MECHANIC SKILLS: Explanation
Skills explanations and demonstrations are a great teaching tool. They require fewer tools and less time than hands-on “practice” classes; however, they are less engaging. As noted in the introduction, we follow four main guidelines when teaching all our classes:

- Ask twice as many questions as you answer.
- Emphasize a hands-on approach to learning.
- Focus on “problem solving” and “troubleshooting.”
- Safety is part of every lesson.

Asking questions and allowing youth to talk about their experiences helps keep youth engaged and promotes problem solving, instead of just mechanics for the sake of mechanics. Emphasizing a “hands-on” approach is particularly difficult during “Explanation” lessons. At Bike Works we combine these lessons with hands-on “Practice” lessons in every class. “Problem Solving” and “Troubleshooting” during these lessons involves asking youth what they think might happen if their brakes fail, or encouraging them to look at an entire system instead of just one part of the bike. Safety in every lesson often revolves around the youth experience. Why do we care if a chain is worn? What is an example of a time your brakes didn’t work as well as you’d hoped? Each teacher will add his or her own energy and ideas to each lesson, however, these four guidelines help us provide uniform quality of programs across instructors.
### WHAT YOU WILL FIND IN THIS SECTION

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introductions</td>
<td>63</td>
</tr>
<tr>
<td>Parts of the Bike</td>
<td>65</td>
</tr>
<tr>
<td>In–Room Scavenger Hunt</td>
<td>66</td>
</tr>
<tr>
<td>Fix a Flat Explanation</td>
<td>67</td>
</tr>
<tr>
<td>Ball Bearings Explanation</td>
<td>71</td>
</tr>
<tr>
<td>Front Hub Explanation</td>
<td>73</td>
</tr>
<tr>
<td>Threaded Headset Explanation</td>
<td>78</td>
</tr>
<tr>
<td>1–Piece Bottom Bracket Explanation</td>
<td>82</td>
</tr>
<tr>
<td>Brakes: BMX and MTB Explanation</td>
<td>85</td>
</tr>
<tr>
<td>Rear Derailleur Explanation</td>
<td>89</td>
</tr>
<tr>
<td>Front Derailleur Explanation</td>
<td>94</td>
</tr>
<tr>
<td>Threadless Headset Explanation</td>
<td>96</td>
</tr>
<tr>
<td>3–Piece Bottom Bracket Explanation</td>
<td>98</td>
</tr>
<tr>
<td>Advanced Drivetrain Explanation</td>
<td>101</td>
</tr>
<tr>
<td>Rear Hub Explanation</td>
<td>105</td>
</tr>
<tr>
<td>Wheel Truing Explanation</td>
<td>108</td>
</tr>
</tbody>
</table>
INTRODUCTIONS 1 OF 2

Introduce yourself, the project, the space, the organization and expectations.

LESSON

Take time to welcome students into the space by introducing all the elements of your organization.

1. Staff and students
   Give the students the opportunity to introduce themselves and give a brief explanation of why they’re taking the class, if they have any repair experience, what kind of bikes they like. Students are often shy at first, but may get into telling stories; this is good as an ice-breaker of sorts, but can quickly start taking up time.

2. Your organization
   Ask youth what they know about the organization, and then fill in the gaps. Cover non-profit status, community bike shop, how donations work, recycling ethos, Earn-a-Bike, rides, weekend/ additional events, as well as why we do this.

3. Mandated reporters
   Talk about who is a mandated reporter (all staff who work with youth) and what this means. Disclose the fact that we are each Mandated Reporters here at Bike Works in a clear, specific, and tangible way that is age appropriate.

4. Contract and shop rules
   Use standard organization rules or do one of the activities in the “Group Forming” section of this book in order to create a class–specific set of guidelines. Have students read off a rule and discuss its importance for a minute or two. If using standard organization rules, let the students come up with ideas, then add whatever you think is necessary. (See pages 27–33 for more ideas about how to create a contract that works for you.)

CONTINUED ON P. 64

MATERIALS

Print out signage with shop expectations/rules—this can be created in some of the earlier activities in the “Forming” section

RESOURCES

None

FRAMEWORKS
Mechanic Skills: Explanation
LESSON (CONTINUED FROM P. 63)

5. Tour of the Space
   At this point the youth can be getting antsy, if so have them move around for the tour. Be sure to show them where to wash hands, the bathroom, where to hang their jackets and backpacks, etc.

NOTE
For classes with many returning students, have youth lead the review of these things for new students and each other.

MATERIALS & RESOURCES
See p. 63
PARTS OF THE BIKE

Introduce students to the parts of a bike.

LESSON

1. Pass out a handout with an image of a bicycle (labeled for younger youth or for a shorter time frame; or un-labeled for older youth or a longer class).

2. Using the bicycle in the stand, talk about the different parts of the bicycle pointing at the parts on the bicycle in the stand and comparing that to the handout. If you have an older group, you can use an un-labeled handout and have students fill in the parts as you learn about them.

3. Give participants a chance to share what they know as well as different names for different parts depending on region and country of origin.

MATERIALS

Pens/ pencils
Bicycle in a stand
Parts of the Bike handout

RESOURCES

Parts of the Bike—English/ Spanish (p. 239)
Parts of the Bike—Student Worksheet (p. 240)
Parts of the Bike—Student Worksheet Answers (p. 242)
Partes de la Bicicleta—Student Worksheet Spanish (p. 241)
Partes de la Bicicleta—Student Worksheet Spanish Answers (p. 243)
IN-ROOM SCAVENGER HUNT

Familiarize youth with the space, allow them to explore.

LESSON

1. Split kids into groups of 2 or 3.
2. Give each group a “goodie bag” of bike parts or tools. Try to choose materials that youth are likely to need during the class. This is an opportunity for youth to learn where things are located and explore the space.
3. Have them look around the shop to find where that part is kept and what it is called. You may want to leave out catalogues and books so they can look up parts.
4. Once they find where that part (or tool) goes, have them make a sign (English plus any other languages they may know) for that drawer and draw a pic if possible. You can also prepare the signs ahead of time.

MATERIALS

Brown paper bags for “goodie bags”
Variety of parts and/or tools
Paper
Markers
Books and catalogs for identifying part names

RESOURCES

None

SOURCE

Recycle-A-Bicycle
**LESSON**

**Demonstration:**

1. What is the most common type of bicycle repair? Flat tire.
2. Why? Based on the students’ experience, discuss the different ways a tire can go flat. For each cause, briefly go over how to prevent that type of flat, i.e. proper tire pressure (what’s PSI? why do different bikes take different PSI’s?), check tire for wear, etc... Prevention is key.

   - Punctures
   - Pinch flats
   - Too little air
   - Too much air
   - Bike sitting in the garage for 6 months
   - Cut valve stem
   - Leaky/loose valve
   - Broken rim strip
   - Bald tire
   - Worn-thru sidewall
   - Burred rim
   - Whatever else they can think of...

**MATERIALS**

- Repair stands
- 13, 14, 15mm wrenches
- Pens
- Sandpaper
- Vulcanizing fluid
- Bulk patches
- Rags
- Floor pumps
- Holey tubes
- BMX bikes with flats & worn out tires and/or wheels

**RESOURCES**

None

CONTINUED ON P. 68
3. Introduce important shop concepts and ideas:

_Proper tool selection_

One great way to explain this with the three sizes of 15mm wrenches—the cone, pedal and combination. Why in this case is the last wrench the best to use?

