Journal of Conventional Weapons Destruction

Volume 10
Issue 1 *The Journal of Mine Action*

Article 38

August 2006

Power Tillers and Snails for Demining in Sri Lanka

Emanuela Cepolina
Snail Aid – Technology for Development

Power Tillers and Snails for Demining in Sri Lanka

This paper presents a project the author has been working on since January 2005 in the context of her doctoral research and offers some of the first results. The topic concerns the participatory design and development of a distributed system for humanitarian-demining operations in Sri Lanka. The completed research is expected to encompass the relationship among landmines, humanitarian technologies and development. This article looks at the adaptation of power tillers for demining applications in Sri Lanka using a participatory design methodology called the Snail System.

by Emanuela Elisa Cepolina [University of Genova, Italy]

There is a common understanding that research into humanitarian demining technology has not yet provided the positive results initially expected. In the last 10–15 years, hundreds of millions of U.S. dollars[1] have been spent on research, and promising technologies have been developed and tested. However, there has been very limited introduction and integration of new mechanical technologies into common demining practices in the field.

This observation is supported by results from a field study conducted last year in collaboration with the European project, European Union in Humanitarian Demining 2 (EUDEM2), of which I was a part. Our research focused on collecting information about machines and technologies created for use in the field of humanitarian demining, as well as the efficiency of these tools and end-users' feedback about them. We found 16 demining machines in use by nine organizations working in the four countries we visited, while the total number of sensor technologies in use by the same organizations was 1,081.[2]

Such a discrepancy in the number of machines and sensors employed by demining organizations is surprising. In fact, while sensors are considered part of equipment assigned to personnel and therefore each deminer has one, the number of machines employed by each organization was generally very low, usually between zero and two items. One exception was a single organisation that was using nine different machines.

While gathering various data, we asked nongovernmental organization logisticians about the maintenance costs of technologies in terms of the operating cost, salary of operators, downtime due to mechanical failures, time between failures and cost to repair failed machines. Generally, we found a huge difference between the maintenance costs of a machine and that of a sensor. Taking as an example our data gathered in Mozambique, the maintenance cost per month of a machine in use at an organization was US$530 while the cost for maintaining a sensor was $194. These calculations do not even take into consideration the cost of training, which lasts 25 days for a machine and less than one day for a sensor.[2]

Thus, we believe high maintenance costs are one of the key factors behind the low adoption rate of machines by demining organizations. In our calculations, the high maintenance expenses were primarily due to the excessive cost to repair machines, multiplied by the high frequency of machine failures. We concluded demining machines are complex systems that have not been conceived by the deminers who use them; nor have most machines been developed specifically for the environment in which they are being used.

Establishing a Participatory Approach to Demining Machine Design

These findings support the argument that there is a need to change the approach of designing new machines to one that is participatory and specially tailored to specific demining environments. Allowing deminers to build the machines they like with richer countries providing the missing but necessary tools can improve demining efficiency as well as help the development process.

In fact, technology plays a pivotal role in the development process of a country. Jeffrey Sachs, Special Adviser to the U.N. Secretary-General, writes, "I believe the single most important reason why prosperity spread, and why it continues to spread, is the transmission of technologies and the ideas behind them."[3] Indeed, rapid economic development requires technical capacities to suffuse the entire society from the bottom up. In developing countries, homegrown technologies are needed to adapt the global technological development process to a wide range of local needs including energy production and use, construction, natural hazard mitigation, disease control and agricultural production. Moreover, homegrown technologies for humanitarian demining applications are required as landmines influence both economic and human development of affected countries.

With these exploratory findings in mind, I would like to present a project I have been a part of in the context of my doctoral research since January 2005. The methodology proposal is applied to the design of HD technology based on agricultural technology (the power tiller); later on it could be applied to the improvement of old agricultural technologies to new agricultural tasks. This approach suggests a participatory way to design technology that makes use of and improves local knowledge. Generally, this methodology can be used for designing new agricultural technologies or adapting and improving old ones.

The methodology presented will be tested for designing and developing a distributed system for area-reduction operations in Sri Lanka. Given that every mine problem is unique and strictly linked to the area where it occurs, the research focuses on one particular region of Sri Lanka: the northeastern area of Vanni.

