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EUDEM: The European Union in Humanitarian Demining

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EUDEM:

The European Union in Humanitarian Demining

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Background of EUDEM

The EUDEM project tried to provide the European Commission, as one of the largest sponsors of research in European humanitarian demining, with a survey titled "A State of the Art on Humanitarian Demining Technology, Products and Practice." Current practices and emerging technologies were discussed so that applied research can be directed toward solving real problems. Sustainable demining has to become more than "a man with a probe."

Framework of the EUDEM project

Public awareness of the landmine problem has grown in the last 5 to 10 years, and so has the response of the international community. The European Union (EU) committed to reinforce its efforts in helping afflicted nations clear their land of these deadly weapons. Given the scale and complexity of the problem, it would be highly beneficial to increase the coordination for maximum efficiency.

At the EU level, civil research has started within the High Performance Computing and Networking (HPCN) domain of the Information Technologies (IT) program, to promote industrial R&D activities in Europe in support of humanitarian demining operations world-wide. The aim is to bring advanced equipment to the field in two to four years to improve speed, cost and safety of demining operations.

ESPRIT is an information technologies program of industrial R&D projects managed by the DG III. Three ESPRIT R&D projects started in early 1998 and six more in early 1999. These projects aim at researching, developing and testing new systems for detecting anti-personnel landmines. These R&D projects are supported by testing and evaluation, surveys and data collection. EUDEM is one of these support activities. Recent humanitarian demining falls under the responsibility of DG XIII, as an integral part of the Information Society Technologies program.

EUDEM goals

EUDEM established a list of goals: to establish a list of organizations to be consulted, primarily industrial companies developing equipment used in humanitarian demining; and organizations performing or supervising humanitarian demining operations. These organizations include key research centers and university laboratories active in this field.

How goals were achieved

EUDEM accessed the Internet to find: lists of existing links and databases, internal list of persons and organizations active in humanitarian demining, EU financed projects, participant lists to well known conferences in the domain and literature on the subject. The EUDEM database was gradually populated during the survey, and will remain an open working tool allowing updates and new entries on a continuous basis. The EUDEM database is accessible world wide and not limited to organizations active in Europe.

The survey exploited a combination of literature review, telephone contacts, questionnaires, interviews and other methods.

Selected organizations were visited. Persons active at an organization level, or in demining practice and technical development were interviewed. Also, some organizations not yet active in the field but showing relevant interest and innovative ideas were included.

Methods

In making the selection of contacts, we tried to reach the whole spectrum in the EU. The database now covers a population that goes beyond the list of people that were directly contacted by us.

The questionnaire

After the initial list of organizations was established, the second phase of EUDEM consisted of a mailing. At first, 110 organizations were contacted on Jan. 26, 1999. These organizations received a one-page letter and a two-page questionnaire. The questionnaire was short and most questions could be answered by checking boxes.

The typical interview

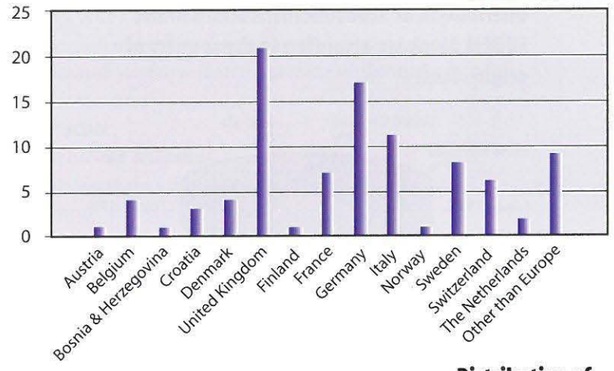
Each interviewee received a short introduction of what our survey consisted of, and its purpose. Consequently, a brief overview of the interviewed organization was requested, followed with a clarifcation of the involvement in humanitarian demining activities. A brief discussion was held on the past and current activities of the organization. Most emphasis was placed during the interviews on the personal opinion of the interviewee with respect to a certain technologies and practices.

When specific projects not necessarily directly related to humanitarian demining were discussed, we tried to identify the project's aims, maturity of the different technologies involved and corresponding cost estimates, testing procedures; transferability of the developed techniques to different aspects of humanitarian demining, technical specifications of the equipment, performances in certain circumstances, compatibility between different techniques, degree of success in the field, R&D activities and strategies, research funding and commercial perspectives.

