EUDEM2

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

IST–2000-29220

EUDEM2 Conference Report

Nordic Demining Research Forum (NDRF)
Summer Conference, Bergen, Norway
27-29 August 2003

Report on all Sessions

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November 2003, v2.1

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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Nordic Demining Research Forum (NDRF) *Summer Conference* 2003, Bergen, Norway, 27-29 August 2003

Report on all Sessions and Presentations made

1) Conference Overview and Summary

The summer conference as a whole listed about 60 participants, and sessions carried on over three full days. The audience was mainly Scandinavian, as NDRF meetings tend to be with a few invited guests from abroad and some that come spontaneously, like myself. The mixture of people was very interesting. Some are deminers, representing the NGO they work for, some are industrials that develop or sell a tool (mechanical or other demining equipment), some are researchers/engineers from FOI (Swedish Defence Research Agency) or other large research institutes, some are military, and others are not directly involved in humanitarian demining but carry out social or economical research and apply their theories to demining scenarios and data. In summary the audience was a very impressive group of scientists and engineers. My participation was under the aegis of the EC IST EUDEM2 project (**www.eudem.info**). I shortly presented the project's underlying ideas, what had been achieved up to the conference date, and announced the EUDEM2-SCOT conference. Funding was provided by VUB-ETRO, the main contractor of the EUDEM2 project.

***Disclaimer**:* These notes represent the author's personal impressions only, based for the most part on notes taken during the talks and later discussions with participants; as such they do not pretend to be complete and engage only herself. For an official account see the corresponding conference Website and/or contact the individual authors.

To sum up my conclusions about this meeting is not easy. I was very impressed by the group which got together for 3 days, and by the presentations made. There ought to be more meetings of this kind to close the gap between sciences and towards an interdisciplinary approach to the humanitarian demining issue. What bothers me is that a lot of the information provided will probably not come out of the conference room after the meeting, apart from inside the minds of people that were there. The group of people present mostly knew each other very well and seemed close but if they are actually collaborating is not clear. The NDRF aims at small scale meetings with a selective audience and not at large publics who may be equally interested in participating in the interesting discussions. There is no driving force to do more with the meetings because of the lack of staff devoted to take on this job and the involvement of the attendees in totally different areas. Therefore things are not taken much further than Scandinavia and this is unfortunate.
The presentations I personally appreciated most are the introduction talk of Håvard Bach, the talk on the bees from INSENS (John Wilkins), the talks on REST by Ian McLean and Rune Fjellanger and the talk of Jan Larsen on the statistics. Vernon Joynt made good comments all the time.

Type of conference: yearly *Summer Conference*.

The Nordic Demining Research Forum (NDRF) aims at stimulating research and development activities to support improvement in demining efficiency and safety through promotion of co-operation between operators, research and development, and industrial environment, stimulation of information exchange, and initiation of cross border and cross sector research and development activities between companies and institutions in the Nordic countries. Source: (http:// http://www.ndrf.dk/index_frame.htm)

2) Summary of all Sessions and Presentations

The introduction was given by Bjarne Haugstad, FFI (Norwegian Defence Research Establishment) – Chairman of NDRF – as the official opening of the Conference. He explained the position of NDRF as its members come all from small nations – only small contributions can be made – the NDRF composition is very diverse and consists of special people that undertake special actions to detect landmines.

Guest of Honor: Håvard Bach, GICHD - Humanitarian Mine Action, - Trends, Future and Challenges

Mine action is a complex process – not anymore simple mine clearance but a professional activity of international specialists.
The aim to make the world mine free by 2010 cannot be met, not even if 10.000K EURO of extra resources were available.
Research is not leading to many results – should we continue giving more money to research than to demining activities?
In the past interaction between researchers & field users was less than today.
The demining scene is not an entity but multiple pockets to be filled – funds have been wasted as a result.
The demining market is artificial and is also a very small market whose forces are not driven by economic agendas.
Equipment needs to be produced in the donor country.
Important end user reluctance for new technologies. Improve existing technologies (dogs, mechanical, vapor – vast improvement) rather than finding new ones.

- REST: sampling and analysis needs improvement and animal behavior needs to be better studied.
  Complementary use of animals and vapor detection could lead to better results.
- Machines: brush cutter, magnets, combined use, rollers (now good for area reduction).
- Mechanical: flails + tillers.
- Difficult to test – lack of sufficient statistical data.
- Manual demining most common approach.

A balance between improving current equipment and inventing new one is necessary, both can be done. Demining is risk deduction – there is a clear link towards risk assessment.
Risk is not a standard – depends on the society – very difficult to define tolerable risk reduction. *Not perfect but acceptable* = risk assessment.
Rather good for survey and area reduction: flails: remove trip wire and vegetation and prepare for MD + dogs.

