

MIT Pick Prod
Design for Demining, Spring 2005
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Introduction

It is difficult for deminers to excavate metal detector signals in hard ground, which is found in many mined areas (Afghanistan, for example). Mines buried in hard ground can be set off accidentally, when deminers use excessive force or unsafe tools in an attempt to penetrate the ground. They can also be missed and later stepped on, when the ground is just too hard to penetrate to the depth of a deeply buried mine.

Some existing tools, such as Andy Smith's pick prod, cannot penetrate very hard ground easily, although they are generally safe since they are meant to be used with slow, controlled movements. Other tools such as regular pick axes are more effective at breaking up the earth but encourage hard, uncontrolled striking at the ground, where the tool approaches the earth from above and the user is in an upright position. All of these factors make such tools very unsafe.

The MIT pick prod uses momentum to make ground-breaking easier, like a regular pick-axe, but is designed to be used at a low angle and from a kneeling position, making it much safer. It is hoped that this tool will help deminers to penetrate hard ground more easily while maintaining safety standards.

Design

The current prototype (shown in figures 1 and 2) has a 3 foot angle steel body (1/8 inch thickness.) The handles are D-shaped, with doubled steel tubes (3/4 inch diameter) as grips. The shield is black rubber (1/2 inch, butyl). This model is the result of feedback from members of the demining community, including Bob Keeley and staff of Fort Leonard Wood.

We incorporated several improvements to enhance safety, usability, comfort, production, and marketability. The body was changed from square steel to angle, which improves manufacturability in developing countries, allows us to increase the thickness for greater durability, and eliminates the safety hazard from a possible barrel effect. We also moved to a symmetric rubber shield, which improved product image and usability. The new handles retain the double tube grip, but are now oriented to allow easier swing and better angle of impact.



Figure 1. The MIT pick prod in use.



Figure 2. The D-handle pick prod.

Testing

Several versions of the pick prod were tested in rocky ground in the Cambridge area. One timed trial was done, comparing the time to dig an approximately 10cm x 10cm square to a depth of approximately 15cm for different tools. The tools compared were the right-handed version of the MIT pick prod, the symmetric "V" straight-handled version of the MIT pick prod, a regular garden trowel and Andy Smith's pick prod. Both MIT pick prods showed much quicker excavation times than the other tools, mostly for their ability to penetrate deeply into the ground and then scoop in a single motion. Although the results are approximate (the size of the excavation was not well-controlled), there is a significant difference between the MIT pick-prod times and the other tools.

Results are shown in table 1.

	Trial 1	Trial 2
Right-handed pick prod	9 sec	10 sec
V straight-handle pick prod	10 sec	11 sec
Trowel	39 sec	29 sec
A. Smith pick prod	51 sec	45 sec

Several trials were also performed to assess the utility and comfort of different handle and shield configurations. Various models of the pick prod were tested in rocky, although not incredibly hard, soil. Issues noted during use were:

Large tube handle (front)

- Handle encourages excavating at a steep angle (greater than 30°), which is unsafe.
- The tube is too large to hold comfortably: the weight of the pick is held more by the fingertips than the whole hand.
- The user's fingers are "visible" to the blast on the underside of the tool.
- The knuckles may scrape against the ground during the swing (although this did not occur during testing.)

To address these issues, it is recommended that a version with the tube replaced by a sideways D handle (see Appendix 1 for figure) be tested, where the smaller handle diameter will be more comfortable to grip and the elevated handle will correct the other problems noted.

Vertical handles (front and back)

- The forward handle is uncomfortable to use. Trying to maintain a full grip on the vertical handle caused contortion in the wrist and arm.

To address this issue, it is recommended that a version with an angled forward handle (see Appendix 2 for figure) be tested.

General

- Comfort and correct use were found to vary with the size of the user. For example, if the handles are far apart it is difficult for small users to be able to bring the tool far enough away from the ground to use the swinging action that makes the tool effective, but if the handles are close together it is easy for larger users to use the tool incorrectly by prodding forwards, towards a mine, rather than sideways.

To address this, the tool should have at least a general fit with the user's size (i.e., small, medium and large versions).

