Future Development Trends in Mechanical Demining Systems

Many mine affected countries are also suffering by the world food crisis. Procedures for Land Release with Non-Technical Survey and/or Technical Survey will be used in the near future to speed up the land use for agriculture and grazing. There is also an urgent need to change to cheaper and more efficient mechanical demining to react to financial restrictions and to strengthen national ownership in demining activities. This report lead to an optimized mechanical demining machine, to meet new requirements for cost effectiveness.

Development trends
Richard G. Kidd, director of the U.S. department of State’s Office of Weapons Removal and Abatement, reports in his speech on Perspective on Global Policies to End the Landmine Crisis: “Yet the most significant factor limiting the future impact of the Ottawa Convention is not one of policy but one of economic. And while the money will not be there to make the world mine free, the funds, commitment and insight already exists to make it mine safe. We can remove the most pressing impacts of landmines within years, and than redirect those funds to other areas and other causes where they will do more to safe lives and promote reconstruction.”

UN, GICHD and international ministries report, that the landmine problems have been considerably reduced, a success story of the Ottawa convention
- The number of victims has been reduced continuously and are already under 2000/Jahr
- The global trade with AP mines has come to a halt.
- U.S. and China, not member of the Ottawa convention have agreed to an export moratorium
- The Ottawa Convention, has increased inhibition in using AP mines
- Large areas were cleared each year
- The number of demining machines have increased every year
- Quality assurance to release cleared land has been considerably simplified

⇒ Financial resources for demining might be reduced, with Priority be given to other humanitarian catastrophes as hunger, HIV, malaria, environmental pollution, etc.

National ownership in demining activities has to be strengthened

⇒ Financial restrictions and national ownership will lead to strong requirements for reduced investment- and on operation-, logistic-, repair- and maintenance costs and the request for simplified and robust technology.

Changes required in demining technology

Today – Too many Differences of mechanical demining machines
Different sizes with 5 to 55 tons total weight, wheel and crawler type, with or without operator. In addition machines with flail or tiller, with combined systems, and with multi tool application as shown in the GICHD, “Demining Equipment Catalogue 2008”.
Neither a specific system nor a specific configuration is dominating the market. In contrary despite the enormous international technical and commercial efforts, many machines have never left the prototype status or have not been successful in the market. More than 50 different types of machines, with variation in size, weight, demining technology, direct driver operated or remote control will of course lead to excessive machine and operation cost. This scenario is typical for the research phase if not enough basic knowledge is available.

Specification to optimize cost-effectiveness of mechanical demining machines
The international symposium “Humanitarian Demining – Mechanical Demining” in Sibenik, Republic of Croatia, includes demonstration of different type of machines.
In 2007 the program committee summarized the results as follows:
- Tillers are certainly good for some conditions and threats but flails can be better in other conditions and perhaps the ideal is to consider the availability or interchange ability of both.
- Machine operators are a large influence on the performance of machines.
- A huge change in Management thinking and planning is required in order to avoid the purchase of machines which simply stand and rust.
- What you may not have seen was the huge line up of logistical support vehicle in the adjoining field an which gave an indication of the broader consequences and considerations of using machines.

In 2009 the EUDEM2 Technology Survey “Field Survey Results” E.E. Cepolina, University of Genova, and C. Bruschini, K. De Bruyn, EUDEM2 Team, published a summery of interviews with MgM, ADP, FSD, MAG and others with the following results: “[…] The study found a strong general desire for new, small, light and cheap machines, and it shows that there is a unanimous opinion, held by organisation representatives, that deminers are willing to learn new technologies. End-users have in general appeared to consider mini and medium flails as useful, while representatives have expressed the desire to have at their disposal earth processing and agricultural machines, to employ them in humanitarian demining operations. A general requirement for machines is to work in hot-humid weather and to last at least five years.”

**Size of demining-machine with operator**
Analytic analysis of world wide activities with different type of mechanical demining machines and results from the test centres at CROMAC, ITEP, SWEDEC- and SWISS-, BRITISH- and GERMAN ARMY have been made to come to an optimum specification for demining machines.

Tests with and without dummies, with and without flail and tiller equipment and a very detailed measure of actual loadings of the human body leads to a machine with a total weight of 15 to 20 tons (medium size). Experience gained with flail and tiller operation at different soil and vegetation condition leads to an engine power of 250 to 400 PS.

In addition test with AT-Mines demonstrated that a distance between the AT-Detonation and the Driver Cabin has to be at least four meters.