Research: 2 weeks visit to field pays better than 1000 books and photos.
Partnership is important for exchanging ideas – no isolation – avoid duplication. See IMAS and user needs study.

Discussion: Vernon Joynt: one big problem: databases! Very comprehensive figures are not available – they need to be available. Manual deminers miss 10 % when mine density is low – should include cost per sqm.
Rollers don't demine but give you a surface where a detector can work – not like tillers. We need databases to show these things – use the toolbox, which machine can be used where?
Not all deminers use databases.

A. Session Day one: 27 August 2003: Molecule Detection, chaired by Peter Gårdhagen, G2:

I. Peter Gårdhagen, G2: *Introduction*

Molecules are transported from mine to the surface – when at surface: wind + sunlight + rain, temperature, PH factors have a great impact on the molecules.
Detection of molecules can be done by dogs, rats, bees, vegetation or bacteria. One can also pre-concentrate molecules in a filter – this is studied in the REST programmes: take the mine molecules to the rat/dog instead of vice versa.
Or detect with machines like biosensor, HPLC (High Performance Liquid Chromatography), GC (Gas Chromatography), other sensors.

II. Ove Dullum: *TNT Migration in the soil*

Gave an introduction in soil science and explained the difference between dispersivity in sand – loam – silt and clay.
Concentrations depend on the soil texture.
Concentration build-up is quick in clay and slow in sand (washed away by rain).
Dispersion: high dispersion – quick build-up. Low dispersion – slow concentration build-up.
Final concentration does not depend so much on dispersivity after a longer time.

Deep or shallowly buried is also less important over a longer time.
There are many variations in gaseous & non-gaseous phase.
More testing is needed – calibration tests also remain to be done.
Concerns: are data available from the demining side to run the model?
Focus nearly only on TNT rather than on DNB & DNT? Why?

After a while DNT disappears – it is a side product used for producing TNT. We don't know what substances dogs smell – they smell what they are trained for.

III. Hakan Carlsson, FOI: *Detection of Explosives in Vapor Phase: Air Sampling and Chemical Analysis.*

The explosive makes the difference between a dangerous or non dangerous object
High volume sampling needed. However, cannot sample more than 3 L/min → too low volume.
TNT contains DNT, TNB and DNB. The target is DNT – higher concentration (DNT: 0.2 ng/L, TNT: 1 pg/L).
Membrane is better: higher flow rate: smaller particles retained??
With new sampler: 3 ng/min DNT?? and 15 pg/min TNT?? without any breakthrough/leakage.
Portable collector + pump: 0,5 kg. 30 L/min, weighs 5 kg, costs 3000 $.
The systems releases collected air via a thermal device. The gas passes via an explosive vapor detector with temperature & humidity control.

IV. Magnus Eriksson, SU – Stockholm University: *Development of a Portable Vapor Detector for Explosives in Mines: An Approach to Humanitarian Mine Detection.*

With DNT for minefield area reduction, small vehicle or hand-held device = aim.
Need to sample very little to analyse.
Active sampling with a pump in sampling tubes – stainless steel & glass. Pump 2 L/min.
Fully automatic analysis.
Cost effective, samplers can be reused and analysis is solvent free.

The system works fast, and is small, 100 % is analysed
It uses only nitrogen gas & can be battery operated.
Duration for analysis: 3 minutes = aim.

V. Simon Oostergaard, Aresa Biodetection ApS: *The use of Plants as Explosive Detector*: www.aresa.dk

Biodetection of landmines & heavy metals.
Plant used: Arabidopsis thaliana: mustard plant.
Grows all over the world – growth phase 4 – 6 weeks.
Protein that goes red when plants are under stress (not enough water etc.).
In this application: manipulated plant goes red when in contact with TNT, not when it is stressed.
Seeds need to be coated as they are so small with a filler (filling product to make them larger)
Sprayed out together with water – need to make a safe path – cut down vegetation – spray with roundup to kill all existing plants – spray the seeds – water for 3 – 6 weeks – after 3 weeks (red dots at presence of landmines) plant in contact with mines dies and plants do not spread as they cannot reproduce themselves.
Problem with the age of minefields – new mines might not have any leakage.

