



# The Card Sorting Method for Map Symbol Design

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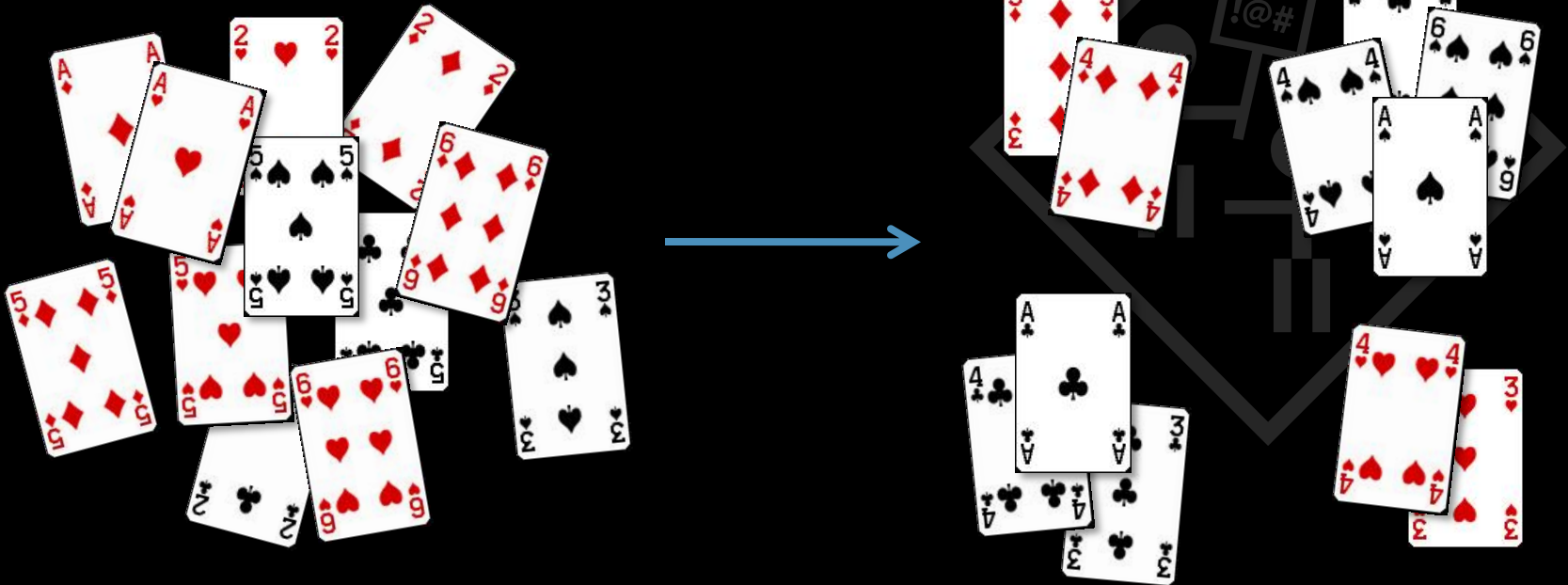
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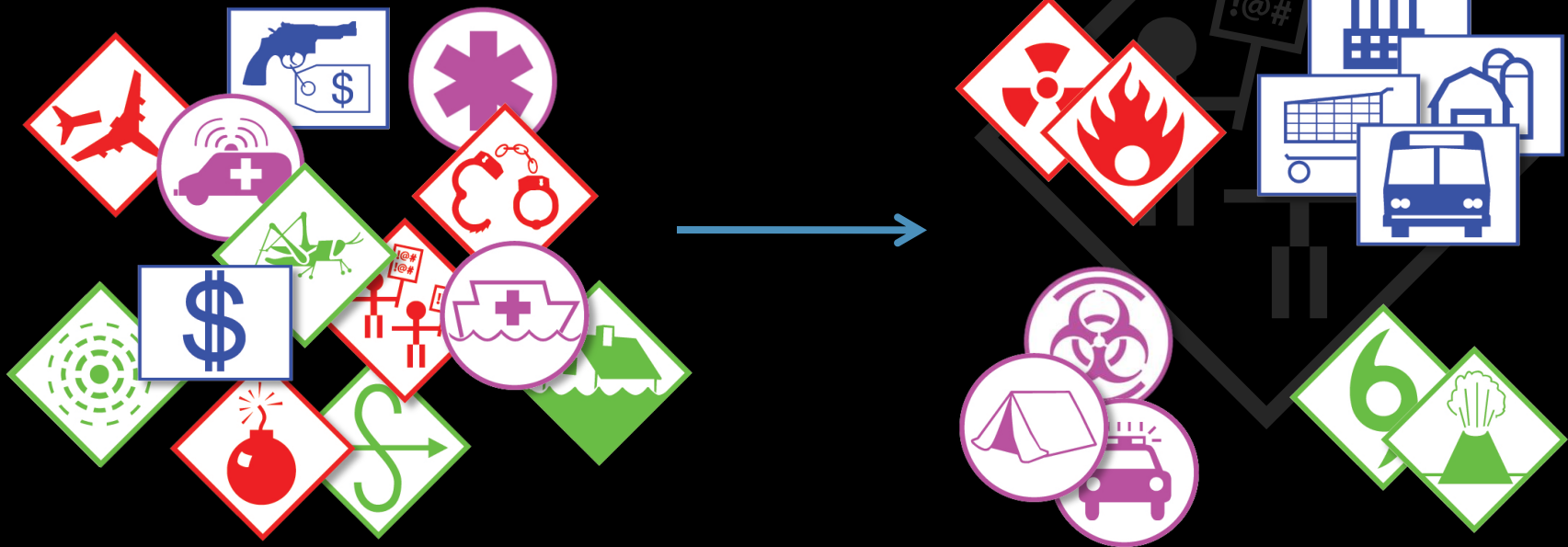
# Introduction *definition*

