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Improved MTDC Trail Rake for ATVs

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In 1998, the Missoula Technology and Development Center (MTDC) developed a trail rake that could be pulled with an all-terrain vehicle (ATV). That trail rake used a York landscaping rake fitted with hydraulics to swivel the rake and raise and lower the wheels. These adjustments could be made as the machine was being pulled down the trail. With several passes of the rake, ruts and moguls—sometimes called *whoop-de-doos*—could be smoothed out. The performance of the rake and similar trail-grading equipment was described in the report, *Off-Highway Vehicle Trail and Road Grading Equipment* (9823–2837–MTDC, available at *http://www.fs.fed.us/t-d/pubs/htmlpubs/htm98232837/* Username: t-d, Password: t-d).

A handful of MTDC's trail rakes have proven effective on trails across the country. Despite the rake's overall success, years of field use revealed several areas for improvement. MTDC decided to redesign the original model and fabricate a second-generation trail rake, called the MTDC Trail Rake (figure 1).

Figure 1—The redesigned MTDC Trail Rake is easier to operate than the original model and can pull dirt back from berms beside the trail without requiring the operator to drive off the trail.

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Features of the MTDC Trail Rake

Based on comments received from Trails Unlimited, a U.S. Department of Agriculture Forest Service enterprise group, from Dick Dufourd and others on the Deschutes National Forest, and on our own observations, MTDC redesigned the trail rake with the following key features:

- A 4-foot-wide tine assembly that can be shifted 11 inches to either side and raised from 3 inches below grade to 11 inches above grade
- Replacement tines that are commercially available
- A U-joint connection between the ATV and the rake to provide flexibility on uneven terrain and to reduce the possibility that the ATV might roll over if the rake does
- A special heavy-duty battery that can be tipped at any angle and that is not easily damaged by vibration
- Handlebar-mounted joystick controls

The new trail rake weighs 580 pounds and will fit in the back of an 8-foot-long truck bed (standard in most full-size pickup trucks).

Design and Specifications

The MTDC Trail Rake is equipped with a 12-volt hydraulic power pack, paired with three hydraulic cylinders. This allows the rake's tine assembly to be moved up and down, rotated clockwise and counterclockwise, and shifted from side to side.

All movements are controlled with a four-way joystick (figure 2), mounted on the handlebars of the ATV. Depending on the position of the toggle switch, left and right on the joystick activate either the rotate or side-shift cylinder. Up and down on the joystick always control the elevation of the rake assembly, no matter how the toggle switch is positioned. The joystick housing is mounted to a flexible gooseneck arm, allowing it to be positioned where it can be reached easily. This feature allows the ATV operator to keep both hands on the handlebars while driving.

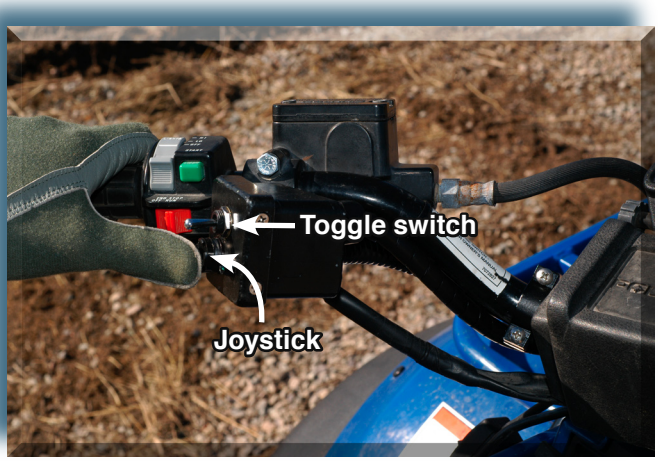

Figure 2—A handlebar-mounted joystick that controls the trail rake's hydraulics is easy to reach and easy to use.