- The cone wrench is thin so it can fit in-between the hub and the cone. We use this one for hub adjustments.
- The pedal wrench is really long to give us lots of leverage when taking off pedals, but thin enough to fit between the pedal bearings and the pedal arm.
- The combination wrench is long enough that we can get leverage, but not so long we are far away from our bike, and it is strong enough to grip those stuck axle nuts.

*Leverage*

Show how starting the wrench at 9 o’clock provides the best leverage to loosen axle nuts.

*Clockwise and counter-clockwise*

Try to get students away from “lefty loosey, righty tighty.” This is because sometimes we are reaching through the bike or the bike is upside down and “righty tighty, lefty loosey” gets confusing.

*Dropouts*

Introduce these by catching the wheel when it drops out of the fork once the axle nuts are loose enough. Students should understand that it’s always important to hold on to whatever it is they are loosening.

_NOTE:_ When it comes to “nuts,” be sure to distinguish what kind of nut it is, whether axle nut, lock nut, adjustable nut, anchor nut, brazil nut, etc. This helps keep the giggles to a minimum, especially when instructing 10-13 year olds.
LESSON (CONTINUED FROM P. 68)

Demonstration:

1. **Remove the wheel**
   Explain the difference between quick release and bolt-on wheels.

2. **Remove the tire**
   Be sure to deflate the tube completely first, then use tire levers to remove the tire from the rim.
   - Explain what the bead of the tire is and pass a tire around so they can feel it.
   - It is easiest to remove a tire starting opposite the valve.

3. **Find and mark the hole**
   Remove the tube, pump it up nice and plump. Using a ballpoint pen, mark the hole with a big “X”. This makes it easy to find later.
   - Look, listen and feel for the hole (using your cheek); still difficult?
   - Use the water bucket. Ask them why the water bucket works? What is happening here? What could you use if you didn’t carry a bucket of water on every ride? In the woods? In rainy Seattle?

4. **Apply the patch**
   Deflate the tube.
   Scuff the area to be patched with sandpaper.
   - Why? This is like scoring a clay pot or buffing nails before a manicure.
   - The rough surface helps the two parts bond together.
   Apply to vulcanizing fluid.
   - Lay a thin layer of vulcanizing fluid in a circle around the hole. Stress that the glue must be spread thinly, evenly, and over an area larger than the patch.
   - Students can draw a circle around the hole when they make their “X’s” to make this easier.
   Let the glue dry.
   - Why? Actually, vulcanizing fluid isn’t glue. It’s science! The fluid, patch and rubber in the tube create a chemical reaction when they meet. This reaction happens best when the fluid is dry.
LESSON (CONTINUED FROM P. 69)

Apply the patch.

- Peel the patch off the foil, lay it down over the glue, rub over the cellophane with a tire lever or wrench on a hard surface.
- What could you use as a hard surface if you were out on a ride?

Wait.

- Have everyone guess how long the patch should be held on the tube before the next step (approx. 5 minutes).
- While you wait, skip to step 6 and inspect all the parts of the tire and rim.

Remove cellophane.

- This step is purely aesthetic, so kids can skip it if they like; peeling the cellophane will often pull a poorly-glued patch off.

5. **Test for leaks**
   Inflate the tube gently and look, listen and feel for other holes.

6. **Inspect the tire and rim**
   Before reinstalling, inspect the inside and outside of tire, rim strip, condition of valve stem, etc. Use a cloth or corner of your t-shirt to check the inside of the tire and rim.

7. **Reinstall tire and tube**
   Install one side of the tire. Then insert the slightly inflated tube with the valve in the valve hole of the rim. Tube should look like a “floppy donut.”

   Replace the bead on the rim using only your hands—NO TOOLS! Why? Show how to use thumbs, heels of hands, and other people’s help to ease the process.

8. **Reinstall the wheel and inflate tire to proper pressure**
   Emphasize that the wheel should be all the way up in the dropouts and centered. For tight axle nuts, place the wrench at 3 o’clock for best leverage.

**Coaster hubs, freewheels, derailleurs, brakes:**
Briefly discuss challenges encountered when removing wheels with coaster hubs, with freewheels/derailleurs and with brakes in the way.
LESSON

Overview:

1. **What are bearings?**
   Start by discussing bearings: what are they? What do they do? Why are they in bicycles? Where on bicycles are they? What would bikes be like without them? Most of the systems in the bike that move have ball bearings to help make the movement smooth and lasting.

   *The three key elements:*
   - Bearings reduce friction.
   - Bearings support weight.
   - Their ability to do a) and b) increase with the number of bearings.

2. **Friction**
   Why is friction unwanted in your bicycle?
   Have everyone rub their hands together really fast; what does friction generate?
   *Heat!*
   Translate this to energy lost when riding a bike. What else is used in a bike to reduce friction?
   *Grease.*

3. **What can go wrong?**
   What can happen to bearings and grease over time? Let students brainstorm all the possible things that could go wrong with bearings, specifically in the hub. Dirt, water, mud, rust, dried-out grease, loose bearings...
   How can we prevent any of these things from happening? (i.e. not riding through huge puddles). What can we do if things get so bad that the hub has a ton of friction? Is an overhaul necessary or just an adjustment?

CONTINUED ON P. 72
LESSON (CONTINUED FROM P. 71)

4. **Different kinds of bearings: loose, caged, cartridge**
   Caged bearings always go bearing side into the cup.

5. **Cup and cone systems**
   Use the “ice cream” analogy at right.
   Ice cream comes in a cup or a cone, right?
   Bearing systems have both a cup and a cone. The cone goes into the cup, with the bearings in-between the two. The “locknut” is on top like the “ice cream.”

**MATERIALS & RESOURCES**
See p. 71

**Demonstration:**

**Activity #1:**
1. Get a heavy toolbox and place it on the table.
2. Have the kids try to push the box across the table with one finger. Then two fingers, then their whole hand. Is it difficult or easy?
3. Next take out a few loose ball bearings and place them under the toolbox. Now have youth push the box with one finger, two fingers, whole hand. Is it easy or hard? Is it different than before?
4. Finally, put a whole handful of ball bearings under the box. How does that change the motion? More bearings = easier motion.

**Activity #2**
1. If you don’t have the above materials, ask youth to imagine stepping onto 1 bearing vs. 10 bearings vs. 100 bearings. Are different things going to happen?

**NOTE**
For everyone’s sake, refer to them as “ball bearings” or “bearings,” but never, ever “balls.”
LESSON

Pay attention to dustcaps! We usually save hubs with dustcaps for our more advanced classes. To remove the dustcaps, use a flathead screwdriver to gently pry them out. Damaged dustcaps can ruin a wheel, and dustcaps put in upside-down will make a wheel impossible to adjust.

Overview:

1. **Overhauls!**
   What does that word mean to everyone?
   For us, it means taking everything apart and putting it back together.

2. **Ball bearings review**
   What are they?
   What do they do?
   Why are they in bicycles?
   Where on bicycles are they?
   What would bikes be like without them?

