your shop or workspace?

Quiz answers:

1. How should you dispose of oily rags?
   *If you’re thinking that the oily rag you tossed into the pail might be the problem, you’re right. Something as seemingly harmless as tossing an oily rag aside and forgetting about it can ignite a big problem for you. That’s because of a phenomenon called spontaneous combustion.*
   Carefully store oil-, gasoline-, or paint-soaked rags. Store them in a tightly sealed container in a cool, well-ventilated place away from other combustibles. Or lay the rags out individually on a flat surface and leave them to dry completely before reusing.

2. Do you use gasoline to clean your greasy hands?
   *Do not use gasoline to clean greasy hands, use a proper hand cleaner to clean them.*

3. Why is it important to maintain a clean and organized work area?
   *It is important to have an organized work area to avoid accidents: People can trip and fall if the area is cluttered with tools. The floor can also be slippery from various things spilling.*
4. Before you turn the blade of your lawn mower by hand you should:
   a. Spit on your hands
   b. Wear gloves
   c. **Disconnect spark plug**
   d. Clean the blade
   e. Check oil level

5. When using a wrench, it is best to:
   a. **Pull it towards you**
   b. Push it away from you

6. When lifting something heavy:
   a. Bend over at the waist and grasp it firmly
   b. **Bend with your knees and grasp it firmly**
   c. Lift it with one strong jerk

7. Is it safe to use compressed air to clean your clothes
   a. True  b. **False**

8. A running gas engine produces which deadly gas:
   a. Hydrogen sulfide
   b. **Carbon monoxide**
   c. Carbon dioxide
   d. Dihydrogen monoxide

**Dig it!**

To help members reflect on their learning and apply what they know, ask them the following questions:

1. What did you learn about safety in this meeting?
2. Why was this meeting important?
3. How could the things you learned today be used to help you in other situations?
4. What did you learn about the workshop you will be working in?

**What’s next?**

In the next builder members will learn the parts of 2 and 4 stroke engines and how they work. To get members thinking about the next builder ask them if they know how a gasoline engine works.

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**Leader’s Notes**
In the Member Manual

Skill Builder 1: Intro to Small Engines & Engine Safety

Gizmo says...

An internal combustion engine is an engine that works by burning its fuel inside the engine, unlike a steam engine which burns its fuel outside the engine. The most common engine type is gasoline powered; others are those that run on diesel, hydrogen, methane, and propane.

SKILLS CHECKLIST

- Identify the different types of small engines
- Explain the basic safety rules when working with engines
- Identify and describe the tools used to maintain small engines

Dream it!

There are different kinds of internal combustion engines: Four stroke engines, diesel engines, gas turbine engines, rotary engines and two-stroke engines. Each has its own advantages and disadvantages.

The word stroke in the world of engine mechanics is each upward or downward movement of a piston within the cylinder. A 4 stroke or 4-cycle motor has 4 strokes between the spark plug firing. On a 2 stroke or 2 cycle motor, the spark fires at the top of each stroke (down-up-fire, down-up-fire).

Today's internal combustion engine is a marvel of technology. But amazingly, after more than 100 years the basic process has not changed.

<table>
<thead>
<tr>
<th>Examples of Machines With Small Engines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lawn mower</td>
</tr>
<tr>
<td>Snow blower</td>
</tr>
<tr>
<td>Garden tiller</td>
</tr>
</tbody>
</table>

Intro to engines

- What do you know about small engines?

While you probably have used a machine that uses a small engine, have you ever done any maintenance on one? Have you changed a spark plug or changed the oil? Brainstorm with the list below to see just how much you know about small engines. Check your answers with your leader when you are done.

Brainstorming - How Do Small Engines Work?

1. What turns the engine off?

2. What do you need to use in order to start a cold engine?

3. What protects the engine from dust in the air?

4. Where do you put the gasoline that runs the engine?

5. What ignites the fuel mixture?

6. Where would you need to remove the dirty oil from?

7. Where is the gas and the air mixed?

8. If the engine is running too slow what do you turn?

9. The engine turns this mechanism:

10. The gas moves from the tank to the engine through this:

   How did you do? What was the hardest question?

Tools of the Trade

Using the proper tool when working on your engine will help ensure things go smoothly. The following tools are the most common when working on a small engine:

- Socket wrenches (good quality) - for small engine work, a 3/8" ratchet and a set of sockets from 1/4" to 1" as well as a special spark plug socket
- Screwdrivers – A variety may be needed. Slotted (straight) and Philips (crosshead) are essential.
- Oil filter wrench
- Pliers - Needle-nose and utility
- Wire cutters and strippers
- Hammer (ball-peen)
- Rubber mallet
- Funnel, drain pan, and plastic milk jug for used oil
- Old rags, cotton swabs, paper towels, etc. for cleaning. An old but soft paint brush for getting dust and dirt out of various places
- Wood blocks for propping things up or securing the blade or flywheel when loosening or tightening
- Torque wrench – for measuring and controlling the amount of torque or turning force to be exerted on nuts and bolts. Find one that will work with your 3/8" sockets
- Feeler gauge - a set of precise thickness strips or wires for setting spark plug and point gaps. The .020" and .030" sizes are good for basic maintenance.
- Flywheel puller (build or buy) - If purchased, it should be one specifically designed for your model of engine.
- Carburetor cleaner - This comes in a spray can. It is as flammable as gasoline, toxic, and will eat plastics and painted surfaces. Therefore, use only in a well-ventilated area or outdoors and take precautions.
- A tube of thread-lock - for locking, sealing, and protecting the threads of screws and bolts
- A tube of anti-seize compound like graphite grease – keeps metal lubricated at high temperatures
In the Member Manual

Engine Safety

Safety is always important when you are working with any kind of machine. Knowing your machine is important, but there is much more to know. Small engines are used in many different situations. Sometimes people become careless when working with them. These machines can be very dangerous and do hurt people every day.

Strategies and tips for an accident free engine experience:
- A tool or machine should be used only after it has been discussed and demonstrated by your instructor.
- Safety glasses must be worn when using power machinery or when there is a chance of eye injury.
- Things can get tangled and cause serious injury. When you are working on small engines be sure to avoid:
  - Jewellery
  - Loose clothing
  - Long hair
- Stop the engine and remove the spark plug wire before doing any kind of maintenance.
- Safe use of gasoline:
  - Do not use as a solvent
  - Store away from fire
  - Do not fill the tank while the engine is running
  - Gasoline fumes may be ignited by a hot muffler
- All running engines must have the exhaust vented outside because exhaust fumes contain carbon monoxide, a deadly poison that is colorless and odourless.
- Read the equipment manual prior to first time equipment operation.
- Keep equipment in perfect operating condition with all guards in place.
- Basics of shop safety:
  - Using the right tool for the job avoids injuring yourself or damaging the tool.
  - Keeping the floor neat is important to avoid the chance of slipping or tripping.
  - Compressed air should never be used to clean dirt and dust from your clothing.

Do it!

Safety at Work

- How do you stay safe around machines?

Have you heard about someone who was injured operating or working on a machine? Injuries happen all time when working with machines. What do you do to ensure you don’t get hurt around machines? Sharpen your pencil and show how safety savvy you are by doing the following quiz. You can check your answers with your Leader.

Safety at Work Quiz

1. How should you dispose of oily rags?
2. Do you use gasoline to clean your greasy hands?
3. Why is it important to maintain a clean and organized work area?
4. Before you turn the blade of your lawn mower by hand you should:
   a. Spit on your hands
   b. Wear gloves
   c. Disconnect spark plug
   d. Clean the blade
   e. Check oil level
5. A running gas engine produces which deadly gas:
   a. Hydrogen sulfide
   b. Carbon monoxide
   c. Carbon dioxide
   d. Dihydrogen monoxide
6. When using a wrench, it is best to:
   a. Pull it towards you
   b. Push it away from you
7. Is it safe to use compressed air to clean your clothes?
   a. True
   b. False
8. When lifting something heavy:
   a. Bend over at the waist and grasp it firmly
   b. Bend with your knees and grasp it firmly
   c. Lift it with one strong jerk
   d. How did you do? How is working with engines potentially dangerous?

Dig it!

Think about your learning...

Think about this builder and the activities you did...

Review the Skills Checklist on page 3. What skills have you developed? Do you need more practice?

Record it...

Discuss what you have learned with your leader so the information can be recorded on your Portfolio Page.

Apply it...

How could you explain to others how safety and tools are related?

Engine Education

For more information on the automobile pioneer Nikolaus Otto see: http://www.nationmaster.com/encyclopedia/Nikolaus-Otto

What’s next?

Learning about the proper tools and safety precautions used in repairing and maintaining small engines is very important. Without this knowledge you would not get far without hurting yourself or your engine. But before you can get your hands dirty you first need a good understanding how small engines actually work. The next section will give you all the background you need on two and four-stroke engines, paving the way for successful hands on maintenance and troubleshooting of small engines.
Skill Builder 2: Two and Four Stroke Engines

Skills Checklist

- Explain how 2 and 4 stroke engines work
- Demonstrate how a piston and crankshaft work
- Identify the advantages and disadvantages of 2 and 4 stroke engines

Dream it!

Background for Leaders

Major Parts of a Small Engine

1. Fuel Tank
2. Drain Plug
3. Fuel Filter
4. Fuel Valve
5. Power Shaft
6. Oil Drain Plug
7. Oil Filter Plug
8. Needle Valve
9. Choke Lever
10. Idle Valve
11. Air Cleaner
12. Idle Screw
13. Governor Screw
14. Spark Plug
15. Stop Switch
16. Oil Sump
17. Cylinder Head
18. Carburetor
19. Fuel Line

Two Stroke Engines

Some of the things that might have a two-stroke engine are:

- Lawn and garden equipment (chainsaws, leaf blowers, trimmers)
- Dirt bikes
- Mopeds
- Jet skis
- Small outboard motors
- Grain augers

Often a two-stroke engine produces a lot of power for its size but uses more gasoline and burns lots of oil, so it can cause more pollution.
The Two-stroke Engine

A two-stroke engine has no moving valves and the spark plug fires each time the piston hits the top of its cycle. The engine uses the space above the piston (combustion chamber) and below the piston (crankcase). Below the piston are fresh gases, above the piston these gases are ignited. Now the process starts again.

The two-stroke engine uses the crankcase to hold the next mixture of gases for the combustion chamber instead of using this location as an oil reservoir, because of this you have to mix oil into the gas. This mixture is called the gas to oil ratio, and must follow the manufacturer’s instructions.

**Parts of a 2-stroke engine:**
- **Piston** – a cast cylindrical piece of metal that fits in the cylinder of the engine and moves up and down.
- **Reed valve** – allows fresh air/fuel to be drawn into the crankcase from the carburetor and traps it. It acts like a check valve.
- **Air-fuel mixture** enters the crankcase and is trapped there by the one-way reed valve.
- **Spark plug** – a device designed to let a spark jump across a small gap to ignite fuel.
- **Combustion chamber** – the area in the cylinder where the fuel/air is compressed, and burned; As the piston moves up and down the size of the Combustion chamber changes.
- **Exhaust Outlet** – the exhaust waste exit
- **Cooling fins** - Most small two-stroke engines are air-cooled, air flows over cooling fins around the outside of the combustion chamber.

