

How Product Design Can Improve Manual Demining



■ A long reach for the right tool. The bag was generally considered to be performing badly; carrying and closing the bag and inspection and protection of tools were difficult.

The Design without Borders (DwB) programme was initiated and is led by Norsk Form, the Norwegian Centre for Design and Architecture. It aims to use designers' creative and analytical skills to create solutions for developing countries and areas of emergency. DwB aims to create meeting points between problem owners and professional problem solvers, and to be a catalyst for cooperation and development of new products and services. Our demining work is carried out in close collaboration with Norwegian Peoples Aid (NPA).

by **Anders Ilsøy, Design without Borders**

Introduction

Manual demining is a key component in the humanitarian demining projects run by NPA. Currently, significant resources are invested internationally on issues such as mine dogs, mechanically assisted demining and ground penetrating radar.

However, none of these technologies replaces manual demining—each only complement. Despite this, manual demining receives relatively little attention.

Manual demining is very resource-intensive. NPA has found that a day's work for a deminer can range from as little as 0.5 sq m up to 80 sq m in different projects. If we can improve the working conditions for deminers without compromising safety, so that more projects

can manage 80 sq m/person/day and fewer 0.5 sq m, our effort will make a difference for all demining operations! DwB has joined NPA in this effort, providing knowledge in product design issues such as ergonomics/human factors, materials and manufacturing processes.

Analysis and Field Study

In order to gain a proper understanding of the challenges of manual demining, it was necessary for DwB to carry out an extensive analysis, including a field study. This work was partially funded by the Norwegian Agency for Development Cooperation (Norad). Three professional product designers were chosen for the task, carrying out the analysis and a 10-day field study in Tete, Manica and Sofala provinces in Mozambique.



The study concentrated on the deminer's work situation, tasks, protection equipment and personal tools (except the detector)—and especially their mutual interaction. These equipment and tools were chosen because they are bought and used in sufficient numbers to also make them commercially interesting.

NPA has been manufacturing a range of their prodders and other hand tools locally where possible. The field study investigated local manufacturing possibilities in order to see if local manufacturing could be further utilised for other products. The full report is published in .pdf-format on the Internet at http://www.norskform.no/dug/rapport_fase1.pdf.

Potentials for Improvement

First, the demining operations all seemed well run. The equipment and work operations were overall held to be satisfactory or good, but not without scope for improvement. The results from the field study and analysis are summarised in figures showing potentials for improvement in six important categories. This is done for each piece of equipment that has been considered, and forms the background information for our project proposals.

Generally (and unsurprisingly) the protection against landmine blasts appears to be attended to. Usability, both in terms of comfort and performance, seems to be less considered. Also, safety and health beyond explosives protection are issues in need of attention. Dehydration and overheating are consequences of working with heavy and non-ventilated protection gear in hot climates. This rarely has major direct effects on human health, but besides being uncomfortable, it will certainly influence deminers' concentration and reaction time, which are crucial. Interviews with deminers support that this is a problem to be taken seriously.

General body protection should be improved, especially of the knee joint. The kneeling posture used in demining has been shown to cause damage to the joints when used often and over time. Integration of explosives protection may be considered, as the knee will be exposed to any explosion. Reinforcements in the

uniforms will reduce the number of cuts and scars, in addition to increasing uniform lifetime.

It is difficult for an outsider to make a judgement on the operating procedures. But it is obvious that the way deminers relate and conform to standard operating procedures (SOPs) can be made more efficient. This can especially be seen when deminers are switching between tools: after identifying a potential mine or UXO, the deminer often has to change his focus completely, from the potentially dangerous object to looking for where the right tool might be lying. Sometimes a long reach may be sufficient, but sometimes the deminer has to get up from the baseline, walk back to where the toolbag is kept, and then relocate the object. This is inefficient and potentially dangerous. This also encourages the deminers to take shortcuts. We observed one-hand operation of two-handed equipment and deminers pushing excavators under their vests and scythes in their belts. Carpenters, rock-climbers and others have solved this problem by using a tool belt—it seems like this would be a good solution to consider for deminers as well!

The Vest

The vests studied in the field were developed for NPA by the Norwegian manufacturer Rofi. The dialogue between NPA and Rofi is good, and hence the most recent vests are functioning very well as they are modified and improved according to NPA requirements. However, there are some issues that are not solved satisfactorily:

- The deflector/overlap between vest and visor restricts mobility and adds weight away from the body. Also, we must bear in mind that the visor is not worn completely down in each and every case.
- The weight of the vest and the materials used restrict the ventilation of the body. Heavy perspiration leaves the deminer completely soaking wet after one hour of work. Some deminers claim that this results in colds when they are staying in the waiting area.
- Possibly as a result of the points above, the deminers have a tendency to "sag" the vest slightly, leading to body areas not being covered as intended.