**NOTE**
For everyone’s sake, refer to them as “ball bearings” or “bearings,” but never, ever “balls.”
LESSON (CONTINUED FROM P. 73)

Demonstration:

Explain the 5½ steps of an Overhaul for the first time!

½. Put out a rag

Make sure you have a place to set your parts as you take something apart and that these parts are oriented to how they go back on the bike.

1. Disassemble

Pull the front wheel off the bike and demonstrate how to use the cone wrench and another wrench in opposition to one another. Put wrenches at 5 and 6 o’clock making a “tiny pizza slice” and squeeze together.

Be careful not to have your fingers between the two wrenches. The nuts may loosen quickly and smoosh your fingers!

Thread off the locknut, any spacers, and the cone. Discuss what the locknuts do, using the terms “lock” and “unlock”.

The bearings will drop onto the rag and the axle (with accompanying locknut, cone and bearings) can be pulled out the other side.

Stress that only one side needs to be pulled apart. Why? This is because the cones should be measured out perfectly on the axle for even axle length one each side in order to attach the wheel to the fork. Working on only one side helps maintain this spacing.

Youth tools should remain on one side of the hub throughout this work. This is very important.

CONTINUED ON P. 75
2. **Clean**

   Old grease looks like dirty ear wax. Gross. We don’t want that in there.

   Cleaning can mean wiping with Simple Green, using a toothbrush or even using steel wool. Start with three squirts of simple green on a rag and use that. Don’t squirt directly onto bike parts. This is because Simple Green is a de-greaser and if excess is left in the hub it will break down new grease. More elbow grease, less simple green!

   If the sample hub is fairly dirty, pretend to clean it during your demonstration instead of actually doing it, as students will quickly become bored watching the instructor clean parts.

3. **Inspect**

   **Bearings**

   Have students think about the divots in a golf ball. That’s what pitting on a bearing looks like. If students see pits, or if a bearing doesn’t “shine up” it is damaged and should be replaced.

   What size bearings? Have students show you (with their fingers) the equivalent of: an inch, a $\frac{1}{4}$ inch, a $\frac{1}{8}$ inch, etc. all the way down to $\frac{1}{32}$ of an inch. How can we see size differences in such small increments? For drama, you can pitch a bearing into a random crate of parts and ask how we will find that same size. Bust out the Drop Gauge here if you have one.

   **Cups**

   Check the cups for pitting, just like the bearings.

   **Cones**

   Check for pitting, scratching or cracks. In addition, if the cone has built-in dustcaps, make sure they aren’t bent or chipped.

   **Axle**

   Look to make sure the axle is not bent and the threads are in good shape.

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**FRONT HUB EXPLANATION 3 OF 5**

**MATERIALS & RESOURCES**

See p. 73
LESSON (CONTINUED FROM P. 75)

4. Grease and Reassemble

Scrape some grease into the cup; how much is enough? How much is too much? There should be just enough for the bearings to stick in it upside down. Another way of showing this is to just fill the edges of the cup.

A good grease analogy for youth is to think about putting “frosting on a cake,” not “butter on toast.” When you put butter on toast, you can still see the toast but if you add frosting to the cake, you can’t see the cake anymore. Think more like frosting and less like butter!

After laying the bearings in, add a second, thin layer of grease on top. Students can think about “tucking in” the bearings.

Reinstall the axle; does it matter which side it goes in? No, on a front hub, the wheel is centered on the axle. Thread the cone, any washers and the locknut on. Is it OK to have grease on the threads? Yes. It’s a good idea!

5. Adjust

Have a student help out by holding the fixed side of the axle so it doesn’t spin.

Finger-tighten the cone until it touches the bearings, then back it off a ¼ turn (15 min. in the clock analogy).

Holding the cone in that spot with a cone wrench (it may be helpful to lightly hold a spoke in that area so you are sure not to move), tighten (“lock”) the locknut with another wrench. This is “tool tight” as opposed to the cones which are “finger tight.”

Too Tight: What would the problem be if the cone were too tight, i.e. touching the bearings? The wheel won’t spin smoothly, it will feel “crunchy” and hard to turn.

Too Loose: What would the problem be if the cone were too loose? The wheel will spin smoothly, but there will be “knocking” in the hub.

Test the adjustment in two ways:

• First, spin the axle in the hub—does it spin freely without slowing down?
• Second wiggle the axle up and down—can you feel any movement? This knocking movement is called play and we want none of it.

Have the students feel these adjustments if time permits.

CONTINUED ON P. 77
If either is the case, hold the cone still with a cone wrench, unlock the locknut, and make a small adjustment of the cone: if the axle had play, tighten the cone about 2–5 min, hold it there, and lock the locknut. If the wheel didn’t spin smoothly, loosen the cone about 2–5 min, hold it there, and lock the locknut.

Emphasize to students that small adjustments go a long way!

6. Review key points
   - Make sure everything is tight.
     Make sure the locknut is “tool tight” before checking any adjustments.
   - Don’t lose the point of reference.
     Don’t let the cone move when you unlock the locknut; if it moves, you have to start the adjustment process all over again.
   - Use small rotations of the cone.
     They make a big difference in terms of adjustment.
   - Don’t get frustrated!
     Even seasoned mechanics don’t always get adjustments on the first try.

7. Remount the wheel in the frame
   - Make sure axle nuts are “tool tight.”

Many mechanics use a cone wrench on each side of the hub for small adjustments. We teach beginning youth to only work on one side of the hub in order to preserve axle spacing.
THREADED HEADSET EXPLANATION 1 OF 4

Know what that word overhaul means. Review the 5½ steps of an overhaul. Understand maintenance, adjustment, and overhaul of the headset.

LESSON

Overview:

1. Review the 5½ steps of an overhaul
   Ask for input from everyone. Discuss and ask questions about each step. Write the step on a blank chalkboard as you go.
   ½. Put out a rag
   1. Disassemble
   2. Clean
   3. Inspect
   4. Grease and Reassemble
   5. Adjust

2. Discuss stem and handlebars
   We will be overhauling the headset. The stem and handlebars are nearby, but not part of the headset. Cover the different types of stem and handlebars; what the individual parts are; how they connect. Pass out a stem for the class to inspect.

Make sure to point out:
   • Binder bolts
   • Stem
   • Stem wedge
   • Stem bolt
   • Limit markings

MATERIALS

Repair stands
Allen keys
Combination wrenches
30, 32, 36, 40mm headset wrenches
Channel locks
Large adjustable wrench
Simple green
Rags
Grease
Bearings
Drop gauges
Bikes to work on!

RESOURCES

None

SOURCE

Threaded Stem image: www.montaguebikes.com

CONTINUED ON P. 79
LESSON (CONTINUED FROM P. 78)

3. Remove the stem
   Before removing the stem take a “mental picture” of how the housing is routed! Be sure the cables are running the same way, and not twisted when reassembling.

   Face the front of the bike and stabilize the front wheel with your legs to loosen the stem bolt with the allen key. If necessary, tap stem bolt with a mallet. Pull the stem and handlebars out. You may find it useful to remove the wheel from the fork before beginning the overhaul.

4. Hold the fork!
   Remind everyone to hold the fork during disassembly. It’s a good reminder to hold on to anything you are loosening on a bike to prevent it from falling.

Demonstration:

½. Put out a rag
   A rag helps keep parts organized in the order that you disassembled it and prevents loose bearings from rolling away.