**Intake** - Air-fuel mixture enters the crankcase and is trapped there by the one-way reed valve. A hole in the lower part of the cylinder wall lets gas and air into the combustion chamber.

As the piston moves up these gases are compressed, but a venturi creates an area of low pressure below the piston, and fresh air and fuel is sucked inside.

The spark plug ignites the gases and pushes the piston down compressing the air/fuel mixture in the crankcase.

The exhaust waste exits through another hole in the cylinder. Because of the air pressure differences, the fresh gases flow into the cylinder pushing the exhaust fumes out.
Why you should look at a Two-Stroke Motor:

Advantages:
- Two-stroke engines do not have valves, simplifying their construction.
- Two-stroke engines fire once every revolution (four-stroke engines fire once every other revolution).
  - Two-stroke engines are lighter, and cost less to manufacture.
  - Two-stroke engines have the potential for about twice the power in the same size because there are twice as many power strokes per revolution.

Disadvantages:
- Two-stroke engines don’t last as long as four-stroke engines. The lack of a lubrication system means that the parts will wear-out faster. Two-stroke engines require a mix of oil in with the gas to lubricate the crankshaft, connecting rod and cylinder walls.
- Two-stroke oil can be expensive. Mixing ratio is about 4 ounces per gallon of gas: burning about a gallon of oil every 1,000 miles.
- Two-stroke engines do not use fuel efficiently, yielding fewer liters per kilometer.
- Two-stroke engines can produce more pollution.
- The combustion of the oil in the gas makes all two-stroke engines smoky, and an old two-stroke engine can emit even more oily smoke.
- Each time a new mix of air/fuel is loaded into the combustion chamber part of it leaks out through the exhaust port.

Four Stroke Engines

The four-stroke engine is the type of engine most commonly used in automotive and industrial things today (cars and trucks, generators, etc). The four-stroke cycle is more efficient than the two-stroke cycle, but has more moving parts. The four-stroke approach is also known as the Otto cycle, in honor of Nikolaus Otto, who invented it in 1867.

Parts of a 4 stroke engine:

- Camshaft
- Tappet
- Valve spring
- Spark plug
- Exhaust port
- Piston
- Crankcase
- Big end
- Crankshaft
- Connecting rod (or Conrod or just rod)
- Cylinder
- Wrist pin (or Gudeon pin)
- Combustion chamber
- Inlet port
- Inlet Valve
Parts of a 4 stroke engine:

**Camshaft** - the shaft in an engine which pushes open the intake and exhaust valves.

**Tappet (or valve lifter)** – a part of the pushrod-rocker arm assembly. Small rods with one flat end that fits on the bottom end of the pushrod, and is the part that the eccentric lobe of the camshaft is in contact with. They push the valve open. **Valve spring**- closes intake and exhaust valves by spring action.

*Spark plug or glow plug* – a device designed to let a spark jump across a small gap to ignite fuel.

*Exhaust port* – the exhaust waste exit in a two-stroke engine.

*Piston* – a cast cylindrical piece of metal that fits in the cylinder of the engine and moves up and down.

*Crankcase* - the crankcase is the storage unit for oil – the inside of the engine.

*Crankshaft* – the rotating, main shaft in an engine - the piston and connecting rods make it rotate to convert energy to work.

**Connecting rod (or Conrod)** – connects the piston to the crankshaft. It can rotate at both ends so that its angle can change as the piston moves and the crankshaft rotates.

*Big end* - The part of the connecting rod attaching it to the crankshaft is called the big end, and the connection to the piston is called the *little end*.

*Wrist pin (or Gudeon pin)* - The connecting rod connection to the piston is called the little end. The inner part of the little end is a steel pin that goes through the piston; this pin is called the Wrist pin.

*Cylinder (or liner)* – the number varies. Small engines tend to have one or two while cars have either four, six, eight, or twelve cylinders. These cylindrical holes are cast into the engine block.

*Combustion chamber* – the cavity in the cylinder where the fuel/air is compressed and burned. As the piston moves up and down the size of the Combustion chamber changes.

*Intake port* – the pipe or tube that brings the fuel/air mixture from the carburetor to the cylinder for combustion.

*Intake valve* – opens (and closes) a hole in the cylinder head that lets in the fuel from the carburetor at a given moment – the intake stroke of the four- stroke piston cycle.

Let’s look at the four strokes of the internal combustion engine, which are:

1. Intake
2. Compression
3. Power
4. Exhaust
The Intake Stroke:
The first stroke is the intake stroke; the intake valve is open. The piston is moving down, and a mixture of air and vaporized fuel is drawn into the cylinder from the carburetor through the intake port.

The Compression Stroke:
The piston begins to move upward. The intake valve and the exhaust valve are closed, so the cylinder is sealed. As the piston moves upward the air/fuel mixture is compressed.

The Power Stroke:
As the piston reaches the top of the stroke the spark plug fires igniting the air/fuel mixture. This explosion creates expanding exhaust gases that force the piston downward for the third stroke. This force is converted into power turning the crankshaft and the flywheel. This motion is provided from the energy of converting fuel energy into mechanical energy and does work for us.

The Exhaust Stroke:
As the piston reaches the bottom of its travel, the exhaust valve opens. The piston moves it up pushing the exhaust gases out of the cylinder. When the piston reaches the top of its stroke, the exhaust valve closes, and the intake valve opens. The cycle repeats again with the intake stroke, using energy left in the flywheel to start the four strokes again.

Most four-stroke engines are water-cooled. Water surrounds the cylinders; and a water pump circulates the water around the motor, drawing heat from the engine. The water flows into a radiator where the heat is released to the air by tiny fins; the water then moves back into the motor to repeat the cycle.

The gasoline and oil are separate unlike the 2-stroke engine where they are mixed together. Four-stroke engines are lubricated by oil from a separate oil reservoir, from which a gear pump delivers it to different places in the engine. Because of this separation oil changes are required.

The carburetor is where the air and fuel are mixed before they are sent to the cylinders for combustion. The carburetor has to mix just the right amount of gasoline with air so that the engine runs properly. If there is not enough fuel mixed with the air, the engine "runs lean", and if there is too much fuel mixed with the air the engine "runs rich" and either will not run (it floods), run very smoky, or just run poorly. When the mixture is correct the engine runs well. The carburetor can be adjusted to give the engine the right amount fuel and air for the conditions.

Resources/Handouts/References
- A good resource on the internal combustion engine, with animations and videos: http://auto.howstuffworks.com/engine1.htm
- To see in detail the movement of a 2 stroke engine: http://Science.howstuffworks.com/two-stroke.htm
Important Words

Help members define the following words and look for members using this vocabulary in their discussions. One strategy to help members learn new vocabulary is to have them paraphrase the definitions. Having members to use their own words increases connection making.

<table>
<thead>
<tr>
<th>Stroke</th>
<th>The word stroke in the world of engine mechanics is each upward or downward movement of a piston within the cylinder.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crankshaft</td>
<td>The shaft in an engine which pushes open the intake and exhaust valves.</td>
</tr>
<tr>
<td>Piston</td>
<td>A cast cylindrical piece of metal that fits in the cylinder of the engine and moves up and down.</td>
</tr>
<tr>
<td>Venturi</td>
<td>The Venturi effect is the reduction in fluid pressure that results when a fluid flows through a constricted section of pipe.</td>
</tr>
</tbody>
</table>

Age Considerations

- 10 and up

Thinking Ahead

- What will you discuss with members? Gather observations that will help support your discussion.

Preparing for Success

- Ask members how they know they will be successful in this builder. Discuss what success looks like, sounds like, and feels like.

Activating Strategies

- Activate members’ prior knowledge by asking them what they know about engines and about engines they use.

Do it!

Model Piston/Crankshaft System

NOTE: Leaders indicate this project is either confusing or fantastic. If you have a real piston and crankshaft to demonstrate how it works, please feel free to use this. There are links below to show members videos and animations of how they works. This may be used in addition to or instead of the model activity if there is trouble creating it. It is best to build a sample model prior to the meeting to be sure it is operational.

For an animation of a model 2-stroke engines check out this webpage: http://science.howstuffworks.com/two-stroke2.htm. Also, you can look for the “Two Stroke Cycle Engine Video” on this website or go directly to: http://videos.howstuffworks.com/user/4729-two-stroke-cycle-engine-video.htm. The animation and video may help you to visualize how pistons move.

Time required: 1 hour
In this activity you will build a model piston/crankshaft system to demonstrate how two and four-cycle engines transfer energy and changes reciprocating motion to rotary motion.

**Instructions**

1. Lead a discussion with the members about the different uses of two-stroke engines around the farm. Have them come up with as many examples of machines as they can.
2. Describe the stages of a two-stroke and a four-stroke engine and have members give reasons why two-stroke engines are best suited for their respective machines.
3. Form the outline of a cylinder with three Popsicle sticks by gluing them to the bottom edge of the 16 cm x 16 cm piece of cardboard.
4. Glue the other Popsicle sticks on top of the first three Popsicle sticks.
5. Cut an 8 cm x 8 cm square from the other piece of cardboard to represent the piston.
6. Cut an 11 cm x 2 cm strip and a 6 x 2 cm strip.
7. Poke a hole in the end of each strip.
8. Attach one end of the strip (the piston connecting rod and crankshaft) together with a fastener.
9. Poke a hole in the piston and attach the other end of the piston rod with a fastener. Allow enough room so that the piston rod can turn the crankshaft completely when the piston head moves up and down.
10. Put the last fastener halfway through the second hole in the crankshaft and flatten the ends of it. This should make a knob which can be used to turn the crankshaft.
11. Have members begin with the piston at the top of the cylinder. Holding onto the knob, gently rotate the crankshaft. As members turn their crankshafts ask them questions on what is happening:
   a. What happened to the piston when the crankshaft was rotated? *The piston moved down in the cylinder shaft*
   b. This represents which stroke? *Intake*
   c. (Holding onto the knob, have members gently rotate the crankshaft again). What happened to the piston when the crankshaft was rotated? *Piston moved up in the shaft*
   d. This represents which stroke? *Compression*
   e. Describe the next stroke in a four-cycle engine. The spark plug fires and forces the piston down in the shaft turning the crankshaft. This is the power stroke.
   f. (Holding onto the knob, gently rotate the crankshaft again). What happened to the piston when the crankshaft was rotated? *The piston will move back up the shaft and force the used gas mixture out the exhaust port.*
   g. This represents which stroke? *Exhaust stroke.*

- Did this model make it easier to understand how engines work? Why?