**Picture 1 and 2**

**Mechanical application and tools**
GICHD reports in the “Study of mechanical application in demining” that only 3 Percent of the total area is contaminated with AP/AT-mines and/or UXO’s. A risk assessment is required about the presents of AP- and/or AT-Mines and/or UXO’s in order to decide witch type of mechanical application should be used. In addition different ground-and vegetation conditions require different rotation speeds and different tool-designs. For example:
- Presence of AT-Mines require flail operation first
- Topsoil, low and medium vegetation tiller operation with chisel tools
- The use of tiller and flail can provide double efficiency
- High vegetation require tiller operation with cutting tools
- Sand/loose ground require high speed of operation
- Presence of UXO’s might require a machine with equipped “large loop” arrangement

To achieve a reliable process tests are required before any demining operation specification is agreed. High risk due to AT-Mines and/or UXO’s might require remote control.

If we now summarize the different key requirements, we come to the following specifications:

**Proposed Specification tracked and wheeled vehicle**
- Total Weight of vehicle with tiller or flail 15-20 tons
- Engine Power 200 - 300 KW (250 - 400 HP)
- Safety Distance between detonation (flail/tiller) and cabin 4.0 m
- Direct Driver operated
- Flail and Tiller, open Tiller design, operated PTO or hydraulic driven
- Tool Box Concept for demining, agriculture, forestry, building industry, transport, etc
- Container transport

Picture 3 and 4

*This spec. will lead to dramatic cost-reduction for machine, operation, maintenance, repair and transport*
Should it be a tracked or a wheeled type Vehicle?

Our knowledge of 10 years in demining technology is summarised in the table below, taking into account 10 key points from safety to cost, comparing Medium Crawler, Medium Tractor, Light Crawler with remote control as summarised in the GICHD catalogue:

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<th>Medium Crawler</th>
<th>Medium Tractor</th>
<th>Light Crawler</th>
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<td>max. 18 to</td>
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<td></td>
<td>Operator Control</td>
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<td>Remote Control</td>
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<td>1. Safety</td>
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<td>2. Mine Clearing Effectiveness</td>
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<td>5</td>
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<td>3. Ground/Vegetation/Topography</td>
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<td>4. Vulnerability/Damage</td>
<td>10</td>
<td>8</td>
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<td>5. Demining Performance</td>
<td>10</td>
<td>8</td>
<td>5</td>
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<td>6. Application/Handling</td>
<td>6</td>
<td>10</td>
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<td>7. Serviceability</td>
<td>7</td>
<td>10</td>
<td>7</td>
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<tr>
<td>8. Mobility/Transport</td>
<td>4</td>
<td>10</td>
<td>7</td>
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<td>9. Multiple Use Toolbox</td>
<td>4</td>
<td>10</td>
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<td>10. Cost Operation, estimated</td>
<td>5</td>
<td>10</td>
<td>3 *</td>
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<td>11. Estimated Cost Manufacturing</td>
<td>Up to 350.000 €</td>
<td>Up to 180.000 €</td>
<td>Up to 180.000 € *</td>
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*Cost of separate guiding vehicle not included

As demonstrated, the crawler type machine is the best in class in demining performance and effectiveness, but the tractor based demining machine with flail and tiller unit is by far the most cost effective arrangement. Tractors with operator do not require a logistical support vehicle and/or a system for remote control operation.

Powerful tractors up to 400 PS, i.e. John Deere, New Holland, Claas, Valtra, Case, Fendt, Belarus etc, are available in almost every country. They could be modified into demining tractors as already demonstrated by Pearson, Armtcrac and by US Government Test Side NVECD Raptor. Protected Tractors are already the standard equipment for most NGO’s as Halo Trust, MAG etc. They could even be modified into a demining machine locally, where also support is provided and know-how available.

All modifications in line with our proposed specifications have already been used during extensive test programs on existing machines, i.e. open tiller technology, protected cabin and protection of the basic machine.

The proposed changes are modifications to existing machines and do not require additional expensive tests.
Multi-Function system
A multi-function tractor based system is more cost effective, less complicated and easier to handle and to service. It can be use for:
- Mine clearance
- Survey, Reconnaissance
- Quality assurance
- Transportation
- Cultivation, farming, Vegetation cutting
- Reconstruction and development
- Obstacle Removal
- Airfields clearance, bomblets
- Pioneer vehicle for military use
- Vehicle for multi.-sensor technology

Picture 5 and 6

Conclusion
To meet new development trends demanding more national ownership and reduced demining cost, the tractor based toolbox-system with flail and tiller, driver operated will meet best new requirements. Investment- and operational cost can be reduced by half. A tracked or wheeled vehicle should meet the proposed spec. It should be driver operated with flail and tiller system, tool box concept for demining agriculture and building industry and transported in container. The tractor based system will meet best the new requirements for major cost reductions and stronger local ownership in demining activities.

For peace keeping operations this concept could also be of interest for pioneer vehicles of international armies.

Dramatic Cost reduction ensures that present activities to make the world mine safe will not be reduced.

STS, a team of engineers with the aim to contribute to technology to avoid mine victims, offers advice and assistance, free of charge, based on 10 years of Demining Technology experience.
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