1. Disassemble
   First remove the locknut. Look for keyway and keyed washers. Why is the washer keyed? How will this help your adjustment?

   Remove the keyed washer.

   Remove the cone next. Unscrew the cone and point out the bearings. If retainer bearings are used, take note of their orientation (which way are the bearings facing?) in the cup. Also a good time to ask where is the cup anyway?

   A little different than the hub...

   Depending on the age of the class, you can also explain the “crown race” on the fork, and how the bearings “race” around the cone, also known as the “crown race” on the fork.

2. Clean
   Get rid of all that old “ear wax” looking grease. Use a minimum of Simple Green and a maximum of elbow grease!

CONTINUED ON P. 80
3. **Inspect**
   Inspect the crown race, cups and bearings for pitting, cracks or other damage. Replace if necessary.

4. **Grease and Reassemble**
   If retainer bearings are used, make sure the bearing side faces into the cup. Make sure that everyone knows that this will mean having the bearings facing upward on the bottom of the headset. (Inverted bearings or ‘spaceship’ bearings are different).
   Make sure bearings are seated properly when reassembling.
   Make sure you aren’t cross threading when putting the cone back on. Always start putting on parts by hand to prevent cross-threading.
   Put all parts on and lock down locknut with wrench before checking adjustments.

5. **Adjust**
   It may be helpful to re-install the wheel at this point as it will make it easier to feel the adjustments.
   Be sure to tighten the locknut before testing your adjustment! If your headset is perfectly adjusted before tightening the locknut, thread compression will make the adjustment too tight once you tighten the locknut. For this reason, try to adjust the cone to be a little too loose, tighten the lock nut, and check for play again.

   **Too Tight:** Fork won’t turn with fluid motion. This is sometimes called “indexed steering.” The handlebars click into different positions.

   **Too Loose:** Movement can be felt between fork and frame. This is called play. Have everyone feel while pushing and pulling forwards and backwards.

   Test this adjustment in two ways:
   - Turn the handlebars to one side and let them swing back and forth. They should swing easily.
   - Put one hand on the lower part of the fork and one hand on the frame. Push and pull your hands forward and backwards. You should not be able to move the parts independently.

**CONTINUED ON P. 81**
LESSON (CONTINUED FROM P. 80)

6. Re-install and align stem and handlebars
   Grease the stem.
   Check height level—you should not be able to see limit marks.
   Make sure all the housing is running the same as when you took it apart.
   Refer to the “mental picture” you took at the beginning of class.
   Tighten the stem bolt.

MATERIALS & RESOURCES
See p. 78
One-Piece Bottom Bracket Explanation 1 of 3

Drive home the steps of an overhaul. Introduce the bottom bracket and the one-piece crankset overhaul.

LESSON

Overview:
1. **Review the 5½ steps of the overhaul.**
   Ask for input from everyone. Discuss and ask questions about each step.
   1/2. Put out a rag
   1. Disassemble
   2. Clean
   3. Inspect
   4. Grease and Reassemble
   5. Adjust

2. **Remove the chainguard**
   With the bike in the stand, show how to remove the chain guard (if necessary) to get to the bottom bracket.

3. **Drive–side vs. non–drive–side**
   Re–position the bike in the stand so everyone can see the two sides of the bike. Introduce the terms drive–side and non–drive–side.

NOTE

Be sure to start each week with a blank chalkboard, which you fill in as the youth contribute the correct answers—and encourage them to remember the names, and the descriptions, of every step on their own. Ask for specifics, get details, and start a dialogue if they get stuck. Repetition is the key to success.

MATERIALS

- Repair stands
- Bottom bracket wrenches
- Large and small adjustable wrench
- Simple green
- Rags
- Grease
- Spanner wrenches
- Pedal wrench
- Screwdriver
- BMX bikes

RESOURCES

None

CONTINUED ON P. 83
**LESSON (CONTINUED FROM P. 82)**

4. **Reverse threading**
   Make sure that everyone understands that with a one-piece bottom bracket, on the non-drive side of the bike, that everything associated with the bottom bracket is reverse threaded. Why is this? So that things don’t un-thread and loosen as you pedal the bike!

   One way to help youth remember that the non-drive side is reverse-threaded is to call it “Backward Land!” Anything that is not on the side with the chain is “Backward Land.” If a student is having trouble loosening a bolt, ask them where they are. “Are you in Candyland?” “No.” “Are you in Disneyland?” “No.” “Where are you?” “Backward Land!”

**Demonstration:**

½. **Put out a rag**
   Make sure you have a place to set your parts as you take something apart and that these parts are oriented to how they go back on the bike.

1. **Disassemble**
   Remove non-drive-side pedal. Remember, you’re in “Backward Land,” so all the parts, including the pedal, are reverse threaded.

   Remove the locknut, keyed washer, and cone.

   Remove the one-piece crank and bearings. Where are the cups? Where is the other cone? It’s on the crank next to the chainring. Tighten it onto the crank. Which direction? Clockwise or counter-clockwise?

   **NOTE**
   This is another good time to discourage the use of the phrase “lefty loosey, righty tighty.” Reinforce how important it is to think about the way you are turning the tool, how you are standing in relation to the bike, and which part of the bike you are working on.

2. **Clean**
   Get rid of any rust, old grease, dirt and grime.
   Make sure there’s no “old earwax” in there!

**CONTINUED ON P. 84**
LESSON (CONTINUED FROM P. 83)

3. **Inspect**
   Look for pitting in the cups and the cones on both sides. Inspect bearings for golf-ball like pitting.

4. **Grease and Reassemble**
   If you put bearings into the cups before re-installing the crank, is there enough room? How can you fix this? Which way do bearings go?

5. **Adjust**
   Remember the adjustment will tighten when you tighten the lockring. Keep the cone just a “smidge” loose.
   
   Which way do you turn the wrench to tighten the locknut? Stop and think before you do it.

6. **Re–install pedal, chain and chainguard**
   Re–install the pedal.
   
   Loosen the rear axle nuts, push the wheel forward (watch for the coaster brake strap).
   
   Set the chain on, and pull the wheel back into place.
   
   Make sure the wheel is centered, the chain tension is correct, and tighten down each side little by little.
   
   While pedaling, feel the chain tension all the way around since the rear and front chainrings are often slightly elliptical.
   
   Re–install the chain guard!

MATERIALS & RESOURCES

See p. 82
Learn the parts and functions of the brake system. Introduce the concept of "troubleshooting." Encourage youth to get into a pattern of sleuthing through problems in order to find the part that needs adjusting or replacing.

**Overview:**

1. **What is “troubleshooting?”**
   In the past classes we have overhauled different components of the bike. This works well for bearing systems where we can’t see what’s going on until we take it apart. But what if we can see all the parts of the system, like in the brake system? Then we don’t need to dis-assemble the whole thing, we only need to find the broken part and fix that. This is called “troubleshooting.”

2. **Cables**
   What is a wire? What is bundle of wires called? A cable.
   Pass around examples of the different cables (bmx/mtn brakes, road brakes).