**Difference between 2 and 4 stroke engines**

**Time required:** 30 minutes

**Equipment/Supplies**
- Pencil
Instructions

1. Have members discuss the process of two and four-cycle engines
2. Members are to complete the following chart that is in the Member Manual.

- What is the biggest difference between 2 and 4 stroke engines?

<table>
<thead>
<tr>
<th></th>
<th>2 Cycle Engine</th>
<th>4 Cycle Engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel</td>
<td>Mixed</td>
<td>Straight gas</td>
</tr>
<tr>
<td>Oil</td>
<td>In fuel</td>
<td>In a sump</td>
</tr>
<tr>
<td>Muffler</td>
<td>Exhaust ports on the cylinder itself</td>
<td>Muffler is threaded or bolted to the engine near one end</td>
</tr>
<tr>
<td>Number strokes per crankshaft</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Method of getting fuel/air mixture in combustion chamber and burned gases out</td>
<td>No valve usually Uses ports (piston closes off ports)</td>
<td>Intake valve Exhaust valve</td>
</tr>
<tr>
<td>Number moving parts in the engine</td>
<td>Fewer simpler in design</td>
<td>More</td>
</tr>
<tr>
<td>Weight</td>
<td>Lighter/hp</td>
<td>Heavier/hp</td>
</tr>
<tr>
<td>Size</td>
<td>Smaller</td>
<td>Bigger</td>
</tr>
<tr>
<td>Pollution</td>
<td>More pollution in exhaust gases than 4 stroke</td>
<td>Less pollution than 2 stroke</td>
</tr>
<tr>
<td>Camshaft</td>
<td>Usually doesn't have one</td>
<td>Always</td>
</tr>
<tr>
<td>Sound</td>
<td>Louder in operation</td>
<td>Generally quieter</td>
</tr>
<tr>
<td>Initial Cost</td>
<td>Less</td>
<td>More</td>
</tr>
<tr>
<td>General Maintenance</td>
<td>Less</td>
<td>More</td>
</tr>
<tr>
<td>General Operating Efficiency (hp.wt. ratio)</td>
<td>More efficient</td>
<td>Less efficient</td>
</tr>
<tr>
<td>Number of major moving parts</td>
<td>Fewer</td>
<td>More</td>
</tr>
</tbody>
</table>

Dig it!

To help members reflect on their learning and apply what they know, ask them the following questions:

1. What did you learn in this meeting that you didn’t know before?
2. How will learning about how engines work help you?
3. How would you teach someone about how internal combustion engines work?

What’s next?

With a background on how engines work members will now begin to learn about engine maintenance. In the next builder members will learn about the importance of oil in an engine and perform an oil change. To get members thinking about the next builder ask them what is done to an engine (small or big) to keep it running smoothly.
In the Member Manual

**Skill Builder 2: 2 & 4 Stroke Engines**

_Gil Raggs says..._

All gasoline and diesel engines come in two types: 2 and 4 stroke. 2 stroke engines have only a few moving parts and are found in small vehicles (such as motorbikes) and small machinery (like a chainsaw). 4 stroke engines are found mostly in cars and trucks.

**SKILLS CHECKLIST**
- Explain how 2 and 4 stroke engines work
- Demonstrate how a piston and crankshaft work
- Identify the advantages and disadvantages of 2 and 4 stroke engines

**Important words**
Watch for these important words throughout this builder:
- Piston, Crankshaft, Venturi

**Dream it!**

There are two kinds of internal combustion or gasoline engines: 2 stroke and 4 stroke. You will learn about how they work, their similarities and differences, and the pros and cons of each.

Examples of 2-stroke engines:
- Chainsaws
- Leaf blowers
- Dirt bikes
- Moped
- Small outboard motors

Examples of 4-stroke engines:
- Lawnmowers
- Pumps
- Generators
- Motorcycles
- Cars & trucks

**Major Parts of a Small Engine**

1. Fuel Tank
2. Drain Plug
3. Fuel Filter
4. Fuel Valve
5. Power Shaft
6. Oil Drain Plug
7. Oil Filter Plug
8. Needle Valve
9. Choke Lever
10. Idle Valve
11. Air Cleaner
12. Idle Screw
13. Governor Screw
14. Spark Plug
15. Stop Switch
16. Oil Sump
17. Cylinder Head
18. Carburetor
19. Fuel Line
In the Member Manual

The Two Stroke Engine

Piston – a cast cylindrical piece of metal that fits in the cylinder of the engine and moves up and down.

Reed valve – allows fresh air/fuel to be drawn into the crankcase from the carburetor and traps it. It acts like a check valve as the air-fuel mixture is trapped by the one-way reed valve.

Spark plug – a device designed to let a spark jump across a small gap to ignite fuel.

Combustion chamber – the area in the cylinder where the fuel/air is compressed, and burned. As the piston moves up and down, the size of the combustion chamber changes.

Exhaust Outlet – the exhaust waste exit.

Cooling fins - Most small two-stroke engines are air-cooled which means that air flows over cooling fins around the outside of the combustion chamber.

How a 2-Stroke Engine Works

Intake - Air-fuel mixture enters the crankcase and is trapped there by the one-way reed valve. A hole in the lower part of the cylinder wall lets gas and air into the combustion chamber.

As the piston moves up these gases are compressed, but a venturi creates an area of low pressure below the piston and fresh air and fuel is sucked inside.

The spark plug ignites the gases and pushes down the piston compressing the air/fuel mixture in the crankcase.

The exhaust waste exits through another hole in the cylinder. Because of air pressure differences the fresh gases flow into the cylinder pushing the exhaust fumes out.

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>No valves, has simple construction</td>
<td>Doesn't last as long as four-stroke engines. The lack of a lubrication system means that the parts will wear-out faster. Two-stroke engines require a mix of oil in with the gas to lubricate the crankshaft, connecting rod and cylinder walls.</td>
</tr>
<tr>
<td>Lighter, and costs less to manufacture</td>
<td>Two-stroke oil can be expensive. Mixing ratio is about 4 ounces per gallon of gas.</td>
</tr>
<tr>
<td>Potential for about twice the power over a 4-stroke in the same size engine because there is twice as many power strokes per revolution</td>
<td>Not fuel efficient</td>
</tr>
<tr>
<td></td>
<td>Produces more pollution (smoky).</td>
</tr>
</tbody>
</table>

The 4-Stroke Engine

A. Camshaft
B. Tappet
C. Valve spring
D. Spark plug
E. Exhaust port
F. Piston
G. Crankcase
H. Big end
I. Crankshaft
J. Connecting rod (or Conrod or just rod)
K. Cylinder
L. Wrist pin (or Gudgeon pin)
M. Combustion chamber
N. Inlet port
O. Inlet Valve

How a 4-Stroke Engine Works

The Intake Stroke: The first stroke is the intake stroke; the intake valve is open. The piston is moving down, and a mixture of air and vaporized fuel is drawn into the cylinder from the carburetor through the intake port.

The Compression Stroke: The piston begins to move upward. The intake valve and the exhaust valve are closed, so the cylinder is sealed. As the piston moves upward, the air/fuel mixture is compressed.

The Power Stroke: As the piston reaches the top of the stroke, the spark plug fires igniting the air/fuel mixture. This explosion creates expanding exhaust gases that force the piston downward for the third stroke. The force is transformed into power turning the crankshaft and the flywheel. This motion is provided from the energy of converting fuel energy into mechanical energy and does work for us.

The Exhaust Stroke: As the piston reaches the bottom of its travel, the exhaust valve opens. The piston moves up, pushing the exhaust gases out of the cylinder. When the piston reaches the top of its stroke, the exhaust valve closes and the intake valve opens. The cycle repeats again with the intake stroke, using the energy left in the flywheel to start the four strokes again.
In the Member Manual

Do it!
Model Piston/Crankshaft
What you will need: popsicle sticks, brass fasteners, scissors, glue, cardboard

For an animation of a model 2-stroke engines check out this webpage: http://science.howstuffworks.com/two-stroke2.htm. Also, you can look for the “Two Stroke Cycle Engine Video” on this website or go directly to: http://videos.howstuffworks.com/user/4729-two-stroke-cycle-engine-video.htm. The animation and video may help you to visualize how pistons move.

• How do an engine’s pistons move?

For the blades of a lawnmower to turn or for a car to move, the blades and wheels have to turn in a rotary motion. Internal combustion engines are powered by pistons which move in a back-and-forth or linear motion. By building and testing a model piston/crankshaft system, you’ll discover how energy transfers from linear (or reciprocating) motion to rotary motion. One thing small engines do is turn things. Wheels and blades, for example, turn in a circular or rotary fashion. But how does this happen? Think about how a bicycle compares to a motorcycle: how do you think a motorcycle engine turns its rear wheel?

1. Form the outline of a cylinder with three Popsicle sticks by gluing them to the bottom edge of a 16 cm x 16 cm piece of cardboard.
2. Glue the other Popsicle sticks on top of the first three Popsicle sticks.
3. Cut an 8 cm x 8 cm square from a piece of cardboard to represent the piston.
4. Cut an 11 cm x 2 cm strip and a 6 x 2 cm strip.
5. Poke a hole in the end of each strip.
6. Attach one end of the strip (the piston connecting rod and crankshaft) together with a fastener.
7. Poke a hole in the piston and attach the other end of the piston rod with a fastener. Allow enough room so that the piston rod can turn the crankshaft completely when the piston head moves up and down.
8. Put the last fastener halfway through the second hole in the crankshaft and flatten the ends of it. This should make a knob, which can be used to turn the crankshaft.
9. Turn the knob on the crankshaft and note what happens.

Write down your observations below
Begin with the piston at the top of the cylinder. Holding onto the knob, gently rotate the crankshaft. What happened to the piston when the crankshaft was rotated?

This represents which stroke? ___________________________________________________________________________

Holding onto the knob, gently rotate the crankshaft again. What happened to the piston when the crankshaft was rotated?

This represents which stroke? _________________________________________________________________________

Describe the next stroke in a four-cycle engine. ____________________________________________________________________________

Holding onto the knob, gently rotate the crankshaft again. What happened to the piston when the crankshaft was rotated?

This represents which stroke? __________________________________________________________________________

What is the purpose of the motion of the crankshaft? _______________________________________________________________________

Difference Between Two and Four Stroke Engines
Show what you know about 2 and 4 stroke engines by filling out the chart below.

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Two Cycle Engine</th>
<th>Four Cycle Engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Muffler</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number strokes per crankshaft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Method of getting fuel/air mixture in combustion chamber and burned gases out</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of moving parts in the engine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pollution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camshaft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sound</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial Cost</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Operating Efficiency (hp. wt. ratio)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of major moving parts</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dig it!
Think about the builder and the activities you did...

Review the Skills Checklist at the start of the builder. What skills have you developed? Do you need more practice?

How Did it Go?
Discuss these questions with your leader, parent, or another adult:
• Did the model piston/crankshaft help you understand how an internal combustion engine works? Why?

