A New Set of Cartographic Symbols for IMSMA and Humanitarian Demining

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Project Overview

- Study of map symbols used in humanitarian demining activities

- Sponsored by the Geneva International Centre for Humanitarian Demining (GICHD)

- Final Report and Recommendations: September 2004
Final Report and Recommendations

Cartographic Recommendations for Humanitarian Demining Map Symbols in the Information Management System for Mine Action (IMSMA)

www.gichd.ch

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Project Objectives

- To investigate the need for a common set of cartographic symbols to support humanitarian demining.

- To research and catalog existing map symbols used by humanitarian and military organizations to depict landmines, minefields, and mine actions.

- To develop and propose an improved set of cartographic symbols that may be implemented in IMSMA for possible standardization.
Standardized Map Symbols

- Symbols on maps serve as a graphical language
- Multiple symbol sets may cause confusion
- Standardized symbols = Communication via the same graphical language
Standardized Map Symbols

Benefits of Standardized Symbols for Demining

- Consistent method for marking hazards on maps
- Increase efficiency in operations
- Aid in the exchange of maps and information between organizations
- Other standards for humanitarian demining, International Mine Action Standards (IMAS)
Standardized Map Symbols

Important Questions:

- How similar or different are landmine, minefield, and mine action map symbols between organizations?

- How can IMSMA symbols be designed in a manner to lead efforts in standardizing a set of symbols for humanitarian demining?
Existing Humanitarian Demining Map Symbols
Symbol Inventory Methods

- Maps and symbols collected from several sources
  - Humanitarian Demining Organizations
    - International Organizations (IOs)
    - NGOs
    - Mine Action Centers (MACs)
  - Military Organizations
Symbol Inventory Methods

- Maps and symbols collected from several sources
  - Map Libraries
    - Library of Congress Geography and Map Division
    - American Geographical Society Library
  - GIS vendors
Symbol Inventory Methods

- E-mail request sent to each organization
- European Union in Humanitarian Demining (EUDEM2) e-mail listserv and website posting
- Maps and symbols gathered from websites
Symbol Inventory Responses

Military / Government

- Australian Defence Force
- Belgium Staff Defence
- Canadian National Defense
- German Federal Foreign Office, Task Force for Humanitarian Aid and Mine Action
- Mozambique National Demining Institute
- National Geospatial-Intelligence Agency
- North America Treaty Alliance
- Signal and Image Center of the Royal Military Academy of Belgium
- U.S. Department of Defense Humanitarian Demining Research and Development Program
- U.S. Department of Defense Humanitarian Demining Training Center
Symbol Inventory Responses

United Nations

- United Nations Geospatial Information Working Group
- United Nations Mine Action Service
Symbol Inventory Responses

International Organizations / Mine Action Centers / NGOs

- Accelerated Demining Program Mozambique
- Adopt-A-Minefield
- Albanian Mine Action Executive
- Applied Research Institute—Jerusalem
- Azerbaijan National Agency for Mine Action
- BACTEC International Limited, UK
- Bosnia-Herzegovina Mine Action Center
- Canadian International Demining Corps
- Croatian Mine Action Centre
- Danish Demining Group
- European Union in Humanitarian Demining
- Golden West Humanitarian Foundation
Symbol Inventory Responses

**International Organizations / Mine Action Centers / NGOs**

- International Campaign to Ban Landmines
- International Test and Evaluation Program for Humanitarian Demining
- International Trust Fund for Demining and Mine Victims Assistance
- Mine Action Information Center
- Mine Advisory Group
- International Committee of the Red Cross
- South East Europe Mine Action Coordination Council
- Survey Action Center
- Swiss Foundation for Mine Action
- United Nations Interim Administration Mission in Kosovo Mine Action Coordination Centre
- Vietnam Veterans Association
Symbol Inventory Responses

GIS Software Vendors

- Environmental Systems Research Institute (ESRI)
- MapInfo
Symbol Inventory Results

- 40+ total responses

- See Appendix A: Symbol inventory responses

- See Appendix B: Landmine, minefield, and mine action symbol catalogue
## Sample Military Symbols

