
Engineers: The Forgotten Stakeholder in the Resilience Conversation

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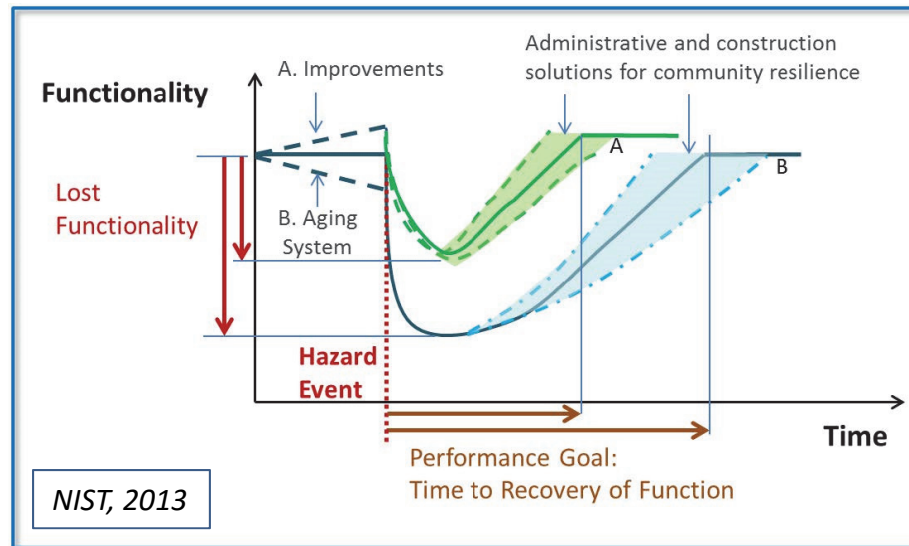
Engineers: The Forgotten Stakeholder in the Resilience Conversation

Agenda

- Background context
- Resilience concepts and technologies
- Lessons from seismic design
- An elephant in the room
- A call to action

Resilience Defined

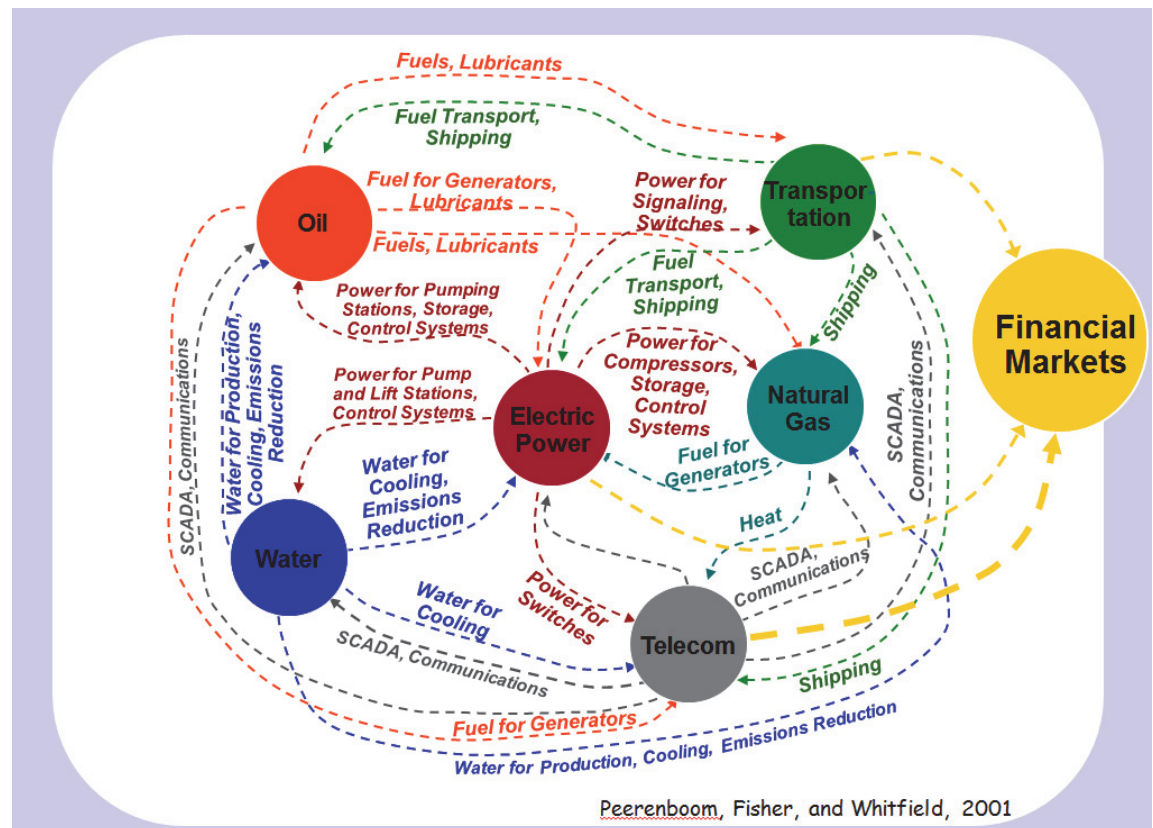
- Resilience – the ability to prepare for, respond, and recover from a disaster