• Explain to someone the differences between 2 & 4 stroke engines?

What’s next?
By now you are probably full of small engine information. Knowing how 2 and 4-stroke engines work will help you down the road when you maintain, troubleshoot, and repair a small engine. Next up you will be learning the maintenance side of things as you learn about oil and how it works in the engine. You will also give a small engine an oil change.
Skill Builder 3: Oil Maintenance

Skills Checklist

- Explain the importance of maintenance on small engines
- Explain the purpose of motor oil
- Perform an oil change

Dream it!

Background for Leaders

Proper maintenance of small engines should be routine, following a schedule. Some things are done each time you fuel; others are done at certain intervals, such as oil changes, and some are done annually, such as getting your engine ready for winter.

The proper amount of oil is vital to the way that your engine will perform. If you have too little oil it may overheat, cause excessive wear, and sometimes causes engine parts to stop moving and fail. Oil also loses its abilities and cooling effectiveness with use and this will not protect your engine parts. Make it a habit to check the oil regularly. Doing this after about every 5 hours of operation is generally recommended.

What is the purpose of oil?

Oil must look after your engine in five ways:

- Lubricate - reduces friction and wear on the moving engine parts. It is very important to have correct viscosity of oil (viscosity means thickness).
- Cool engine parts - keeping piston, connecting rods, and bearings at safe working temperatures.
- Seal - forms a seal between the piston rings and the cylinder wall to prevent exhaust gases from entering the crankcase.
- Absorbs shock and reduces engine noise.
- Cleans - provides a cleaning agent to keep soot and varnish from forming during combustion. When the oil is changed, these particles are drained from the engine.

About one gallon of water is produced for every gallon of gasoline burned. When an engine operates normally at temperature, this water escapes as steam. When the engine is cold, some water is trapped in the oil, and helps to form sludge. When the engine operates too hot this causes the oils to form deposits on parts, which is the main cause of sticky rings and intake valves.

Oil information

- The viscosity grade is very important, because oil has many functions it shouldn’t be too thick or parts of the engine won’t move free enough. It can’t be too thin either as it will “break down”.
- Above 10°C, the best viscosity grade of oil to use is 30W, the higher the number the thicker it is.
- Oil is also classified by letter grades. The letter grade refers to the additives and detergents formulated with the oil.
Additives found in oil

- Detergents - Put in oil to help hold contaminants in suspension to prevent clumping and formation of sludge.
- Antioxidants - Put in oil to help reduce the formation of corrosive acids that are particularly damaging to bearing surfaces.
- Rust inhibitors - Put in oil to protect against rust.
- Foam inhibitors - Put in oil to help prevent the build-up of foam that is caused when oil is agitated.

Changing oil is based upon the following, according to Briggs and Stratton:

- When an engine is new, change the oil after 5 hours of use.
- When an engine is used daily, or in hot, dusty conditions, change the oil at least after 25 hours of use.
- When an engine is operated normally, and reaches 50 hours of use or annually, whichever comes first.
- If an engine is to be stored for the winter season it’s a good idea to change the oil before storage.

Don’t forget to dispose of your used oil properly at a location that recycles oil. NEVER pour used oil onto the ground. Once the oil is drained into a proper container, try your local garage. All garage workshops must have disposal barrels and many will allow you to dump your used oil into their barrels.

Resources/Handouts/References

- Oil changing guide from Briggs and Stratton:
  http://www.briggsandstratton.com/maint%5Frepair/routine%5Fmaintenance/changing%5Foil/

Important Words

Help members define the following words and look for members using this vocabulary in their discussions. Ask for sentences that "show you know." When members construct novel sentences they confirm their understanding of a new word. Have members use as many terms per sentence to show that connections can be useful. Members can also create impromptu speeches using these terms.

| Oil | A liquid extracted from petroleum and used as a domestic fuel or as a machinery and engine lubricant, e.g. heating oil or motor oil. |
| Viscosity | Thickness and stickiness. The property of a fluid that causes it to resist flowing. |
| Filter | A device made of or containing a porous material used to collect particles from a liquid or gas passing through it. |
| Additive | Something added to something else to alter or improve it in some way. |

Age Considerations

- 12 and up

Thinking Ahead

- What will you discuss with members? Gather observations that will help support your discussion.
Preparing for Success

- Ask members how they know they will be successful in this builder. Discuss what success looks like, sounds like, and feels like.

Activating Strategies

- From the Member Manual, ask members why certain things need lubrication or oiling? (such as hinges, bicycle chains, engines, etc.)

Do it!

Work on Your Oil Burner

Time required: 2 hours

Equipment/Supplies

- Four stroke engine, wrench, oil filter wrench, rags, oil, drain pan

Instructions

1. Share stories about people who had new vehicles or equipment that was not maintained properly and in disrepair. Examples may include, tires not rotated or replaced, items not kept clean, equipment not changed or checked routinely. Have members discuss their own stories.
2. Direct members as they perform oil maintenance on a four-stroke engine. Explain and demonstrate as necessary. Make sure members use the lubrication checklist in the Member Manual.

- Why is important to change oil regularly?

<table>
<thead>
<tr>
<th>Lubrication Checklist</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Locate oil filter</td>
<td></td>
</tr>
<tr>
<td>2. Clean off filler plug or cap</td>
<td></td>
</tr>
<tr>
<td>3. Remove filler plug or cap</td>
<td></td>
</tr>
<tr>
<td>4. Identify presence or absence of dipstick</td>
<td></td>
</tr>
<tr>
<td>5. Oil level, no dipstick (oil low, oil correct)</td>
<td></td>
</tr>
<tr>
<td>6. Oil level, dipstick</td>
<td></td>
</tr>
<tr>
<td>a. Remove dipstick</td>
<td></td>
</tr>
<tr>
<td>b. Wipe clean</td>
<td></td>
</tr>
<tr>
<td>c. Reinsert</td>
<td></td>
</tr>
<tr>
<td>d. Check level (normal, low)</td>
<td></td>
</tr>
<tr>
<td>7. Check oil condition</td>
<td></td>
</tr>
<tr>
<td>8. Add oil (if low)</td>
<td></td>
</tr>
<tr>
<td>9. Changing oil</td>
<td></td>
</tr>
<tr>
<td>a. Operate engine until warm</td>
<td></td>
</tr>
<tr>
<td>b. Stop engine, disconnect spark plug</td>
<td></td>
</tr>
<tr>
<td>c. Locate drain plug and clean</td>
<td></td>
</tr>
<tr>
<td>d. Remove drain plug</td>
<td></td>
</tr>
<tr>
<td>e. Drain five minutes</td>
<td></td>
</tr>
<tr>
<td>f. Replace drain plug</td>
<td></td>
</tr>
<tr>
<td>g. Refill crankcase with oil recommended by manufacturer’s specifications</td>
<td></td>
</tr>
<tr>
<td>h. Area around plug cleaned</td>
<td></td>
</tr>
<tr>
<td>i. Reconnect spark plug, start engine</td>
<td></td>
</tr>
<tr>
<td>j. Checked for oil leaks</td>
<td></td>
</tr>
<tr>
<td>k. Stop engine</td>
<td></td>
</tr>
<tr>
<td>l. Recheck oil level</td>
<td></td>
</tr>
<tr>
<td>m. Destroy or clean the rags used</td>
<td></td>
</tr>
<tr>
<td>n. Place old oil into oil recycling container</td>
<td></td>
</tr>
</tbody>
</table>
**Dig it!**

To help members reflect on their learning and apply what they know, ask them the following questions:

1. What surprised you about engine oil?
2. What are some ways you would like to learn?
3. Will there be times when you will need to use your skills in changing oil in an engine?

**What’s next?**

Members will continue learning about basic small engine maintenance in the next builder where they will be introduced to the spark plug and the air filter. To get members thinking about the next builder ask them if a clean engine runs better than a dirty one, and if so why?

---

**Leader’s Notes**
In the Member Manual

Skill Builder 3: Oil Maintenance

Gizmo says...
Motor oil or Engine oil is a type of liquid oil used for lubrication by various types of internal combustion engines. It creates a layer that acts as a protective film. This film reduces friction and essentially keeps metal moving parts from ever coming in contact with each other, which creates less wear on your engine.

SKILLS CHECKLIST
- Explain the importance of maintenance on small engines
- Explain the purpose of motor oil
- Perform an oil change

Important words
Watch for these important words throughout this builder:
Oil, Viscosity, Filter, Additives

Dream it!
While the main function is to lubricate moving parts, motor oil also cleans, prevents corrosion, and cools the engine by carrying heat away from the moving parts. Oil should be changed on a regular basis because, left unclean, the suspended molecules of contamination from cleaning can start to settle. This settling creates sludge in your engine, accelerating wear on all components that come in contact with your oil. And clean oil performs much better than dirty oil.

The proper amount of oil is vital to the way that your engine will perform. Too little and it may overheat, cause excessive wear, and sometimes cause engine parts to stop moving and fail. Oil also loses its abilities and cooling effectiveness with use and this will not protect your engine parts. Make it a habit to check the oil regularly. Doing this after about every 5 hours of operation is generally recommended.

What is the purpose of oil?
Oil must look after your engine in five ways:
- Lubricates - reduces friction and wear on the moving engine parts. It is very important to have correct viscosity of oil (viscosity means thickness).
- Cool engine parts - keeping piston, connecting rods, and bearings at safe working temperatures.
- Seal - forms a seal between the piston rings and the cylinder wall to prevent exhaust gases from entering the crankcase.
- Absorbs shock and reduces engine noise.
- Cleans - provides a cleaning agent to keep soot and varnish from forming during combustion. When the oil is changed these particles are drained from the engine.

Discuss with your leader why do certain things need lubrication or oiling (such as hinges, bicycle chains, or engines)?

Do it!

Work on Your Oil Burner
- Why is oil important to an engine?

What you will need: Four stroke engine, wrenches, rags, oil, drain pan

- Before you change the oil in your small engine let it run for a few minutes and make a note of how it runs. Does it burn any oil or have any other problems?
- Follow the lubrication checklist below as you change the oil in your small engine.

<table>
<thead>
<tr>
<th>Lubrication Checklist</th>
<th>Check When Done</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>n. Place old oil into oil recycling container</td>
<td></td>
</tr>
</tbody>
</table>
In the Member Manual

Dig it!

- Compare how the engine runs now from before you began. Did you notice any difference?

Picture This...

In this picture I am ____________________

Share your learning experiences with friends and family

I want you to notice ____________________

I want to explain to you why you should regularly change your engine’s oil ____________________

Engine Education

For additional information on checking and changing oil in a small engine, check out this webpage:
http://www.smallengineadvisor.com/oilchange.htm

What’s next?

Oil plays a very important part in the smooth running of an engine. In the next lesson, you will be learning about another important part of an engine: the sparkplug. The sparkplug is important because it starts the whole combustion process and because a dirty or faulty one can make your engine run very poorly or not at all.
Dream it!

