EUDEM2

The EU in Humanitarian Demining- State of the Art on HD Technologies, Products, Services and Practices in Europe

IST–2000-29220

EUDEM2 Technology Survey

Catalogue of Demining Technologies in Field Use

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http://www.eudem.info/

Project funded by the European Community and OFES (Swiss Federal Office for Education and Science) under the "Information Society Technologies" Programme (1998-2002)

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Executive Summary and Disclaimer

Executive Summary

Within the framework of its Technology Survey, the EUDEM2 project addressed the need of collecting information on technologies. This *Catalogue* is the output of a field survey conducted during three month in 2004. It provides details on humanitarian demining technologies in use in several mine affected countries. The data were collected in the field from humanitarian demining organization operating in several countries. It concerns technologies in use, technologies which have been enhanced by end-users and technologies which have been tested in the field.

Details on a wide range of different equipment, used by a total of nine organisations have been collected. It ranged from simple rakes with a cost of a few USD, to large and correspondingly expensive ground preparation machines.

This *Catalogue* is complementary to the GICHD Catalogues as it presents data collected directly from the end users about technologies already used in the field, rather than providing a comprehensive list of manufacturers' data about proposed and available technologies.

It has to be noted that this document does obviously not pretend to list all the technologies in use, as such it is incomplete. It rather summarizes our findings during the field survey. It is meant as a first attempt at collecting, not only commercial and technical information on technologies, for this the reader is referred to the GICHD catalogues, but also quantitative and qualitative information from the end-users. For a complete overview of existing and in use technologies, this catalogue could be taken over and enhanced by other organization.

Disclaimer

The information appearing in this document has been prepared in good faith. It has to be noted that this document does obviously not pretend all the technologies in use, as such it is incomplete. It rather summarizes our findings during the field survey. All information contained herein is based on the stated opinions of the individuals and organizations who contributed through interviews and questionnaires, and therefore reflects the view of the respondents.

Note
In case you notice errors or incoherence's please send comments to K. De Bruyn kdebruyn@vub.ac.be

Content

1 INTRODUCTION

1.1 Aims and objectives

This catalogue is one of the results of the field survey study carried out by the EUDEM2 project, in collaboration with the University of Genova/PMAR Lab during 2004. The survey has been conducted by visiting minefield sites and demining organisations and interviewing staff and deminers using humanitarian demining technologies, and by subsequently analysing the collected data.

The *Catalogue* falls within the framework of the EUDEM2 Technology Survey objectives aimed at collecting and analysing information on humanitarian demining technologies for the purpose of improving communication between technology developers and end-users, by presenting, for the benefit of researchers, details about the implementation of technologies which are in field use, and technologies which have been developed or enhanced by end-users in the field.

At the same time, this *Catalogue* presents to end-users details on technologies which are in field-use, and technologies which have been developed or enhanced by other end-users in the field. This with the aim of promoting the interchange of ideas, and helping improving the uptake of new technologies already in the field.

This *Catalogue* has a narrow focus, as the technologies presented are limited to those already in use and covered by the survey fieldwork. It is meant to be complementary to the Geneva International Centre for Humanitarian Demining (GICHD) existing Catalogues on Mechanical Demining Technologies and Metal Detectors. In the GICHD Catalogues, manufacturers' data on the technologies produced (or soon to be produced) are reported, whereas this *Catalogue contains* end-user data on the technologies already in use.

Twelve technologies are listed: eight machines, mainly developed by end users in the field, particularly by MgM in Namibia, three types of rakes, grouped under the section of sensors even if they are used as excavation tools, and one example of advanced information and communication technology (ICT) used in impact surveys in Sri Lanka.

The technologies investigated are sorted according to its type: first mechanical technologies for humanitarian demining or for preparation or support to clearance, and then sensor technologies. Within each technology section, the technical data sheet is reported first, followed by data about origin/development, data about tests, and finally the details of use.

It has to be noted that this document does obviously not pretend to list all the technologies in use, as such it is incomplete. It rather summarizes our findings during the field survey. It is meant as a first attempt at collecting, not only commercial and technical information on technologies, for this the reader is referred to the GICHD catalogues, but also quantitative and qualitative information from the end-users. For a complete overview of existing and in use technologies, this catalogue could be taken over and enhanced by other organization.

1.2 Visited Organizations

The Catalogue is provided for the following visited organizations:

Country	Organisation	Date
Mozambique	ADP	30 Mar 2004 – 2 Apr 2004
Namibia	MgM	5 Apr 2004 – 8 Apr 2004
Sri Lanka	FSD	16 Apr 2004 – 21 Apr 2004
	MAG	23 Apr 2004
	NPA	24 Apr 2004 – 25 Apr 2004
Cambodia	CMAC	4 May 2004 – 6 May 2004
	MAG	10 May 2004 – 11 May 2004

1.3 Related documents

The field study has been conducted under the EUDEM2 WP4 Technology Survey. The following table lists the related documents available on the EUDEM web site:

Title	Content
D15 Technology Survey Report II	Field Survey objectives
D19 Interviews Final Report	Information collection methodology and questionnaires
Field Survey Results	Summarizes the finding of the survey
Catalogue of Demining Technologies in Field Use	This document

2 MECHANICAL DEMINING TECHNOLOGIES

2.1 VEGETATION CUTTERS

2.1.1 TEMPEST Mk V

TECHNICAL DATA SHEET for Mechanical Demining Technologies		
General description		Remotely controlled, light-weight multi-tool system with vegetation cutting and tripwire clearing abilities. Tools: flail, vegetation slasher, magnets, buckets, grader blades.
Application	Use within demining practices [tripwire removal, vegetation removal, mine detection, earth removal,…]	tripwire, vegetation removal
	Designed to drive over mines	AP mines: yes, AT mines: no
	hours of operation/hours of maintenance	2/1
Dimensional data	Length	3,5 m
	Width	1,5 m
	Height	1,5 m
	Mass	3'200 kg
Driving specifications	Waterproof	light waterproof
	Ability to stand hot weather	no
	Means of locomotion	steel wheels
	Ground pressure	
	Hill climbing ability	20-25°
	Control type [pilot on board, remote + operator, automatic control….]	remote + operator
	Type of signal to the operator [sight, screen, acoustic,…]	sight + acoustic
	Camera	no
	Max. control distance (length)	300 m
	Emergency control [none, stop,…]	yes
Working performance	Working speed:	
	- light soil/small vegetation	400-600 m^2/hour
	- medium soil/medium vegetation	200-400 m^2/hour
	- heavy soil/dense vegetation	150-200 m^2/hour
	Clearance/detection depth	30 cm
	Control of clear./detect. depth	
	(For multi-tools, *e.g.* chains) Number of tools	36 chains
	(For multi-tools, *e.g.* chains) Distance between tools	30 mm
	(For multi-tools, *e.g.* chains) Rotation speed	1300 rpm
System specifications	Engine	DEUTZ 4 cylinder diesel turbocharged engine BF4L1011F/T of 52kW (70hp)
	Fuel capacity	42 l
	Fuel consumption	10 l/hour
	Separate engine for working unit	no
	Cooling system engine	air-cooled engine and hydraulics
	Oil capacity	10 l
	Hydraulic oil capacity	113 l
Cost	R&D cost ($)	
	Price of item ($)	90'000
	Running cost ($/month)	220
Time	Delivery time	
	Time for training	5 weeks