3. **Housing**
   Where do some people live? In a house. Where does the cable live? In housing.
   **Brake housing:** brakes have spiraled metal housing. Looks a little like a spring (but isn’t one.)
   **Shift housing:** shift housing looks like a bundle of un-cooked spaghetti.
   Show examples of cable through “good” housing, versus cable through kinked or broken housing. Have everyone feel the difference.

**Materials**
- Repair stands
- Examples of housing and cables
- Cable and housing cutters
- Tri-flow or other chain lube
- Spares for project
- Cables
- Offset brake tools
- 3rd & 4th hand tools (optional)
- Housing
- Cable ends
- Ferrules
- Brake pads
- Y-socket (8,9,10)
- Needle nose pliers
- BMX bikes

**Resources**
- Brake Types (p. 248)
- Brake Type Flow Chart (p. 249)

Depending on what skill level you are teaching, youth can work on BMX (Beginner) or MTB (Intermediate) bikes.

CONTINUED ON P. 86
4. **The braking system**

   How does the brake work? Follow the system from the levers to the cable, to the housing, to the calipers to the brake shoes and rim. Point out each part and what it does. When “troubleshooting,” start at the brake levers and work your way to the rim.

   Parts of the braking system:
   - Brake levers
   - Cables
   - Housing
   - Brake calipers
   - Brake pads
   - Rims

   What are some of the things that can go wrong in cable systems? Cables stretch, dry, break, and fray. Springs collapse. Housing could crack, bend, or break in parts.

5. **Types of brakes**

   Ask youth to brainstorm as many types of brakes as they can.
   - Coaster brakes
   - Cantilever brakes
   - Side pull or caliper brakes
   - V-brakes
   - Center pull brakes
   - Disk brakes (can be cable or hydraulic)
   - Drum brakes

   See Brake Type Flow Chart (p. 249)

6. **Springs**

   Why do the brake calipers, after releasing the brake lever, move away from the rim? Explain the role of springs.
   - Cable = tension
   - Springs = release

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**MATERIALS & RESOURCES**

See p. 85

- “Marshmallow on a Stick” Shift Cable
- “Mini Microphone” Road Brake Cable
- “Root Beer Barrel” Mountain Brake Cable

CONTINUED ON P. 87
LESSON (CONTINUED FROM P. 86)

Demonstration:

There are 5 main aspects of brake adjustment:

1. **Brake pads**
   - **Height**
     Make sure that all the pads are contacting the rim only. They should not hang off the bottom, or rub on the tire.
   - **Angle-Toe-In**
     Toe-in refers to the angle at which the bike pads hit the rim. What causes squealing brakes? Think about chalk squealing on a chalk board- this happens when the chalk is perpendicular to the board. How can we fix it?
     “Toe-in” the brake pads by angling them so that they are closer to the rim at the front of the pad than the back.

2. **Cables**
   - **Rust**
     Check cables for rust. If they are rusty anywhere, replace them.
   - **Fray**
     If cables are frayed anywhere, replace them.
     Pay close attention to the cable routing so you know how to re-assemble.
     Dis-engage the pinch bolt and pull the cable out of the housing. Cut off cable end if necessary.
     Remove the cable from the brake lever last.

3. **Housing**
   Cable housing should be cut to the correct length to make a smooth curve—no corners or kinks.
   Use metal or plastic ferrules on the ends of the housing if they fit.

4. **Tension**
   After routing a new cable, have one partner hold the brake pads on the rim while the other partner pulls on the cable and tightens the pinch bolt.
   When properly adjusted the brake lever should be two fingers away from the handlebar when squeezed fully. When there is no pressure on the brake lever, the wheel should spin freely without touching the brake pads at any point.
   Check the adjustment by spinning the wheel.
   Use the barrel adjuster to fine tune the cable tension.

CONTINUED ON P. 88
LESSON (CONTINUED FROM P. 87)

5. **Length**
   
   Cut the cables. Leave four fingers-length at the end. Why? Enough cable is needed for future adjustments and leverage.
   
   Attach cable ends.
UNDERSTAND HOW TO CORRECTLY ASSESS, SET UP, AND ADJUST THE FOUR ASPECTS OF DERAILEURS AND SHIFTING.

To encourage youth to work through problems in order to find the part that needs adjusting or replacing.

LESSON

This is a dense lesson that requires lots of time to teach. The lesson is broken into three “overview” areas: gears, chains, derailleurs; and one “demonstration.” Going over all of these points will take a long time, given your schedule and the level of your class, chose a few points from each area to talk about with youth. When going over front derailleurs you can address more of the points here, or use it as a review.

Overview:

1. Parts of the system
   - Front derailleur
   - Front chainrings
   - Rear derailleur
   - Rear cogs/freewheel/cassette
   - Front and rear shifters
   - Shift cables
   - Shift housing

How many gears does the demo bike have? How do you know? How do they work? How do they help us?

MATERIALS

- Repair stands
- Examples of housing and cables for all systems
- Cable and housing cutters
- Tri-flow or other chain lube
- Screwdrivers
- Cables
- Housing
- Cable ends
- Ferrules
- Y-socket (8, 9, 10)
- Allen wrenches (4, 5, 6)
- Mountain bikes
- Derailleur hanger alignment tool (optional)

RESOURCES

None

CONTINUED ON P. 90
REAR DERAILLEUR EXPLANATION 2 OF 5

LESSON (CONTINUED FROM P. 89)

2. **“Troubleshooting”**
   Revisit the concept of “troubleshooting.” What is unique to the system of gears versus that of brakes? Look at the system from end to end and find the potential “trouble.”

   Show examples of the derailleur cables and housing. Derailleurs use parallel-running housing and thinner cables with a smaller, parallel-facing barrel end. Shift housing looks like a handful of un-cooked spaghetti.

3. **Gears, Front chainrings, rear cogs/freewheel/cassette**
   What does the word derailleur make you think of? De-rail? Off the track? Show how levers will pull the cable to move derailleurs and move the chain off of the “tracks” in the gears (cogs/chainrings). Also keeps chain tension.

   If you have 3 chainrings in the front, and 7 cogs in the back, how many gears do you have? Why? How does that make a difference?

   When the chain is in the big gear in the front, is it easier or harder to pedal? In the small gear? What about the chain when it is on the rear cogs? Easier on small cog in the rear or harder? Why do you want to have a wider gear range (in Seattle, with hills)?

   Do you always have to be pedaling to change gears? Why?

   Make a point that the fast/slow gears are opposite with the cogs versus the chainrings. Show how the gears work while the bike is in the stand, running through all the gears. When you move the chain towards the bike, the pedaling gets easier, when you move it away from the bike, it gets harder.

   Discuss cross-chaining and how to avoid it.

   When troubleshooting chainrings and rear cogs what are we looking for? Worn or broken teeth. What do those look like?

   Check for loose chainring bolts.

CONTINUED ON P. 91

MATERIALS & RESOURCES

See p. 89

“Handful of Spaghetti”
Compressionless Shift Housing

Coiled Brake Housing
LESSON (CONTINUED FROM P. 90)

4. **Chains**
   Can you use any kind of chain on any kind of drivetrain? Why not? Discuss matching the chain with the number of cogs in the rear cluster. (For example, a 9 speed chain goes on a bike with 9 cogs in the rear cluster.)

   When troubleshooting: what kinds of wear or problems might you find with a chain? Rust, broken links, “stretch.”