**Card sorting:** A knowledge elicitation technique designed to reveal the conceptual structures, or categorizations, of the targeted individuals



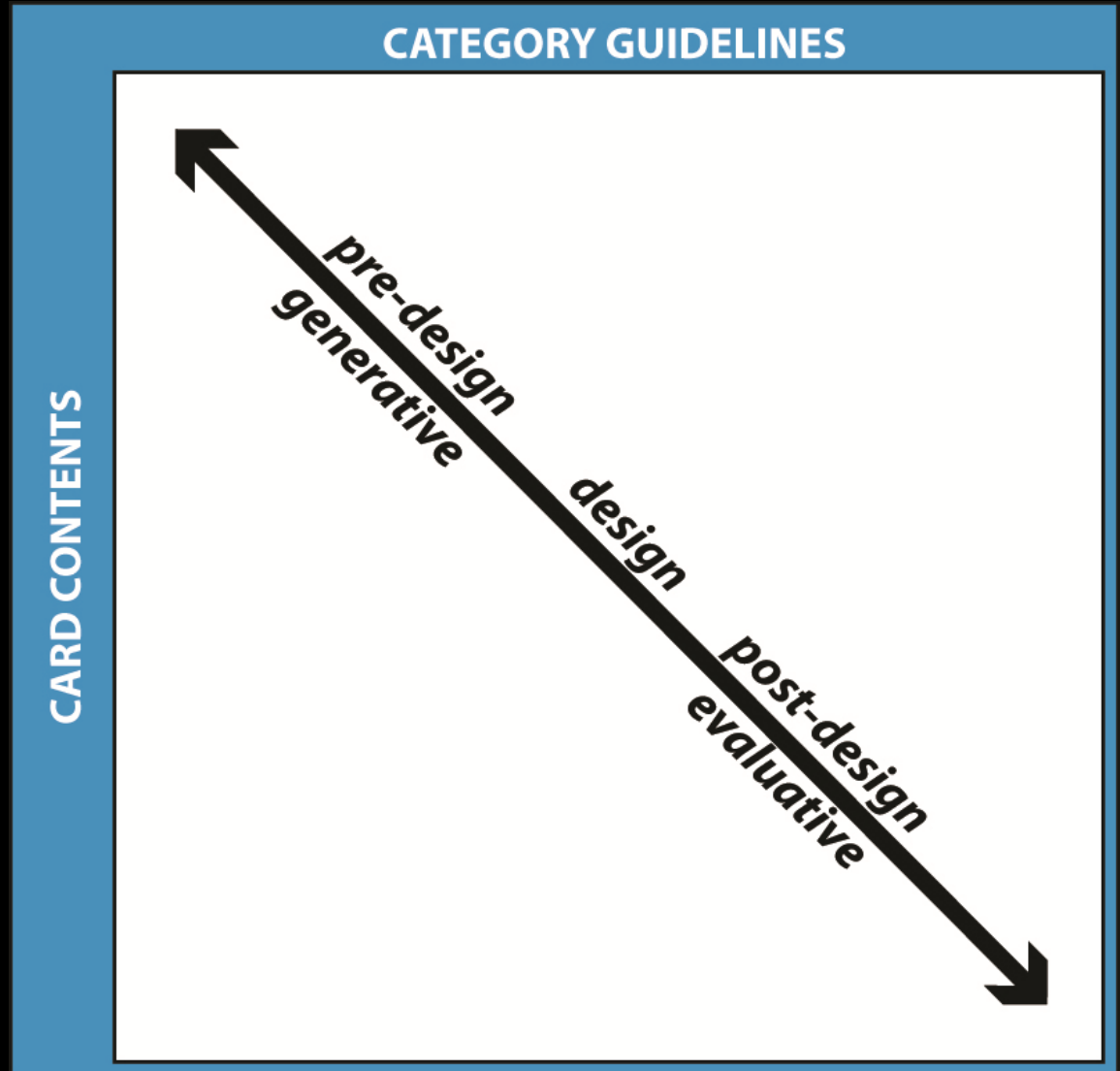
# Introduction *card sorting for Cartography*

- identify broader categories
- design collaboratively
- identify missing/redundant symbols
- identify ambiguous symbols
- identify poor feature definitions
- generate/evaluate symbolization to indicate the categories



