Without standardized symbology on emergency and hazards maps, first responders are forced to develop their own symbols during crucial emergency situations. This can lead to confusion and error in the interpretation of maps provided to assist emergency managers and first responders during an ongoing disaster, either natural or human-made. This was highlighted during the September Eleventh event in New York City, where first responders had to develop their own symbology during the response stage. This process took valuable time away from other urgent matters. Concerns about interpretation errors and the need for clarification of map symbology led the Federal Geographic Data Committee (FGDC) to establish the Homeland Security Working Group on Symbology to specifically address these shortcomings. This paper describes the process involved in researching, defining, evaluating and redrawing emergency and hazard mapping symbology. It also explains the purposes of the Emergency and Hazard Mapping Symbology standard and the process that led to the submission of a final report to the American National Standard Institute (ANSI).

**Keywords**: Standardization, Symbology, Emergency and Hazard Mapping, ANSI.

### Background

Since the introduction of the application of computer technology during and after disasters, maps for emergency and hazardous situations are produced and compiled at very high rates. Increasingly this information is made available in digital format. Currently, symbol design on emergency and hazards maps is fairly ad hoc – as maps are drawn new symbol sets are designed by the map maker without reference to the suitability or appropriateness of the symbol. In the United States, after Hurricane Andrew made landfall on the Florida coast in August of 1992, we saw for the first time mapping on demand in the Disaster Field Office (DFO). A private firm provided the service of making maps at the scene by setting up a Geographic Information System (GIS) in the DFO. Through this process they were able to supply first responders with maps when needed. The request for maps ranged from maps showing the location of portable toilets for the bivouacked soldiers to the location of burn sites for the debris. Clearly, the need for maps was demonstrated. This need for crisis maps at the scene was illuminated again in the wake of the 9/11/2001 event in New York when many different agencies made maps of the changing conditions and in the process created their own symbology to convey critical information to emergency managers. The exchange and quick interpretation of vital information was made difficult by the lack of a common symbology and the need for research into symbology for emergency maps was highlighted.

While cartographers have undertaking research on symbology, relatively little or none has been undertaken on emergency mapping symbology [1]. In addition, symbology for the use of computer screens and data exchange needs to address new design and perceptual considerations [2]. The Federal Emergency Management Agency (FEMA), now under the Department of Homeland Security initiated research into emergency mapping symbology. The Kent State University Department of Geography was charged to conduct this research.

### Research Approach and Methodology
A systematic research approach into symbology was required to develop a logical framework to develop an ANSI standard for emergency mapping symbology. The research was conducted in five steps:

- The **first step** was to define what a symbol is.
- The **second step** required the identification of existing emergency and hazard mapping symbology.
- The **third step** required the organization of the found symbols into a logical framework.
- The **fourth** required the development of a matrix to:
  - Identify the hazard and emergency themes for which symbology were used.
  - To identify the agencies that currently use hazard and emergency symbology.
  - To identify hazard mapping symbols embedded in commercial software.
- The **fifth step** required finding a logical definition for each symbol.

**What is a Symbol?**

Webster defines symbols as:

1. something used for or regarded as representing something else, a material object representing something, often immaterial; emblem, token, or sign [3]
2. as a letter, figure, or other character or mark or a combination of letters or the like used to represent something [4].
3. Oxford Dictionary defines symbols “as an object used to represent something abstract, a mark, letter etc.” [5].

When we consider the dictionary definitions for symbols, a hospital can be drawn on a map as a letter

or

In mapping there are generally two classes of symbols used: replicative or abstract once.

**Identification of Existing Sources and Symbols**

Information about hazard and emergency mapping symbology was not readily available. This required the identification of symbols used by government, state and local agencies and organizations including the private sector. It also included symbols embedded in commercial software. Extensive web searches, referrals and networking were used to develop a lengthy list of sources. The US military and NATO symbology sources were also included.

**A Logical Framework**

The identification of hazard and emergency features and content was the logical next step. This provided an overview into what symbols were currently being used. Classification and analysis provided a master list of major emergency headings and schemes. These include: Emergency Facilities, Emergency / Services, Fire Symbols, Technological Hazards, Natural Hazards, Warning, Crime and Terrorism, Damage and Failure and Evacuation Symbols

**Development of a Matrix**
A matrix showing all the found symbols in groupings was developed. The matrix indicated GIS symbology schemes used by international organizations, individual, federal, state, local and private agencies or businesses tailoring numerous emergency symbols to specific hazard and emergency applications. It also highlighted the problem of lack of standards and guidelines. For example ‘medical facilities’ were represented by 44 different symbols (See Figure 1). It also revealed the problem that symbols used on paper maps are not always appropriate for use on the computer screen.

The matrix was the result of 12 month of research by two research associates [6]. Clearly, emergency managers with limited time during a disaster cannot afford the time and may not have the skill to research what emergency symbology is valid for application.

The matrix also included a recommendation of a symbol to be used for each section. The redrawn symbols had to be sensitive to diverse groups, visually acceptable and most of all unambiguous. The redrawn symbols were put on the web for extensive review by the emergency management community on all levels. Many of the symbols needed to be redrawn, some needed to be added and in some cases totally new symbols needed to be designed.

A Symbology Subgroup of the Federal Geographic Data Committee (FGDC) began reviewing the report and recommended that the symbols be categorized into five major groups, **Incidents** (such as Civil Disturbance), **Natural Events** (such as Severe Storms), **Operations** (such as Medical Facilities), **Infrastructures** (such as Power Plant), **Damage and Operations** (such as EMT Stations). Each category received a distinct design such as squares, circles etc. This will provide emergency managers the opportunity to recognize a symbol category at a glance during an emergency situation (see Figure 2).
Figure 2: Major Categories of Emergency Mapping Symbology

Identifying Logical Definition for Each Symbol

The next step was to find an appropriate definition for each symbol. These definitions were of great importance to make sure that everyone using the symbol perceives its use the same way. The definitions were evaluated, discussed and often changed by a focus group consisting of emergency managers on all levels. In case that there was already an international or national accepted definition for a given symbol, that this definition was used. Figure 3 provides an example of symbols...
Figure 3: Emergency Mapping Symbols with Definition

with definitions. After extensive review and redesign the symbols were posted on the web site: http://www.fgdc.gov/HSWG/ or http://dept.kent.edu/geography/dymon/. The final symbology was written up in a report and is currently under consideration for acceptance as an American National Standard Institute (ANSI) standard.

References:

Biographical note: Dr. Ute J. Dymon is a Professor of Geography at Kent State University, Ohio, USA. Her research deals with the content and use of maps during mega-disasters. Funding for this research was provided by the Federal Emergency Management Agency (FEMA) under the Department of Homeland Security in the USA.