ORIGIN/DEVELOPMENT		
Developed by		**Development Technology Workshops Cambodia, Phnom Penh**
(If developed by end users) Development	**Where (Country, Region)** **Who** **Adapted from** **Added material** **Time for development** **Funded by**	

TEST (if possible, these data will be acquired directly from documents)		
Tested in mine affected country? [Yes/No]		**Yes, still under test**
(If Yes) Test report**	**Where (Country, Region)** **Who (names, roles)** **When (date)** **Scope of tests (phase1: reliability, depth of operation, …)** **Details of tests (phase1: type, depth of mines, temperature,…)** ***Test programme* (phase1: 20 cm line checking,…)** ***Analysis of test* results (phase1: test results and analysis)** **Recommendations (improve speed, do more field *trials*,...)**	**Mozambique, Maputo province** **ADP Platoon** **Since Feb. 2003** **Mobility, difficulties** **different areas** **Improve hydraulic hoses as they fail too often due to the high temperatures**
(If Yes) Test report**	**Where (Country, Region)** **Who (names, roles)** **When (date)** **Scope of tests (phase1: reliability, depth of operation, …)** **Details of tests (phase1: type, depth of mines, temperature,…)** ***Test programme* (phase1: 20 cm line checking,…)** ***Analysis of test* results (phase1: test results and analysis)** **Recommendations (improve speed, do more field *trials*,...)**	**Cambodia** **John Wright from DTW** ***May2000*** **engine performance and survivability test 0,25 kg live mine under flail unit and cage wheel; machine cutting performance** **Phase 1: manufacturer test, and Phase 2: MAG field test to cut vegetation** **vegetation testing** **contact DTW**

FIELD USE		
COUNTRY:MOZAMBIQUE		
DEMINING ORGANZIATION: ADP		
Specifications of equipment in use	**N° of pieces in use by this organisation** **Period of use (years)**	**1** **1**
Conditions	**Age of equipment (years)** **External conditions [bad(1)/acceptable(2)/good(3)]** **Responsible for maintenance [deminer/mechanic/supervisor]**	**3** **2** **mechanic, supervisor**
Application	**Use within demining practices [tripwire removal, vegetation removal, mine detect., earth removal,…]** **Freq. of use (hours/day)** **Unusable in: [wet, hot,…] weather** **Unusable in: [hilly, rocky,...] terrain** **N° of accidents in the last year (n°)**	**tripwire, vegetation removal** **5** **hot weather** **0**
Cost-Effectiveness **Cost** **Human Resources** **Time**	**Price of item ($)** **Running cost ($/month)** **Repairing cost (including transport of spare parts from abroad) ($)** **N° of staff to run (n°)** **Monthly cost of operator ($)** **Time for training (days)** **MTBF (days)** **Time for repairing (days)** **Main reasons for downtime [mechanical pb, electric pb,…]**	**89'000** **60** **150** **1** **170** **25** **14** **0** **replacing chains**
General comments (representative)		
General comments (deminers)	**Advantages** **Drawbacks** **Possible improvements**	**very fast** **hydraulic hoses fail too often due to the high temperatures**

COUNTRY:CAMBODIA		
DEMINING ORGANZIATION: MAG		
Specifications of equipment in use	**N° of pieces in use by this organization** **Period of use (years)**	**3** **5**
Conditions	**Age of equipment (years)** **External conditions [bad(1)/acceptable(2)/good(3)]** **Responsible for maintenance [deminer/mechanic/supervisor]**	**5** **2** **operators**
Application	**Use within demining practices [tripwire removal, vegetation removal, mine detect., earth removal,…]** **Freq. of use (hours/day)** **Unusable in: [wet, hot,…] weather** **Unusable in: [hilly, rocky,...] terrain** **N° of accidents in the last year (n°)**	**small tree, grass and thick vegetation cutting** **5** **wet season** **rocky areas near to mountains and AT mined areas** **0**
Cost-Effectiveness **Cost** **Human Resources** **Time**	**Price of item ($)** **Running cost ($/month)** **Repairing cost (including transport of spare parts from abroad) ($)** **N° of staff to run (n°)** **Monthly cost of operator ($)** **Time for training (days)** **MTBF (days)** **Time for repairing (days)** **Main reasons for downtime [mechanical pb, electric pb,…]**	**91'000** **380** ***500*** **1** **200** **45** **7** **6** **replacing parts**
General comments (representative)	**Advantages** **Drawbacks** **Possible improvements**	**deminers are very happy** **spare parts are expensive and delivery is slow and expensive**
General comments (deminers)		

2.1.2 SAMIL 20 Mulcher

TECHNICAL DATA SHEET for Mechanical Demining Technologies		
General description		Armoured vehicle with hydraulic vegetation cutter
Application	Use within demining practices [tripwire removal, vegetation removal, mine detection, earth removal,…] Designed to drive over mines hours of operation/hours of maintenance	tripwire, vegetation removal
Dimensional data		
Driving specifications	Waterproof Ability to stand hot weather Means of locomotion Ground pressure Hill climbing ability Control type [pilot on board, remote + operator, automatic control.…] Type of signal to the operator [sight, screen, acoustic,…] Camera Max. control distance (length) Emergency control [none, stop,…]	light waterproof yes wheels pilot on board sight and acoustic no
Working performance		
System specifications		
Cost	R&D cost ($) Price of item ($) Running cost ($/month)	 50'000 *1'000*
Time	Delivery time Time for training	 4 weeks

ORIGIN/DEVELOPMENT		
Developed by		MgM Mine Clearance NGO - R&D
(If developed by end users) Development	Where (Country, Region)	Windhoek, Namibia
	Who	MgM Mine Clearance NGO - R&D
	Adapted from	military troop carrier + agricultural equipment
	Added material	armoured steel cab and agricultural equipment
	Time for development	2 months
	Funded by	Dutch gov., German gov., US gov., EU