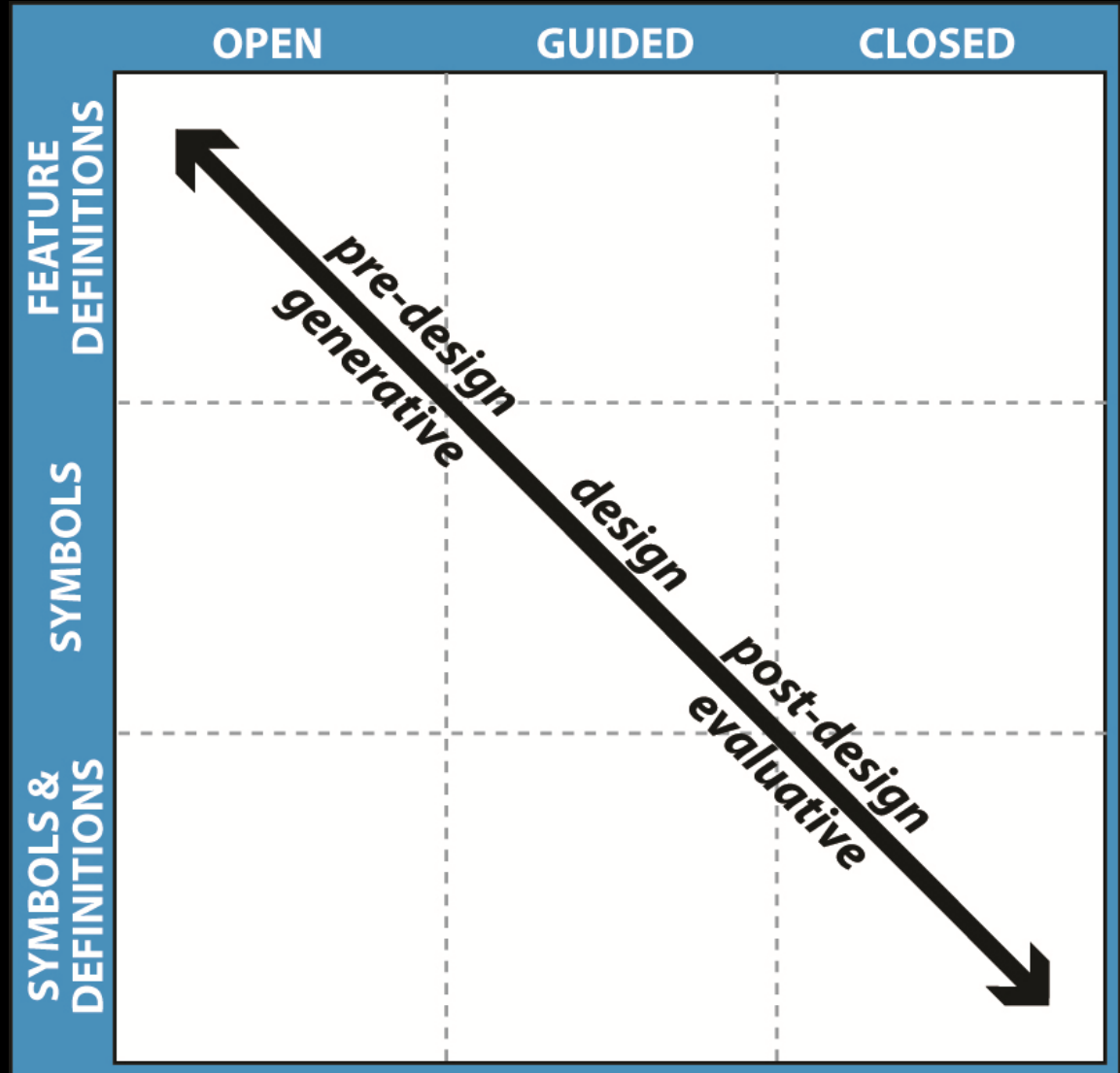
# Framework *for map symbol design*

**generative**  
*vs.*  
**evaluative**



# Framework *for map symbol design*









card contents  
&  
category guidelines



	OPEN	GUIDED	CLOSED
FEATURE DEFINITIONS	<p><b>Generate:</b></p> <ul style="list-style-type: none"> <li>• competing criteria</li> <li>• categories</li> </ul> <p><b>Evaluate:</b></p> <ul style="list-style-type: none"> <li>• feature definitions</li> </ul>	<p><b>Generate:</b></p> <ul style="list-style-type: none"> <li>• categories</li> </ul> <p><b>Evaluate:</b></p> <ul style="list-style-type: none"> <li>• <i>a priori</i> criterion</li> <li>• feature definitions</li> </ul>	<p><b>Generate:</b></p> <p>&lt;none&gt;</p> <p><b>Evaluate:</b></p> <ul style="list-style-type: none"> <li>• <i>a priori</i> categories</li> <li>• feature definitions</li> </ul>
SYMBOLS	<p><b>Generate:</b></p> <ul style="list-style-type: none"> <li>• competing criteria</li> <li>• categories</li> </ul> <p><b>Evaluate:</b></p> <ul style="list-style-type: none"> <li>• symbol designs</li> </ul>	<p><b>Generate:</b></p> <ul style="list-style-type: none"> <li>• categories</li> </ul> <p><b>Evaluate:</b></p> <ul style="list-style-type: none"> <li>• sorting criterion</li> <li>• symbol designs</li> </ul>	<p><b>Generate:</b></p> <p>&lt;none&gt;</p> <p><b>Evaluate:</b></p> <ul style="list-style-type: none"> <li>• established categories</li> <li>• symbol designs</li> </ul>
SYMBOLS & DEFINITIONS	<p><b>Generate:</b></p> <ul style="list-style-type: none"> <li>• competing criteria</li> <li>• categories</li> </ul> <p><b>Evaluate:</b></p> <ul style="list-style-type: none"> <li>• feature definitions</li> <li>• symbol designs</li> </ul>	<p><b>Generate:</b></p> <ul style="list-style-type: none"> <li>• categories</li> </ul> <p><b>Evaluate:</b></p> <ul style="list-style-type: none"> <li>• sorting criterion</li> <li>• feature definitions</li> <li>• symbol designs</li> </ul>	<p><b>Generate:</b></p> <p>&lt;none&gt;</p> <p><b>Evaluate:</b></p> <ul style="list-style-type: none"> <li>• established categories</li> <li>• feature definitions</li> <li>• symbol designs</li> </ul>



