Extended One-Handed Vegetation Clippers
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Introduction
Deminers must frequently remove low-lying vegetation in order to perform subsequent demining operations such as metal detection and excavation. Vegetation clearance is accomplished both with mechanical equipment and with manual hand tools. Several types of hand tools are commonly used, such as two-handed grass shears, one-handed clippers, or secateurs, and pruning saws. Of these, there are no known one-handed clippers in use that feature an extended distance from the hand to the cutting blades. An increased distance from the hand to the operational end of a tool decreases the likelihood of a serious injury to the deminer in the event of the accidental triggering of a mine. This distance also provides greater scope for the incorporation of a blast shield for the hand, further improving safety. Finally, conventional one-handed clippers are prone to the unsafe usage mode of approaching vegetation from above, putting the deminer at risk of applying pressure in the likely direction of the mine’s pressure trigger.

One-handed clippers are a recommended component of a deminer’s hand tool kit. They are designed to cut hardier vegetation such as thick stems, small branches and roots, which are not as easily cut with two-handed shears, as well as light vegetation that does not require the additional effort of manipulating a two-handed tool. They are more suited to careful work requiring precise control. They can also be used without releasing a tool held in the other hand, or they can leave the other hand free to remove cut vegetation without it falling into the danger zone.

Design
The extended one-handed clippers are shown in Figure 1. Figure 2 indicates one way the clippers would be held during normal use. The clippers can be used in either the right or the left hand and are designed to cut vegetation close to the ground for optimum subsequent metal detection. They may also be used to cut vegetation in other situations, but are designed primarily for trimming vegetation in an area where a blast may occur.

The distance between the operating hand and the tip of the tool is 30cm, a distance at which the likely seriousness of injury incurred from triggering a typical anti-personnel blast mine is substantially reduced. In addition, the operating hand is placed close to the ground, largely away from the typical “blast cone” of a mine. The tool is configured in such a way that it is kinematically difficult for the deminer to use it in a less safe fashion, by approaching with the hand directly over the area being cleared. The cutting head is an “anvil” style, which is believed to transmit less pulling force to the vegetation being cut than “shear” style cutting heads. Disturbances transmitted to vegetation can potentially trigger mines that have been entangled in the subterranean root system. The spring, a necessary component of a comfortable one-handed clipper, has been relocated to the handle area rather than the head area to prevent it from becoming a projectile that could exacerbate injury to a deminer who is the victim of an accidental detonation. Both the extended head and the front handgrip are suitable for the incorporation of a protective blast shield.

Ergonomically, the tool is designed to feel like an extension of the human arm. The rear of the tool is counterbalanced
against the forearm to reduce wrist fatigue that would occur if the hand had to support all the torque of the extended head. The handgrips have substantial flanges to cradle the hand, saving the operator from having to maintain an active grasp on the tool to keep it elevated when not in the process of clipping. The tool is designed to stand in an upright position when placed on the ground, to enable the operator to easily set it down and pick it up again with one hand.

Testing
The extended one-handed clippers were tested by handing them to volunteers without instruction and by cutting stems, grasses and small branches in the Cambridge Massachusetts area. The overwhelming majority of subjects were able to operate the clippers in their designed configuration without prompting. The clippers proved capable of cutting most basic vegetation, but there is room for improvement in the peak torque applied when the hand is at its strongest gripping position. This could be accomplished by moving the attachment point of the pull rod either at the cutting end or the handgrip end. Users found the clippers comfortable and well balanced, though the handgrips should ultimately be designed to accommodate larger hand sizes.

Manufacture
The frame and forearm support of the clippers and perhaps even the anvil side of the cutting head could be made out of a single piece of mild steel sheet, folded into a U-channel. Alternatively, if welded joints are cheaper than wasted stock, several pieces could be welded together. In particular, the stiffener at the bend of the clipper frame can be made from a small piece of steel, bent using blacksmith techniques and welded or spot-welded in place. The handles can be made from steel tube or channel, or molded plastic with a metal spine. The pull-rod could pass through a loose hole at the handgrip end, removing the need for the 2-axis adjustable joint featured in the prototype, and be mushroomed in place. Similarly, the handgrip pivot could be a single rod mushroomed in place. The total parts count could thus be around nine pieces including the head pivot and cutting blade. A significant number of parts are located within the cutting head, but clippers with this type of cutting head have survived blast testing successfully, so the high parts count may not be a limiting aspect of the design. The manufacture of the device is limited to locations with the ability to produce existing clipper designs — in particular, manufacturing locations must be able to fabricate or import cutting blades. No new materials or technologies beyond those involved in existing clipper construction are required.