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Source</strong></td>
<td>MIL-STD-2525B</td>
<td>MIL-STD-1477C</td>
<td>FM 101-5-1</td>
<td>STANAG APP-6A</td>
<td>B-GL-331-003/FP-001</td>
<td>GEN 150</td>
</tr>
<tr>
<td><strong>Minefields</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>AP Minefield</strong></td>
<td><img src="symbol1.png" alt="Symbol" /></td>
<td><img src="symbol2.png" alt="Symbol" /></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>AT Minefield</strong></td>
<td><img src="symbol3.png" alt="Symbol" /></td>
<td><img src="symbol4.png" alt="Symbol" /></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mined Area</strong></td>
<td><img src="symbol5.png" alt="Symbol" /></td>
<td><img src="symbol6.png" alt="Symbol" /></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>UXO Area</strong></td>
<td><img src="symbol7.png" alt="Symbol" /></td>
<td><img src="symbol8.png" alt="Symbol" /></td>
<td></td>
<td></td>
<td><img src="symbol9.png" alt="Symbol" /></td>
<td><img src="symbol10.png" alt="Symbol" /></td>
</tr>
</tbody>
</table>
Sample Humanitarian Demining Symbols

<table>
<thead>
<tr>
<th></th>
<th>AMAE</th>
<th>CROMAC</th>
<th>BHMAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncleared Minefield (Point)</td>
<td>![Symbol]</td>
<td>![Symbol]</td>
<td>![Symbol]</td>
</tr>
<tr>
<td>Cleared Minefield (Point)</td>
<td>![Symbol]</td>
<td>![Symbol]</td>
<td>![Symbol]</td>
</tr>
<tr>
<td>Uncleared Minefield (Area)</td>
<td>![Symbol]</td>
<td>![Symbol]</td>
<td>![Symbol]</td>
</tr>
<tr>
<td>Cleared Minefield (Area)</td>
<td>![Symbol]</td>
<td>![Symbol]</td>
<td>![Symbol]</td>
</tr>
</tbody>
</table>

**AMAE** = Albanian Mine Action Executive  
**CROMAC** = Croatian Mine Action Centre  
**BHMAC** = Bosnia-Herzegovina Mine Action Centre
Symbol Inventory Conclusions

- Military symbols
  - Symbols formally standardized (e.g., APP-6A)
  - Drawbacks of extending military symbols into humanitarian demining
Symbol Inventory Conclusions

- Humanitarian demining symbols
  - No formal standards, but some general areas of agreement
  - IMSMA as the unofficial standard
IMSMA 3.x Map Symbols
IMSMA Map Symbol Categories

- Hazards (points/areas)
  - Processes (points/areas)
    - Mine Risk Education
    - Impact Survey
    - Technical Survey
    - Clearance
    - Completion Survey
- Accidents/Victims (points)
- Locations (points)
- Towns (points)
- \(\approx 150\) total symbols
IMSMA GIS Module (ArcView 3.x)
IMSMA GIS Module (ArcView 3.x)
IMSMA 3.x Symbols

- Limitations
  - Non-intuitive
  - Few general symbols
  - Black and white printing limitations
  - Duplication of symbols
New Symbol Set for IMSMA and Humanitarian Demining
Rationale for Symbol Set

1. Hazard symbols clearly imply danger and should be similar to landmine hazard signs and markers

2. Symbols should be intuitive

3. Symbols should cross cultural barriers whenever possible

4. Symbols should be flexible to display both general and specific information

5. Symbols should adhere to existing standards as feasible
6. Symbols should be based on cartographic and perceptual research of symbols and colors

7. Symbols should print and photocopy in black and white

8. Symbols should be legible when displayed on topographic maps, aerial photographs/orthophotos, and satellite images

9. Symbol set should accommodate multiple map scales

10. Symbols should adhere to symbolization limitations of common GIS software
Rationale for Symbol Set

- Hazard symbols should clearly imply danger and should be similar to landmine hazard signs and markers
  - May improve recognition of hazards on maps
  - IMAS 08.40 “Marking Mine and UXO Hazards”
Minefield Hazard Marker Signs