Designing a technology for operation in a specific region helps concentrate efforts on a well-defined problem; moreover, it allows local deminers to be involved in a project from which they will benefit and to exploit the knowledge they have acquired over many years working in the field. We have chosen Sri Lanka for several reasons. People are generally well educated (having typically attended 10 years of school), enthusiastic, and willing to work and learn new skills. Additionally, the country is facing an immediate post-conflict situation in which people are strongly involved in rebuilding the country. Furthermore, although the tsunami disaster of late 2004 did not greatly modify the landmine situation since the coastal areas were previously cleared, it heavily impacted the local economy, making even more urgent the need to provide cleared land to farmers.

A one-month trip to northeast Sri Lanka was organized in January–February 2005. The trip was aimed at establishing contacts, deepening knowledge of the local environment and improving communication skills to make the participatory contribution more effective. I interviewed groups of deminers to start the research in the right direction, better understand local needs and establish a reciprocal trust between local people and expatriates coordinating humanitarian operations there.

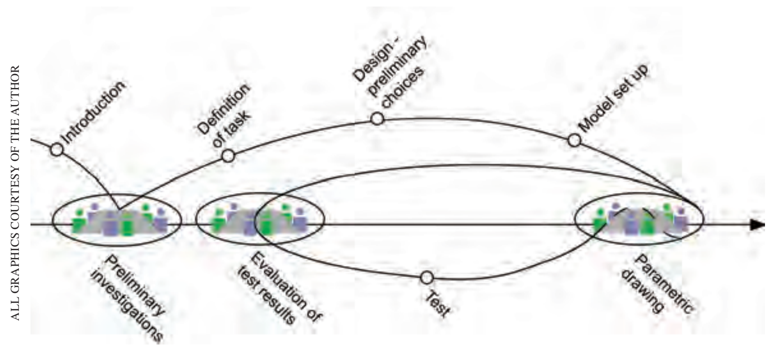

Figure 1: Snail representing the workflow of the first work package: preliminary work.

From Agricultural Machines to Demining Machines

After my solo trip to Sri Lanka, the research team, which included several staff from the Laboratory of Design and Measurement for Automation and Robotics(PMARlab), spent time formalizing the input received from those working in the field, from defining the environment of the northeastern region of Sri Lanka to organizing the ideas that came up during interviews with local deminers. Most notably, in the field, I gathered information by working on the functional requirements for a system of small, light and cheap demining machines to be used for working close to the deminers. The need of such a system of machines arose from a study I conducted last year in collaboration with EUDEM2 at the University of Genova PMARlab under the supervision of the EUDEM2 team, which co-funded the study. I conducted part of the study in the field, collecting information from end–users. In that study, when deminers were asked about their preferences for new machine technology, they expressed a strong desire for new machines that were small, light and cheap.[2]

Based on these findings, we suggested adapting power tillers to demining applications. Power tillers are widely used and commercially available in Sri Lanka, and they are available secondhand.[4] They are easy to transport as they are small and light, and available