TEST (if possible, these data will be acquired directly from documents)		
Tested in mine affected country? [Yes/No]		Yes
(If Yes) Test report**	Where (Country, Region)	on site
	Who (names, roles)	MgM
	When (date)	1996, 1998, 2000
	Scope of tests (phase1: reliability, depth of operation, …)	
	Details of tests (phase1: type, depth of mines, temperature,…)	
	Test programme (phase1: 20 cm line checking,…)	
	Analysis of test results (phase1: test results and analysis)	
	Recommendations (improve speed, do more field *trials*,...)	buy more

FIELD USE		
COUNTRY:ANGOLA		
DEMINING ORGANZIATION: MgM		
Specifications of equipment in use	N° of pieces in use by this organisation	3
	Period of use (years)	8 / 6 / 3
Conditions	Age of equipment (years)	8 / 7 / 5
	External conditions [bad(1)/acceptable(2)/good(3)]	2
	Responsible for maintenance [deminer/mechanic/supervisor]	mechanics
Application	Use within demining practices [tripwire removal, vegetation removal, mine detect., earth removal,…]	tripwire, vegetation removal
	Freq. of use (hours/day)	4
	Unusable in: [wet, hot,…] weather	flood, wet weather
	Unusable in: [hilly, rocky,...] terrain	
	N° of accidents in the last year (n°)	0
Cost-Effectiveness	Price of item ($)	50’000
Cost	Running cost ($/month)	*1’000*
	Repairing cost (including transport of spare parts from abroad) ($)	
Human Resources	N° of staff to run (n°)	1
	Monthly cost of operator ($)	350
Time	Time for training (days)	24
	MTBF (days)	
	Time for repairing (days)	1
	Main reasons for downtime [mechanical pb, electric pb,…]	tyres, mechanical problems
General comments (representative)	Advantages	long lasting, reliable, productive
	Drawbacks	hot inside the cabin
	Possible improvements	air conditioning
General comments (deminers)		

2.2 GRADERS

2.2.1 MgM Grader CAT 12F

TECHNICAL DATA SHEET for Mechanical Demining Technologies		
General description		Modified, strongly armoured, road construction machine
Application	Use within demining practices [tripwire removal, vegetation removal, mine detection, earth removal,…]	tripwire, vegetation, mine, earth removal
	Designed to drive over mines	yes
	hours of operation/hours of maintenance	
Dimensional data		
Driving specifications	Waterproof	light waterproof
	Ability to stand hot weather	yes
	Means of locomotion	wheels
	Ground pressure	
	Hill climbing ability	
	Control type [pilot on board, remote + operator, automatic control.…]	pilot on board
	Type of signal to the operator [sight, screen, acoustic,…]	sight and acoustic
	Camera	no
	Max. control distance (length)	
	Emergency control [none, stop,…]	no
Working performance		
System specifications		
Cost	R&D cost ($)	
	Price of item ($)	80’000
	Running cost ($/month)	*1’000*
Time	Delivery time	
	Time for training	4 weeks

ORIGIN/DEVELOPMENT		
Developed by		MgM Mine Clearance NGO - R&D
(If developed by end users) Development	Where (Country, Region)	Windhoek, Namibia
	Who	MgM Mine Clearance NGO – R&D
	Adapted from	Road construction machine CAT 12 F
	Added material	Armoured cabin, air conditioning
	Time for development	6 weeks
	Funded by	Dutch gov., German gov., US gov., EU, private donations

TEST (if possible, these data will be acquired directly from documents)		
Tested in mine affected country? [Yes/No]		no
(If Yes) Test report**		

FIELD USE		
COUNTRY:ANGOLA		
DEMINING ORGANZIATION: MgM		
Specifications of equipment in use	N° of pieces in use by this organisation	2
	Period of use (years)	8 / 6
Conditions	Age of equipment (years)	30
	External conditions [bad(1)/acceptable(2)/good(3)]	2
	Responsible for maintenance [deminer/mechanic/supervisor]	mechanics
Application	Use within demining practices [tripwire removal, vegetation removal, mine detect., earth removal,…]	tripwire, vegetation, mine, earth removal
	Freq. of use (hours/day)	8
	Unusable in: [wet, hot,…] weather	flood, wet conditions
	Unusable in: [hilly, rocky,...] terrain	
	N° of accidents in the last year (n°)	0
Cost-Effectiveness	Price of item ($)	80’000
Cost	Running cost ($/month)	*1’000*
	Repairing cost (including transport of spare parts from abroad) ($)	
Human Resources	N° of staff to run (n°)	1
	Monthly cost of operator ($)	350
Time	Time for training (days)	24
	MTBF (days)	
	Time for repairing (days)	1
	Main reasons for downtime [mechanical pb, electric pb,…]	tyres, mechanics
General comments (representative)	Advantages	robust
	Drawbacks	none
	Possible improvements	remote control
General comments (deminers)		

2.2.2 MgM Grader Gallin 500

TECHNICAL DATA SHEET for Mechanical Demining Technologies		
General description		Modified, strongly armoured, road construction machine
Application	Use within demining practices [tripwire removal, vegetation removal, mine detection, earth removal,…]	tripwire, vegetation, mine, earth removal
	Designed to drive over mines	yes
	hours of operation/hours of maintenance	
Dimensional data		
Driving specifications	Waterproof	light waterproof
	Ability to stand hot weather	yes
	Means of locomotion	wheels
	Ground pressure	
	Hill climbing ability	
	Control type [pilot on board, remote + operator, automatic control.…]	pilot on board
	Type of signal to the operator [sight, screen, acoustic,…]	sight and acoustic
	Camera	no
	Max. control distance (length)	
	Emergency control [none, stop,…]	no
Working performance		
System specifications		
Cost	R&D cost ($)	
	Price of item ($)	80’000
	Running cost ($/month)	*1’000*
Time	Delivery time	
	Time for training	4 weeks

ORIGIN/DEVELOPMENT		
Developed by		MgM Mine Clearance NGO - R&D
(If developed by end users) Development	Where (Country, Region)	Windhoek, Namibia
	Who	MgM Mine Clearance NGO – R&D
	Adapted from	Road construction machine Gallin 500
	Added material	Armoured cabin, air conditioning
	Time for development	6 weeks
	Funded by	Dutch gov., German gov., US gov., EU, private donations

TEST (if possible, these data will be acquired directly from documents)	
Tested in mine affected country? [Yes/No]	no
(If Yes) Test report**	