VI. John Wilkins, Insense Ltd.: *The Use of Honey Bees as Explosive Detector.*

Many spin-off possibilities – smells for QC, for tracking disease etc.
The bees are conditioned with the smell to be detected with food = Pavlovian conditioning.
It takes only 30' – 40' to condition/train a set of bees.
Conclusions:
Dogs are the best vapour detector there is.
Bees are 10 – 100 x more sensitive than humans and are on the same line with sniffer dogs. Advantages: Reliable, sensitive, flexible, cost-effective, rapidly re-targeted → vapor sensing unit.
DARPA: uses flying bees for anti-terror attacks with a wireless transmitter on the bees that can be tracked and lead to mines – bombs – airport explosives.
DSTL: partners.
Disadvantages: environmental conditions.

VII. Ian McLean, GICHD: *Trials in Bosnia and Afghanistan.*

The REST project – *Remote Explosive Scent Tracing* → bring odor to the detector.
1980s – USA – used by MECHEM
There is little documentation of R&D, recent revival, it is very sensitive – analysis cannot be done outdoors.
Primary application: for area reduction
Training issues
Motivation (dogs), Sensitivity, Reliability, Fine Tuning and getting reliable samples is a very important issue.
Mechem: dog with handler – assist dog in identification
NOKSH: dog alone – reward is clicker or whistle
APOPO: rat alone – reward with clicker and reinforced by food → sealed unit.
Reporting is a problem = difficult to see what is done during reporting
Sampling: Effective sampling distance remains a question

The Mechem filter is the standard because it works.
APOPO tested alternative filters - no 4 (internal tube from a marker pen is good).

Time of day and days are giving different results.
Environmental effects (see talk of Rune Fjellanger).
Future of REST?
All of the aspects need further research.
Funds are needed. Main use would be for area reduction.
Need to explore links to other clearance systems.
Challenges: limited resources, few detectors, few trainers, 1 – 2 years of investment is needed to establish a REST facility = long term. Coordinated effort is needed.

VIII. Rune Fjellanger, NOKSH: *The REST Project.*

Vapour sensing using dogs in Bosnia: Tests done by Rune Fjellanger.
Test field in Sarajevo & Mostar in collaboration with NPA for sampling – analysis in Norway – mines were in the ground since many years.
Dogs have problems with cold climate, heavy & wet summers → expected bad results.
Sand & stones in a dry climate is much easier for the dogs.
Different factors were studied – some factors were kept constant – one dog handler, one test leader, one technical to prepare the carousel. Each dog 3x over the set of filters – test leader and handler record their own data independently.

Out of 88, 68 % positive filters were found. More success in Mostar than in Sarajevo: TMA4 – TMM1.
When humidity goes up (over 60%) much lower detection.
Best detection between 30% & 40% humidity.
Temperature best detection 20 – 25°C (over 15°C).
TMM 1 difficult to find for dogs.
Conclusion: REST can find mines in Bosnia in the right time (humidity – temperature) & place.
More research is needed to be operational – detector does not have to be in Bosnia but a sampler who knows where and how to sample & ship it to the detector.

IX. Håvard Bach, GICHD: *The use of African Giant Pouched Rats as Explosive Detector.*

Why rats? They are small, easier for the kennel/transport, do not need not much food.
They are fast & easy to bread and can be trained from 6 weeks onwards.

MgM Mozambique 03/2003
NPA Mozambique 2003
Rats scratch or bite a little when they mark a mine.
Portable Skinner box as a second verification.
Sampling is very important!

Idea from Vernon Joynt: Elephants that can communicate with each other & can smell mines. IR (InfraRed) satellites of military to see where elephant herds do not go could be an indication of the presence of mines.

B. Day 2: 28 August 2003: Session Ground Penetrating Radar

I. Brian Karlsen, DTU-ØRSTED: *GPR Clutter Rejection by Use of Statistical Methods.*

Examination of how GPR (Ground Penetrating Radar) works. Problems with GPR are rough surface, small scatterers, insufficient dielectric contrast, moisture level, target depth.

GPR can detect landmines but AP landmines (shallowly buried) are hard to detect.
Stepped Freq. GPR – bow-tie (monostatic) antenna.

Clutter reduction: mean subtraction, parametric decomposition methods.
They use the latter method as the first one has a poor performance. ICA is the best method (Independent Component Analysis).
There is a need for larger landmine signature databases.

Has the JRC signature database been updated the last 3 years?