The tine assembly can be raised from 3 inches below to 11 inches above grade. This range allows the rake to cut deeply enough to level the trail and also provides enough clearance for the rake to be loaded onto a trailer easily when the tine assembly is fully raised.

The side-shift capability is new. When the tine assembly is shifted to the side and rotated, the rake can pull soil back from berms alongside the trail (figure 3). These berms can be removed without having to drive the ATV off the trail—a major improvement.

Figure 3—The assembly can be extended 11 inches beyond the edge of the wheels to pull dirt back onto the trail.

Field Evaluation

Trails Unlimited has used the original trail rake for years and proposed that MTDC redesign it, offering several suggestions that were incorporated into the new design. The first prototype of the new design was field tested for a year by Trails Unlimited. They were impressed with the MTDC Trail Rake's ability to move material. Because the new rake is heavier and has heavy-duty tines, it can move much more material than the original trail rake. They believe that the new trail rake can take the place of heavier equipment, such as skid steers, for some projects. Trails Unlimited also appreciated the ability to shift the blade from side to side, the increased vertical travel of the tine assembly, and the convenience of the joystick control.

Trails Unlimited also suggested a couple of improvements. Sometimes operators wearing thick gloves would inadvertently push the joystick left or right, shifting the tine assembly to the side or rotating it, when they intended to raise it. MTDC remedied this problem in the final design by using a four-way instead of an eight-way joystick, reducing the precision needed to operate it.

The other complaint was that the rake was top heavy. In the final design, the battery was moved from its original location above the blade to a lower position on the back axle. This not only lowered the center of gravity, but also lightened the tongue weight to about 180 pounds.

MTDC built two more trail rakes with the improved design. Those trail rakes are undergoing field testing by Trails Unlimited and Central Oregon Combined Off-Highway Vehicle Operations (COHVOPS).

The first prototype tested by Trails Unlimited is back at MTDC. Inspection showed that it held up well over a year of field testing.

ATV Considerations

The new 580-pound trail rake may tax the limits of many ATVs. At least a 500-cubic-centimeter ATV is recommended to pull the MTDC trail rake. Bigger is better. The ATV must be four-wheel drive, liquid cooled, and have low-range gearing. Some belt-driven ATV drive trains are reported to slip and overheat under heavy loads. Trails Unlimited used a 2003 500-cubic-centimeter Honda Rubicon to pull the rake. MTDC has not evaluated the suitability of particular ATVs for pulling the MTDC Trail Rake.

The U-joint connection between the ATV and the rake was designed to provide flexibility on uneven terrain and to reduce the possibility that the ATV might roll over if the trail rake does (figure 4). This system allows for better articulation than provided by a standard ball-and-socket trailer hitch. The ATV must have a 1¼-inch receiver, which is not standard equipment on many ATVs. Aftermarket receivers are available for certain makes of ATVs. Otherwise, a custom hitch must be fabricated.

Figure 4—The U-joint assembly connecting the ATV and the trail rake provides better articulation than a ball-and-socket hitch. The receiver on this ATV is custom built. Aftermarket receivers for some ATVs are commercially available.

Although the trail rake has its own 12-volt battery, the battery is charged by the ATV charging system. We recommend that the ATV alternator have an output of at least 20 amps.

Basic Operating Procedures

The MTDC Trail Rake performs best when it is used to cut small amounts of material at speeds ranging from 3 to 7 miles per hour. Ruts and whoop-de-doos will be removed after several passes. The ATV should be operated in four-wheel-drive low range.

Move the side shifter from side to side occasionally to keep dirt and debris from building up in the side-shifter's channels. To properly maintain your ATV, allow the ATV a chance to cool down when it becomes hot, and always keep fluids at the appropriate levels.

The trail rake also requires maintenance. Hydraulic fluid levels need to be checked periodically and the rake's two grease fittings (zerks) should be greased periodically. One fitting is in the U-joint assembly; the second is in the head of the main pivot bolt of the tine assembly. Lubricate the pivot plates and the height adjustment holes with copper antiseize lubricant.