FIELD USE		
COUNTRY:ANGOLA		
DEMINING ORGANZIATION: MgM		
Specifications of equipment in use	N° of pieces in use by this organisation	1
	Period of use (years)	1
Conditions	Age of equipment (years)	30
	External conditions [bad(1)/acceptable(2)/good(3)]	2
	Responsible for maintenance [deminer/mechanic/supervisor]	mechanics
Application	Use within demining practices [tripwire removal, vegetation removal, mine detect., earth removal,…]	tripwire, vegetation, mine, earth removal
	Freq. of use (hours/day)	8
	Unusable in: [wet, hot,…] weather	flood, wet conditions
	Unusable in: [hilly, rocky,...] terrain	
	N° of accidents in the last year (n°)	0
Cost-Effectiveness	Price of item ($)	80’000
Cost	Running cost ($/month)	*1’000*
	Repairing cost (including transport of spare parts from abroad) ($)	
Human Resources	N° of staff to run (n°)	1
	Monthly cost of operator ($)	350
Time	Time for training (days)	24
	MTBF (days)	
	Time for repairing (days)	1
	Main reasons for downtime [mechanical pb, electric pb,…]	tyres, mechanics
General comments (representative)	Advantages	robust
	Drawbacks	none
	Possible improvements	remote control
General comments (deminers)		

2.3 MULTI-TOOLS UNMANNED GROUND VEHICLE (UGV)

2.3.1 MAXXPLUS

TECHNICAL DATA SHEET for Mechanical Demining Technologies		
General description		Multi-tool Unmanned Ground Vehicle (UGV), tracked, tele-operated, platform + arm + changeable tools and actuators: ACTIVE: Mulcher (used for cutting vegetation), Rotor, PASSIVE: material handler, fork
Application	Use within demining practices [tripwire removal, vegetation removal, mine detection, earth removal,…]	vegetation, tripwires, earth, mines removal
	Designed to drive over mines	no
	hours of operation/hours of maintenance	8/1
Dimensional data	Length	4,9 m
	Width	1,9 m
	Height	1,5 m
	Mass	Without attachment: 4'700 kg, with attachment: 5'000 kg.
Driving specifications	Waterproof	machine: yes, control box: no
	Ability to stand hot weather	yes
	Means of locomotion	tracks
	Ground pressure	
	Hill climbing ability	45°
	Control type [pilot on board, remote + operator, automatic control.…]	remote + operator
	Type of signal to the operator [sight, screen, acoustic,…]	sight / screen and acoustic
	Camera	3 + 1 pan/tilt for field overview
	Max. control distance (length)	150 m using Broxx control handler, 350m using Maxxplus control box
	Emergency control [none, stop,…]	mushroom bottom
Working performance	Working speed:	3 km/hour
	- light soil/small vegetation	3 km/hour
	- medium soil/medium vegetation	3 km/hour
	- heavy soil/dense vegetation	3 km/hour
	Clearance/detection depth	the arm can dig to a depth of 4 m depth
	Control of clear./detect. depth	none
	(For multi-tools, *e.g.* chains) Number of tools	4
	(For multi-tools, *e.g.* chains) Distance between tools	
	(For multi-tools, *e.g.* chains) Rotation speed	Mulcher: 3000 rpm
System specifications	Engine	60 kW turbo diesel
	Fuel capacity	50 l tank
	Fuel consumption	2,5 l/hour
	Separate engine for working unit	2 hydraulic pumps: 1 for motion which uses 100 l/min at 120 bar and 1 for arm and tracks
	Cooling system engine	water cooling
	Oil capacity	large
	Hydraulic oil capacity	large
Cost	R&D cost ($)	750'000
	Price of item ($)	250'000
	Running cost ($/month)	
Time	Delivery time	
	Time for training	

ORIGIN/DEVELOPMENT		
Developed by		MgM Mine Clearance NGO - R&D
(If developed by end users) Development	Where (Country, Region)	Windhoek, Namibia
	Who	MgM Mine Clearance NGO - R&D
	Adapted from	commercial BROKK 330TD
	Added material	attachments
	Time for development	28 months (from December 2001)
	Funded by	USDoD (US Department of Defence)

TEST (if possible, these data will be acquired directly from documents)		
Tested in mine affected country? [Yes/No]		yes, still under test
(If Yes) Test report**	Where (Country, Region)	Namibia, countryside near Windhoek
	Who (names, roles)	MgM (Scott Smith) and USDoD
	When (date)	7-8-9 April 2004
	Scope of tests (phase1: reliability, depth of operation, …)	Test vehicle capabilities
	Details of tests (phase1: type, depth of mines, temperature,…)	4 different types of vegetation
	Test programme (phase1: 20 cm line checking,…)	Day 1: broad control of Mulcher attachment, Day2: box control of Mulcher attachment, Day 3: Rotor attachment
	Analysis of test results (phase1: test results and analysis)	Namibia, countryside near Windhoek
	Recommendations (improve speed, do more field *trials*,...)	MgM (Scott Smith) and USDoD

MAXXPLUS is not used in regular field operations yet.

2.4 ARMOURED BACKHOE TRACTOR

2.4.1 ROTAR MKI

TECHNICAL DATA SHEET for Mechanical Demining Technologies*		
General description		Armoured wheeled front-end loader with Rotar attachment
Application	Use within demining practices [tripwire removal, vegetation removal, mine detection, earth removal,…]	earth removal, soil sifting
	Designed to drive over mines	AP mines: yes, AT mines: no
	hours of operation/hours of maintenance	
Dimensional data	Length	7,4 m
	Width	2,9 m
	Height	3,4 m
	Mass	9'600 kg
Driving specifications	Waterproof	light waterproof
	Ability to stand hot weather	yes
	Means of locomotion	wheels
	Ground pressure	
	Hill climbing ability	
	Control type [pilot on board, remote + operator, automatic control.…]	pilot on board
	Type of signal to the operator [sight, screen, acoustic,…]	sight and acoustic
	Camera	no
	Max. control distance (length)	
	Emergency control [none, stop,…]	
Working performance	Working speed:	
	- light soil/small vegetation	20 m^2/hour
	- medium soil/medium vegetation	
	- heavy soil/dense vegetation	
	Clearance/detection depth	
	Control of clear./detect. depth	
	(For multi-tools, *e.g.* chains) Number of tools	
	(For multi-tools, *e.g.* chains) Distance between tools	
	(For multi-tools, *e.g.* chains) Rotation speed	
System specifications		
Cost	R&D cost ($)	
	Price of item ($)	200'000
	Running cost ($/month)	*2'000*
Time	Delivery time	
	Time for training	4 weeks

