



I·M·B·A
International Mountain
Bicycling Association

Trailbuilding Basics

**International Mountain
Bicycling Association**
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Special Thanks

This booklet was conceived and created by Jan and Mike Riter, the first Subaru/IMBA Trail Care Crew. Between March 1997 and January 2000 the Riters taught trail construction and maintenance techniques to thousands of land managers, mountain bike club leaders and other trail users. Their pioneering work took them to 48 U.S. states, several Canadian provinces and nine countries in Europe. The Riters established a Georgia-based consulting business, Trail Design Services, early in 2000. They can be reached at: TDS.@mindspring.com

Thanks to IMBA's Wisconsin state representative Scott Frey, of Hyperionstudios Inc., for design and layout assistance.

Other Useful Trailbuilding and Design Resources

1. Trail Construction and Maintenance Notebook – U.S. Forest Service. To order: call 406-329-3900
2. Lightly on the Land, The SCA Trailbuilding and Maintenance Manual. To order: call 800-553-4453
3. Managing Mountain Bikes. To order: call IMBA 303-545-9011
4. IMBA Website: www.imba.com



photos courtesy Rich Etchberger

Mineral soil - Soil that is below the top layer of leaves, roots, and organic material. When digging in a new bench cut always dig down to the mineral soil.

Multiple use trails - Trails that are built for more than one possible user. For example: hikers, bikers and equestrians on one trail.

Open and flowing - A type of design that allows for sweeping turns, higher speeds, and better sight lines.

Outslope - Trail tread should slope slightly downhill so water runs off the trail, rather than being trapped and running on the trail.

Percent of grade - The method of measuring how steep a trail or slope is. (10 percent = a rise or fall of 10 feet per 100 linear feet of trail.)

Rolling grade dip - Non-obtrusive drainage device that shunts water off the side of a hill by altering the grade of the trail.

Single use trails - Trails that are designed and built for only one intended user. This can be problematic if future use may include other types of use.

Slope - The natural (or created) shape of the land. What is shown on contour maps. The term is generally used to refer to the hill, not the trail.

Social trails - Trails created by recreationalists as they wander from the "official" trail.

Subaru - Great car! Ask for the heated seats.

Switchbacks - A switchback is a level structure that the trail is routed into, makes a transition (turn), then is routed out in the opposite direction.

Texturing - The act of placing natural features (rocks, logs) back into a trail to help control speed or user conflict.

Tight and technical - A type of design that allows for tight turns, slow speeds, and can take fuller advantage of natural technical features.

Topo map - Map that charts elevation changes and shows features such as knolls, ravines, rivers, and contours.

Trail Care Crews - IMBA's "Johnny Appleseed" approach to spreading knowledge on trail design, construction and maintenance.

Trail corridor - Area three feet on either side of tread. Corridor should be cleared of fast-growing impediments, but grasses and trees should be left in or encouraged.

Tread - Clear ground on which trail users travel. Grass, bare dirt, roots and rocks may be part of the tread. The tread width varies depending on the type of trail or users.

Tread creep - When a trail sags or slides down the side of the hill. Usually caused by roots on the downhill side of a tree or an improper bench cut.

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A. The Trail Care Crew Program

The Subaru/IMBA Trail Care Crew is a time-tested international trails program. Since 1997, Subaru/IMBA Trail Care Crews have been traveling coast to coast (and beyond), teaching trail users, mountain bikers, clubs, retailers and land managers how to design, build, maintain and manage trails that are environmentally sound and fun to ride, walk or run. Each two-person crew travels in a new 2000 Subaru Outback. Subaru of America is the title sponsor of the program.

B. Meet the Crews

Joey Klein and Kathy Summers joined the Trail Care Crew program in March 1999. They hail from Montezuma, Colorado. In addition to extensive trail building and maintenance experience, both have impressive mountain biking travel and racing resumes. Klein and Summers have ridden in Indonesia, Singapore, Malaysia, Thailand, Laos, western Europe, the Caribbean, Mexico, and Japan. Some of their most notable on-the-bike adventures have unfolded close to home in Colorado. Both are past winners of Montezuma's Revenge, the one-of-a-kind alpine epic mountain bike race



Kathy Summers & Joey Klein

that encompasses the summits of two 14,000-footers. Joey designed the Keystone (Colorado) mountain bike trail system, working in conjunction with the U.S. Forest Service on an environmental impact study as well as trail mapping and signage. Kathy took the overall title in the Monserrat Fat Tire Festival in '95 and won Montezuma's Revenge the same year.