Background for Leaders

Spark plugs

A spark plug consists of three parts: the insulator, electrode, and a threaded metal shell. It forces electricity to arc across a gap, just like a bolt of lightning. The electricity must be at a very high voltage in order to travel across the gap and create a good spark. The plug has to withstand the extreme heat and pressure inside the cylinder, and is designed so that deposits do not build up on the plug.

A. Connector to plug wire - Made from metal it is at the opposite end to the electrodes
B. Ceramic insulator - Houses the centre electrode and terminal and insulates them from the shell.
C. Center electrode - In standard plugs it is melted gas-tight into the insulator. It protrudes slightly from the insulator creating a specific size gap with the ground electrode.
D. Gap - electricity travels across in order to produce a spark.
E. Ground electrode- In a standard plug the electrode reaches out from the threaded end of the plug and curves over to create a specific gap size with the centre electrode.

New spark plugs are manufactured to have the proper gap between the two electrodes at their tips. Always check the gap before you install a plug.

Look in your owner’s manual to find the right gap size, insert the tip of a feeler gauge into the gap of the plug. The gauge should slide between the electrodes with light to moderate contact on either side. If the gap is too large, tap down on the ground electrode with a light hammer or wrench until it’s the right size. If it’s too small, bend the side up slightly with the flat tip of a screwdriver inserted into the gap. Tap and bend until the gap is right. This whole process of checking and adjusting is called "gapping" the plug.
Air filter

There are 3 types of air filters:

- Oil foam element - which uses oil to assist in trapping dirt
- Dry element (paper cartridge type) - which relies upon a great surface area and small pore sizes to trap dirt
- Dual element - a paper cartridge element surrounded by an oil-foam pre-cleaner element which uses the benefits of each type

One thing to remember is that pressurized air will damage the filter by driving dirt particles through the filter, creating dirt-sized holes that will allow dirt into an engine. The service interval for filters is easy to remember - every 25 hours unless under rough conditions - (dusty, dirty). Every 100 hours of use or annually, remove the cartridge and replace/clean.

Things to remember:

**Oil Foam**
- Wash filter in kerosene or hot, soapy water
- Wrap in cloth and squeeze dry - not twisting filter
- Saturate foam with engine oil - squeeze out excess
Dry Element (paper cartridge type)
- No compressed air - simply tap filter gently on a flat surface

Dual Element
- Wash pre-cleaner and treat with oil as shown in manual
- Clean dry filter by tapping on flat surface

Oil Foam Element
Clean and re-oil foam element every 25 hours of use under normal conditions; clean more frequently under extremely dusty conditions.

1. Remove cover or air cleaner.
2. Remove foam element.
   a. Wash in kerosene or liquid detergent and water.
   b. Wrap in cloth and squeeze dry.
   c. Saturate with engine oil and squeeze out excess.

Dry Element
Clean cartridge every 25 hours under normal conditions; clean more frequently under extremely dusty conditions.

Clean cartridge by tapping gently on flat surface.
If very dirty or damaged, replace cartridge.

Note: Do not use petroleum solvents, such as kerosene, nor pressurized air to clean cartridge. They will cause cartridge to deteriorate.

Dual Element
Clean pre-cleaner every 25 hours under normal conditions; clean more frequently under extremely dusty conditions.
Clean cartridge every 100 hours under normal conditions; clean more frequently under extremely dusty conditions.

1. Remove fastener(s) and cover.
2. Remove pre-cleaner.
   a. Wash pre-cleaner in kerosene or liquid detergent and water.
   b. Wrap pre-cleaner in cloth and squeeze dry.
   c. Saturate pre-cleaner in engine oil. Squeeze to remove excess oil.
Note: Some flat pre-cleaners are not to be oiled. DO NOT OIL is printed on them in large letters.
3. Install pre-cleaner cover. Re-assemble cover and screw down tight.
Yearly or every 100 hours, whichever occurs first, remove cartridge. Clean by tapping gently on flat surface. If very dirty or damaged, replace cartridge. Service more often if necessary.
Note: Do not use petroleum solvents, such as kerosene, or pressurized air to clean cartridge. Solvents will cause cartridge to deteriorate and/or pressurized air can damage the cartridge.
Keeping the engine clean

Keeping the engine clean will do more to ensure the engine is long-lived:

- Air must be able to flow across the fins under the blower housing.
- Any trash or debris will create “hot spots” in the engine.
- Clean the finger guard, rotating screen and exposed fins daily, or more often as needed. At each refuelling it would be a good idea to look at them.
- Keep trash and debris out of throttle linkages and govern linkage. Clean and inspect them after each day of use.
- Before starting engine, clean muffler of any combustible debris. Keep it clean as needed.
- If the muffler has a spark arrestor screen, remove it and clean it every 50 hours.
- Dirt and debris can enter the block housing with cooling air and block the fins. Every 100 hours of use or once a season remove the block housing and clean the cooling fins.

Resources/Handouts/References

For information on how to gauge the health of an engine by its spark plug:
http://www.theultralightplace.com/sparkplugs.htm

Important Words

Help members define the following words and look for members using this vocabulary in their discussions. To increase the members’ understanding try providing a synonym members know or provide examples. The more personalized the examples the better.

<table>
<thead>
<tr>
<th>Spark plug</th>
<th>A device designed to let a spark jump across a small gap to ignite fuel.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gapping</td>
<td>The process of checking and adjusting the gap in a spark plug.</td>
</tr>
<tr>
<td>Dry element</td>
<td>A paper cartridge air filter which relies upon a great surface area and small pore sizes to trap dirt.</td>
</tr>
<tr>
<td>Oil foam element</td>
<td>An air filter which uses oil to assist in trapping dirt.</td>
</tr>
<tr>
<td>Dual element</td>
<td>An air filter with a paper cartridge element surrounded by an oil-foam pre-cleaner element which uses the benefits of each type.</td>
</tr>
<tr>
<td>Air filter</td>
<td>A device composed of fibrous materials which removes solid particulates such as dust, pollen, mold, and bacteria from the air.</td>
</tr>
</tbody>
</table>

Age Considerations

- 12 and up

Thinking Ahead

- What will you discuss with members? Gather observations that will help support your discussion.

Preparing for Success

- Ask members how they know they will be successful in this builder. Discuss what success looks like, sounds like, and feels like.

Activating Strategies

- Ask members how an engine gets dirty (inside and out). How might that dirt affect how the engine runs?
Gapping a spark plug

Time required: 1 hour

Equipment/Supplies
- Four stroke engine
- Various used spark plugs
- Sparkplug wrench
- Owner’s manual

Instructions
1. Discuss with members how a spark plug works. Go over its parts and function.
2. Show members the used spark plugs and ask them if they can determine the health of the engine they came out of.
3. Have members gap a sparkplug by following the directions on the following table. Once a task has been completed members can check it off.
- So what is the importance of gapping a spark plug?

<table>
<thead>
<tr>
<th>Gapping a sparkplug</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Removed the spark plug</td>
</tr>
<tr>
<td>a. Disconnect spark plug wire</td>
</tr>
<tr>
<td>b. Loosen spark plug wire</td>
</tr>
<tr>
<td>c. Remove dirt from around plug</td>
</tr>
<tr>
<td>d. Correct wrench used</td>
</tr>
<tr>
<td>e. Removed without stripping threads</td>
</tr>
<tr>
<td>f. Gasket removed</td>
</tr>
<tr>
<td>2. Checking the spark</td>
</tr>
<tr>
<td>a. Reconnect the wire</td>
</tr>
<tr>
<td>b. Ground plug to engine</td>
</tr>
<tr>
<td>c. Crank engine</td>
</tr>
<tr>
<td>d. Identification of spark quality</td>
</tr>
<tr>
<td>3. No Spark</td>
</tr>
<tr>
<td>a. Disconnect wire</td>
</tr>
<tr>
<td>b. Hold wire ½ a centimetre from cylinder head, crank engine</td>
</tr>
<tr>
<td>c. Problem identification</td>
</tr>
<tr>
<td>4. Checking the plug</td>
</tr>
<tr>
<td>a. Condition identification</td>
</tr>
<tr>
<td>b. Plug selection id required</td>
</tr>
<tr>
<td>5. Cleaning spark plugs</td>
</tr>
<tr>
<td>a. Cleaned in solvent</td>
</tr>
<tr>
<td>b. Dried correctly</td>
</tr>
<tr>
<td>c. Threads cleaned with wire brush</td>
</tr>
<tr>
<td>d. Hard deposits removed</td>
</tr>
<tr>
<td>e. All loose material removed</td>
</tr>
<tr>
<td>f. Electrodes files smooth</td>
</tr>
<tr>
<td>g. Ground electrode in original position</td>
</tr>
<tr>
<td>6. Spark plug and spacing</td>
</tr>
<tr>
<td>a. Proper spacing according to manufacturer’s specifications</td>
</tr>
<tr>
<td>b. Feeler gauge according to manufacturer’s specifications</td>
</tr>
<tr>
<td>7. Spark plug installation</td>
</tr>
<tr>
<td>a. Hand tighten in place</td>
</tr>
<tr>
<td>b. Correctly tighten</td>
</tr>
<tr>
<td>c. Reconnect wire</td>
</tr>
</tbody>
</table>
Air Cleaner Checklist

Time Required: 30 min.

Equipment/Supplies

- Engines with air cleaner types talked about
- Wrench
- screw drivers
- sockets
- owners manual

Instructions

1. Discuss with members the purpose and the different types of air filters
2. Have members first determine which kind of filter their engine has and then go about cleaning it by following the directions on the appropriate table

<table>
<thead>
<tr>
<th>Oil Bath Type</th>
<th>Dry Filter Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Disable engine</td>
<td>1. Disable engine</td>
</tr>
<tr>
<td>2. Remove air cleaner</td>
<td>2. Clean around the air cleaner</td>
</tr>
<tr>
<td>a. Free bail wire</td>
<td>3. Remove Filter element</td>
</tr>
<tr>
<td>Or b. Unscrew cover</td>
<td>a. Remove stud bolt</td>
</tr>
<tr>
<td>Or c. Remove wing nut</td>
<td>b. Remove cover</td>
</tr>
<tr>
<td>3. Cover air intake</td>
<td>c. Cover carburetor air intake</td>
</tr>
<tr>
<td>4. Measure sediment deposit</td>
<td>4. Filter element</td>
</tr>
<tr>
<td>5. Clean parts in solvent</td>
<td>a. Damaged, replaced</td>
</tr>
<tr>
<td>a. Cup</td>
<td>b. Paper element – clean by tapping on flat surface</td>
</tr>
<tr>
<td>b. Filter</td>
<td>c. Moss fibre, wash in soapy water</td>
</tr>
<tr>
<td>6. Refill oil cup</td>
<td>5. Reassembly</td>
</tr>
<tr>
<td>a. Correct oil</td>
<td>a. Uncover carburetor</td>
</tr>
<tr>
<td>b. Fill level (high, on line, low)</td>
<td>b. Clean filter cover</td>
</tr>
<tr>
<td>7. Reassemble and install air cleaner</td>
<td>c. Clean carburetor intake</td>
</tr>
<tr>
<td></td>
<td>d. Replace filter element</td>
</tr>
<tr>
<td></td>
<td>e. Replace cover, tighten</td>
</tr>
</tbody>
</table>

- What happens to an engine with a dirty air filter?
Dig it!