ORIGIN/DEVELOPMENT		
Developed by		MgM Mine Clearance NGO - R&D
(If developed by end users) Development	Where (Country, Region)	Windhoek, Namibia
	Who	MgM Mine Clearance NGO – R&D
	Adapted from	CAT 916
	Added material	armoured steel cab and attachments
	Time for development	9 months
	Funded by	USDoD

TEST (if possible, these data will be acquired directly from documents)		
Tested in mine affected country? [Yes/No]		yes
(If Yes) Test report**	Where (Country, Region)	Namibia, Ruacana Omburu electricity pylon line
	Who (names, roles)	MgM + International experts
	When (date)	1999
	Scope of tests (phase1: reliability, depth of operation, …)	prove operational effectiveness of the machine in a live minefield
	Details of tests (phase1: type, depth of mines, temperature,…)	Phase 1: Berm 5 North (B5N): sandy soil, Phase 2: Berm 3 South (B3S): rocks and heavier soil. Mines known to be contained in the berms were the R2M2 Blast anti-personnel mine, and the J69 Bounding Fragmentation anti-personnel mine
	Test programme (phase1: 20 cm line checking,…)	dog clearance, grader, rotar
	Analysis of test results (phase1: test results and analysis)	Phase 1: 3 blast mines exploded inside the bucket, the damage was not relevant as the increase in this grid size was not relevant. Phase 2: around 70 m^3 of rocks and earth were processed in 13hours 50min of testing, and 2500 m^2 of surface area around the pylon cleared; five R2M2's exploded in the bucket producing little structural damage, whilst one R2M2 was defused and one J69 along with an unknown mine were destroyed by controlled demolition.
	Recommendations (improve speed, do more field *trials*,...)	A modification should be made to the Rotar drum so that it cannot turn if the jaws are open more than 4.5 cm

* Some data have been extracted from the GICHD Mechanical Demining Equipment Catalogue 2004.
** Some data have been extracted from the MgM-Rotar Facts CD.

FIELD USE		
COUNTRY:ANGOLA		
DEMINING ORGANZIATION: MgM		
Specifications of equipment in use	N° of pieces in use by this organisation	1
	Period of use (years)	5
Conditions	Age of equipment (years)	6
	External conditions [bad(1)/acceptable(2)/good(3)]	2
	Responsible for maintenance [deminer/mechanic/supervisor]	mechanic
Application	Use within demining practices [tripwire removal, vegetation removal, mine detect., earth removal,…]	earth removal, soil sifting
	Freq. of use (hours/day)	8
	Unusable in: [wet, hot,…] weather	flood, wet weather
	Unusable in: [hilly, rocky,...] terrain	
	N° of accidents in the last year (n°)	0
Cost-Effectiveness	Price of item ($)	200'000
Cost	Running cost ($/month)	*1'200*
	Repairing cost (including transport of spare parts from abroad) ($)	
Human Resources	N° of staff to run (n°)	1
	Monthly cost of operator ($)	350
Time	Time for training (days)	24
	MTBF (days)	
	Time for repairing (days)	1
	Main reasons for downtime [mechanical pb, electric pb,…]	tyres, mechanical
General comments (representative)	Advantages	more powerful than Rotar MkII
	Drawbacks	it leaves behind uneven surfaces
	Possible improvements	
General comments (deminers)		

2.4.2 ROTAR MKII

TECHNICAL DATA SHEET for Mechanical Demining Technologies*		
General description		Light carrier with demining tools mounted at the front and a vegetation cutter at the rear. The carrier is an armoured Caterpillar backhoe tractor, the tools are an MgM designed bucket sifter and the standard Caterpillar bucket.
Application	Use within demining practices [tripwire removal, vegetation removal, mine detection, earth removal,…]	tripwire, vegetation, mine, earth removal
	Designed to drive over mines	AP mines: yes, AT mines: no
	hours of operation/hours of maintenance	
Dimensional data	Length	5,7 m
	Width	2,4 m
	Height	3,25 m
	Mass	10'400 kg
Driving specifications	Waterproof	light waterproof
	Ability to stand hot weather	yes
	Means of locomotion	wheels
	Ground pressure	
	Hill climbing ability	30°
	Control type [pilot on board, remote + operator, automatic control.…]	pilot on board
	Type of signal to the operator [sight, screen, acoustic,…]	sight and acoustic
	Camera	no
	Max. control distance (length)	
	Emergency control [none, stop,…]	
Working performance	Working speed:	
	- light soil/small vegetation	
	- medium soil/medium vegetation	
	- heavy soil/dense vegetation	
	Clearance/detection depth	200-300 mm
	Control of clear./detect. depth	manual
	(For multi-tools, *e.g.* chains) Number of tools	2
	(For multi-tools, *e.g.* chains) Distance between tools	
	(For multi-tools, *e.g.* chains) Rotation speed	variable
System specifications	Engine	Caterpillar 3054 T turbo charged diesel engine, 56 or 60 kW;,four-cylinder, four-stroke, direct-injection engine.
	Fuel capacity	128 l
	Fuel consumption	15-25 l/hour depending on configuration and soil
	Separate engine for working unit	No
	Cooling system engine	Water
	Oil capacity	
	Hydraulic oil capacity	79 l
Cost	R&D cost ($)	
	Price of item ($)	200'000
	Running cost ($/month)	*1'200*
Time	Delivery time	
	Time for training	4 weeks

ORIGIN/DEVELOPMENT		
Developed by		MgM Mine Clearance NGO - R&D
(If developed by end users) Development	Where (Country, Region)	Windhoek, Namibia
	Who	MgM Mine Clearance NGO – R&D
	Adapted from	CAT 428c + agricultural attachments
	Added material	armoured steel cab and attachments
	Time for development	9 months
	Funded by	USDoD

TEST (if possible, these data will be acquired directly from documents)		
Tested in mine affected country? [Yes/No]		no
(If Yes) Test report		

* Some data have been extracted from the GICHD Mechanical Demining Equipment Catalogue 2004.