IMAS 08.40, 2nd edition, p. 7

Minefield sign in Africa

IMAS 08.40, 2nd edition, p. 8

Minefield sign in Chile

Minefield sign in Bosnia
## Hazard Map Symbols

<table>
<thead>
<tr>
<th>Tactic</th>
<th>IMSMA 3.x Symbols</th>
<th>New Symbols</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dangerous Area</td>
<td><img src="image" alt="DA" /></td>
<td><img src="image" alt="New Symbol" /></td>
</tr>
<tr>
<td>Mined Area</td>
<td><img src="image" alt="MA" /></td>
<td><img src="image" alt="New Symbol" /></td>
</tr>
<tr>
<td>Minefield</td>
<td><img src="image" alt="MF" /></td>
<td><img src="image" alt="New Symbol" /></td>
</tr>
</tbody>
</table>
Additional Marker Signs

Reference Point Marker
IMAS 08.20, 2nd edition, p. 13

Benchmark Marker
IMAS 08.20, 2nd edition, p. 14

Turning Point Marker
IMAS 08.20, 2nd edition, p. 15
Additional Marker Signs

Reference Point Marker
IMAS 08.20, 2nd edition, p. 13

Benchmark Marker
IMAS 08.20, 2nd edition, p. 14

Turning Point Marker
IMAS 08.20, 2nd edition, p. 15
Rationale for Symbol Set

- Symbols should be intuitive
  - Intuitive, pictorial icons developed whenever possible
  - Icons may be especially useful for symbols that must span culture and language differences
Intuitive Symbols for Clearance Operations

Manual Clearance

Mine Dog Clearance

Mechanical Clearance
Intuitive Symbols for Clearance Operations


Mine Dog Clearance → Mine Dog Symbol → Mechanical Clearance

Mechanical Clearance → Mechanical Clearance Symbol
## Intuitive Symbols

<table>
<thead>
<tr>
<th></th>
<th>IMSMA Symbol</th>
<th>New Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mine Risk Education</td>
<td><img src="image" alt="MR" /></td>
<td><img src="image" alt="Image" /></td>
</tr>
<tr>
<td>Impact Survey</td>
<td><img src="image" alt="IS" /></td>
<td><img src="image" alt="Image" /></td>
</tr>
<tr>
<td>Technical Survey</td>
<td><img src="image" alt="TS" /></td>
<td><img src="image" alt="Image" /></td>
</tr>
<tr>
<td>Clearances</td>
<td><img src="image" alt="CL" /></td>
<td><img src="image" alt="Image" /></td>
</tr>
</tbody>
</table>
EOD IS Survey Handheld System
Digital from start to finish

Pocket PC

GPS Receiver

Laser Rangefinder Binoculars

Digital Camera
Rationale for Symbol Set

4. Symbols should be flexible to display both general and specific information
   - Tiered or hierarchical structure
   - Creates a logical order to symbols
Tiered or Hierarchical Structure

Graphic Attributes

Point Symbol

Area Symbol
Tiered or Hierarchical Structure

Hazard

Hazard
Tiered or Hierarchical Structure

Hazard → Minefield

Hazard → Minefield
Tiered or Hierarchical Structure

Hazard

Minefield

Grenades

Hazard

Minefield
Rationale for Symbol Set

5. Symbols should adhere to existing standards as feasible

- Homeland Security Working Group symbol set
  - School
  - Police Station
  - Airport

- NATO, APP-6A, “Military Symbols for Land Based Systems"
  - Landmine
  - Sea Mine
  - Rocket
  - Missile
Rationale for Symbol Set

5. Symbols should adhere to existing standards as feasible

- Military symbols are not ideal for humanitarian demining in all cases

<table>
<thead>
<tr>
<th></th>
<th>NATO (APP-6A) Symbols</th>
<th>Recommended Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minefields</td>
<td>![Minefield Symbol]</td>
<td>![Recommended Symbol]</td>
</tr>
<tr>
<td>Mined Area</td>
<td>![Mined Area Symbol]</td>
<td>![Recommended Symbol]</td>
</tr>
</tbody>
</table>
Rationale for Symbol Set

6. Symbols should be based on cartographic and perceptual research of symbols and colors

- Appropriate colors for danger and safety
  - International Organization for Standardization (ISO) safety color guidelines
- Color-blind friendly color schemes
## Color Schemes