   How can you check chain wear? You can use a chain stretch tool, or measure how many links are in one foot. The 12th pin should line up with the 12th inch mark. If it is 1/8 inch past the 12 inch mark, it’s time to replace things.

   Many people refer to chain wear as “chain stretch.” Is the metal actually stretching? No, it’s really the metal wearing away around the pins and rollers.

   Why is it important to avoid over-lubing?

5. **Derailleurs**
   When troubleshooting what are some of the things that can go wrong in these systems? Cables stretch, dry, break, and fray. Springs collapse. Housing could crack, bend, rust, or break in parts. Teeth and pulleys break. Chains stretch.

   Briefly explain the role of limit screws. H & L = High and Low. It is helpful to describe the role of limit screws as being like walls that determine how far the derailleur can move. Tighten the screws and the walls move in, limiting movement; loosen the screws and the walls move out, allowing for increased movement.
LESSON (CONTINUED FROM P. 91)

Demonstration:

There are 4 main aspects of adjustment of the Rear derailleur (perform in this order):

1. **Derailleur hanger alignment**
   
   True, not actually part of the derailleur, but it can’t work correctly without it.
   
   What happens if the derailleur is not parallel to the wheel?
   
   Show how a derailleur hanger alignment tool works if you have one.

2. **B-limit screw**
   
   The B-limit screw adjusts the distance of the top jockey wheel from the gear cluster. Once set correctly this can generally be forgotten about.
   
   This should be set when the chain is on the middle chainring and largest cog.
   
   Dial the screw out until the top of the top pulley wheel is 3-8mm (approximately) from the bottom of the largest cog.

3. **Limit screws**
   
   Limit screws adjust only the highest and lowest gears. Think of them as the wall on either side of the gear cluster that keeps the chain from falling off.
   
   Adjust rear limit screws with chain on the middle chainring. Loosen (unscrew) H limit screw to make chain move out towards dropout; loosen L limit screw to move chain out towards the wheel.
   
   The limit screws should be dialed in as far as they can go without the chain making a clicking sound while pedaling in the respective (H or L) gear.
   
   Double check that the L screw adjustment is not dialed out too far by pedaling while physically pulling on the rear shift cable, not by using the shifter.
LESSON (CONTINUED FROM P. 92)

4. **Cable tension**
   - With the H limit screw properly set and the chain still on the middle chainring, shift onto the smallest (H) cog.
   - Undo the pinch bolt holding the shift cable, then grab the end of the cable and pull the slack out of it and then tighten the pinch bolt back down.
   - Pay attention to where the cable is running! There should be a groove in the washer where the cable sits.
   - Try shifting. Does the chain hesitate moving up to the next largest cog? What does that mean? Too little tension—with increased tension the derailleur pulls a little further with each click of the shifter. Increase tension via the barrel adjuster with quarter turn increments! Does it hesitate moving down to the next smallest? Decrease tension!
   - An easy way to help youth understand which way to turn the limit screw is to always turn towards the direction where the chain is having trouble moving.
   - Repeat until you have shifted multiple times between every cog.
Front Derailleur Explanation 1 of 2

Understand the four aspects of front derailleur and shifting. Encourage youth to work through problems in order to find the part that needs adjusting or replacing.

Lesson

Overview:

1. Parts of the system
   - Front derailleur
   - Front chainrings
   - Rear derailleur
   - Rear cogs/freewheel/cassette
   - Front and rear shifters
   - Shift cables
   - Shift housing

   How many gears does the demo bike have? How do they work? How do they help us?

2. Revisit the concept of “troubleshooting”
   What is unique to the system of gears versus that of brakes? Look at the system from end to end and find the potential “trouble.”

3. Derailleur cables and housing
   Show examples of shift housing and shift cables. Derailleurs use parallel-running housing and thinner cables.

Materials

- Repair stands
- Examples of housing and cables for all systems
- Cable and housing cutters
- Tri-flow or other chain lube
- Screwdrivers
- Cables
- Housing
- Cable ends
- Ferrules
- Y-socket (8, 9, 10)
- Allen wrenches (4, 5, 6)
- Mountain bikes

Resources

None

CONTINUED ON P. 95
Demonstration:

There are 4 main aspects of adjustment of the front derailleur (in this order):

1. **Height**
   The closest point at the bottom front of the derailleur should be 1-3mm from the top of the highest tooth on the large chainring.

2. **Alignment**
   The flat front part of the derailleur should be perfectly parallel to the large chainring.

3. **Limit screws**
   There is not always an H and L printed! Look inside the derailleur for where the rocker hits the screws.

   - Set the L limit screw with the chain on the large cog and small chainring; turn it in until the chain just clears the inside back of the derailleur.
   - Set the H screw with the chain on the small cog and large chainring; turn it in until the chain just clears the inside front of the derailleur.
   - Adjust as needed for the chain to shift quickly down or up to the respective gear.

4. **Cable tension**
   Shift down to the small chainring.

   - Undo the pinch bolt holding the shift cable, then grab the end of the cable and pull the slack out of it and then tighten the pinch bolt back down.
   - Pay attention to where the cable is running! There should be a groove in the washer where the cable sits.
   - Try shifting up to the middle. Does it hesitate? What should we do? Increase tension! Repeat steps like with the rear derailleur.
THREADLESS HEADSET EXPLANATION 1 OF 2

Know what that word overhaul means. Review the 5½ steps of an overhaul. Understand maintenance, adjustment, and overhaul of the headset.

LESSON

Pay close attention to cable routing. Encourage everyone to take a “mental picture” of the bike before beginning. Also if there is a cable stopper/hanger on your bike, make sure that it will get back in the stack as you are re-assembling.

Overview:
1. Different types of headset cups
   Discuss integrated or “slip fit” systems vs. threadless or “press fit” systems.
2. Parts of the headset and fork
   - Head tube
   - Steer tube
   - Crown
   - Crown race
   - Cups
   - Cone
   - Stem
   - Bearings—inverted and “regular”

   Explain the “crown race” on the fork, and how the bearings “race” around the cone, also known as the “crown race” on the fork.

CONTINUED ON P. 97
Demonstration:
Perform the 5½ steps of an overhaul.

½. Put out a rag
   A rag helps keep parts organized in the order that you disassembled it and
   prevents loose bearings from rolling away.

1. Disassemble
   To disassemble and re-adjust a threadless headset, take off top cap.
   Loosen stem binder bolts and remove stem
   Remove spacers.
   Pull the fork out of the frame and set aside.
   Take off dust caps and remove bearings.

2. Clean
   Get rid of any rust, old grease, dirt and grime.

3. Inspect
   Inspect the crown race, cups and bearings for pitting, cracks or other damage.
   Replace if necessary.

4. Grease and Reassemble
   Reassembly for a threaded headset is relatively simple. Replace the bearings
   with new grease, install the fork and re–install the stem. Make sure spacers
   are in the same place as when you started.