Manufacture

The main structure of the pick is manufactured out of type 304 stainless steel. 304 stainless is corrosion resistant, easy to weld, and ductile enough that it is expected to warp in a blast, rather than shatter. All materials (including the angle steel used for the body of the tool, the steel strap used in the D-handles and shield brackets, the steel tubing used in the handles, and the rubber for the shield) can be cut with either a hacksaw or a band saw. The tip of the tool is sharpened using a grinder, and the V-shaped cut in the shield rubber is made by first drilling slightly oversized holes at the corners and then cutting between them with a small coping saw. In all cases, the strap was bent using a sheet metal break, but it could also be shaped with a vise and hammer. All metal parts are welded together to avoid fragmentation in a blast, and the rubber shield is firmly sandwiched between two L-brackets so it cannot be removed. The double tubes used for the D-handles encourage a proper grip on the tool. Additionally, the shield is located so that it is between the user's hand and a possible blast, and so that the standoff distance between the user and a mine is greater than 30cm.

Future Work

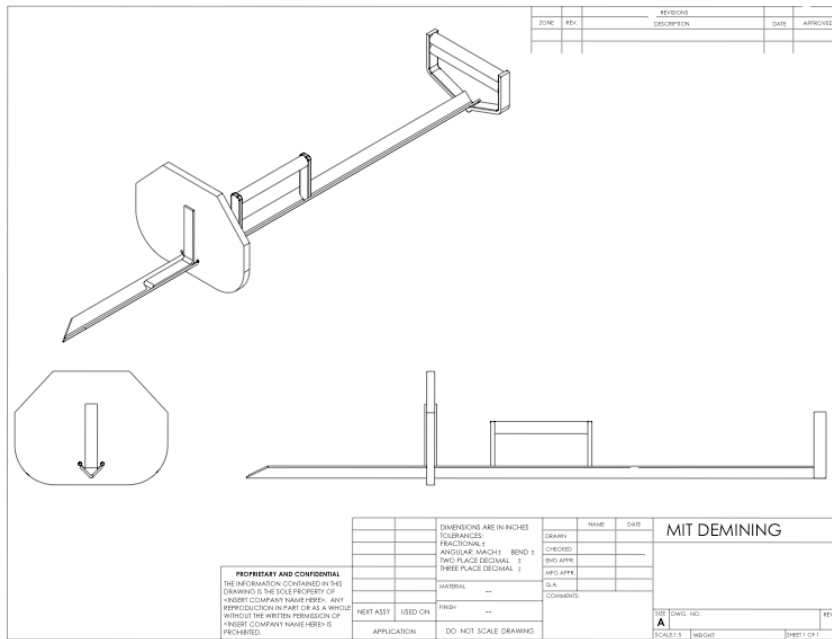
Future students need to decide on a handle design. We recommended prototyping the variation of the D-shaped handles shown in the appendix. Three prototypes of two final designs need

to be blast-tested at the Energetic Materials Research and Testing Center in New Mexico. If the shield is effective and the tool does not fragment, the design should be field tested in Afghanistan before being commercially produced.

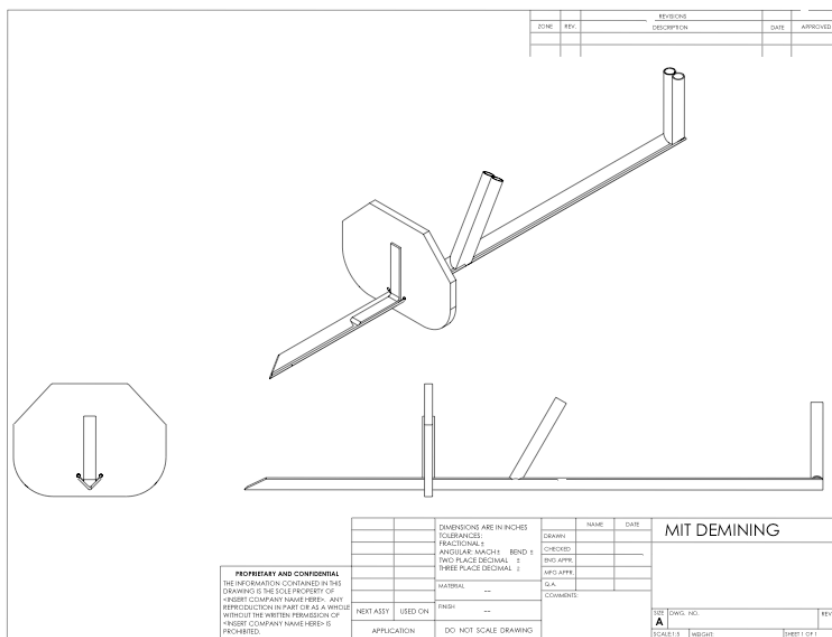
Credits

The pick prod team includes Rosalind Takata, Aron Zingman, and Katherine Rorschach. Pictures by Aron and Katherine, and Solidworks models by Rosalind.

Appendix 1



Appendix 2



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