The EUDEM Database

Analysis

The overall response rate to the questionnaire has been high. The entries were taken into account for the extraction of statistics until the end of May 1999. Out of the 168 contacted organizations, 96 entries were made in the online database at http://www.eudem.vub.ac.be/

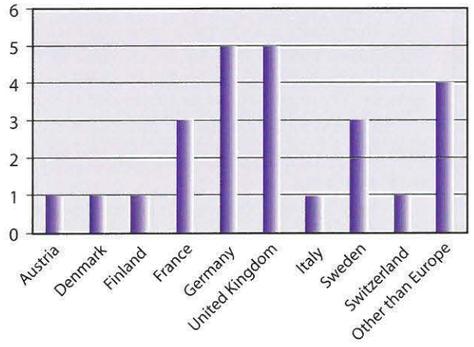


Distribution of entries Graph 1

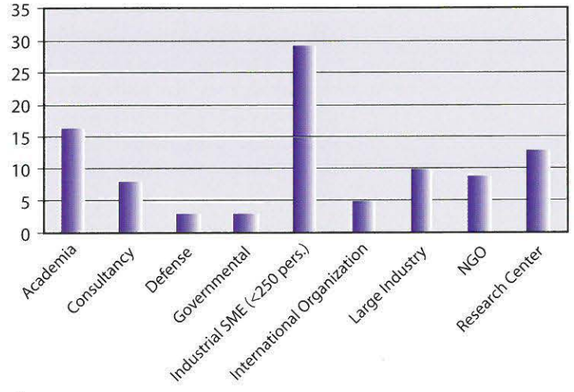
A brief analysis on the distribution of the entries over the different countries reveals the following stated in Graph 1. Note that also nine entries of organizations from outside the EU have been registered. Distribution of entries in the EUDEM database over countries (total: 96)

The greatest number of database entries clearly comes from Industrial Small and Medium Enterprises with less than 250 employees [Industrial SME (<250 pers.)] see Graph 2. These are often not exclusively focusing their production on tools for humanitarian demining. Their willingness to participate in the EUDEM survey may also be explained by commercial agendas. The eight entries labeled "consultancy" in Graph 2 are small companies, mostly created by

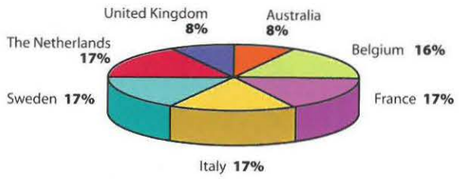
Distribution of industrial SME, by country of origin Graph 2



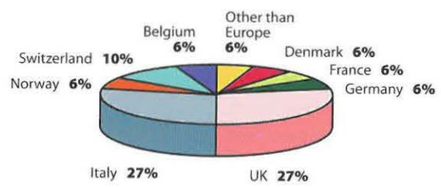
Distribution according to organization type Graph 3



Distribution of academic institutions in the EUDEM database according to the country of origin Graph 4



Distribution of research centers entries in the EUDEM database according to country of origin Graph 5



private consultants. In total, 31 organizations mention consultancy as one of their activities.

The highest concentration of Industrial SMEs is found in Germany (5) and the UK (5), followed by Sweden, hosting 3 Industrial SMEs. (See Graph 3)

Academia (universities) take the second largest share of entries made in the database. This may be explained by their eagerness to participate in collaborative EU research and development projects, their policy of putting results in the public domain through publications and patents and the less stringent constraints to protect their property rights. The densest concentrations of academic institutions involved in humanitarian demining are in the UK and Italy. They each count for 27 percent of the academic organizations involved in humanitarian demining in Europe. Entries are in clockwise order from the top.

Types of organizations and number of corresponding interviews Table 1

Organizations	*Type*	*Interviews*
Industry	Equipment manufacturers (for humanitarian demining)	6
	R&D	9
Operators	NGO	3
	MAC	4 (Geneva, Croatia)
	Commercial	2
Research centers	Supra-national	2 (ISL, JRC)
	National	7
University laboratories		4
Government agencies	MOD, Foreign Affairs, Development Aid	5

Besides universities, research centers have also made a large amount of database entries. The research centers in Europe are mostly located in five countries: Sweden, The Netherlands, France, Italy and Belgium.