II. Jan Larsen, DTU-IMM: *Impact on Detection Probability and False Alarm Rate by Successive Use of Independent or Partly Independent Mine Clearance Methods.*

Combining existing Equipment:
Risk analysis is important: Risk is Probability of casualty + Consequence.
Risk models are situation specific.
The 99.6% UN Standard is justified, maybe we need better even.
When designing a risk assessment model we use several data.
System/methods, expert data, informal data (locals), environment, targets → via statistical learning.
To ensure a high confidence and estimate the no. of mines– optimal design methods within statistics is needed to reduce the no. of targets.
Combine methods to improve performance as no single existing method can provide the needed high standard.
→ Apply binary decision fusion to existing mine detection equipment. This leads to exponential increase in performance, and provides a "better robustness" against environmental charges.
The NDRF wants to take a leading role in such a project.
Need for certification procedure of equipment by new improved or extended tests.
Exponential increase in detection, linear increase in false alarm rates.
Combine as many methods as possible using statistical fusion.
A system with 70 % detection probability is most of the time cheaper and faster but the systems have to be independent from each other.

III. Colin Hatchard, CyTerra Corporation: *A Combined MD/GPR Detector – The HSTAMIDS System – AN/PSS-14*

Since 8 years under development - entirely funded by the US Army.
Minelab F1A4 metal detector – now F3.
GPR + pulsed MD (both work all the time) to replace the US Army standard Schiebel detector; dropped IR with display.
Today it is a small, ergonomic tool, it weighs 4 kg – is easy to use, and portable
Costs 23,500 US$ → goal 10 – 15.000 US$ in 18 MM.
400 units used in Afghanistan by US army
Battery lasts 4 hours, lithium 6 hours – will address HD this year.
The operator is very important, gets a no. of signals but he decides and not the data fusion.
GPR uses a PCA method (Principal Component Analysis), stepped frequency radar, system self adapting to the terrain, looks for man made objects.
Low false alarm rate and nearly 100 % probability of detection.

Next steps ahead: vehicle and robotic systems, larger vehicles, investigate additional sensors

→ adding acoustic vibration as it detects different aspects of the mine than GPR & MD – no or little weight added to the current system.
Only in R&D phase at this time.

IV.Jens Busck, FOFT/DTU : *3D Gated Viewing LIDAR*

LIDAR: LIght Detection and Ranging – for underwater detection.

Laser optical system – pulsed laser – gated Image Sequence
→ nanolaser
Camera Stanford.
Problem: water is strongly absorbing light – so the performance under water is still not clear.
Fast 3D imaging (1-5 sec) – monostatic system: No application possibility for landmine detection.

V. Jan-Olof Widar, SWEDEC: *Mine Clearence Trial in Croatia: Mechanical Clearance Combined with Dogs*

Croatia EDD trial: Scanjack flail + long leash EDD (free running dogs).
Aim: validation of combined approach mech. Flail + dogs & check the time of acclimatization of dogs.

Croatia: dry-hot climate 35-38°C [summer]
SRSA test field – limited endurance EDDS
After a week normal daily routine (6 H/day), there was a snake problem at test field so change to NPA training field, resulted in very good accreditation 27 800 m searched

In the flailed area 1 AT – 3 AP mines were found, dogs did not miss any mine
Flail: AT all, AP 98%. EDD search capacity: 100 %
EDD is ready for tropical climate in a timeframe of 4 weeks.

EDD should search after 24 hours due to smell of machines, cut vegetation, cultivated ground, crushed & deteriorated mines
2 x flail before EDD

Dogs used are: German shepherd + Danish Springer Spaniel

Session: Operation and Management
I Jan Larsen, DTU – IMM: *Review of RAND report "Alternatives for Landmine Detection"*

Explains technology in each area – very good reference book. No further explanation was given.

II. Kristian B. Harpviken, PRIO: *The Peace Building Role of Mine Action*

Donor policies in relation to peace building: mine action is primarily referred to as a security issue, secondarily as reconstruction, and only lastly as rebuilding in security-feeling, reconciliation, confidence building.
Mine action is a singular success story or specific case.
It is very rarely referred to the political impact of peace building.

Peace building is a consequence of an activity and an activity on its own.
Mine action is a contribution to peace building.

III. Kim Allan Fog, DANDEC: *Accident Report from Kabul*

Air to surface missile pointed directly to Kabul airport:

- SOP was not followed at central demolition site where UK, German & Danish (army) worked together.
- Collecting information – was not correct – as there was no manual how to use it, or how to disarm it.
- Missile was removed but it was already dangerous to transport.
- Warhead contained 60 kg of explosives and aluminum: scatter/fragment.
- Operation was planned by taking out the lid of the warhead and taking the explosives out and this resulted in putting a lot of stress on the lid.
- Explosives were taken out and collected in a cardboard box in the pit.

In total 5 people killed, 7 severely damaged.
Possible explanation: *tunnel vision* – focus too much on the job, and neglect of safety regulations.

- Need for a conference with all EOD operators.