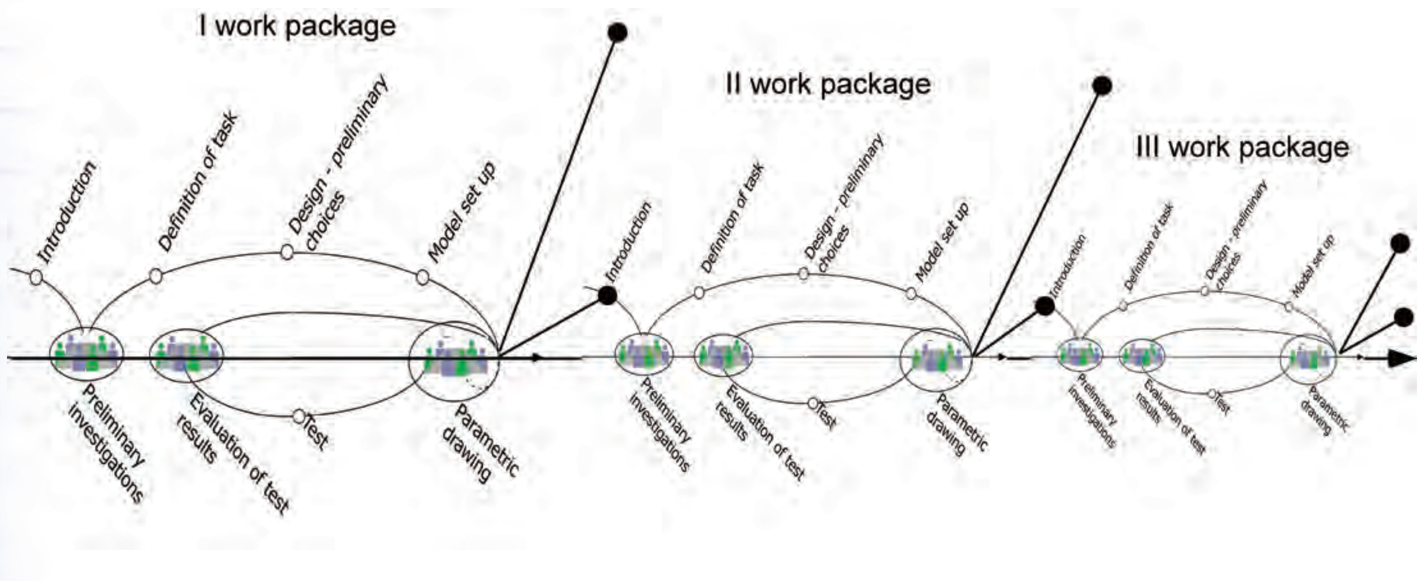

Figure 2: Workflow for achieving the final design methodology.

with different types of engines. The most powerful one (approximately 14 kW) is sturdy enough for our task.

As this project progresses, machines will be adapted to perform ground preparation and vegetation cutting. A special end-effector[5] will be designed to process the soil and bring mines up to the soil surface. Each machine can be remotely controlled to help a single deminer in his work by preparing the ground in front of him, and all the machines can be controlled automatically to perform area-reduction operations. Deminers will always assist machines: once a mine is found and lifted up on the soil surface by the special end-effector, a deminer can remove the mine manually. Manual mine removal has been introduced in order to lower the complexity and cost of the machines, as well as to allow a quicker integration of machines in operational procedures.

A Participatory Methodology For Machine Creation: The Snail System

This project focuses both on practical and philosophical aspects of machine design. Not only does the input for improved machine design need to be participatory, but the practical work of developing a new participatory methodology for mine clearance technologies is also at the core of our research. The premise is that design methodology must be participatory throughout the process, involving local workers' input.

I have elaborated just such a provisional design methodology called the Snail System, a primary system to design technology in a participatory way, and represented by a snail. The Snail System was used on the first visit, trying to involve deminers in the design of the new technology from the very beginning. The Snail System will also be used later to involve end-users in the next steps of the design process.

The Snail System allows a progressive involvement of end-users in the design process. Snails are lines connecting subsequent steps of the design process that develop along a straight line indicating work progress. Meetings with end-users happen along the straight work progress line. Every decision is made with end-users; only studies prior to these decisions, such as the preparation of possible choices, simulations and calculations, are carried out by researchers and later presented to end-users.

Each Snail represents a work module necessary to carry out the main package of the total work for the project. The workflow of machine design is represented by Snail lines, as often it is iterative; the design process is repeated until a satisfactory result is reached. The Snail representing the first work package of the preliminary research for the demining machine design is represented in Figure 1. Other future work packages, each with its own snail, will involve end-effector design of the ground-processing tool and vegetation tool; integration of tools, prototype and testing; control design; and final prototype and testing.

Each Snail requires different work and responsibilities before meetings with end-users, but holding meetings of end-users for various Snails at the same time can be done to reduce travel expenses. Graphically, two Snails can overlap.

The overall task of defining a new participatory design methodology is complex and unresolved. The final methodology is being designed through an iterative process—the first step of the methodology, the scheme, represented with the Snail, will be used, tested, evaluated and changed many times. Each iteration will produce a new version of the technical design of the machine, as well as an improved design methodology. Once the technical design of the demining tool under research in a given work package is satisfactory, the participatory methodology design will be reviewed again for application in the next work package.

The workflow for achieving the final machine design methodology, therefore, can be represented graphically on a line depicting the work progress as a family of Snails, walking one behind the other, as shown in Figure 2. Each Snail represents how the methodology evolves, together with the necessary work that will be carried out to finish the overall project of designing demining machines from power tillers. Each Snail is smaller than the previous one, needing less work and therefore shorter lines to be carried out. We believe end-users and researchers will acquire efficiency and practical expertise with more practice and learn better skills along the process in both participation and technological design.