Jen and Rich Edwards became Subaru/IMBA Trail Care Crew No. 3 in March 2000. Originally from Pennsylvania and upstate New York, the Edwards gained years of bicycle retail and bike messenger experience in Washington, DC. They spent two summers as mountain bike guides

Back-cut - The vertical part of the bench cut that is blended into the backslope.

Backslope - Slope on the uphill side of the trail. This should be a gradual change from the tread, preventing a waterfall effect when runoff flows off the uphill side onto the tread. Helps slow the water.

Bench cut - Creating a semi-flat trail tread where there wasn't one before by digging into the hill side, down to mineral soil. Care must be taken when cutting into hillsides to preserve some outslope while making a rideable path.

Berm - The ridge that develops on the downhill side of a trail. It is caused by tread compaction and soil displacement by trail users. A berm will cause water to be trapped on the trail.

Bridges - Used to transport trail users over obstacles like ravines, bogs, creeks, or rivers.

Climbing turn - A turn that climbs (or descends) the existing grade of a hill, as it makes the transition from the upper leg to the lower leg.

Clinometer - Device used to measure the slope of the land.

Control points - Points of interest that trail users will be attracted to or should avoid. These should be marked and used to create the trail. Types include geographic, historic, or boundaries.

Cribwall - A wall that is built up to raise the trail significantly. Can be built with rock or wood.

Deberming - Removing the ridge of dirt that forms on the downhill side of the trail, preventing water from flowing across the trail. See "outsloping" and "berm."

Directional use trail - A trail that users are intended to travel in one direction.

Drainage - Getting water off the trail.

Exceeding the fall of the hill - If a trail is built on more than half of the existing hillside slope, gravity will pull water down the trail instead of across.

Fall line - Direction water flows down hill (path of least resistance). A trail that runs on the fall line will cause water to run down the trail.

Fillslope - When dirt that is excavated during the bench cut is used to create half or more of the tread. Fillslope should not be used in a bench cut as it will not compact as well as mineral soil.

IMBA - International Mountain Bicycling Association, PO Box 7578, Boulder, CO, USA 80306, 303-545-9011, www.imba.com - Great help on trail design, construction, maintenance and management information.

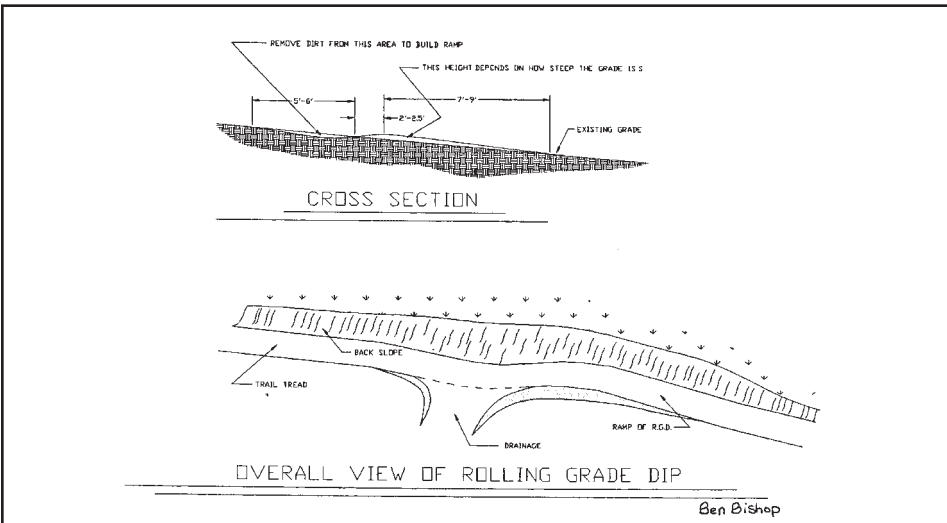
Land Manager - Any person that makes decisions regarding land use.