Although we have made a distinction between universities and research centers, in practice both are often funded by the government, and depend primarily on the countries' strategy for organizing research whether a certain research activity is carried out in universities or in separate research centers. The last two graphs show that the EU hosts a large independent research potential, compared to the industrial involvement.

Involvement in humanitarian demining

The 87 European organizations that filled in the "type of involvement in demining" field are all mentioning mine detection, some combined with clearance/destruction and survey/mapping. Out of the 87 organizations, 74 percent declared to be involved in mine detection.

European technologies

Out of the 87 respondents in Europe, (see Graph 1) only 70 have given information on technology studies. The nine organizations outside of Europe are not taken into account. The numbers given in this section should not be taken as absolute numbers. We find the highest focus on the Ground Penetrating Radar (GPR) technology, declared by 20 organizations. The second highest was the Metal Detector (MD), mentioned by 15 organizations.

The State of Humanitarian Demining

The organizations and individuals we encountered include industrial companies, operators, key research centers, university laboratories and government agencies active in humanitarian demining, as well as some organizations not yet active in the field but showing relevant interest and innovative ideas. We concentrated mostly on detection, and partly on clearance and destruction equipment technologies; other aspects of the mine action process were investigated with the operators themselves, and some government agencies. The organizations are subdivided as follows:

EUDEM found a myriad of equipment, ranging from dogs to technological systems, used for humanitarian demining.

The following table shows the technology, and the corrolating maturity and cost. We added comments to clarify the aforementioned fields. Technological "maturity" should be interpreted as a qualitative measure expressing a mixture of the: state of advancement of the R&D; demonstration of detection capabilities useful for humanitarian demining; and demonstration of building a practical system. "Cost" includes technological cost only, and does not take into account the actual productivity in the field. (See Table 2)

Conslusions and Discussions

The EUDEM report is a summary of EU humanitarian demining technology, products and practice. Sometimes the conclusions reflect personal opinions of the authors, and some of them had to be simplified leaving out nuances in order to make their message clear. For detailed information and the origin of the individual conclusions, the reader is referred to the information coming from different sources in the original report and its annexes.

The conclusions, are classified in three categories: "policy," related to organizational and coordination aspects; "practice," related to currently used demining technology and procedures; and "technology," related to R&D for new technologies, specification of equipment and testing.

Policy

Equipment procurement (agency)

Several NGOs have stressed the need for new technology to speed-up current demining procedures, but they are often reluctant to invest. Each circumstance requires specific logistics, campaign organization and equipment, and as a consequence not all existing equipment is continuously in use. Investment in equipment maintenance is also too high. The concept of an Equipment Procurement Agency, acquiring, organizing and maintaining a central pool of equipment, could form the basis of a solution to meet the market requirements. Work on setting up such an agency is currently ongoing.

Information sharing

Apart from the normal protections of industrial property rights, we have found many government-funded projects for humanitarian demining purposes which are not releasing any of their results to the public. This resulted from the early military involvement in the domain. For example, many classified NATO reports could bring the development of new technology, the assessment of usefulness of certain techniques and the standardization of testing protocols.

EUDEM database

The EUDEM database is an attempt to give an overview of European humanitarian demining. It could serve as a common data repository and a practical search tool for all participants in the demining sector, simplifying contacts and favoring joint efforts. Maintaining the availability of the EUDEM database requires effort, continued over a number of years. Information sources on humanitarian demining can be consulted via the Internet, but most of them repeat the same topics.

Practice

Mine dog programs

Although the use of dogs is far from being a perfect science, well-run dog programs have managed to convince skeptic deminers. The use of dogs is approved by most humanitarian demining organizations for area verification and mine-field delineation purposes, which allow important time gains compared to manual clearance operations and quality control after mine-clearance activities.

Mechanical systems

An evolution is observed from mechanical demining towards mechanically assisted demining adaptable to local circumstances. Machines usually have to be backed-up by some manual method. These systems are employed for mine verification and area reduction tasks, as well as clearance of actual mine fields. Large mechanical systems require substantial investments.

Humanitarian vs. military objectives

It is important to understand that mine detection and mine-field delineation technology is based on military operational doctrine, compared to humanitarian or post-conflict requirements.