To help members reflect on their learning and apply what they know, ask them the following questions:

1. Why is it important to be able to change a spark plug or clean an air filter?
2. What did you learn by observation?
3. How could the things you learned today help you in other situations?

What’s next?

Now that members have learned about the basic small engine maintenance tasks, in the next builder they will learn hands on the engine’s components my dismantling one. To get members thinking about the next builder ask them: what do you think the inside of an engine looks like? How many parts do they think are in an engine?
In the Member Manual

Skill Builder 4: Spark Plug & Air Filter Maintenance

Gizmo says...
Both the spark plug and the air filter are very important in the smooth running of your engine. Apart from its job of initiating the combustion process, the spark plug is also like a thermometer that can tell how well or sick the patient (or engine) is. For example, a spark plug that comes into contact with oil (oil fouled) often means that the piston rings or cylinder walls are badly worn.

Important words
Watch for these important words throughout this builder:
Spark plug, gapping, air filter

Dream it!

Spark Plugs
A spark plug consists of three parts: the insulator, electrode, and a threaded metal shell. It forces electricity to arc across a gap, just like a bolt of lightning. The electricity must be at a very high voltage in order to travel across the gap and create a good spark. The plug has to withstand the extreme heat and pressure inside the cylinder, and is designed so that deposits do not build up on the plug.

1. Connector to plug wire - Made from metal it is at the opposite end to the electrodes
2. Ceramic insulator - Houses the centre electrode and terminal and insulates them from the shell.
3. Center electrode - In standard plugs it is melted gas-tight into the insulator. It protrudes slightly from the insulator creating a specific size gap with the ground electrode.
4. Gap - electricity travels across in order to produce a spark.
5. Ground electrode - In a standard plug the electrode reaches out from the threaded end of the plug and curves over to create a specific gap size with the centre electrode.

New spark plugs are manufactured to have the proper gap between the two electrodes at their tips. Always check the gap before you install a plug.

SKILLS CHECKLIST
- Describe the components of a spark plug and air filter and describe how they work.
- Gap a spark plug
- Clean and care for an air filter

Analyzing a Spark Plug

1. Normal
2. Normal with red coating
3. Fuel fouled
4. Decompression
5. Worn plug

1. Cause: red coating resulting from fuel additive in unleaded fuel
2. Cause: faulty choke - overly rich fuel mixture, ignition problems or plug heat range too cold
3. Cause: over advanced timing, low octane fuel
4. Cause: plug used beyond its service life. Need to replace
5. Cause: melting lead deposits—plug too hot at high speeds
6. Carbon fouled
7. Pre-ignition
8. Lead fouled
9. Oil fouled

1. Cause: plug heat range too hot—over advanced timing, air/fuel mixture too lean
2. Cause: use of leaded fuel
3. Cause: poor oil control—worn rings, worn valve guides and valve seals

Air Filters
Since many small engines are used in machines that get dirty and/or dusty, the air filter (which traps dust and dirt in the incoming air) is especially important. Without it there would be dust or dirt drawn into the engine clogging the carburetor and air passages and causing internal engine wear.

There are 3 types of air filters:
- Oil foam element - which uses oil to assist in trapping dirt
- Dry element (paper cartridge type) - which relies upon a great surface area and small pore sizes to trap dirt
- Dual element - a paper cartridge element surrounded by an oil-foam pre-cleaner element which uses the benefits of each type
In the Member Manual

Oil Foams Element
Clean and re-oil foam element every 25 hours of use under normal conditions; clean more frequently under extremely dusty conditions.

Dual Element
Clean pre-cleaner every 50 hours under normal conditions; clean more frequently under extremely dusty conditions.

Clean cartridge every 100 hours under normal conditions; clean more frequently under extremely dusty conditions.

1. Remove cover or air cleaner.
2. Remove foam element.
   a. Wash in kerosene or liquid detergent and water.
   b. Wrap in cloth and squeeze dry.
   c. Saturate with engine oil and squeeze out excess.

Dry Element
Clean cartridge every 25 hours under normal conditions; clean more frequently under extremely dusty conditions.

1. Remove flange(s) and cover.
2. Remove pre-cleaner.
   a. Wash pre-cleaner in kerosene or liquid detergent and water.
   b. Wrap pre-cleaner in cloth and squeeze dry.
   c. Saturate pre-cleaner in engine oil. Squeeze to remove excess oil.
   Note: Some flat pre-cleaners are not to be oiled. DO NOT OIL is printed on them in large letters.
3. Install pre-cleaner cover. Re-assemble cover and screw down tight.

Yearly or every 100 hours, whichever occurs first, remove cartridge. Clean by tapping gently on flat surface. If very dirty or damaged, replace cartridge. Service more often if necessary.

Note: Do not use petroleum solvents, such as kerosene, or pressurized air to clean cartridge. They will cause cartridge to deteriorate and/or pressurized air can damage the cartridge.

Cleaning filters:
- Oil Foam
  - Wash filter in kerosene or hot soapy water
  - Wrap in cloth and squeeze dry - not twisting filter
  - Saturate foam with engine oil - squeeze out excess

- Dry Element (paper cartridge type)
  - No compressed air - simply tap filter gently on a flat surface

- Dual Element
  - Wash pre-cleaner and treat with oil as shown in manual
  - Clean dry filter by tapping on flat surface

Engine Cleanliness

Keep your machine clean! Keeping the engine clean will do more to ensure your engine lasts a long time:

- Air must be able to flow across the fins under the blower housing.
- Any trash or debris will create "hot spots" in the engine.
- Keep clean the finger guard, rotating screen and exposed fins daily, or more often as needed. At each refueling it would be a good idea to look at them.
- Keep trash and debris out of throttle linkages and governor linkage. Clean and inspect them each day of use.
- Before starting engine, clean muffler of any combustible debris. Keep it clean as needed.
- If the muffler has a spark arresting screen, remove it and clean it every 50 hours.
- Dirt and debris can enter the block housing with cooling air and block the fins. Every 100 hours of use or once a season, remove the block housing and clean the cooling fins.
- Make sure the cooling fins are clear of debris. Use compressed air or water pressure. (DO NOT SPRAY A HOT ENGINE WITH WATER).

Do it!

Gapping a Spark Plug

- How does a spark plug’s gap relate to performance?

Look at the various spark plugs your leader has provided you. Compare them to a new spark plug and try to analyze the health of the engines they came from.

Using the table on the following page, clean and gap your engine’s spark plug.
# In the Member Manual

<table>
<thead>
<tr>
<th>Gapping a Spark Plug Checklist</th>
<th>Check Once Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Removing the spark plug</td>
<td></td>
</tr>
<tr>
<td>a. Disconnect spark plug wire</td>
<td></td>
</tr>
<tr>
<td>b. Loosen spark plug wire</td>
<td></td>
</tr>
<tr>
<td>c. Remove dirt from around plug</td>
<td></td>
</tr>
<tr>
<td>d. Correct wrench used</td>
<td></td>
</tr>
<tr>
<td>e. Removed without stripping threads</td>
<td></td>
</tr>
<tr>
<td>f. Gasket removed</td>
<td></td>
</tr>
<tr>
<td>2. Checking the spark</td>
<td></td>
</tr>
<tr>
<td>a. Reconnect the wire</td>
<td></td>
</tr>
<tr>
<td>b. Ground plug to engine</td>
<td></td>
</tr>
<tr>
<td>c. Crank engine</td>
<td></td>
</tr>
<tr>
<td>d. Identification of spark quality</td>
<td></td>
</tr>
<tr>
<td>3. No Spark</td>
<td></td>
</tr>
<tr>
<td>a. Disconnect wire</td>
<td></td>
</tr>
<tr>
<td>b. Hold wire ½ a centimetre from cylinder head, crank engine</td>
<td></td>
</tr>
<tr>
<td>c. Problem identification</td>
<td></td>
</tr>
<tr>
<td>4. Checking the plug</td>
<td></td>
</tr>
<tr>
<td>a. Condition identification</td>
<td></td>
</tr>
<tr>
<td>b. Plug selection id required</td>
<td></td>
</tr>
<tr>
<td>5. Cleaning spark plugs</td>
<td></td>
</tr>
<tr>
<td>a. Cleaned in solvent</td>
<td></td>
</tr>
<tr>
<td>b. Dried correctly</td>
<td></td>
</tr>
<tr>
<td>c. Threads cleaned with wire brush</td>
<td></td>
</tr>
<tr>
<td>d. Hard deposits removed</td>
<td></td>
</tr>
<tr>
<td>e. All loose material removed</td>
<td></td>
</tr>
<tr>
<td>f. Electrode files smooth</td>
<td></td>
</tr>
<tr>
<td>g. Ground electrode in original position</td>
<td></td>
</tr>
<tr>
<td>6. Spark plug and spacing</td>
<td></td>
</tr>
<tr>
<td>a. Proper spacing according to manufacturer’s specifications</td>
<td></td>
</tr>
<tr>
<td>b. Feeler gauge according to manufacturer’s specifications</td>
<td></td>
</tr>
<tr>
<td>7. Spark plug installation</td>
<td></td>
</tr>
<tr>
<td>a. Hand tighten in place</td>
<td></td>
</tr>
<tr>
<td>b. Correctly tighten</td>
<td></td>
</tr>
<tr>
<td>c. Reconnect wire</td>
<td></td>
</tr>
</tbody>
</table>

## Gizmo’s Fast Facts
Spark plug gap adjustment is important and if it is not adjusted correctly the engine may run badly, or not at all. A narrow gap may give too small and weak a spark to effectively ignite the fuel-air mixture, while a gap that is too wide might prevent a spark from firing at all. Either way, a spark which only intermittently fails to ignite the fuel-air mixture may not be noticeable directly, but will show up as a reduction in the engine’s power and fuel efficiency. The main issues with spark plug gaps are:
- **narrow-gap**
  - risk: spark might be too weak/small to ignite fuel
- **wide-gap**
  - risk: plug might not fire, or miss at high speeds
A properly gapped plug will be wide enough to burn hot, but not so wide that it skips or misses at high speeds, causing that cylinder to drag, or the engine to begin to rattle.