5. Adjust
   Re-install the top cap. Tighten it down enough so that there is no play, but
   loose enough that the headset turns smoothly. Remind students that this is
   NOT one of those “as tight as your muscles can get it” adjustments.
   Then tighten the two stem bolts evenly—by alternating back and forth.
   A proper adjustment allows the fork to turn smoothly without any play.
LESSON

Overview:
Go over the parts of the three piece crank with regards to terminology:

- Crank arms
- Spindle (square taper), octolink, etc.
- Crank Bolts
- Sealed BB Cartridge
- Cup
- Cones
- Bearings
- Discuss Cartridge Style vs. Cup and Cone (Adjustable)

NOTE
This is another good time to discourage the use of the phrase “lefty loosey,” etc. and reinforce how important it is to think about the way you are turning the tool, how you are standing in relation to the bike, and which side of the bike you are on.

Demonstration:
½. Put out a rag
Make sure you have a place to set your parts as you take something apart and that these parts are oriented to how they go back on the bike.

MATERIALS
Repair stands
Bottom bracket sockets
Large and small adjustable wrench
Allen keys
Simple green
Lockring wrench
Spanner wrenches
Rags
Grease
Crank pullers
Screwdriver
Pedal wrench
Mountain bikes

RESOURCES
Bottom Brackets (p. 250)

CONTINUED ON P. 99
LESSON (CONTINUED FROM P. 98)

1. **Disassemble**
   - Remove both pedals. Non-drive-side will be reverse-threaded.
   - Carefully remove both crank bolt caps and crank bolts from the crank arms.
   - Be sure to look for a washer before removing the crank arm! Check for the bolt type that has a washer attached to it. Look for a square shape after removing the crank bolt on the crank arm.
   - Stress the importance of initially installing the crank arm remover tool by hand. Then fully thread in the tool onto crank arms with a wrench before progressing any further.
   - Remove both crank arms.
   - Remove lockring—it is most often right hand threaded and will move counterclockwise to loosen.
   - Remove the non-drive-side cup—it will most often need to be turned counterclockwise to take it off.
   - Adjustable bottom brackets will have a lock ring, adjustable cup (non-drive) and a fixed cup (drive).
   - Remove the spindle. Be sure to take note of the orientation or writing on the spindle as it is taken out of the bottom bracket shell.

2. **Clean**
   - Use a clean, dry rag to remove any old grease or gunk on the cups, bearings, lockring and inside the frame. Careful for sharp parts inside the frame!

3. **Inspect**
   - Check for pitting in the cups as well as damaged threads and worn bearings.

NOTE
The students need to know that with the three piece bottom bracket system: the non-drive side is most often regular threaded on bottom bracket (pedals still reverse); and the drive side is reverse threaded on bottom bracket (pedals still regular thread). This is just a rule of thumb however. For reference look at the bottom bracket charts in the appendix.

CONTINUED ON P. 100
LESSON (CONTINUED FROM P. 99)

4. **Grease and Reassemble**

   **Cartridge bottom bracket**
   Discuss this process with the group and show proper tools. Students with these on their bike should remove the system, check its condition, reinstall and tighten.

   **Loose Bearing Bottom Bracket**
   For the purposes of this class, it is optional to remove the drive side fixed cup. Be sure to check the tightness of the drive side cup if it was not removed. The drive side cup will be reverse-threaded. Move the chain onto the bottom bracket shell before reassembling. Think about why we would do this.

   When re-installing the spindle be sure to note the orientation or writing on the spindle. In most cases, if you are straddling the bike, and looking “through” the bottom bracket shell, you would be able to read the markings on the spindle. Do not grease the outside of the spindle because this is a press-fit system and we don’t want the cranks to fall off!

   Install drive side crank arm (only) in order to check your adjustment. Grease the bolt threads! Use a torque wrench, if you have one, and have class look up the specifications in their Park Tool books.

5. **Adjust**
   Adjustment should be as loose as possible, without play, with the lock ring tightened—if you have one, and if you do then it should be tightened with the correct tool—on the drive side.

6. **Re-install crank arms and pedals**
   Install non-drive crank arm—clean the tapers and pedals—make sure to get the right side and left side pedals on the correct crank arms.

   Make sure the correct pedals are on each side and remind students that the non-drive side pedal is reverse-threaded. Grease the pedal threads and be careful not to cross thread!
Advanced "troubleshooting" skills. Understand drive train wear—how to check it and what to do about it.

LESSON

Overview:

1. **Components of the drivetrain**
   - Chain
   - Chainrings
   - Freewheel/cassette
   - Cranks
   - Pedals and shoes (according to the Park Tool Repair Book)

2. **Chain**
   
   *What is a chain?*
   A system of rollers separated by inner plates which are held together at the outer plate by rivets. Because of its design it is allowed to freely rotate around the cogs and chainrings.

   *Sizes and compatibility*
   Specific chains for different gear options. Single speed vs. 5speed vs. 10speed. What is happening to the chain to accommodate more gears? Does it get thinner, thicker? Can we use any chain on any bike? How to replace a chain depends on the type and size. BMX chain is 1/8 inch and general gear bikes use 3/32 inch.

   *Wear*
   How is this happening? What happens every time you pedal forward? What is the chain being exposed to? Water, road grime, dirt, oil.

   Define cross-chaining (riding in improper gear combinations such as front high and rear low that stresses a drive chain by putting your chain at an angle where it contacts chainrings/cogs/derailleur) and how this can cause faster wear on a chain. Emphasize that the same gear ratio can be found with different gear combinations. Pay attention to good chain line.

CONTINUED ON P. 102

MATERIALS

- Repair stands
- Bikes
- Cable and housing cutters
- Tri-flow
- Screwdrivers
- Cables
- Cable ends
- Ferrules
- Rags
- Simple green
- Chain checker
- Freewheel example (off a bike)

RESOURCES

None
Lesson (continued from p. 101)

Care
Proper chain care includes keeping it clean and lubing it, as well as checking for chain wear. What are advantages and disadvantages for the different lubrication options? How do you use the chain checker?

Removal and Installation
Show how to properly break a chain with the chain breaker, and how to get out a kink in a chain with the same tool.

Replacing a chain on a bike with gears requires choosing the proper chain, and accommodating for needs with regards to width and length.

Talk about master links, power links, and other modern options.

3. Chainrings
Draw attention to the chain rings, have students note differences in what they see on their bikes... How many rings? How many teeth per chainring?
Define BCD: Chainring Bolt Circle Diameter, common sizes, and tool to measure BCD.

4. Derailleurs, Shifters

What are Derailleurs?
How do they work? Why do we have two on a bike?

Types of Housing
Show compressionless housing and explain why it works with index shifting. There is a defined amount of cable pull in indexed shifting that would be compromised if compression was allowed for, as is the case in coiled brake housing.

Types of Derailleurs
What are the different kinds of derailleurs? Double, triple, long and short cage. When are they used? Why are there differences? Different numbers of front chainrings, sizing of rear cogs and chain slack will designate what types are appropriate. Front bottom/top pull, top/bottom swing, etc.
**LESSON (CONTINUED FROM P. 102)**

Types of Shifters

Friction
- Thumb shifters
- Down tube shifters

Indexed
- Thumb
- Grip shift
- STI
- Down tube
- Rapid fire

Trim vs. Index
Indexed shifters must match the number of gears in the rear cluster. Trim in an indexed system is a half-shift on the front derailleur that alleviates chain rub.

**Demonstration:**

1. “Troubleshooting”
   What sorts of things go wrong in a system? Improper shifting, derail chain into spokes or frame, can’t actuate the lever, persistent clicking, popping of gears, improper cable housing...What sorts of basic steps can we take?