A. Tread

1. Tread should be periodically debermed to ensure proper drainage across the trail.
2. Any holes or ruts in the trail should be filled in and packed down once the cause of the problem has been determined and eliminated (depending on soil type).

B. Drainage

1. If a trail develops a drainage problem that cannot be cured, it should be rerouted. (Typical causes of this are: fall line construction, too steep a grade, or unmovable barriers that prevent cross slope drainage.)
2. In the event that a trail can't be rerouted, then erosion control devices will have to be installed. The rolling grade dip is a device that is long lasting and easy for users to negotiate.



Jen & Rich Edwards and the Trail Care Crew Subaru

at the Elk River Touring Center in West Virginia and later worked for Arizona Off Road Adventures in Tucson. The Edwards are passionate about all aspects of cycling, particularly bike commuting and trailwork.

Jan and Mike Riter of Conyers, Georgia, served as the inaugural Subaru/IMBA Trail Care Crew, 1997-1999. They developed and refined many of the concepts presented in this booklet. The Riters now head Trail Design Services, a trails consulting business based in Conyers, GA.

C. Subaru/IMBA Partnership

IMBA: Founded in 1988, The International Mountain Bicycling Association (IMBA) works to keep trails open and in good condition for everyone. IMBA helps its members solve their local and regional trail access and advocacy problems and improve the sport of mountain bicycling. IMBA works with national land management agencies. IMBA organizes and distributes a library of information about managing mountain bicycling, political tactics, scientific studies, liability and non-profit organization. IMBA participates in the global effort to establish and maintain trail networks and to improve the image of bicycling.

Why Subaru of America supports IMBA

"To show our commitment to cyclists everywhere, Subaru is doing something positive. Something important. Something that will help preserve the trails for you to ride forever. We've teamed with IMBA to create the Subaru/IMBA Trail Care Crew."

— Subaru web site.

A. Erosion is caused by water and wind, not trail users

1. Erosion is a natural process that is always happening.
2. Users loosen soil, but it takes wind and water to remove it.



Erosion

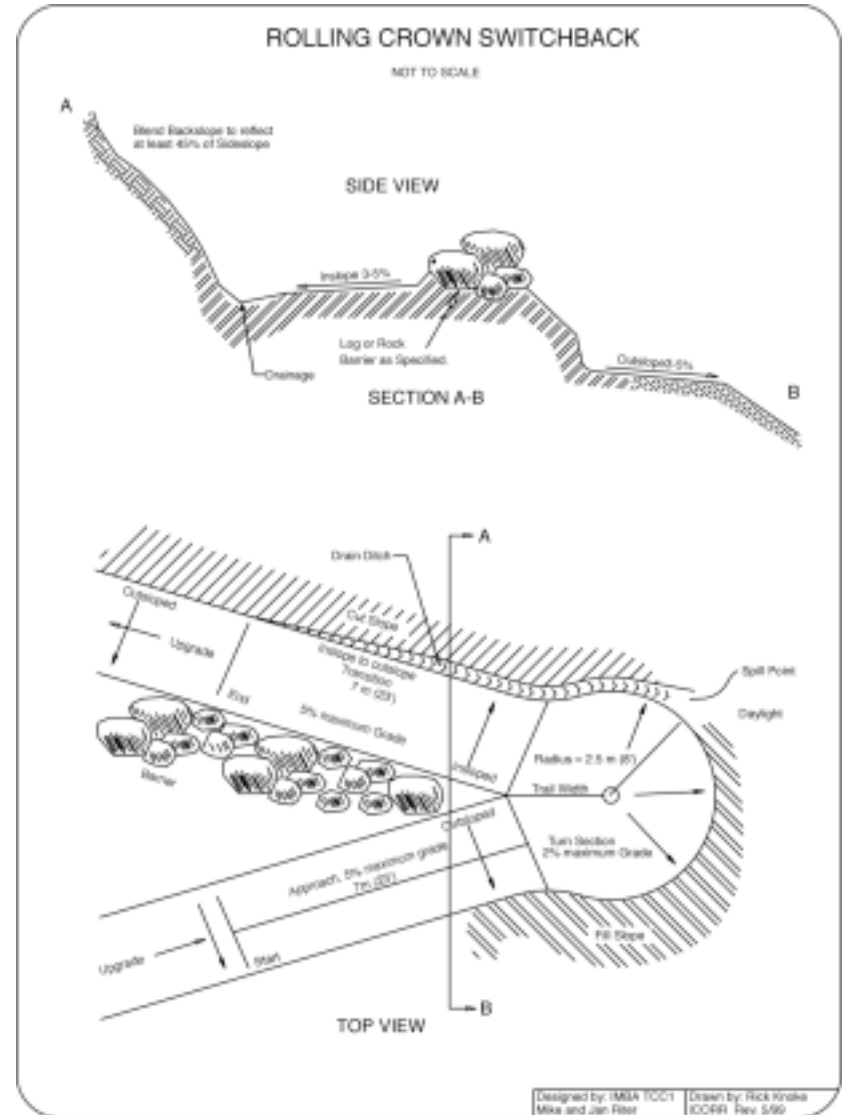
All types of trail users loosen soil and speed natural erosion. Mountain bikers who skid accelerate this process. Cyclists who ride in control don't skid and have minimal impact.