FIELD USE		
COUNTRY:ANGOLA		
DEMINING ORGANZIATION: MgM		
Specifications of equipment in use	N° of pieces in use by this organisation	1
	Period of use (years)	4
Conditions	Age of equipment (years)	4
	External conditions [bad(1)/acceptable(2)/good(3)]	3
	Responsible for maintenance [deminer/mechanic/supervisor]	mechanic
Application	Use within demining practices [tripwire removal, vegetation removal, mine detect., earth removal,…]	tripwire, vegetation, mine, earth removal, soil sifting
	Freq. of use (hours/day)	8
	Unusable in: [wet, hot,…] weather	flood, wet weather
	Unusable in: [hilly, rocky,...] terrain	
	N° of accidents in the last year (n°)	0
Cost-Effectiveness	Price of item ($)	200'000
Cost	Running cost ($/month)	*1'200*
	Repairing cost (including transport of spare parts from abroad) ($)	
Human Resources	N° of staff to run (n°)	1
	Monthly cost of operator ($)	350
Time	Time for training (days)	24
	MTBF (days)	
	Time for repairing (days)	1
	Main reasons for downtime [mechanical pb, electric pb,…]	tyres, mechanical
General comments (representative)	Advantages	multi-purpose
	Drawbacks	too small
	Possible improvements	
General comments (deminers)		

2.5 ARMOURED EXCAVATOR

2.5.1 Uni-Disk

TECHNICAL DATA SHEET for Mechanical Demining Technologies*		
General description		Armoured excavator
Application	Use within demining practices [tripwire removal, vegetation removal, mine detection, earth removal,…] Designed to drive over mines hours of operation/hours of maintenance	tripwire, vegetation, mine, earth removal, soil sifting
Dimensional data	Length Width Height Mass	10,34 m 3,39 m 3,32 m 82’000 kg
Driving specifications	Waterproof Ability to stand hot weather Means of locomotion Ground pressure Hill climbing ability Control type [pilot on board, remote + operator, automatic control….] Type of signal to the operator [sight, screen, acoustic,…] Camera Max. control distance (length) Emergency control [none, stop,…]	light waterproof yes Tracks 134 kPa pilot on board sight and acoustic no
Working performance	Working speed: - light soil/small vegetation - medium soil/medium vegetation - heavy soil/dense vegetation Clearance/detection depth Control of clear./detect. depth (For multi-tools, *e.g.* chains) Number of tools (For multi-tools, *e.g.* chains) Distance between tools (For multi-tools, *e.g.* chains) Rotation speed	3: cutter drum, sifting bucket, bucket
System specifications	Engine Fuel capacity Fuel consumption Separate engine for working unit Cooling system engine Oil capacity Hydraulic oil capacity	140 kW 500 l 50 l/hour 460 hp hydraulic power
Cost	R&D cost ($) Price of item ($) Running cost ($/month)	 600’000 2’400
Time	Delivery time Time for training	 4 weeks

ORIGIN/DEVELOPMENT		
Developed by		MgM Mine Clearance NGO - R&D
(If developed by end users) Development	Where (Country, Region) Who Adapted from Added material Time for development Funded by	Windhoek, Namibia MgM Mine Clearance NGO – R&D CAT excavator Mdl 325 B integrated with a Shinn Cutter System Mdl SC4 and a Rotar sifting bucket

TEST (if possible, these data will be acquired directly from documents)		
Tested in mine affected country? [Yes/No]		yes
(If Yes) Test report**	Where (Country, Region) Who (names, roles) When (date) Scope of tests (phase1: reliability, depth of operation, …) Details of tests (phase1: type, depth of mines, temperature,…) *Test programme* (phase1: 20 cm line checking,…) *Analysis of test* results (phase1: test results and analysis) Recommendations (improve speed, do more field *trials*,...)	Mozambique MgM

FIELD USE		
COUNTRY:ANGOLA		
DEMINING ORGANZIATION: MgM		
Specifications of equipment in use	N° of pieces in use by this organisation Period of use (years)	1 1
Conditions	Age of equipment (years) External conditions [bad(1)/acceptable(2)/good(3)] Responsible for maintenance [deminer/mechanic/supervisor]	5 3 mechanic
Application	Use within demining practices [tripwire removal, vegetation removal, mine detect., earth removal,…] Freq. of use (hours/day) Unusable in: [wet, hot,…] weather Unusable in: [hilly, rocky,...] terrain N° of accidents in the last year (n°)	tripwire, vegetation, mine, earth removal, soil sifting 8 flood, wet weather 0
Cost-Effectiveness Cost	Price of item ($) Running cost ($/month) Repairing cost (including transport of spare parts from abroad) ($)	600’000 2’400
Human Resources Time	N° of staff to run (n°) Monthly cost of operator ($) Time for training (days) MTBF (days) Time for repairing (days) Main reasons for downtime [mechanical pb, electric pb,…]	1 350 24 1 mechanical
General comments (representative)	Advantages Drawbacks Possible improvements	productive high operational costs
General comments (deminers)		

3 SENSOR TECHNOLOGY

3.1 RAKES

3.1.1 HEAVY RAKE

TECHNICAL DATA SHEET for Sensor Technologies		
General description		Simple rake with wooden handle and two curved steel tines
Application	Use within demining practices [tripwire removal, vegetation removal, mine detect., earth removal,…]	earth removal where it is known that only small plastic minimum-metal blast AP mines are present
	Working principle	used to dig hard soil to excavate mines; if it is used correctly it doesn't detonate mines. It has a long handle to keep the deminer at a safe distance in case a detonation occurs
	hours of operation/hours of maintenance	
Dimensional data		
Power supply	Power supply/source	human operator
	Operating time	
	Power supply weight	
	Ground pressure	
	N° of batteries/size/type/voltage	
Working performance	Sensitivity	
	Resolution	
	Accuracy	
	Acquisition time	
	Rest time between measurements	
	Probability of false alarm	0
	Interfering conditions	
	Working depth	
	Soil influence	hard soil must be softened with water
	Capable to detect:	
	- low metal content mines	yes
	- anti-tank mines	
	- UXO's	
	Optimal sweep speed	
	Waterproof	yes
Cost	R&D cost ($)	
	Price of item ($)	3
	Running cost ($/month)	100 (cost of operator)
Time	Delivery time	
	Time for training	3 days

ORIGIN/DEVELOPMENT		
Developed by		MAG, NPA
(If developed by end users) Development	Where (Country, Region)	Sri Lanka, Vanni region
	Who	MAG, NPA
	Adapted from	Adapted from commonly used tools
	Added material	Increased length of wooden handle
	Time for development	Days
	Funded by	Local NGO

TEST (if possible, these data will be acquired directly from documents)		
Tested in mine affected country? [Yes/No]		no
(If Yes) Test report		