# Case Study *ANSI standard categories*

	SYMBOL	NAME/DEFINITION
INCIDENTS		<b>residential fire:</b> a fire affecting a home or housing complex, resulting in partial or total destruction of the structure and/or bodily injury, smoke inhalation or death
		<b>marine accident:</b> a sudden, unexpected event involving a boat or ship resulting in vessel submerging, damage, bodily injury, death and/or the disruption of transportation service
NATURAL EVENTS		<b>drizzle:</b> some time called mist; very small, numerous, and uniformly dispersed water droplets that appear to float while following air currents; unlike fog droplets, drizzle fall to the ground
		<b>landslide:</b> a general term for a wide variety of processes and landforms involving the down slope movement under the force of gravity of masses of soil and rock material
OPERATIONS		<b>medical evacuation helicopter station:</b> the locus of an emergency helicopter landing pad, utilized to transport severely injured persons
		<b>emergency water distribution center:</b> a place where potable water is distributed to displaced persons or victims of war or disaster
INFRA-STRUCTURES		<b>toxic release inventory:</b> the location according to a publicly available database of chemical and other toxic waste releases
		<b>traffic control point:</b> the location of absolute signals controlled by an operator to regulate and maintain transportation flow



# Case Study *experimental design*

**purpose:** evaluation of the ANSI standard symbol categories

**closed card sort** (four categories + 'other')

cards included both the **symbols & definitions**

**n=20** Penn State undergraduate students; average time to complete **~25 minutes**

administered in a controlled setting using the **WebSort** ([www.websort.net](http://www.websort.net)) tool

	OPEN	GUIDED	CLOSED
FEATURE DEFINITIONS	<b>Generate:</b> <ul style="list-style-type: none"><li>• competing criteria</li><li>• categories</li></ul> <b>Evaluate:</b> <ul style="list-style-type: none"><li>• feature definitions</li></ul>	<b>Generate:</b> <ul style="list-style-type: none"><li>• categories</li></ul> <b>Evaluate:</b> <ul style="list-style-type: none"><li>• a priori criterion</li><li>• feature definitions</li></ul>	<b>Generate:</b> <ul style="list-style-type: none"><li>&lt;none&gt;</li></ul> <b>Evaluate:</b> <ul style="list-style-type: none"><li>• a priori categories</li><li>• feature definitions</li></ul>
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*Pre-design* (diagonal label from top-left to bottom-right)  
*Post-design* (diagonal label from top-right to bottom-left)  
*Generative* (diagonal label from top-left to bottom-right)  
*Evaluative* (diagonal label from top-right to bottom-left)

# Case Study *WebSort.net*

The screenshot displays the WebSort.net interface. At the top left, the logo "WebSort.net" is visible, along with links for "Instructions" and "Leave a comment". A sidebar on the left shows "190 unsorted items" and a list of icons with labels: "pumping station", "rail hijacking", "emergency food distribution", "petroleum facilities" (highlighted in yellow), and "telecommunications". The main workspace contains five columns:

- Incidents:** "civil disturbance incident" (stick figure icon)
- Natural Events:** "bird infestation" (bird icon), "tornado" (tornado icon)
- Operations:** "law enforcement operation" (star icon), "FBI", "DEA"
- Infrastructures:** "petroleum facilities" (oil rig icon, highlighted with a yellow box)
- Other:** "unexploded ordnance" (tie icon)

An "I'm Done!" button is located in the bottom right corner.

# Case Study *summary scores*

	AVG # PER CATEGORY	ACTUAL # IN CATEGORY	UNIQUE ITEMS	AGREEMENT
INCIDENTS	41.9	47	95	<b>44%</b>
INFRASTRUCTURES	77.1	81	126	<b>61%</b>
NATURAL EVENTS	23.0	26	41	<b>56%</b>
OPERATIONS	34.6	44	129	<b>27%</b>
OTHER	17.2	0	83	<b>21%</b>