B. Try to mimic mother nature.

1. Man-made trails are unnatural creations. When building or maintaining trails, the goal should be to complement natural processes.
2. Determine what happens naturally in an area and try to imitate it.



2. The upper leg should be insloped, moving into a large flat turning platform, then returned to the normal outslope on the lower leg.
3. Most turns that are described as switchbacks are not actually switchbacks. They are climbing turns. A climbing turn is a turn that climbs (or descends) the existing grade of the hill to make a steep, tight turn.
4. Climbing turns should be used on slopes less than 7% grade and have at least 75 feet between the upper leg and the lower leg (where the turn begins and ends).



Designed by: IMBA TOCT1 Mike and Jan Filer
 Drawn by: Rick Knake ICOPB Rev 5/99

E. Bridges

1. Bridges should be strong enough to hold the heaviest intended user (bike, horse, ATV).
2. Bridges can be constructed of different materials: wood, metal, stone, plastic.
3. Use screws – not nails.
4. Extend ramps into the ground.
5. If trees from the site are used, don't use hardwoods or pines. (Cedars, hemlocks, locust, redwoods, or cypress are all good.)
6. Bark must be stripped or wood will rot and be susceptible to bugs.
7. If rails are required and the bridge is located just before or after a turn, the rail on inside edge should be shortened to accommodate riders leaning into the turn.



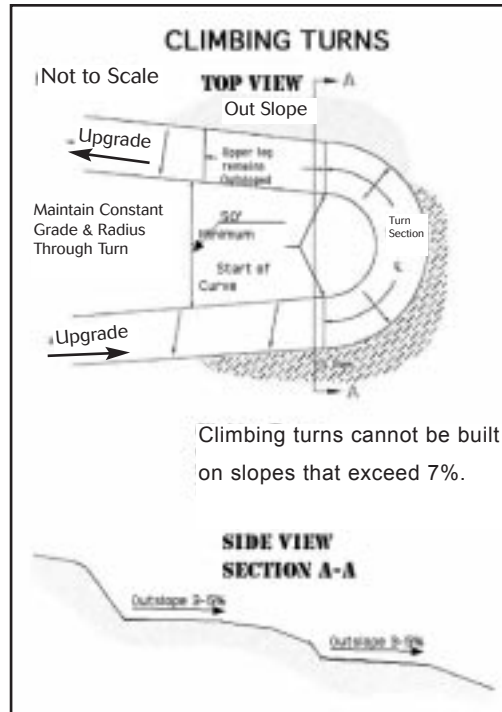
Bridge

F. Switchbacks

1. A switchback is a structure that makes a level turn throughout the transition, and then is routed in a new direction.

Key features:

- Drainage runs off the back of the turn
- Flat table (the turn) forces the trail to cross the fall line of the hill. Users are turning on a level platform. The trail stays on the contour in both directions.
- Split the difference between cutting down and building a crib wall. Use material excavated from the top leg to build up the bottom leg behind the crib wall.