Technology

Input from other domains

Military procedures and technology have influenced the field of humanitarian demining. Other domains are also providing new insights, such as non-

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Table 2

Sensor technology	*Maturity*	*Cost*	*Comments*
Dogs	H	H-HH	Used in practice
Prodding/Excavation	H	LL	Used in practice
Magnetic devices	H	M	Used in practice (Magnetometers, Gradiometers)
Metal detectors	H	L	Used in practice
Metal detector Array	H	H-HH	(Used in practice?)
Passive mm wave	L-M	HH	EU HOPE project claims low cost Handheld multisensor probe including radiometer
mm wave radar	L	HH	Cost figure based on lab equipment
Passive infrared	M-H	H	Cost is decreasing
Polarised infrared	M	HH	
Multispectral	L	HH	
Ground Penetrating Radar (GPR)	H	M-H	
Ultra-wideband radar (UWB)	L-M	H-HH	
GPR Array	M-H	HH	
Nuclear Quadrupole Resonance (NQR)	M	H	
Thermal Neutron Analysis (TNA)	M	HH	
Fast Neutron Analysis (FNA)	L-M	HH	
Ion Mobility Spectrometer (IMS)	M	M-H	
Biosensor	M-H	M	

Table 2 (Qualitative) Maturity and Cost evaluation for the previously mentioned technologies. Maturity indication ranges from Low (L) to Medium (M) up to High (H); Cost indication uses L » 4000 EURO (price of a high end metal detector), M » 2 to 5 times L, H » 5 to 10 times L, and HH >10 times L.

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destructive testing, signal/image processing, remote sensing, Geographic Information Systems and medical imaging.

Existing vs. new technologies

Several national demining campaign sponsors brought up that less emphasis should be put on development of new technologies. The "improvement of existing technology will resolve the problem faster." Some prefer an imperfect technique whose limitations are well-known as compared to a new technique that is not yet trusted. The need for complete solutions, taking into account all aspects was stressed by many NGOs – Mine Action is indeed not only about demining.

(Global) R&D trends

Much of the R&D effort for humanitarian demining has gone toward the detection of individual mines. Two approaches seem to be the most predominant: the use of a multi-sensor system, or the combination of a detection sensor. Some research is currently done on wide-area confirmation methods. Airborne mine field delineation or explosive vapor/trace detection to complement—or partially replace—dogs, in order to save precious time by concentrating on areas which really need to be demined. Evolution should be governed by a set of keywords (NPA): "Safer, Faster and Cheaper."

Sensor technology maturity

Consider: we have to rely on indirect evidence due to the absence of well-established definitions of equipment performance; most of the results of independent performance tests are not publicly available; we have not conducted performance tests ourselves; and we do not share the practical experience of deminers working in the field. We nevertheless think that Table 2 is useful in fixing the large tendencies in technology maturity and equipment cost.

Airborne mine field detection/remote sensing

The role of remote sensing vs. ground-based methods has not yet been fully identified. For airborne mine-field detection on realistic surfaces (100- to 1000-km^2), terabytes (1000 gigabytes) of digital data have to be analyzed. Setting-up a measurement campaign is a complex and expensive operation. Although for civilian applications on-board processing might not be a primary requirement, even off-line analysis requires huge computing facilities. The development of remote sensing systems has been primarily done in the military context and it is unlikely that these systems will be operational for civilian applications in the near future. Several platforms have been tested, like airships, aircrafts, drones and helicopters. The privileged sensors are the optical and the IR imager, although UWB-SAR seems to yield promising results for the future. On certain soil types and non-densely vegetated areas the airborne mine field delineation results are reported to be successful (e.g. deserts).

Testing and evaluation

The implementation of specifications for testing protocols is again an international mission. The existence of several ad hoc protocols is a well-known fact after this survey, but they remain proprietary information, which is inaccessible for the research community. In order to test or compare new technologies that are in the development phase or have been developed, a possibility should exist to gain confidence by application in the field. The establishment of a joint working group, focusing on the development of testing methodologies and the design of standards for sensor and system assessment, is currently ongoing. On the European side, the existing Committee of Advisors: Detection of Mines based on Operational Standards (CADMOS) workgroup, promoted by JRC, acts as the core group.

EUDEM started in December 1998 and ended in July 1999. The survey was conducted by EPFL (École Polytechnique Fédérale de Lausanne) and VUB (Vrije Universiteit Brussel). It was funded by EU; DG XIII. ■

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