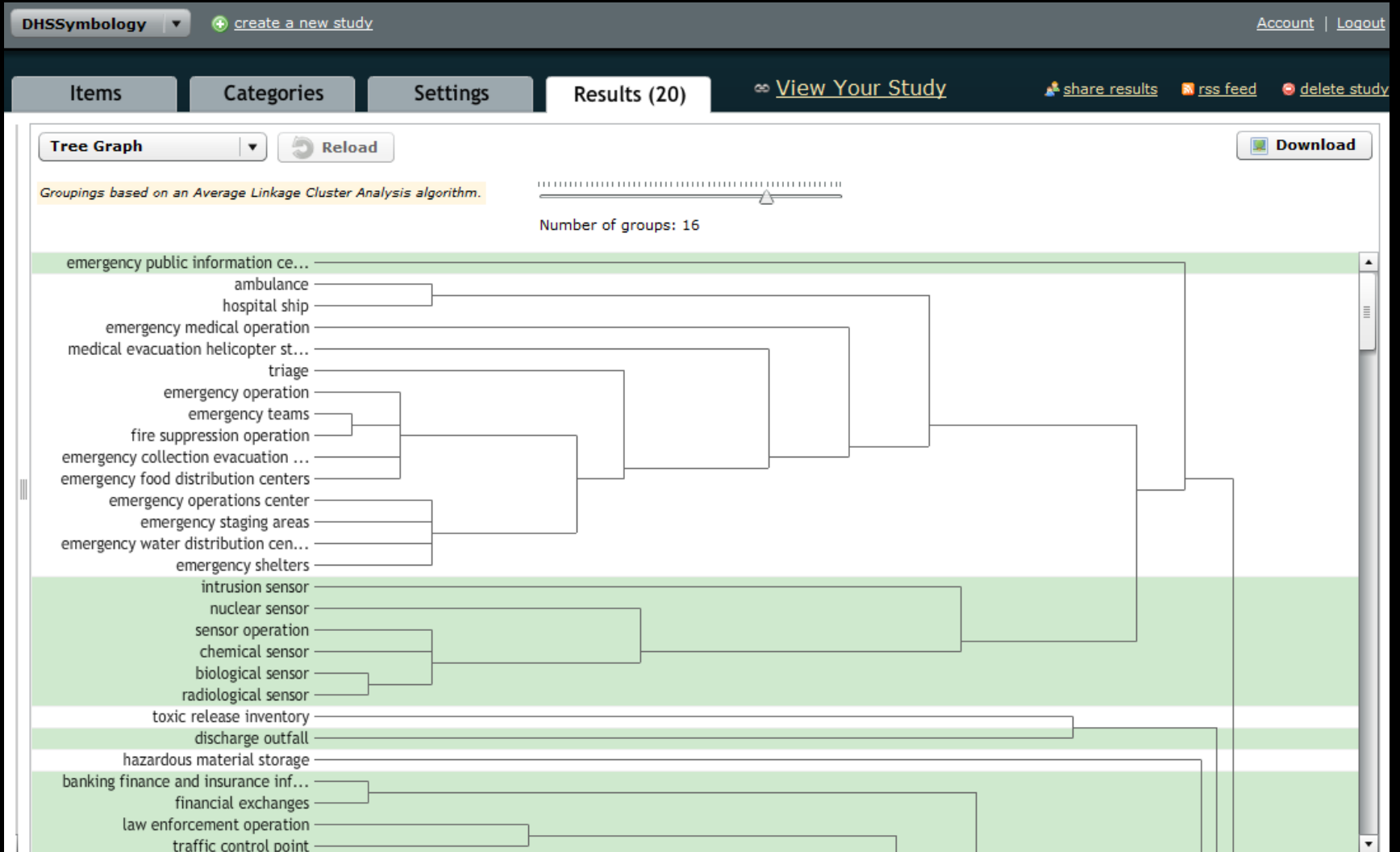
**agreement**

**accuracy**

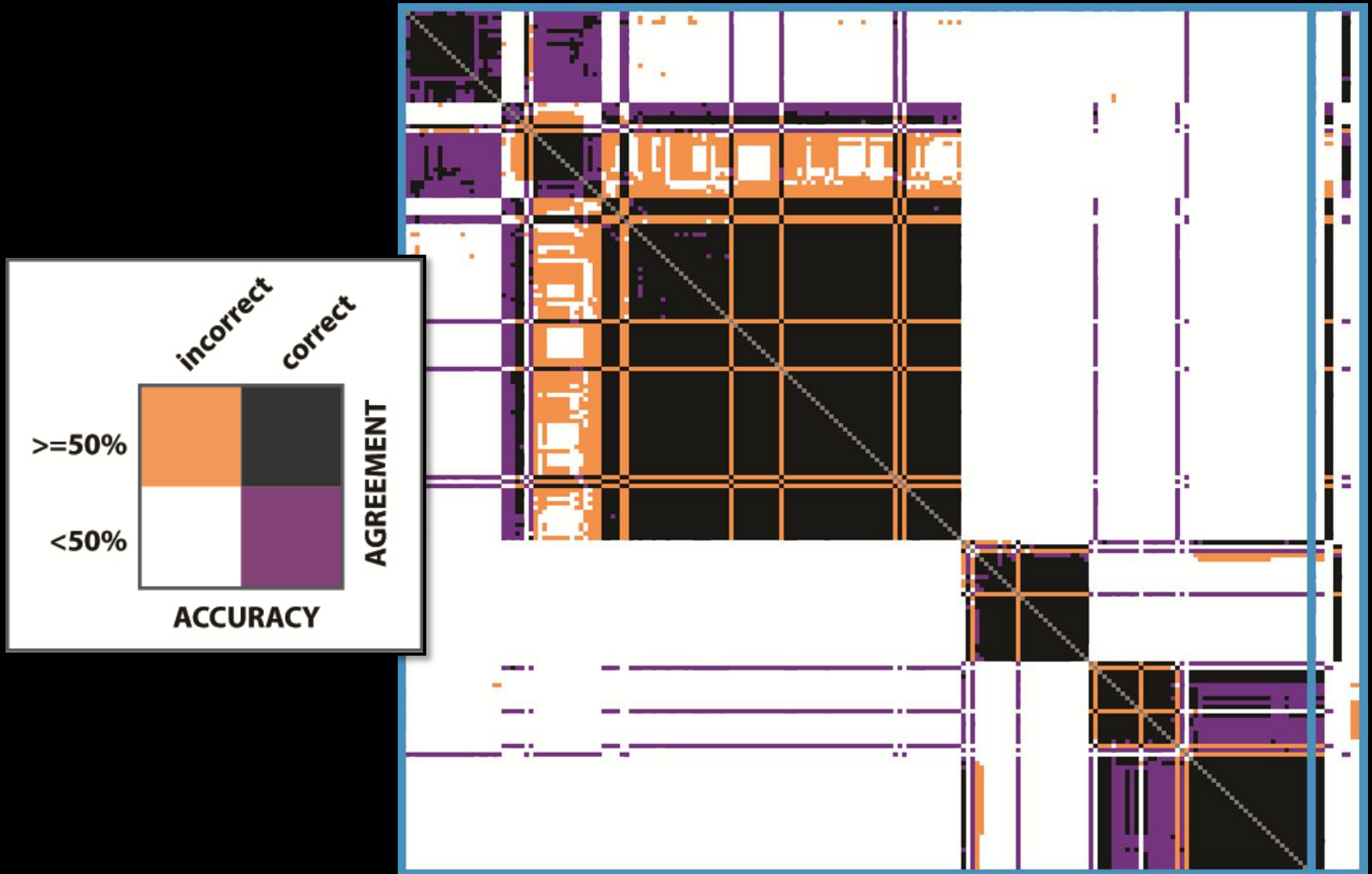
		ANSI STANDARD				
		INCIDENTS	INFRA-STRUCTURES	NATURAL EVENTS	OPERATIONS	TOTAL
<b>SORT RESULTS</b> (based on 50% agreement)	INCIDENTS	<b>31</b>	1	1	1	<b>34</b>
	INFRASTRUCTURES	0	<b>75</b>	0	12	<b>87</b>
	NATURAL EVENTS	2	0	<b>24</b>	0	<b>26</b>
	OPERATIONS	0	1	0	<b>28</b>	<b>29</b>
	OTHER	7	0	0	0	<b>7</b>
	NO MAJORITY	7	4	1	3	<b>15</b>
	<b>TOTAL</b>	<b>47</b>	<b>81</b>	<b>26</b>	<b>44</b>	<b>198</b>
	<b>% CORRECT</b>	<b>66.0%</b>	<b>92.6%</b>	<b>92.3%</b>	<b>63.6%</b>	<b>79.8%</b>