- This concept has taken over the U.S. preparedness and mitigation conversation

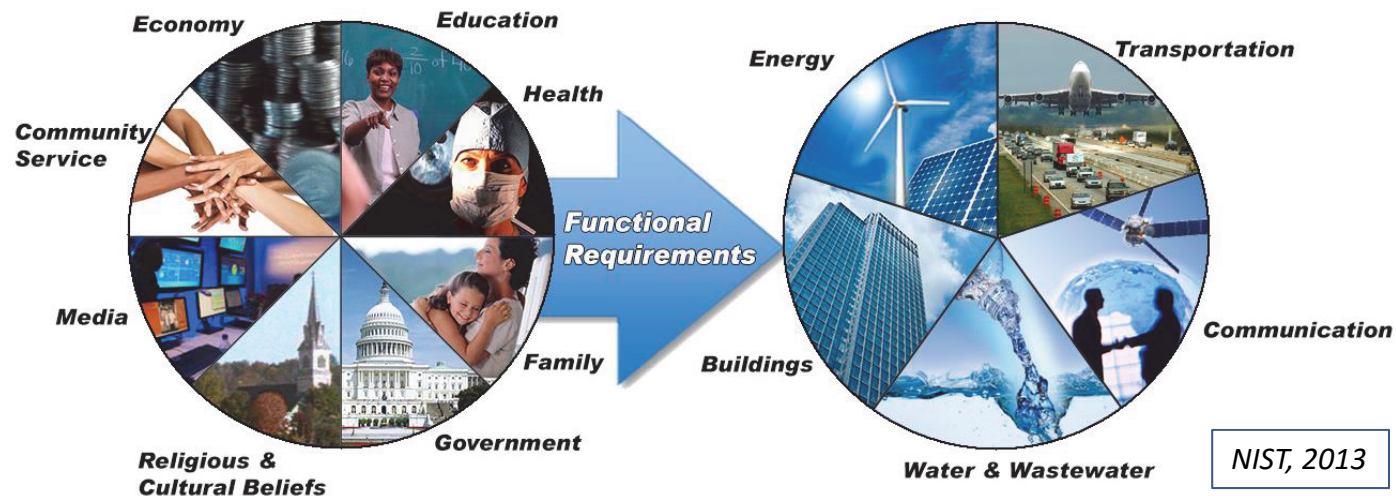
Resilience Defined

- Communities are a complex assembly of interdependencies and possibly competing interests
 - Everything needs something else
 - Priorities can differ