FIELD USE		
COUNTRY:SRI LANKA		
DEMINING ORGANZIATION: MAG		
Specifications of equipment in use	N° of pieces in use in this organization	50
	Period of use (years)	2
Conditions	Age of equipment (years)	not recorded
	External conditions [bad(1)/acceptable(2)/good(3)]	2
	Responsible for maintenance [deminer/mechanic/supervisor]	deminer, supervisor, logistics
Application	Use within demining practices [tripwire removal, vegetation removal, mine detect., earth removal,…]	earth removal
	Freq. of use (hours/day)	3
	Unusable in: [wet, hot,…] weather	
	Unusable in: [hilly, rocky,...] terrain	
	N° of accidents in the last year (n°)	0
Cost-Effectiveness	Price of item ($)	3
Cost	Running cost ($/month)	0
	Repairing cost (including transport of spare parts from abroad) ($)	
Human Resources	N° of staff to run (n°)	1
	Monthly cost of operator ($)	100
Time	Time for training (days)	3
	MTBF (days)	
	Time for repairing (days)	1
	Main reasons for downtime [mechanical pb, electric pb,…]	Broken handle, blunt tines
General comments (representative)	Advantages	Used in conjunction with light rake, cheaper than detectors, increased distance from mine should detonation occur, easy to train, faster, don't have to worry about fragmentation in the ground
	Drawbacks	Recommended to use only on small plastic minimum-metal blast AP mines, Limited depth, difficult to use in hard soil, ground has to be watered
	Possible improvements	Make rake tines like knife blades to ease cutting through roots
General comments (deminers)		

COUNTRY:SRI LANKA		
DEMINING ORGANZIATION: NPA		
Specifications of equipment in use	N° of pieces in use in this organization	442
	Period of use (years)	2
Conditions	Age of equipment (years)	4
	External conditions [bad(1)/acceptable(2)/good(3)]	3
	Responsible for maintenance [deminer/mechanic/supervisor]	logistics
Application	Use within demining practices [tripwire removal, vegetation removal, mine detect., earth removal,…]	used only when light rakes are ineffective
	Freq. of use (hours/day)	5
	Unusable in: [wet, hot,…] weather	
	Unusable in: [hilly, rocky,...] terrain	need to water the ground when it is too dry and hard
	N° of accidents in the last year (n°)	0
Cost-Effectiveness	Price of item ($)	2
Cost	Running cost ($/month)	0
	Repairing cost (including transport of spare parts from abroad) ($)	0 (disposable)
Human Resources	N° of staff to run (n°)	1
	Monthly cost of operator ($)	100
Time	Time for training (days)	1
	MTBF (days)	
	Time for repairing (days)	0
	Main reasons for downtime [mechanical pb, electric pb,…]	not replaced on time
General comments (representative)	Advantages	the system: 100% excavation, fast in light soil; the tool: digs hard soil and does not detonate mines if used correctly
	Drawbacks	
	Possible improvements	
General comments (deminers)	Advantages	
	Drawbacks	the angle of the tines changes because the metal is too soft
	Possible improvements	

3.1.2 METAL LIGHT RAKE

TECHNICAL DATA SHEET for Sensor Technologies		
General description		Simple rake with wooden stick and many flexible steel tines
Application	Use within demining practices [tripwire removal, vegetation removal, mine detect., earth removal,…]	used as primary method: earth removal where it is known that only small plastic minimum-metal blast AP mines are present
	Working principle	used to dig soil to excavate mines; if it is used correctly it does not detonate mines. It has a long handle to keep the deminer at a safe distance in case a detonation occurs
	hours of operation/hours of maintenance	
Dimensional data	Length	
	Width	
	Height	
	Mass	
	Mobility	
	Search head size	
	Search head weight	
	Search head shape	fan shape
Power supply	Power supply/source	human operator
	Operating time	
	Power supply weight	
	Ground pressure	
	N° of batteries/size/type/voltage	
Working performance	Sensitivity	
	Resolution	
	Accuracy	
	Acquisition time	
	Rest time between measurements	
	Probability of false alarm	0
	Interfering conditions	
	Working depth	
	Soil influence	hard dry soil must be watered
	Capable to detect:	
	- low metal content mines	yes
	- anti-tank mines	
	- UXO’s	
	Optimal sweep speed	
	Waterproof	yes
Cost	R&D cost ($)	
	Price of item ($)	3
	Running cost ($/month)	100 (cost of operator)
Time	Delivery time	
	Time for training	3 days

ORIGIN/DEVELOPMENT		
Developed by		MAG, NPA
(If developed by end users) Development	Where (Country, Region)	Sri Lanka, Vanni region
	Who	MAG, NPA
	Adapted from	Adapted from commonly used tools
	Added material	Increased length of wooden handle
	Time for development	Days
	Funded by	Local NGO

TEST (if possible, these data will be acquired directly from documents)		
Tested in mine affected country? [Yes/No]		no
(If Yes) Test report		

FIELD USE		
COUNTRY:SRI LANKA		
DEMINING ORGANZIATION: NPA		
Specifications of equipment in use	N° of pieces in use in this organization	442
	Period of use (years)	2
Conditions	Age of equipment (years)	2
	External conditions [bad(1)/acceptable(2)/good(3)]	3
	Responsible for maintenance [deminer/mechanic/supervisor]	logistics
Application	Use within demining practices [tripwire removal, vegetation removal, mine detect., earth removal,…]	used as primary method
	Freq. of use (hours/day)	5
	Unusable in: [wet, hot,…] weather	
	Unusable in: [hilly, rocky,...] terrain	need to water the ground when it is too dry
	N° of accidents in the last year (n°)	0
Cost-Effectiveness	Price of item ($)	4
Cost	Running cost ($/month)	0
	Repairing cost (including transport of spare parts from abroad) ($)	0 (disposable)
Human Resources	N° of staff to run (n°)	1
	Monthly cost of operator ($)	100
Time	Time for training (days)	1
	MTBF (days)	
	Time for repairing (days)	0
	Main reasons for downtime [mechanical pb, electric pb,…]	not replaced on time
General comments (representative)	Advantages	the system: 100% excavation, fast in light soil; the tool: flexible, not activating mines
	Drawbacks	the system: can be very slow in hard soil and clay
	Possible improvements	
General comments (deminers)	Advantages	
	Drawbacks	the tines' support bar can move and prevent the force from being properly transmitted to the tines themselves
	Possible improvements	