# Case Study *cluster analysis & dendrogram*

12

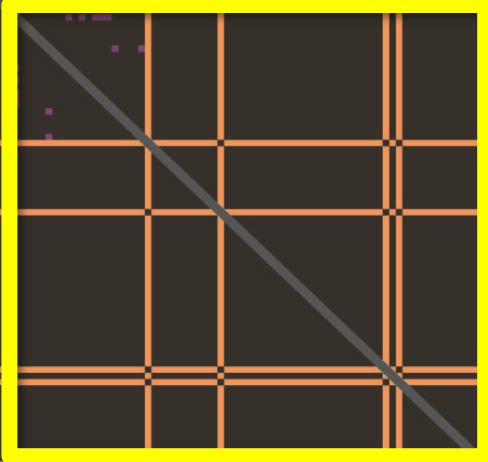


# Case Study *cluster analysis & matrix view*



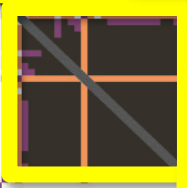


**OPERATIONS**

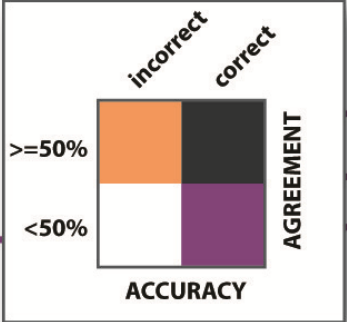


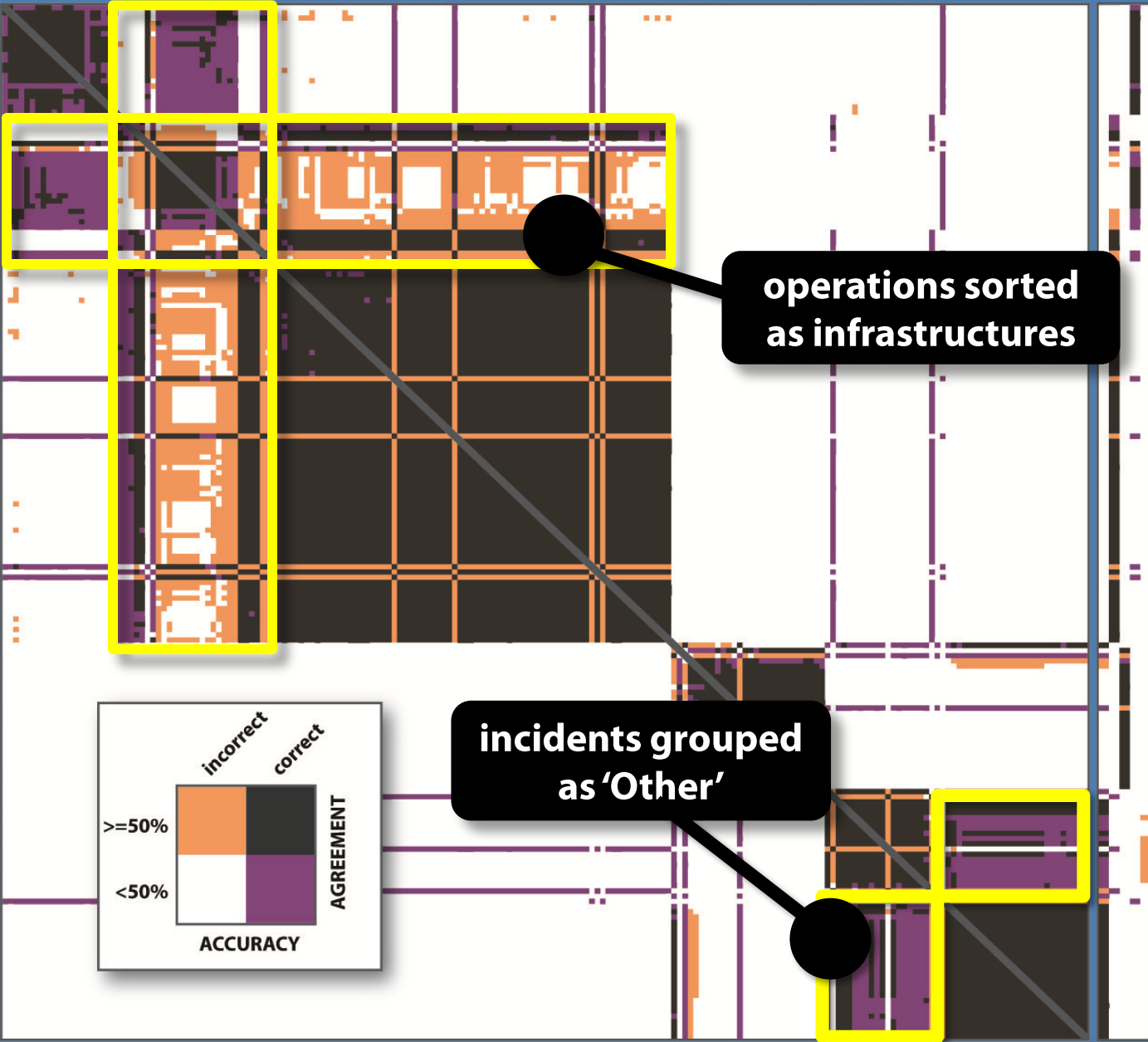
**INFRASTRUCTURES**

**NATURAL EVENTS**



**INCIDENTS**





# Thanks for your attention!

**Contact: [reroth@psu.edu](mailto:reroth@psu.edu)**

<http://www.geovista.psu.edu/Symbology/>

## **Project Team:**

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# Conclusion *process for symbol design*

## e-Symbology Portal

### Round 1 Discussion Topics

Forum	Topics	Posts	Last post
Activity #2: Problems With Existing Symbols	- <b>reorth</b>	Fri, 02/05/2010 - 12:48	
↳ Symbols that are never used	- <b>jblanford</b>	Thu, 02/18/2010 - 12:11	
↳ After reviewing the symbol	- <b>Bravo</b>	Fri, 02/19/2010 - 15:50	
↳ symbol usage	- <b>Juliet</b>	Thu, 02/18/2010 - 12:35	
↳ Problems with existing symbols	- <b>jblanford</b>	Wed, 02/17/2010 - 15:30	
↳ Aircraft crash	- <b>Foxtrot</b>	Thu, 02/18/2010 - 09:01	
↳ Aircraft crash	- <b>Bravo</b>	Fri, 02/19/2010 - 16:04	
↳ Similar symbols	- <b>Foxtrot</b>	Thu, 02/18/2010 - 08:43	
↳ Similar symbols	- <b>Bravo</b>	Fri, 02/19/2010 - 16:22	
↳ Symbol ?	- <b>Juliet</b>	Tue, 02/16/2010 - 10:19	
↳ necessary Symbol Part II	- <b>India</b>	Wed, 02/17/2010 - 15:46	
↳ Infrequently-used (but still recurrent) symbols	- <b>Foxtrot</b>	Thu, 02/18/2010 - 08:35	
↳ I agree with this statement.	- <b>Hotel</b>	Thu, 02/25/2010 - 10:29	
↳ other symbol is useless	- <b>Charlie</b>	Tue, 02/16/2010 - 14:47	
↳ other" symbol	- <b>Foxtrot</b>	Tue, 02/16/2010 - 13:29	
↳ other symbol	- <b>Echo</b>	Tue, 02/16/2010 - 16:44	
↳ Need better description	- <b>Charlie</b>	Wed, 02/17/2010 - 10:31	
↳ symbology	- <b>Juliet</b>	Tue, 02/16/2010 - 10:16	
↳ checkpoint Symbology	- <b>Foxtrot</b>	Tue, 02/16/2010 - 13:24	
↳ checkpoint symbology	- <b>Echo</b>	Tue, 02/16/2010 - 16:39	
↳ checkpoint symbology	- <b>Juliet</b>	Wed, 02/17/2010 - 08:40	
↳ I have only	- <b>Hotel</b>	Thu, 02/18/2010 - 09:59	
↳ symbology	- <b>Echo</b>	Wed, 02/17/2010 - 12:14	
↳ at its Tuscan	- <b>India</b>	Wed, 02/17/2010 - 15:43	
↳ /16/2010	- <b>India</b>	Wed, 02/17/2010 - 10:11	
↳ 6:01	- <b>India</b>	Wed, 02/17/2010 - 10:11	
↳ el	- <b>Hotel</b>	Thu, 02/18/2010 - 09:46	
↳ 02/17/2010	- <b>Hotel</b>	Thu, 02/18/2010 - 12:08	
↳ Tue, 02/16/2010	- <b>Hotel</b>	Thu, 02/18/2010 - 09:59	