The Current Conversation

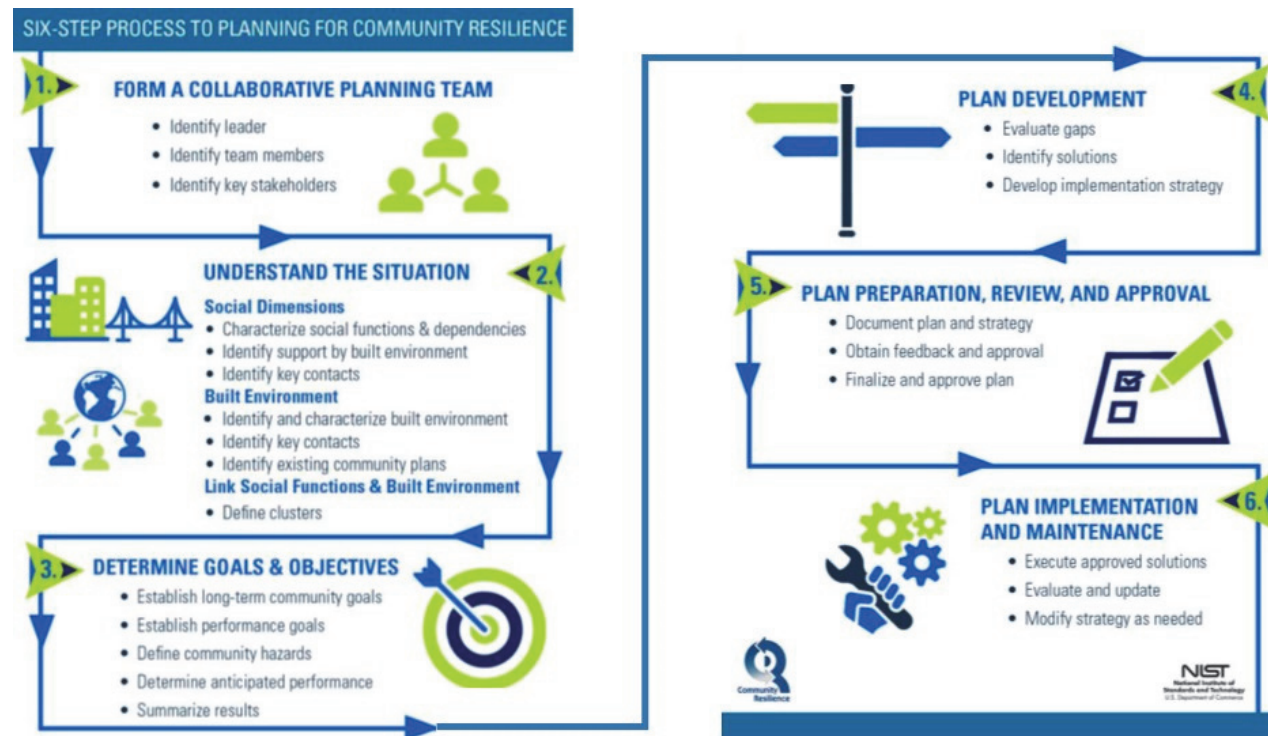
- Involves many different people, interest groups, and political, economic, social, considerations