IV. Geir Bjorsvik, NPA: The Roles and the Commitments of NPA.
Since '92 NPA is working in 10 different countries.
One of the tasks is mine awareness training = very complicated
Two major challenges: . Have a proper analysis of the target group
. Not only spread the news but change the behavior

- Surveys are carried out to collect information
- For mine clearance NPA is using the toolbox concept – low tech can be transferred easily to national capacity
- Task Impact Assessment (TIA): socio-economic impact for priority setting not at national level but provisional level – match info with the very local communities.
  Design a matrix (also resources available need to be studied + own capacity)
- Manual demining: safety equipment – not too much used because it is often too hot and too expensive

- Mechanical mine clearance: NPA is using Aardvark machine, Hydrema (if need be, it can be easily repaired, spare parts are available because it is a commercial machine), Bobcat, Tempest vegetation cutters (easily repaired, improves the work of the dogs)

The flail is good (The Aardvark and Hydrema ARE flails…)
Challenges: it is a whole concept – need good contract with the supplier, spare parts, training of staff
Machines are a logistic burden
Most machines are still prototypes
Mine dog detection: now good international standards, good accreditation methods, also the rats have potential (REST + free running)
NPA uses both short leash & long leash methods.
Challenges:

- Little info on best practices
- Limited knowledge about environmental factors
- Contamination problems during training
- Strong search pressure
- Correct rewarding procedures in order not to create an unwanted behaviour

- REST: sampling has to be good as this part is very important; NPA uses carrousel
  want to bring APOPO to Bosnia
  more testing foreseen with GICHD + NOKSH

→ big impact on a small time: this is the issue now
- EOD: low order techniques

Session: Experience from Mine Action
I. Vernon Joynt: *Experience from Mine Action*

Free running dogs are up to 50x faster – demo given (film)
Vernon Joynt has been involved with demining with dogs, flails and humans. As an aside, he mentioned that elephants learn to stay out of mined areas, and are big enough to be seen from satellites. This is an idea to take further. The presentation showed two dogs running wild from left to right and not structured at all. Dr. Joynt said there is potential in the REST system and he would like to be kept informed about the results.

C. Day 3: 29/8/2003: Session Management and Standards

I. Peter Westrin and Maria Stenstrom, FOI: *Management System Used during EOD on Shooting Ranges in Sweden*

How to deal with UXO – a socio-technical approach
Peter Westrin: Dept. Research Agency
Swedish UXO situation:
Ranges: 300.000 acres
UXO – 1000 acres in target zones: frost lifting problem – what is buried in soil is slowly lifting 1 – 2 cm / year
Multi-disciplinary working group
Problem: conflicting interests: UXO removal is very expensive. Civilians want to use the ranges that are closed down – risk - benefit analysis.
→ Morphological analysis: set of priorities are given and each of them represent non-numerical values in matrices.
Morphological field structure: facts – risk analysis & choice of measures.
Compare clearance cost and value to society and prepare a decision model

II. Jan B. Vistisen, FOFT/DTU: *Operational Analysis Applied to Mine Action*

What equipment to use, how to use it, where to use it?
Operational modeling research: study how to determine optimal operations by using statistical modeling. Objectives are translated into mathematical expressions through data collection to be translated into community specific parameters.
Leads to a structured decision process, consistent, transparent, optimal solution, multi-objective.

III. Nenad Mladineo, GRADST: *Risk Management in Mine-Contaminated Water Resources*

CROMAC is involved in this study – water courses are heavily mined in Croatia.
Made a database of mine afflicted areas for all water in Croatia – system analysis to develop a methodology for decision making – risk reduction objective & multi-criteria and problem characteristics.
Problems: High costs, conflict of interest, hierarchical nature of the problem.
DSS = Decision Support System
. GIS integrated in MIS
. Decision Support for multi-criteria decision making
Categorization of Croatian Waters: some are more risky because of flooding possibilities.

A priority for the government is tourism, for EU the priority is the return of refugees.
All criteria get weights.
Software used for calculation = Decision Lab 2000 (Brans, ULB) + PROMETHEE 1 and 2 which provides an exact ranking.

IV. Kaj Horberg, SWEDEC: *The Need for Comparable Test Results for Equipment Used in Mine Action, - Ongoing Activities*

A lot of tests have been done, lots of duplication – to exchange information, standards have to be available for both equipment & people (demining staff)
To establish a full standard is a very long process, it takes 6-10 years
CEN (European Committee for Standardization) has developed a Working Agreement (not a full standard)

- CWA – MD's
- CWA – Demining machines (before 2004)
- CWA – Competency standards for EOD personnel → is more complicated as it is politically sensitive – focus on practical parts

Web pages with info – see slide: http://www.cenorm.be or www.sis.se