WebSort.net Instructions | Leave a comment

170 unsorted Items

CBP Events Assets DHS Miscellaneous

Other Facility

Intel

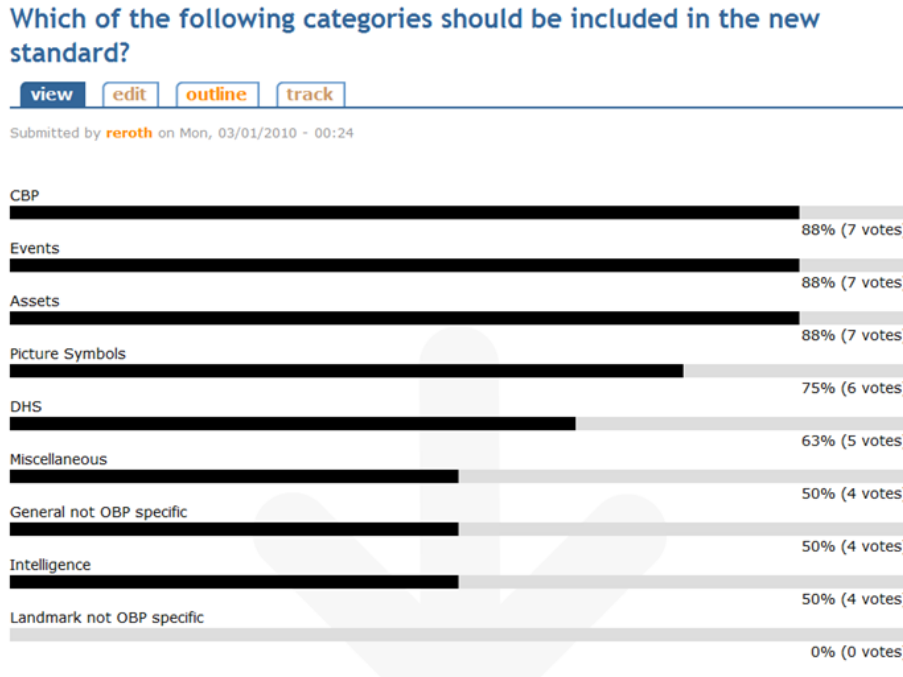
Correctional Facility

Urgent Care Center

Tropical Storm

Electric Power Plant

+



- ANSI set
- CBP
- FEMA
- OIP

INCIDENTS		NATURAL EVENTS		OPERATIONS		INFRASTRUCTURE	
	Civil disturbance		Removable gas		Emergency medical operation		Fast mail
	Civil demonstration		Removable liquid		EAT station locations		grain storage
	Civil displaced population		Removable solid		ambulance		banking finance & insurance
	Civil rioting		non-removable gas		medical evacuation helicopter station		ATMs
	Criminal activity incident		organic pesticides		health department facility		banks
	Bomb threat		radicals		hospital		bulk storage
	Bombs		radiation material		hospital ship		Federal reserve banks
	Bomb explosion		spontaneously combustible		medical facilities non-patient		financial exchanges
	Boating		toxic gas		pharmacy		financial services other
	Bombing		toxic and infectious		pharmacies		Government plant
	Shooting		unexploded ordnance		stage		Chemical plant
	Fire incident		air incident		emergency operation		Beam manufacturers
	Fire spot		air accident		emergency collection processing center		Beam retailers
	Non-residential fire		air hijacking		emergency incident command center		Biocorrosive material production
	Urges		marine incident		emergency operations center		Biocorrosive material storage
	Residential fire		marine accident		emergency public information center		Industrial site
	School fire		marine hijacking		emergency shelters		Health
	Smoke		oil incident		emergency staging area		pharmaceutical manufacturer
	Special needs fire		oil accident		emergency teams		Superfund sites EPA
	Wild fire		oil hijacking		emergency water distribution center		Toxic release inventory
	Hazardous material incident		vehicle accident		emergency food distribution center		educational facilities
	Chemical agents		vehicle hijacking		fire suppression operation		college university
	Corrosive material		insect infestation		fire hydrant		Schools
	Hazardous when wet		insect infestation		Other water supply location		energy facilities infrastructure
	Explosive		radical infestation		fire station		government stations
			radical infestation				Agriculture and food infrastructure
			radical infestation				Agricultural operations
			radical infestation				Animal facilities
			radical infestation				Commercial food distribution center
			radical infestation				Farm ranches
			radical infestation				Food production center
			radical infestation				Law enforcement operation
			radical infestation				Law, Alcohol, Tobacco, Firearms & Explosives
			radical infestation				Locker gained
			radical infestation				Customs service
			radical infestation				Drug Enforcement Administration
			radical infestation				Department of Justice
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			radical infestation				Secret service
			radical infestation				Transportation Security Admin.
			radical infestation				US Coast Guard
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			radical infestation				Sensor operation
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