Make sure that the trail rake's battery and the ATV's battery are fully charged before connecting them through the rake's trickle charger. Even a small voltage difference between the batteries will draw enough current to blow the 20-amp inline fuse. The fuse should prevent permanent damage to the ATV and the trail rake, but the fuse will need to be replaced. A 5-amp fuse in the relay box helps to protect the joystick and control circuitry. ***Keep extra fuses with you!***

Forest Service operators need training before operating ATVs and this specialized piece of equipment. Job hazard analyses need to be customized for the particular conditions and activities of the job at hand. Steep slopes, rocky or uneven terrain, fire danger, and dusty conditions may be among the items that need to be addressed in a job hazard analysis. ATV operation also requires specific personal protective equipment. In the Forest Service, regional policies differ regarding the use of ATVs for trail work, so be sure to know the rules that apply to you.

Availability

The MTDC Trail Rake is not commercially available. Fabrication drawings (MTDC–1036, *MTDC Trail Rake*) are available from MTDC. Contact Deb Mucci (phone: 406–329–3999, e-mail: *dmucci@fs.fed.us*) if you want a copy. MTDC would like to find a manufacturer interested in building and selling the rake. Encourage anyone interested in building the rake to contact us.

Parts for the MTDC Trail Rake prototype cost $2,900. The MTDC Trail Rake takes about 15 days to fabricate. Parts and fabrication costs could be reduced if the rake was produced commercially.

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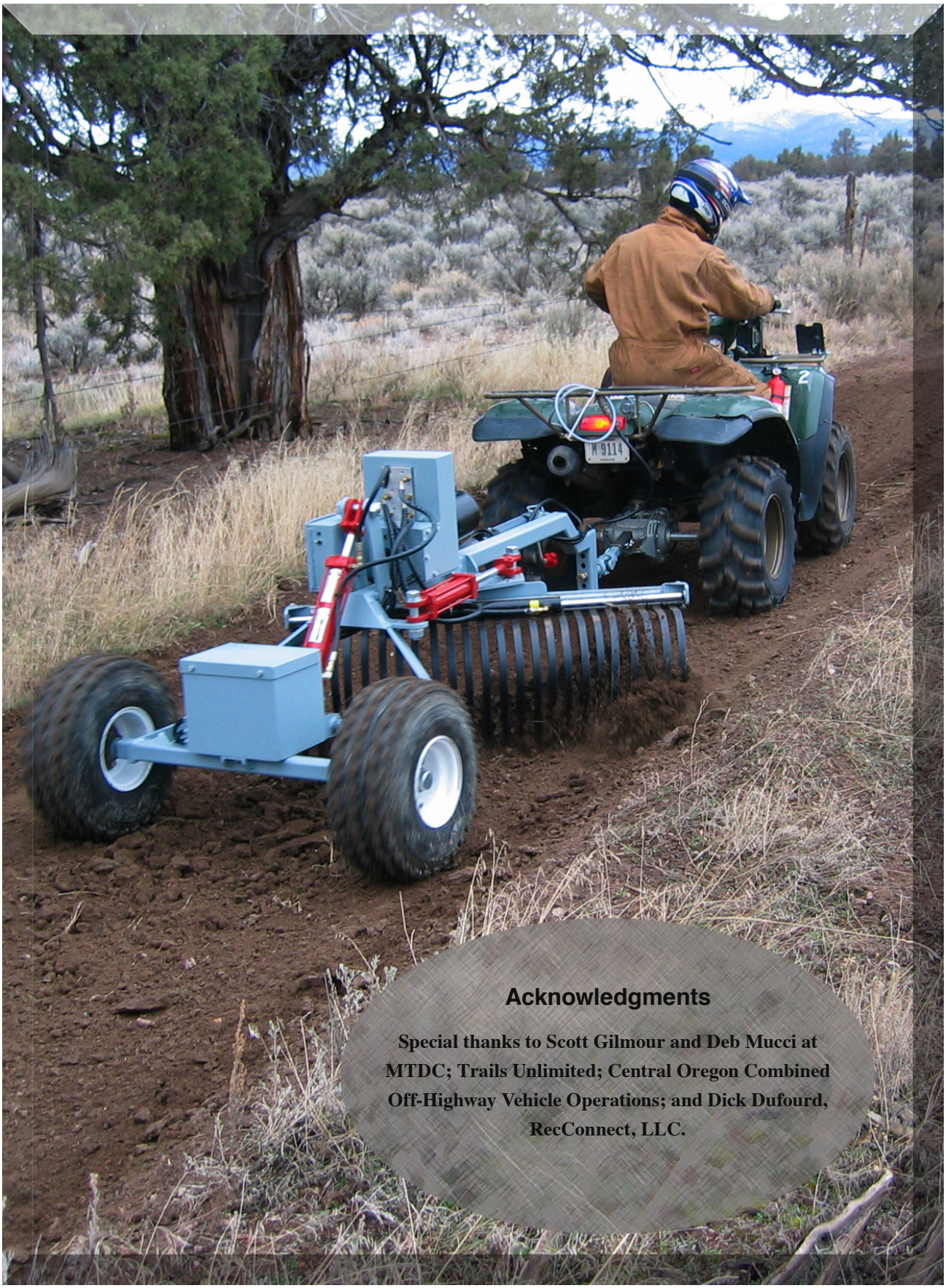