## Air Filter Checklist
- How does the air filter help an engine run smoothly?
- What kind of air filter does your engine have?
- Check your engine’s air filter by following the appropriate filter type checklist:

| What you will need: | Engine with air cleaner type talked about, wrench, screw drivers, sockets, owners manual |

## Oil Bath Type Checklist

<table>
<thead>
<tr>
<th>1. Disable engine</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Remove air cleaner</td>
<td></td>
</tr>
<tr>
<td>a. Free bail wire</td>
<td></td>
</tr>
<tr>
<td>Or b. Unscrew cover</td>
<td></td>
</tr>
<tr>
<td>Or c. Remove wing nut</td>
<td></td>
</tr>
<tr>
<td>3. Cover air intake</td>
<td></td>
</tr>
<tr>
<td>4. Measure sediment deposit</td>
<td></td>
</tr>
<tr>
<td>5. Clean parts in solvent</td>
<td></td>
</tr>
<tr>
<td>a. Cup</td>
<td></td>
</tr>
<tr>
<td>b. Filter</td>
<td></td>
</tr>
<tr>
<td>6. Refill oil cup</td>
<td></td>
</tr>
<tr>
<td>a. Correct oil</td>
<td></td>
</tr>
<tr>
<td>b. Fill level (High, mid, low)</td>
<td></td>
</tr>
<tr>
<td>7. Reassemble and install air cleaner</td>
<td></td>
</tr>
</tbody>
</table>
In the Member Manual

Dry Filter Type Checklist

1. Disable engine
2. Clean around the air cleaner
3. Remove Filter element
   a. Remove stud bolt
   b. Remove cover
   c. Cover carburetor air intake
4. Filter element
   a. Damaged, replaced
   b. Paper element – clean by tapping on flat surface
   c. Moss fibre, wash in soapy water
5. Reassembly
   a. Uncover carburetor
   b. Clean filter cover
   c. Clean carburetor intake
   d. Replace filter element
   e. Replace cover, tighten

Dig it!

Think about your learning …

Think about this builder and the activities you did …
Review the Skills Checklist on page 15. What skills have you developed? Do you need more practice?

Record it …
Discuss what you have learned with your leader so that the information can be recorded on your Portfolio Page.

Apply it …
How could you explain to others how a sparkplug is like your engine’s thermometer?

Showcase Challenge?
Have you thought about what you might like to do for the showcase challenge?

What’s next?

Now that you know some of the basics of small engine maintenance it is time to take a closer look at how small engines are put together. In the next builder you will learn this by taking one apart! So for next time get your tools ready, your work clothes on, and be prepared to get dirty!
Skill Builder 5: Engine Disassembly

Skills Checklist

- Identify all small engine parts
- Take apart a small engine using the correct tools

Dream it!

Members will apply the knowledge they have learned so far in this builder by ripping apart a small engine. Getting in there is the best way to identify the parts and understand how they work. If you can do both a 2 stroke and a 4 stroke engine, it is excellent for members to see the difference. If both engines are not available please do at least one engine. This can be set up as a group, pairs or an individual effort dependent on the ability of members and availability of engines.

Resources/Handouts/References

Information on disassembling a lawnmower engine:
http://www.repairfaq.org/samnew/lmfaq/lmeoverp.htm

Important Words

Help members define the following words and look for members using this vocabulary in their discussions. Get members to use a dictionary (printed or online) and show them the range of information it provides.

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tools</td>
<td>An object designed to do a specific kind of work such as cutting or chopping by directing manually applied force or by means of a motor.</td>
</tr>
</tbody>
</table>

Age Considerations

- 12 and up

Thinking Ahead

- What will you discuss with members? Gather observations that will help support your discussion.

Preparing for Success

- Ask members how they know they will be successful in this builder. Discuss what success looks like, sounds like, and feels like.

Activating Strategies

- Ask members how they think a small engine is built or put together and in what order. Would it matter what parts are removed first?
Do it!

Ripping it Apart

Time required: 2-3 hours

Equipment/Supplies

• Small engine (not working)  • Basic tools  • Engine manual

Safety Considerations

• Safe and proper tool use should be observed by members
• Members should wear eye protection when dismantling engine

Suggested Variations/Age Appropriate Variations

• This activity can be set up as a group, in pairs, or individual effort dependent on ability of members and availability of engines.

Instructions

1. Review with members the parts of a small engine
2. Have members select the tools they think they will need to dismantle an engine
3. Have members rip apart a small engine. Getting in there is the best way of identifying the parts and understanding how they work. If you can do both a 2 stroke and a 4 stroke engine it will be excellent for members to see the difference. If both engines are not available, do at least one engine.
4. Have a member take photographs of the activity as it progresses
   • Give members the option to create a display for the showcase challenge. They can use photos, real parts, or diagrams to show they know the insides of a small engine.

Dig it!

To help members reflect on their learning and apply what they have learned ask them the following questions:

1. What did you learn about engines while dismantling one?
2. Which part(s) were the most difficult to remove?
3. Based on what you have learned so far, do you think you could rebuild a small engine? Why?

What's next?

In the next builder members will apply what they have learned in the project by creating a maintenance checklist for a machine with a small engine and then perform the necessary maintenance on it. To get members thinking about the next builder ask them to think about what they have learned in this project so far about maintaining a small engine.

Leader’s Notes
In the Member Manual

Skill Builder 5: Dismantling An Engine

Gizmo says...
The gasoline engine consists of many parts that work together as a smooth power team. To competently troubleshoot, maintain, and repair a small engine, it is important to be able to identify these parts and explain how they fit and work together. In this builder you are to disassemble a typical four-stroke cycle engine and study the basic parts.

SKILLS CHECKLIST
- Identify engine parts
- Take apart a small engine using the correct tools

Important words
Watch for these important words throughout this builder:
Engine parts, Tools

Dream it!
Now that you know the basics of small engines, it’s time to get your hands dirty! Taking apart a small engine will give you an even better understanding of its components.

In this activity you will:
- Take apart a small engine
- Learn how to use the right tools
- Identify your engine’s parts

How Many Parts?
- How many parts make up a small engine?

Make an educated guess as to the number of parts that are in your engine and write the number in the box below. Then, when you have disassembled your engine count the parts and put in the actual number.

<table>
<thead>
<tr>
<th>Number of Engine Parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>My guess:</td>
</tr>
<tr>
<td>Actual:</td>
</tr>
</tbody>
</table>

Do it!

Ripping It Apart
Before you begin taking apart your engine think about how will you approach it. Do you have a plan as to what parts will come off before others?

What you will need: Four stroke engine, tools, shop setting

Before You Get Started
1. Prepare your work surface
2. Lay out your tools so that they will be easily accessible
3. Decide which parts will be removed first
4. As you dismantle your engine identify and label each part

- Which part was the hardest to remove? ______________________
- Which tool did you use the most? ______________________

Dig it!

Think about this builder and the activities you completed...

Review the Skills Checklist on page 4. What skills have you developed? Do you need more practice?

How Did it Go? Discuss and Answer these questions:

What was it like taking apart an engine?

How did you decide which parts would be removed first?

Did you learn anything new about small engines in this meeting? If so, what?

Engine Education
Check out this step by step guide to small engine disassembly (with pictures):
http://www.dynetwork.com/dyriabl_small_engines/article/0,DIY_13693,2276449,00.html

What’s next?
Taking apart a small engine is the last stage of learning about the operation and maintenance of small engines. You should now know enough about small engines to be able to maintain one successfully. In the next and final builder you will create your own maintenance checklist for a machine with a small engine and provide the basic maintenance to keep it running smoothly.
Skill Builder 6: Maintaining a Small Engine

Skills Checklist
- Make a maintenance check list
- Provide needed maintenance on a small engine
- Properly store a machine at end of season

Dream it!

Background for leaders
By maintaining their own small engine members learn important job-readiness skills such as attention to detail, following instructions, planning, critical thinking, and problem solving.

While this project meeting focuses on members performing maintenance on a small engine, they will need to know how to store their machine when the season is over. When you store an engine properly it should run and operate the same as it did when it went into storage. The end of the season is a good time to service your engine. If any repairs are needed, you can do it then or make a note regarding what is required before starting it up the next time.

Storage of small engines

Storage procedure:

1. Either use a fuel stabilizer product added to the gas tank or pour out unused fuel from the gas tank, then run the engine until it stops. This process drains the gas tank and carburetor.
2. Clean the engine by removing dirt and dust from the cooling fins and outside of the engine.
3. Check and clean (or replace) the air filter
4. Check the spark plug and clean (or replace) if needed
5. Coat the inside of the engine using either:
   a. an engine fogging oil that is sprayed into the engine intake or carburetor while engine is running (follow manufacturer’s directions)
   Or
   b. Pouring one or two ounces (30 or 60 ml) of engine oil into the spark plug hole then manually rotating the engine a few times to distribute the oil.
   c. After engine has been coated turn it over until the piston is at the top of the compression stroke to seal off the combustion chamber (both the intake and exhaust valves are closed)
      Store engine in a garage or shed to keep it dry

Now your engine can be put away for another season.

Resources/Handouts/References
Information on disassembling a lawnmower engine:
http://www.repairfaq.org/samnew/lmfaq/lmeoverp.htm
Important Words

Help members define the following words and look for members using this vocabulary in their discussions. A few strategies you can use include;
- Teach synonyms by providing a synonym members know.
- Also, teach antonyms. Not all words have antonyms, but thinking about opposites requires the members to evaluate the critical attributes of the words in question.
- Provide non-examples. Similar to using antonyms, providing non-examples requires members to evaluate a word's attributes. Invite members to explain why it is not an example.

<table>
<thead>
<tr>
<th>Storage</th>
<th>the act of storing something, or the condition of being stored</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance</td>
<td>Continuing repair work - work that is done regularly to keep a machine, building, or piece of equipment in good condition and working order. Upkeep - the general condition of something with respect to repairs</td>
</tr>
</tbody>
</table>

Age Considerations
- 12 and up

Thinking Ahead
- What will you discuss with members? Gather observations that will help support your discussion.

Preparing for Success
- Ask members how they know they will be successful in this builder. Discuss what success looks like, sounds like, and feels like.

Activating Strategies
- Ask members what they think happens to the fluids in a small engine (oil, gas) over the winter.

Do it!

Maintaining & Storing My Machine

Time required: 3 hours

Equipment/Supplies
- Small engine machines (1 machine per 1 – 3 members)
- Checklists
- Basic tools
- Operating manual

1. Have members select a small machine from home – lawnmower, skidoo, etc.
2. Help them develop a maintenance check list using project knowledge, operator manuals and your support. Have them create an end of season check list as well that they can refer to at the end of the season.

Members will now complete the check and do any basic maintenance required to keep their machine running smoothly.
Dig it!

To help members reflect on their learning and apply what they know, ask them the following questions:
1. What was hard about maintaining an engine?
2. What advice would you give to someone who is thinking of doing this project?
3. With the skills you have acquired in this project, will you now maintain the small engine machines at your home? Why?

What’s next?

It is at this point where members have completed all the developmental activities as set out in this project. This final section is a chance for leaders to evaluate the learning of the members, and a chance for the members to present their findings to their peers and parents.