> "The ultimate goal is to increase demining machine use in order to eradicate more effectively landmines safely and efficiently."

Of the two antennae for each Snail, one goes into the next snail, indicating that the design methodology used in the next work package comes from the one evolved in the last work package, and the other antenna goes into the dissemination of ideas and experiences achieved in the previous work package.

Conclusion

By employing power tillers and adapting them to demining applications, we intend to leverage mature off-the-shelf technology already in use and exploit end-users' knowledge of agricultural practices. Skills acquired in the modification of agricultural technology already in use in order to achieve a new particular task, such as demining technology, could be used later to improve agricultural production after the land has been cleared of mines by better machinery. Technological innovations in the field of agriculture are one of the major contributors to development.

In parallel with the work to define the new participatory design methodology, the research team at the PMARlab and I will carry out research along two other fields of study: investigating the relationship between demining activities and development, and defining the role of humanitarian demining technologies in development.

The premise is that participation, particularly in demining machine design, will be more effective and efficient as it uses local knowledge and resources, and will empower local participants. The ultimate goal is to increase demining machine use in order to more effectively eradicate landmines safely and efficiently. This project attempts to both practically apply local resources and participation into machine design, and formalize a successful theory of methodology that applies participation in machine design. ✣

The research project the author has undertaken in the context of her doctoral studies has been presented to inform the community and to seek comments. The work proposed has been discussed with many valuable people, whom she would like to thank for their time: Erik Tollefsen of the Geneva International Centre for Humanitarian Demining; Professor Richard Bocco of IUED; Andy Smith of AVS Mine Action Consultants; Luke Atkinson and Richard Schmidt of Norwegian People's Aid; Professor Rinaldo Michelini di San Martino and Paolo Silingardi of University of Genova; and Alcherio Martinoli of Ecole Polytechnique Fédérale de Lausanne.

The work presented here has been conceived and structured in an attempt to receive funding from different institutes. Even though the team has not received specific funding for the project, they will continue working.

See Endnotes, page 112

Emanuela Elisa Cepolina is a mechanical engineer. Since her graduation in 2003, she has been researching technologies for humanitarian demining at the University of Genova in Genova, Italy. In 2004, she carried out a survey of technologies in field use in several countries in collaboration with the EUDEM2 team. In 2005, she began the project "Participatory Agriculture Technology for Humanitarian Demining," the subject of her doctoral thesis.

Emanuela Elisa Cepolina
Department of Mechanics and Machine Design
University of Genova
Via All'Opera Pia 15A
16145 Genova / Italy
Tel: +39 010 353 2837
E-mail: emacepo@dimec.unige.it
Web site: http://www.dimec.unige.it/PMAR/demining

News Brief

International Mine Awareness Day Marked Globally

Nane Annan, wife of United Nations Secretary General Kofi Annan, served as keynote speaker for events held by the United Nations Mine Action Service in recognition of International Mine Awareness Day. The day was marked globally April 4. Dozens of dignitaries, representatives and supporters of mine action gathered in New York to hear Annan speak.

Mine Action, a mine-action advocacy group sponsored by the United Nations, screened a film featuring an Iraqi amputee and held a discussion panel featuring actor Danny Glover, a Goodwill Ambassador for UNICEF.

The United Nations, which flew 82 white balloons outside its New York complex for the 82 mine-affected countries, estimates 15,000 deaths each year are the result of landmines. About one-tenth of the world's supply of landmines is emplaced in Angola, according to UNICEF. That country has an amputee population of approximately 70,000 people.

Representatives from the United States were on-hand for the events. Although the United States is not a signatory to the Ottawa Convention, a representative from the U.S. Department of State estimated that the U.S. government has provided more than US$1 billion for landmine and weapons removal over the past decade.

The Mine Action Information Center at James Madison University observed International Mine Awareness Day with a week of events from April 10 to 13. Landmine Awareness Week began with an information booth on the student commons. Students were given green ribbons in recognition of landmine survivors and could explore the global issue of landmines. The film *Disarm* was screened at the campus movie theater and representatives from the U.S. Department of State came to campus to lead a discussion on U.S. policies regarding landmines and similar weapons. A display at JMU's Carrier Library was also available to expose students to the landmine issue through photos, maps and other materials. Ken Rutherford, landmine survivor and Co-founder of Landmine Survivors Network, closed the week of events with a presentation.