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About the Authors

Tyler V. Kuhn began working at MTDC as an intern in 2000. He received a bachelor's degree in mechanical engineering from Montana State University in 2001 and works for the center as a mechanical engineering technician.

Brian Vachowski has been the reforestation and nurseries program leader since 2002 and has been a project leader specializing in recreation, trails, and wilderness projects at MTDC since 1993. He received a bachelor's degree in forestry from the University of Massachusetts and a master's degree in outdoor recreation from Utah State University. He has worked for the Nez Perce, Bighorn, Winema, and Routt National Forests in recreation, wilderness, lands, planning, rural community assistance, special uses, fire, and timber positions. Before coming to MTDC, he was an assistant staff officer for wilderness and recreation on the Nez Perce National Forest.

Library Card

Kuhn, Tyler V.; Vachowski, Brian. 2006. Improved MTDC trail rake for ATVs. Tech Tip 0623–2320–MTDC. Missoula, MT: U.S. Department of Agriculture Forest Service, Missoula Technology and Development Center. 6 p.

Describes an improved trail rake that can be pulled by an all-terrain vehicle to maintain trails. Among the rake's key features are:

- A tine assembly that can be shifted 11 inches to either side and raised from 3 inches below grade to 11 inches above grade
- Joystick controls mounted on the handlebar
- A U-joint connection between the all-terrain vehicle and the trail rake to provide flexibility on uneven terrain and to reduce the possibility that the ATV might roll over if the rake rolls

When the rake's tine assembly is shifted to the side and rotated, the rake can pull soil from berms alongside the trail without requiring the operator to drive off the trail. The parts for the prototype trail rake cost $2,900. The rake takes about 15 days to fabricate. Drawings (MTDC–1036) are available from the Missoula Technology and Development Center.

Keywords: all-terrain vehicles, equipment development, mechanical drawings, off-highway vehicles, prototypes, trail maintenance

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Single copies of this document may be ordered from:

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Electronic copies of MTDC's documents are available on the Internet at: *http://www.fs.fed.us/eng/t-d.php*

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Forest Service and Bureau of Land Management employees can search a more complete collection of MTDC's documents, videos, and CDs on their internal computer network at: *http://fsweb.mtdc.wo.fs.fed.us/search/*

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