- Engineers are noticeably missing from this conversation

The Current Conversation

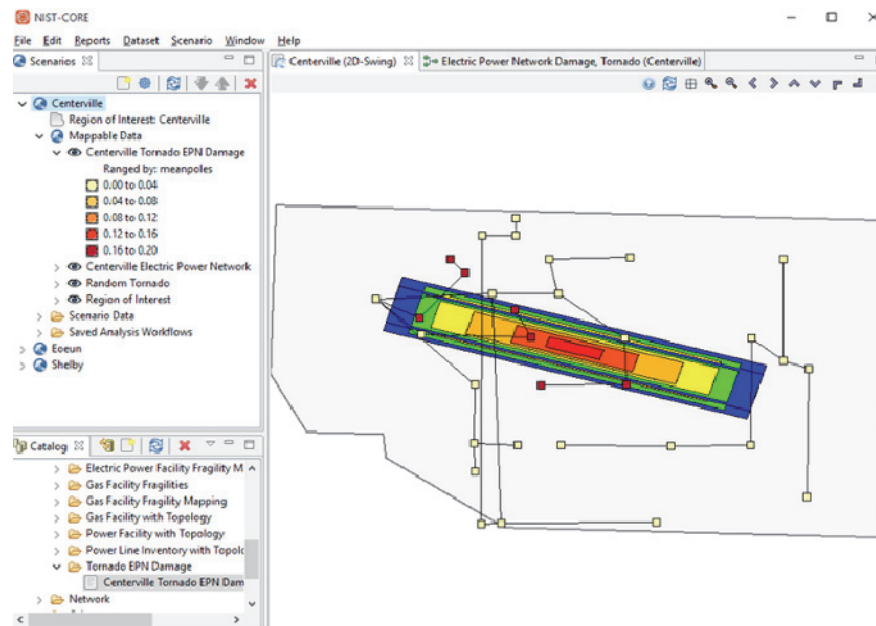
- Stakeholders are involved, and are being offered comprehensive tools and guides



NIST, 2013

The Current Conversation

- Governments are investing millions \$US
- Researchers are promising ambitious, high-fidelity GIS-based modeling



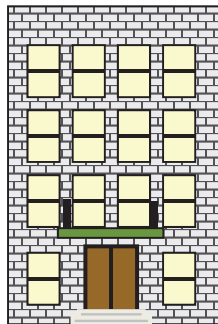
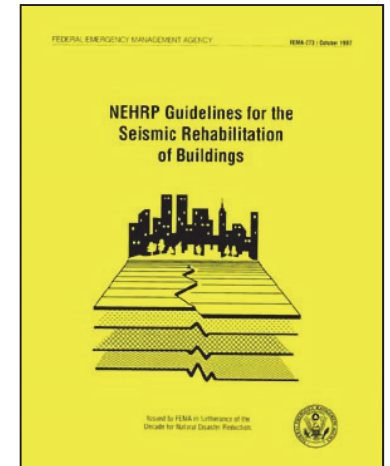
NIST CORE model of electrical power network damage due to tornado hazard

The Current Conversation

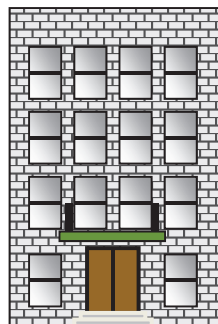
- *But...*
 - Current resilience concepts and technologies are in their infancy
 - We cannot yet reliably quantify resilience, and won't be able to for a long time
 - Difficult decisions must be made based on information that is incomplete, highly uncertain, and likely probabilistic
 - Stakeholders may or may not be able to utilize this type of information

Lessons from Seismic Design

- Present-generation performance based seismic design (PBSD)
 - FEMA 273 *NEHRP Guidelines for Seismic Rehabilitation of Buildings* (1997)