<table>
<thead>
<tr>
<th>Feature</th>
<th>Color</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazards/Accidents/Victims</td>
<td></td>
<td><img src="image" alt="example" /></td>
</tr>
<tr>
<td>Mine Risk Education</td>
<td></td>
<td><img src="image" alt="example" /></td>
</tr>
<tr>
<td>Impact Survey</td>
<td></td>
<td><img src="image" alt="example" /></td>
</tr>
<tr>
<td>Technical Survey</td>
<td></td>
<td><img src="image" alt="example" /></td>
</tr>
<tr>
<td>Clearance</td>
<td></td>
<td><img src="image" alt="example" /></td>
</tr>
<tr>
<td>Completion Survey/Cleared Areas</td>
<td></td>
<td><img src="image" alt="example" /></td>
</tr>
</tbody>
</table>
Rationale for Symbol Set

7. Commonly used symbols should print and photocopy in black and white

Point symbols = border

Area symbols = center symbol
Center Icons for Printing Symbols in Black and White
Center Icons for Printing Symbols in Black and White
Center Icons for Symbolizing Multiple Attributes
Center Icons for Symbolizing Multiple Attributes
Center Icons for Symbolizing Multiple Attributes
Rationale for Symbol Set

Symbols should be legible when displayed on topographic maps, aerial photographs, orthophotos, and satellite images

- Transparent fills for area symbols
- Background color for point symbols
Symbols on Topographic Map and Satellite Imagery
Symbols on Topographic Map
Rationale for Symbol Set

9. Symbol set should accommodate multiple map scales

- Point symbols for overview maps of a larger area
- Area symbols for more detailed maps of a smaller area
Symbols Varying with Map Scale

Zoom Out  

Zoom In
Evaluation of Symbol Set
Symbol Evaluation

- IMSMA Summer Workshop
  - July 2004, Geneva, Switzerland
  - 21 Participants from 17 countries
  - Group discussion about symbology
  - Symbol evaluation form
# IMSMA Symbols Feedback Forms

<table>
<thead>
<tr>
<th>IMSMA Symbol</th>
<th>Explanation</th>
<th>Recommended Symbol</th>
<th>Comments or Suggestions</th>
<th>Is Symbol an Improvement? (Circle one)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hazards (Points)</strong></td>
<td>None</td>
<td>Include general symbol for any type of hazard (point). Triangle as base symbol for point hazards.</td>
<td>▼</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Dangerous Area</strong></td>
<td></td>
<td>Triangle with skull and crossbones is IMSA standard for marking hazards.</td>
<td>▼</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Mined Area</strong></td>
<td></td>
<td>See Above.</td>
<td>▼</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Minefield</strong></td>
<td></td>
<td>See Above.</td>
<td>▼</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Symbol Evaluation Results

- "Is the recommended symbol an improvement?"

<table>
<thead>
<tr>
<th>Hazards</th>
<th>Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Symbol]</td>
<td>![Symbol]</td>
</tr>
<tr>
<td>20/21 (95%)</td>
<td>16/21 (76%)</td>
</tr>
<tr>
<td>![Symbol]</td>
<td>![Symbol]</td>
</tr>
<tr>
<td>20/21 (95%)</td>
<td>15/21 (71%)</td>
</tr>
<tr>
<td>![Symbol]</td>
<td>![Symbol]</td>
</tr>
<tr>
<td>20/21 (95%)</td>
<td>16/21 (76%)</td>
</tr>
<tr>
<td>![Symbol]</td>
<td>![Symbol]</td>
</tr>
<tr>
<td>20/21 (95%)</td>
<td>15/21 (71%)</td>
</tr>
<tr>
<td>![Symbol]</td>
<td>![Symbol]</td>
</tr>
<tr>
<td>20/21 (95%)</td>
<td>14/21 (67%)</td>
</tr>
</tbody>
</table>
Symbol Evaluation Results

- Impact of Symbol Evaluation
  - Modifications to preliminary symbol designs
  - Identification of additional symbols to include in the symbol set
Implementation of the Symbols and Conclusions
Implementation of the Symbols

- True Type Font
- ESRI Style File
- Demonstrations
  - Symbols in ArcMap
  - New IMSMA release
Conclusions

- A common set of map symbols can fill an important void in humanitarian demining

- Map symbols should be designed in a manner to support safety

- Map symbols should be flexible for multiple uses in humanitarian demining