3.1.3 PLASTIC LIGHT RAKE

TECHNICAL DATA SHEET for Sensor Technologies		
General description		Simple rake with wooden stick and many plastic tines
Application	Use within demining practices [tripwire removal, vegetation removal, mine detect., earth removal,…]	used as primary method: earth removal where it is known that only small plastic minimum-metal blast AP mines are present
	Working principle	used to dig soil to excavate mines; if it is used correctly it does not detonate mines. It has a long handle to keep the deminer at a safe distance in case a detonation occurs
	hours of operation/hours of maintenance	
Dimensional data	Length	
	Width	
	Height	
	Mass	
	Mobility	
	Search head size	
	Search head weight	
	Search head shape	fan shape
Power supply	Power supply/source	human operator
	Operating time	
	Power supply weight	
	Ground pressure	
	N° of batteries/size/type/voltage	
Working performance	Sensitivity	
	Resolution	
	Accuracy	
	Acquisition time	
	Rest time between measurements	
	Probability of false alarm	0
	Interfering conditions	
	Working depth	
	Soil influence	hard dry soil must be watered
	Capable to detect:	
	- low metal content mines	yes
	- anti-tank mines	
	- UXO's	
	Optimal sweep speed	
	Waterproof	yes
Cost	R&D cost ($)	
	Price of item ($)	3
	Running cost ($/month)	100 (cost of operator)
Time	Delivery time	
	Time for training	3 days

ORIGIN/DEVELOPMENT

Developed by		MAG, NPA
(If developed by end users) Development	Where (Country, Region)	Sri Lanka, Vanni region
	Who	MAG, NPA
	Adapted from	Adapted from commonly used tools
	Added material	Increased length of wooden handle
	Time for development	Days
	Funded by	Local NGO

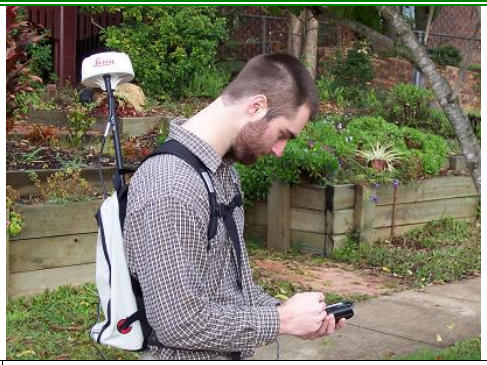
TEST (if possible, these data will be acquired directly from documents)	
Tested in mine affected country? [Yes/No]	no
(If Yes) Test report	

FIELD USE		
COUNTRY:SRI LANKA		
DEMINING ORGANZIATION: NPA		
Specifications of equipment in use	N° of pieces in use in this organization	442
	Period of use (years)	2
Conditions	Age of equipment (years)	2
	External conditions [bad(1)/acceptable(2)/good(3)]	3
	Responsible for maintenance [deminer/mechanic/supervisor]	logistics
Application	Use within demining practices [tripwire removal, vegetation removal, mine detect., earth removal,…]	used as primary method
	Freq. of use (hours/day)	5
	Unusable in: [wet, hot,…] weather	
	Unusable in: [hilly, rocky,...] terrain	need to water ground when it is too dry and hard
	N° of accidents in the last year (n°)	0
Cost-Effectiveness	Price of item ($)	2
Cost	Running cost ($/month)	0
	Repairing cost (including transport of spare parts from abroad) ($)	0 (disposable)
Human Resources	N° of staff to run (n°)	1
	Monthly cost of operator ($)	100
Time	Time for training (days)	1
	MTBF (days)	
	Time for repairing (days)	0
	Main reasons for downtime [mechanical pb, electric pb,…]	not replaced on time
General comments (representative)	Advantages	the system: 100% excavation, fast in light soil; the tool: flexible, not activating mines
	Drawbacks	the system: can be very slow in hard soil and clay
	Possible improvements	
General comments (deminers)	Advantages	
	Drawbacks	the tines' support bar can move and prevent the force from being properly transmitted to the tines themselves
	Possible improvements	

4 INFORMATION AND COMMUNICATION TECHNOLOGIES

4.1 DIFFERENTIAL GPS

4.1.1 Leica DGPS

TECHNICAL DATA SHEET for Information and Communication Technologies		
General description		DGPS is a highly accurate GPS using a differential measuring system. The system fits in a backpack, carried by the operator. It is capable of tracking where the operators walk and the track can be overlapped to a map. Digital magnetic compass binoculars are used to define the perimeter of the minefield without having to walk into it.
Application	Use within demining practices [tripwire removal, vegetation removal, mine detect., earth removal,…]	during impact survey for making maps of villages and measuring positions of important points
	Working principle	accuracy is improved by adding a local reference station, or a satellite-based correction signal, to augment the information provided by the ordinary GPS satellites to a GPS receiver.
	hours of operation/hours of maintenance	
Dimensional data	Approximate size	backpack + hand receiver
	Mass	5 Kg
Power supply	Power supply/source	batteries
	Operating time	1,5 hours
	Power supply weight	0,2 Kg
	N° of batteries/size/type/voltage	2 Li-Ion rechargeable 3,8 Ah/7,2V batteries
Working performance	Accuracy	20 – 30 cm
	Acquisition time	0,05 s
	Rest time between measurements	0,03 s
	Interfering conditions	cloudy weather
	Waterproof	yes
Cost	R&D cost ($)	
	Price of item ($)	30’000
	Running cost ($/month)	106 +[2’000/year for satellite-based correction signal]
Time	Delivery time	
	Time for training (days)	60

ORIGIN/DEVELOPMENT		
Developed by		Leica Geosystems
(If developed by end users) Development	Where (Country, Region) Who Adapted from Added material Time for development Funded by	

TEST (if possible, these data will be acquired directly from documents)		
Tested in mine affected country? [Yes/No]		no
(If Yes) Test report		

FIELD USE		
COUNTRY:SRI LANKA		
DEMINING ORGANZIATION: FSD		
Specifications of equipment in use	N° of pieces in use in this organization Period of use (years)	2 2
Conditions	Age of equipment (years) External conditions [bad(1)/acceptable(2)/good(3)] Responsible for maintenance [deminer/mechanic/supervisor]	4 3 General Mine Action Assessment (GMAA) team leader and assessor
Application	Use within demining practices [tripwire removal, vegetation removal, mine detect., earth removal,…] Freq. of use (hours/day) Unusable in: [wet, hot,…] weather	impact survey 4 wet, cloudy
Cost-Effectiveness Cost Human Resources Time	Price of item ($) Running cost ($/month) Repairing cost (including transport of spare parts from abroad) ($) N° of staff to run (n°) Monthly cost of operator ($) Time for training (days) MTBF (days) Time for repairing (days) Main reasons for downtime [mechanical pb, electric pb,…]	30’000 106 1 172 60 problems with correction signal
General comments (representative)	Advantages Drawbacks Possible improvements	the system can be regulated in order not to measure when the accuracy is lower than a predefined value
General comments (deminers)	Advantages Drawbacks Possible improvements	a sketched map can be uploaded in the system; it is comfortable; a preview of the map can be seen and corrections can be made directly in the minefield batteries need to be changed every 1,5 hours; sometimes the signal is not clear, specially under the shade of large trees