A. Locate the land owner or manager, establish a relationship, and get permission before you build or repair anything.

1. Let them know that you are part of an organized group.
2. Present a written proposal that describes what and where you intend to build.
3. Make your proposal a complete plan from start to finish with a time frame to complete the project. Don't just tell the land manager that you want them to build a trail and expect it to get done without your help.
4. Be willing to compromise, whether you're working on public or private land.

B. Know the area

1. Hike the entire area from boundary to boundary.
2. Look for and identify geographic control points (ie; marshes, rock outcroppings, historic sites, scenic vistas).
3. Control points help you avoid sensitive areas and steer your trail to places people will want to go. Otherwise social trails will develop.



C. Establish the route

1. Mark all control points on a topographic map. Good points in green, bad in red.
2. Draw the trail by connecting the green points together.
3. Be careful to keep the trail drawn on the contours and avoid the fall line.

Mountain bikers always tell us that they want steep hills because they "love the challenge." But 300 feet of elevation is 300 feet of challenge. A long, slow climb with some technical challenge is a thrill that lasts longer than a short wall (that may be unridable in wet conditions). A long, twisty descent is a thrill measured in minutes rather than seconds.

We have found that trying to build trails that require advanced skills in urban parks can lead to user impact problems due to the ease of access for beginners. Urban trails should be kept to an intermediate level at the highest and technical challenge should be provided using natural features.

D. Building flow into the trail

1. There are two basic types of trail building designs: open and flowing, and tight and technical:

- Tight and technical trails promote slower speeds, can be built with sharper and steeper turns, and provide the opportunity to encounter more challenging features (rocks, logs, etc.).
- Open and flowing trails feature sweeping turns, and fewer technical features. They can be ridden by less-skilled riders. Average speeds will be higher than on tight and technical trails.

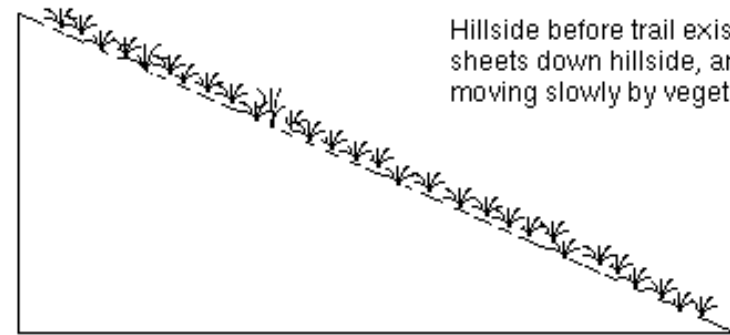
2. Avoid mixing types without a proper segue. The transition from open and flowing to tight and technical should be gradual or on an uphill section of trail. Try not to make constant changes from one type to the other; it encourages skidding and the formation of braking bumps.

3. Know what mountain bikers want. Many are looking for narrow singletrack, some type of technical challenge, and scenic vistas.

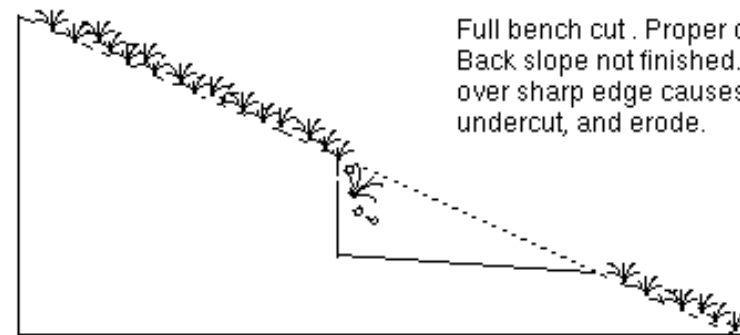
4. Know who will use the trail. Some of the management factors that will affect the design are single use, multiple use, or directional trails. Trails close to urban areas should generally be designed to accommodate beginner to intermediate use. Trails built in less populated areas can often be designed to appeal to more accomplished riders.