Future Work
The next step in the development of the extended one-handed clippers is to seek feedback from the demining community concerning the desirability of the approach demonstrated by this concept prototype. Several specific questions will be posed as part of this feedback collection process. First, it should be determined whether having the pull-rod located out to the side presents a perceived safety hazard. Any final design will be blast-tested to ensure that parts do not separate during a blast, but if deminers believe that the clippers appear dangerous then they will be disinclined to use them. Second, consideration should be given to whether the extended reach of the clippers makes it difficult or dangerous to stretch out the other hand to remove cut vegetation. It may be necessary to incorporate a gripping jaw into the cutting head that would allow clipplings to be removed with the tool as part of the same cutting motion. Third, as always it must be determined whether the weight and cost of the tool can be kept within acceptable parameters. One Zambian manufacturer that has informally discussed the clippers believes they could be manufactured in that country for a selling price of US$10 if the cutting blades were available. This price is comparable to the price of ordinary secateurs in the USA, but more expensive than locally manufactured secateurs in Zambia which sell for approximately US$3.

Several design issues have been identified for further examination in the event that the feedback on the concept prototype is favorable. First, as mentioned in the Manufacture section, the consolidation and simplification of components to reduce complexity and associated cost and weight. Second, as implied in the Testing section, modifying the pull-rod assembly to provide higher maximum cutting torque and greater visual cleanliness of the design. Third, the clipper design is clearly more bulky and challenging to package and transport than a conventional pair of secateurs, so a feature that could be considered is a modification to make the clippers fold in half for storage and transport. The support arm could be made out of two rods rather than a steel channel, and be hinged at the base of the rear handgrip, allowing the entire support arm to fold forward over the handgrips to approximately halve the profile of the clippers when not in use.

Credits
Andrew Brooks designed the extended one-handed vegetation clippers and wrote this report as part of the MIT Humanitarian Demining Course taught in the Spring of 2004 by Benjamin Linder and Andrew Heafitz. Static photos of the clippers were taken by Andrew Brooks and photos of the clippers in use were taken by Daniel McAnulty.
Appendix A: First Prototype and Lessons Learned

The first prototype of the extended one-handed vegetation clippers is shown in Figure 3. Figure 4 shows this prototype in normal use. The design goals of this prototype were similar, but it made greater use of pre-fabricated components and some of its design decisions were a result of this fact. The prototype exhibited a number of problems that exposed important factors to take into account when designing an extended one-handed clipper.

1. Users reported discomfort with the generous stand-off distance offered by this prototype. It is therefore recommended that future extended clipper designs adhere strongly to the accepted “safe demining hand tool” distance of 30cm direct linear distance between the tip of the hand and the tip of the tool.

2. Having the hinge of the handgrips aligned with the clippers’ spine gave the device an unwanted “rifle” metaphor. Almost every test subject who was handed the clippers without instruction proceeded to attempt to wield them upside down. Designers should be aware of dominant physical analogues that may be present in the minds of the intended users of their designs, and that may lead to unexpected or undesired methods of operation when untrained or distracted.

3. The shallow bend angle of the clipper spine did not contribute to either effective low ground approach or user comfort. In order to approach flat to the ground, the deminer would need to lean down in a stressful and possibly unsafe position; if this was not done, the approach angle was somewhat steep. The optimum bend angle seems to be a fairly central compromise between zero (maximum arm extension) and ninety degrees (maximum unwanted transfer of the clipper’s weight to the moving handgrip).

4. The simple plate steel spine was far too compliant for effective cutting, even after a stiffener was added. A U-channel or hollow rectangular cross-section is recommended for high stiffness with low additional weight. A T-shaped cross-section was considered, but rejected for reasons of stock availability in less industrialized countries and stability of the ungrasped tool (see point 5).

5. This prototype did not stand up when placed on the ground, but would tip over on its side, making it hard to effectively re-grasp with one hand. This feature seemed important enough during testing and evaluation that it is recommended to ensure that it is incorporated into future designs even if it necessitates the addition of an additional small part, such as a balancing “foot”.

Figure 3. The first prototype extended one-handed clippers viewed from front, top and side.

Figure 4. The first prototype of the extended one-handed clippers in anticipated use from the squatting and kneeling positions.