Leader’s Notes
In the Member Manual

Skill Builder 6: Maintaining a Small Engine

Gizmo says...
Knowing when to service your small engine is as important as knowing how to service it. By following the service recommendations in the owner’s manual or by using your own maintenance schedule, you are ensuring that your small engine will keep running smoothly and therefore reduce the need for repairs.

SKILLS CHECKLIST
• Make a maintenance check list
• Provide needed maintenance on a small engine
• Properly store a machine at the end of the season

Important words
Watch for these important words throughout this builder: Maintenance, Schedule, Storage

Dream it!
This lesson will let you take all the knowledge you have gained in this project so far and apply it to everyday life. To do this you will maintain a machine from home/your farm with a small engine so that it runs smooth and continues to do so.

Which machine will you pick to maintain? Why?

Do it!
Maintaining & Storing My Machine

What you will need:
Machine with a small engine, tools, owner’s manual, shop setting

Safety First!
Don’t forget the rules of shop safety!

1. After selecting a machine from home make a maintenance checklist/log using the information you have learned in this manual and your engine’s owner’s manual (if available).
2. Do a complete check on your engine of choice and do any maintenance that is needed
3. Put down your information in the checklist on the following page

Storage of small engines
As you have learned, regular maintenance is important for the long and useful life of an engine. Many machines with small engines are used for a particular season and when that season is over those machines need to be stored. When you store an engine properly it should run and operate the same as it did when it went into storage. The end of the season is a good time to service your engine. If any repairs are needed, you can do it now or make a note about what is required before starting it up the next time.

Storage procedure:
1. Either use a fuel stabilizer product added to the gas tank or pour out unused fuel from the gas tank, then run the engine until it stops. This process drains the gas tank and carburetor.
2. Clean the engine by removing dirt and dust from the cooling fins and outside of the engine.
3. Check and clean (or replace) the air filter.
4. Check the spark plug and clean (or replace) if needed.
5. Coat the inside of the engine using either:
   A. an engine fogging oil that is sprayed into the engine intake or carburetor while engine is running (follow manufacturer’s directions)
   Or
   B. Pouring one or two ounces (30 or 60 ml) of engine oil into the spark plug hole then manually rotating the engine a few times to distribute the oil.
6. After engine has been coated turn it over until the piston is at the top of the compression stroke to seal off the combustion chamber (both the intake and exhaust valves are closed). Store engine in a garage or shed to keep it dry.
7. Create an end of season check list that you can refer to at the end of the season.

Now your engine can be put away for another season.

Maintaining My Machine Checklist/Log

<table>
<thead>
<tr>
<th>Engine Part</th>
<th>Date Checked</th>
<th>Required Maintenance? (yes or no)</th>
<th>Parts Needed / Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

24
In the Member Manual

**Dig It!**

Think about this builder and the activities you did...

Review the Skills Checklist at the start of this builder. What skills have you developed? Do you need more practice?

**Picture This...**

In this picture I am ________________________________

**Share your learning experiences with friends and family**

In this picture I want you to notice ________________________________

I want to explain to you how to properly store a machine with a small engine ________________________________

**What's next?**

Now that you have finished all the builders in this project it is time to think about and plan for the Showcase Challenge. Also, do not forget about your Portfolio Page where you can make sure your Discovering Small Engines Project Skills Chart is complete. There is space for you to write down some thoughts and reflections on the project (what you liked, didn’t like, etc.).
Showcase Challenge

Have members use their Member Manual to help them organize what they have learned. The form of this showcase can vary according to the wishes of the leaders and member’s ability. Information can be presented in many forms, some of which are: posters, pamphlets, written reports, speeches, computer presentations, displays, etc. Suggestions are listed on the Showcase Challenge page at the back of the Member Manual. The best results are almost always obtained when members are allowed to present their information in the style of their choice.

Suggestions (not found in the Member Manual):

- Have members plan and give a presentation on the parts of an engine to friends, family members, other school children (their class or a younger grade), senior citizens, etc. The presentation should include both written (planning, speech) and oral (speaking to group) components. Possible demonstration topics:
  - How to change oil
  - Service spark plugs
  - Proper starting procedures
  - Difference between two and four stroke engines
  - Importance of proper small engine maintenance
- Visit a small engine repair shop
- Make a list of small engines your family owns and determine what they need to run smooth.
- Talk to a car or tractor mechanic to learn how a small engine differs from a larger one.
- Rebuild a small engine.
- Compare the cost of work you did on your engine to the cost to hire someone else.
- Volunteer to help a neighbor or friend store their small engine.
In the Member Manual

**Do It!**
Insert or attach your finished product or a photo of you sharing your skills in your Showcase Challenge.

**Dig It!**
Now that you have showcased your project skills:
- How did your Showcase Challenge go?
- What would you do differently next time?
- How will you use your new skills in the future? (in different situations?)
Once members have completed all the builders they will have a lot of information recorded in their manuals. These are products of their learning. As a final exercise in the project, members and leaders will pull together all this learning in completing the Portfolio Page in the Member Manual. There is a skills chart that lists the skills members are expected to complete by the end of the project. Leaders must indicate how they know the member was successful at a particular skill. Leaders will find evidence if they think about what they have observed members doing, what discussions they have had with members, and what members have produced. If leaders think that members need to go back and improve on any skill, this chart helps them clarify what needs to be done.

**My 4-H Portfolio Page**

**Discovering Small Engines Skills Chart**

To be completed by the leader and the member based on observations and conversations throughout the project.

<table>
<thead>
<tr>
<th>Skill Builder</th>
<th>Members will be able to…</th>
<th>We know this because…</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each Builder had a Skills Checklist which identified the skill you will learn.</td>
<td>Identify the different types of small engines</td>
<td>Identify activities completed and record observations and information from discussions about activities.</td>
</tr>
<tr>
<td>Identify the basic safety rules when working with engines</td>
<td>Know the basic safety rules when working with engines</td>
<td></td>
</tr>
<tr>
<td>Identify and describe tools used to maintain small engines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Know how 2 and 4 stroke engines work and the advantages and disadvantages of each</td>
<td>Know how 2 and 4 stroke engines work and the advantages and disadvantages of each</td>
<td></td>
</tr>
<tr>
<td>Identify the parts of 2 and 4 stroke engines</td>
<td>Identify the parts of 2 and 4 stroke engines</td>
<td></td>
</tr>
<tr>
<td>Know the importance of maintenance on small engines</td>
<td>Know the importance of maintenance on small engines</td>
<td></td>
</tr>
<tr>
<td>Know the purpose and ingredients of oil</td>
<td>Know the purpose and ingredients of oil</td>
<td></td>
</tr>
<tr>
<td>Complete an oil change</td>
<td>Complete an oil change</td>
<td></td>
</tr>
<tr>
<td>Know the components of a spark plug and air filter and how they work</td>
<td>Know the components of a spark plug and air filter and how they work</td>
<td></td>
</tr>
<tr>
<td>Gap a sparkplug</td>
<td>Gap a sparkplug</td>
<td></td>
</tr>
<tr>
<td>Clean and care for an air filter</td>
<td>Clean and care for an air filter</td>
<td></td>
</tr>
<tr>
<td>Identify all small engine parts</td>
<td>Identify all small engine parts</td>
<td></td>
</tr>
<tr>
<td>Take apart a small engine using the correct tools</td>
<td>Take apart a small engine using the correct tools</td>
<td></td>
</tr>
<tr>
<td>Make a maintenance check list</td>
<td>Make a maintenance check list</td>
<td></td>
</tr>
<tr>
<td>Provide needed maintenance on a small engine</td>
<td>Provide needed maintenance on a small engine</td>
<td></td>
</tr>
<tr>
<td>Store machines at end of season</td>
<td>Store machines at end of season</td>
<td></td>
</tr>
</tbody>
</table>

Additional Comments/Activities:

**Leader Point of Praise!**

I am most impressed by…

I acknowledge that the member has completed the 4-H project requirements.

Leader's Signature: ____________________________
In the Member Manual

Above and Beyond!

In addition to project skills, 4-H also increases skills in meeting management, communications, leadership, community involvement through participation in club, area, or provincial 4-H events or activities. List below any activities you participated in this year in 4-H.

(Some examples include Executive Positions Held, Workshops, Communication, Community Service, Rally, Bonspriels, Conferences, Judging, Camps, Trips, Awards, Representation to Area or Provincial Councils, etc)

**Feel Free to add additional pages that include awards, certificates, new clippings, photos or other items that describe your 4-H involvement.

Member Point of Pride!

What I learned...

What I need to improve on...

What I want others to notice...

Member’s Signature: ______________________________

Point of Praise! Another’s perspective on your achievements in 4-H.

(community professionals, MAFRI staff, 4-H club head leaders, 4-H Ambassadors, friends of 4-H)

I am most impressed by...

I believe that you have learned...

In the future I encourage you to...

Signature: ______________________________
4-H Achievement

4-H Achievement is... a 4-H club celebration when members have completed their projects. Achievements are planned by the club to give recognition to members and leaders for their accomplishments in their 4-H projects and club activities.

A 4-H Achievement can take many different formats: from choosing a theme, to member project displays, to members using their new skills for the event (entertainment, food, decorating, photographer, etc.), to members presenting their project to the whole group, the options are endless and open to the creativity of the members and leaders in each club!

Clubs may also plan their Achievement to promote 4-H to the community or to recognize sponsors and others who have helped the club.

Members and leaders - be sure to check your project books for the project completion requirements, so you will be ready for your club’s Achievement celebration!

If you have any questions, comments or suggestions for this or other 4-H projects contact:

Manitoba 4-H Projects
Manitoba Agriculture Food and Rural Initiatives
1129 Queens Avenue
Brandon, MB R7A 1L9

Email: 4h@gov.mb.ca
Phone: 204-726-6613
Fax: 204-726-6260

For more information about 4-H and the many 4-H opportunities available please visit

http://www.gov.mb.ca/agriculture/4-h/
What is 4-H?

4-H is an international youth organization involving more than 7 million members in 80 countries around the world.

In Canada, 4-H began in 1913 in Roland, Manitoba as a community-based organization dedicated to growth and development of rural youth. Today’s 4-H program reaches both farm and non-farm youth across Canada. The motto of “Learn to Do by Doing” is embodied in the program, as 4-H focuses on skill development as well as personal development of life skills such as communications, leadership and citizenship.

4-H Motto

“Learn To Do by Doing”

4-H Pledge

I pledge,
My HEAD to clearer thinking,
My HEART to greater loyalty,
My HANDS to greater service,
My HEALTH to better living,
For my club, my community, and my country.

4-H Quality Equation Principles

Quality People
- Promote responsibility, respect, trust, honesty, fairness, sportsmanship, citizenship, teamwork and caring.

Quality Experiences
- Provide members with personal development and skill development experiences.

Quality Projects
- Promote and value quality effort.
- Promote high quality, safe food production within industry standards.

Manitoba 4-H project material is developed by
Manitoba Agriculture, Food and Rural Initiatives (MAFRI)