- Cleaning, maintenance and replacement parts are not properly catered for, reducing the lifetime of the vest and making deminers feel that sharing of vests is quite unhygienic.

Some of these problems are not easily solved, and there may be a need for a complete rethink of how the vests are designed. It may be more appropriate to look into animal life for inspiration, using bionics thinking, rather than the evolution from bulletproof vests. A solution like the Armadillo vest will enable both ventilation and protection.

The Visor

The visor, a second-generation design by Security Devices in Zimbabwe, was clearly more problematic. When worn correctly, heat will get trapped behind the polycarbonate glass, causing the deminer to get overheated and the glass to steam up from the breath of the deminer. Many quoted the need to stop work and open the visor in order to cool down, but in some cases, deminers are known to continue working without wearing the visor fully down.

The visors also scratch easily, obstructing the deminers' most useful detection device—the human eye. The visors are changed frequently, but not frequently enough; deminers were observed lifting their visors for a better look during their work in minefields.

Quality problems also affect visibility through breakage and slippage of the visor. This is a result of heavy weight and constant readjustment of the straps when two people share a visor. Comments were also made on the rather cumbersome opening and closing mechanism.

When considering a new kind of mask, this must be done together with the vest in order to ensure overlapping protection.

Inspiration and knowledge can be taken from masks developed for other demanding applications, such as the baseball catcher, the ice hockey goalie and the smoke diver masks. Moist air from the breath can be channelled away, and a combination of materials may be used for the same protective effect the full-face polycarbonate provides today. The

polycarbonate part may be smaller, able to retract into the mask for scratch protection, and easily replaced without needing to discard the rest of the mask.

Vegetation Cutters

Deminers may use more than half of their time clearing vegetation. Considering this, we were amazed at the low level of vegetation cutting tools. The tools could be wholly inappropriate, such as the furniture saws issued to cut down trees; of low quality and badly maintained, such as the pruning scissors; or just misused, such as the machete and scythe largely would be.

This requires no new product development, as superb products already exist in the market, often locally. But it does require knowledge and attention when purchasing equipment. As a minimum, the following points should be observed:

- Appropriateness—Is it made for the intended use? Is it of an appropriate quality?
- Usability—Will the deminers know, or learn, how to use this tool? Is training required?
- Maintenance—Do the deminers know how to maintain this tool? Is training required? Do they have the tools available to do maintenance?

Simply by using the right vegetation cutters and maintaining them, demining productivity can increase considerably!

Demining Tools

NPA uses locally manufactured prodders and excavators. Bayonets have also been used if available. These tools are crucial to demining and are identified as the tools

that are most likely to cause damage if used incorrectly, but at the same time, these tools may be hard to improve beyond the work that is currently being done by others. Knife- and sword-smiths' skills, such as creating a sharp, hard edge on a soft steel blade, should be investigated for use on demining tools.

Ergonomically, there is a lot to gain by redesigning these tools. Today, fine, precise muscles in the hand and wrist are used for operations requiring a lot of force. This quickly induces fatigue during operation and makes the tools more difficult to control. Larger muscles should provide the power, preferably by pulling

■ Deminer holding the excavator while using the detector.



■ (Above) Heavy body perspiration after a 10-minute demonstration in overcast weather. (Right) Steamed-up visor and heavily perspiring deminer. Note scratches in the field of vision.



■ (Left to Right) Armadillo vest—an example of bionics thinking. Mask design.





■ (Left to Right) NPA prodder and excavator.
(Bottom) Furniture Saw.

the tool rather than pushing it, in order to maintain maximum control. The smaller muscles should then be left to perform the tasks requiring maximum sensitivity.

Redesigning Personal Protective Equipment

Following discussions, the results of the analysis and feedback from the field, NPA and DwB have decided to pursue development of a new set of PPE as our first project. This PPE will be seen as one integrated unit consisting of several parts. Manufacturing will take place with existing suppliers, but also in the local market where possible. We are currently in the process of financing the project, which should run throughout 2003. Discussion partners are most welcome in this project.

Our Vision Ahead

We are all sharing the dream of a mine-free world. But in the process of getting there, we want all deminers to be provided with effective, safe and comfortable equipment at a reasonable cost. We want to help develop this equipment, employing our user-oriented

design methodology. And we want this equipment to improve and speed up manual demining operations.

In the process, we also want to create positive developmental side effects. We can do this through facilitating local business opportunities, learning from others and transferring skills, among other things. When demining operations eventually cease, these skills can be used for other purposes. We have started on the crucial area of manual humanitarian demining. Gradually, we aim to cover more and more of the areas where we as designers can make a difference. ■

**All photos courtesy of the author.*



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