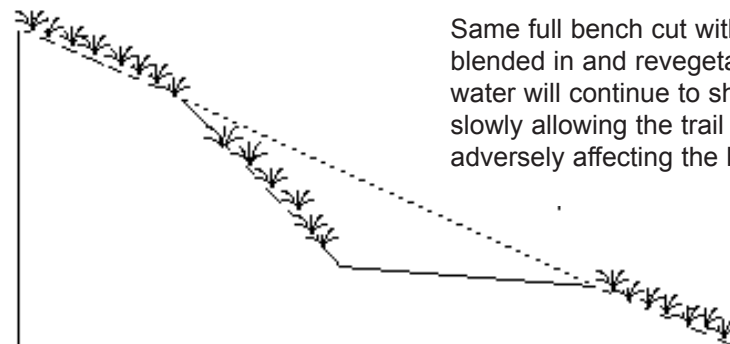
Full Bench Construction



Hillside before trail existed. Water sheets down hillside, and is kept moving slowly by vegetation.



Full bench cut. Proper out slope on tread. Back slope not finished. Water flowing over sharp edge causes back slope to undercut, and erode.



Same full bench cut with backslope blended in and revegetated. Note how water will continue to sheet and move slowly allowing the trail to exist without adversely affecting the landscape



D. Constructing the tread

1. Bench cut construction

Full bench: It is best to dig down to mineral soil for the entire width of the tread. This will result in a trail with a stable tread. It will last longer and require less maintenance.

Partial bench: This type consists of a partial fillslope and partial bench cut. This usually results in tread creep caused by the loose soil being pushed down the side of the hill during use. This type of construction may also result in a berm that will block water flow across the tread.

2. Blending the back-cut into the backslope will prevent water from falling off the backslope onto the trail. Falling water would cause undercutting or a trench in the trail tread.

3. Outsloping is the most important part of the tread. Water will not flow across the tread without proper outslope. The finished the tread should have a 3%-5% outslope from the back of the tread to the outer edge. This can be measured using a digital level or a piece of wood (or cardboard) cut into a triangle and premeasured for the proper outslope. When using the latter method the narrow end should be placed at the inside edge of the trail while making adjustments to the tread outslope until the top edge of the triangle is level.

4. Know who will be the primary users of the trail. For more technical rides, leave in natural obstacles (rock, roots) that are not a safety hazard and will not contribute to erosion. For advanced trails, put in longer sustained climbs and more difficult technical features.



(Left to right) The left drawing shows good open and flowing type design. The middle shows good tight and technical type design. The right, however, is an example of poor design. It shows abrupt transition from one type of design to the other.

A. Knowing the grade

Use a clinometer to keep the trail to a 10% overall grade. This will allow short changes in grade to avoid obstacles yet remain at a maintainable grade overall. Designing grade dips into the trail will break up long, straight linear runs, keep speeds slower naturally, and divert any runoff that might find its way down the trail.



Clinometers

B. Flagging the trail

1. Now that you have established the control points, users and grade, start flagging the trail. Choose your flagging color carefully. Red, yellow, and orange don't work well during the fall season in areas where hardwoods grow, and green may not be visible during the summer. Fluorescent blue or pink work best year round. Check with your local land manager to make sure they are not already using the color you intend to use for other, unrelated projects..



2. When flagging trees, place the knot on the side that you want the tread to fall on.

3. Place flags close together. You cannot over flag a chosen route. Flag any turns extremely well to prevent misalignment.

4. If more than one group will be working to build the trail, then flag the trail corridor, as opposed to just flagging the center line.

5. When flagging the route, go through and spot flags every 50 feet or so, making sure that you can see from flag to flag. Then walk the route backwards, making adjustments to improve the flow. After you return to the beginning, walk the route again, and fill in the gaps between the spot flagging by placing more flagging about every 10 feet. This will help define the actual line that the trail is to follow. Once again walk (or run if you can) the entire flag line in both directions, making small adjustments to improve flow.

Get at least one other person to work with you on the layout. Often they will see what you do not. The end result will be a more interesting trail.

C. Clearing the trail corridor

1. Clear vegetation three feet on either side of tread. Leave grasses and established trees (get approval on what size trees to cut). Completely remove all saplings, briars, vines and other fast-growing impediments by digging them out, roots and all. Do not cut woody plants off at ground level.

2. When trimming branches, always trim at the trunk or branch junction to prevent rot.

3. If necessary, stake the center-line where you want the tread to be placed.



Remove vegetation at the root – not ground level



Pulaski



McLeod