2. Adjustments
   1. Derailleur height
   2. B-limit screw (rear derailier)
   3. Derailleur hanger alignment (rear)
   4. Front derailleur alignment
   5. Cable tension

**CONTINUED ON P. 104**
Rear Derailleur
Always set the rear first—before the front derailleur.
Start with cable tension at zero, and with the pinch bolt unlocked.

**NOTE**

Rear Derailleur:
- H screw: drops chain off to the frame–side if set wrong.
- L screw: drops chain off to the wheel–side if set wrong.

Front Derailleur:
- H screw: drops chain to the foot–side of the chainrings if set wrong.
- L screw: drops chain to the bike–side if set wrong.

**Barrel Adjuster**
Use your barrel adjuster to make any fine adjustments to shifting. Rotate the barrel adjuster in the direction the chain is having problems moving into.

**Front Derailleur**
Start with the adjustment in the high gear first. Have the chain in the big ring up front and small cog in the rear to set the H limit.
The second adjustment should be with the chain in small chain ring and large rear cog to set the L limit.
Front Derailleur Alignment and Height.
**Height:** Bottom of cage should sit 1 to 2mm above outer chainring.
**Alignment:** Should be parallel to chainrings.

3. **Freewheels and cassettes**
Briefly discuss the difference between a freewheel and a cassette.
Show an example of each off a bike.
How can you tell the difference? Cassette has a lockring.
Show examples of freewheel tools and lockring tools.
REAR HUB EXPLANATION 1 OF 3

Introduce freewheels and cassettes. Learn how to overhaul a rear hub. Learn new techniques to adjust a hub.

LESSON

Overview:

1. Spacing
   How or why is a rear hub any different from overhauling a front hub? Discuss the importance of spacing.

2. Freewheels vs. cassettes
   Freewheel—a self-contained system which as a unit will thread onto a hub. Cassette—a grouping of cogs. These will be either individual cog pieces or a spider of cogs which as a unit will slide onto the free hub body and secure to the hub using a lock ring.

3. Parts of the hub
   - Cone
   - Bearings
   - Locknut
   - Axle Nut
   - Spacer (this one is new to the group)
   - Quick Release
   - Axle

4. Process of disassembly
   Go over the proper removal of the freewheel or cassette. How do we tell which one it is and what tools are involved to take it off? (Bench vice, chain whip, adjustable wrench, freewheel remover tools). Explain the importance of using the proper removal tools.

MATERIALS

Repair stands
Bikes
Two cone wrenches
Two combination wrenches
Bench vice
Axle vice
Freewheel remover
Chain whip
Giant adjustable wrench
Cassette lockring tools
Grease
Rags
Simple green
Cleaning brushes
Torque wrench (if you have one)
Free wheel example (on a wheel)
Cassette example (on a wheel)
Cassette hub w/o cassette
Freewheel hub w/o cassette

RESOURCES

None

CONTINUED ON P. 106
5. **Review the 5½ steps to an overhaul.**
   Be sure to discuss and elaborate on these. For some students this will be a refresher class.
   ½. **Get a rag**
   1. **Disassemble**
   2. **Clean**
   3. **Inspect**
   4. **Grease and Reassemble**
   5. **Adjust**

**Demonstration:**

½. **Get a rag**
   Make sure you have a place to set your parts as you take something apart and that these parts are oriented to how they go back on the bike.

1. **Disassemble**
   *Remove the cassette or freewheel*
   Lock down one side of the hub to ensure you don’t lose adjustment. Then remove the opposite side—for freewheels use the bench vice with the tool locked onto it (turn wheel to the left), for cassettes use the chain whip.

**Disassemble the Hub**
Note which side of the axle you are dissembling. Remember, spacing is important for rear hubs!

Lay out parts on the rag so that it is side specific to avoid mishaps. Think about spacers—they go on different sides for different hubs so the layout on the rag can become key to your success.

**Dust caps**
Some students may have dust caps. Leave them in if you have a cassette type rear hub. If they are removed, make sure they are not re-installed upside down—sometimes they may look as if they are going back in backwards, don’t be fooled.

CONTINUED ON P. 107
LESSON (CONTINUED FROM P. 106)

2. **Clean**
   For freewheel—clean the threads grease and install.
   For cassette—clean and grease free hub body, install cogs, and lockring to proper torque rating.

3. **Inspect**
   When checking the cassette or freewheel, look for wear or damaged/pointed teeth, and “overly smoothed” cog edges.

4. **Grease and Reassemble**
   Be sure when re-installing the axle that it goes into the hub the same way it was pulled out.

5. **Adjust**
   Tighten the cone until it is hand tight. Then back off a quarter turn.
   Teach two cone/comboination wrench technique to adjust the hub (two cone wrenches to loosen, two combination wrenches to tighten) working on both sides of the hub. This is new—until now we encouraged youth to work only on one side of the hub. Remember adjustments on both sides will have twice the power—a little goes a long way.
   When adjusting quick release hubs we want to start with a little bit of play. To check, re-install the wheel (without installing cassette or freewheel), tighten quick release and check for more play on bike.

MATERIALS & RESOURCES
See p. 105
WHEEL TRUING EXPLANATION

Discuss different parts of the wheel, types of wheels and the strengths and weaknesses of different components. Understand the concepts of lateral and radial trueness, dish, and correct tension. Practice wheel truing techniques.

LESSON

Overview:

1. Parts of the wheel
   - Rim
   - Hub
   - Spokes
   - Spoke nipples
   - Rim tape

2. Explain how a truing stand works

3. Explain the four aspects of wheel balance (and demo tools)
   - Lateral True (truing stand)
   - Radial True (truing stand)
   - Wheel Dish (dishing tool)
   - Spoke Tension (tensiometer)

What is the importance of each of these aspects and how does one determine if the wheel is out of true?

On the rear wheel, why do drive–side spokes hold a higher tension than the non–drive–side?

NOTE

Enforce the idea of taking it slow. Use ¼ turns on the spoke nipples and constantly spin the wheel to check trueness in order to avoid breaking spokes or rounding out nipples.

CONTINUED ON P. 109

MATERIALS

Truing stands
Spoke wrenches (with correct spoke wrench to match nipple size)
Dishing tool
Tensiometer
Tri–Flow
Rags
Demo wheels, rims, hubs, spokes:
   - Double vs. single wall rim
   - Aero rim
   - Bladed and butted spokes
   - Low and high flange hubs
   - Multi-spoke wrench
   - Wheel with rim damage

RESOURCES

Parts of the Wheel (p. 245)
LESSON (CONTINUED FROM P. 108)

Demonstration:

1. Remove the wheel
   Have students explain how best to remove a geared rear wheel from the bike frame.

2. Put wheel in truing stand
   Demonstrate how to put a wheel in the stand.

3. Demonstrate lateral truing

4. Orient yourself
   Make sure that you point out that students should orient themselves so they are looking at the head of the nipple inside the rim in order to double check that they are turning the spoke wrench in the correct direction.

5. Remove tire

6. Demonstrate radial truing

NOTE

When truing, it is especially important to use the correct sized wrench. Spoke nipples are made of a softer metal than the wrench. If the wrench is slightly bigger than the nipple, or if it is seized against the rim, the nipple could be destroyed.