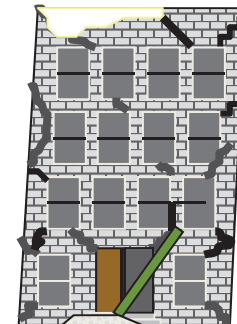
Operational



*Immediate
Occupancy*

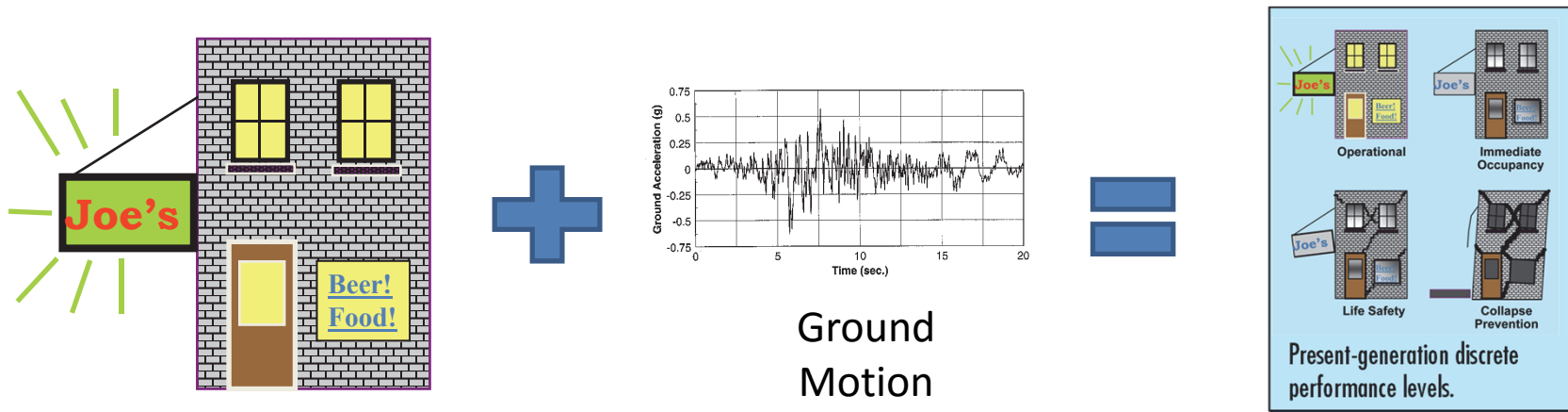


*Life
Safety*



*Collapse
Prevention*

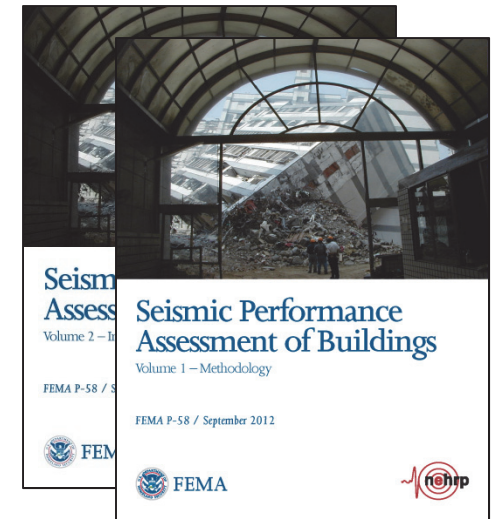
PBSD Communication Problems



- EQ hazard levels (500/2500 years) were difficult to explain
- Stakeholders did not fully understand the consequences of performance objectives
- Discrete performance levels did not translate well into financial decision-making

Next-Generation PBSD

- FEMA P-58 Seismic Performance Assessment
- Probable consequences and explicit consideration of uncertainty
 - Casualties
 - Repair costs
 - Repair time
 - Unsafe placarding



Task Name	Duration	Start	End
1. Develop the Assessment Plan	10 days	10/1/2012	10/10/2012
2. 2.1. Phase 1 - Strategic Plan	10 days	10/1/2012	10/10/2012
3. 2.2. Phase 2 - Assessment Plan	10 days	10/11/2012	10/20/2012
4. 2.3. Phase 3 - Assessment Plan	10 days	10/21/2012	10/30/2012
5. 2.4. Phase 4 - Assessment Plan	10 days	10/31/2012	11/9/2012
6. 2.5. Phase 5 - Assessment Plan	10 days	11/10/2012	11/19/2012
7. 2.6. Phase 6 - Assessment Plan	10 days	11/20/2012	11/29/2012
8. 2.7. Phase 7 - Assessment Plan	10 days	11/30/2012	12/9/2012
9. 2.8. Phase 8 - Assessment Plan	10 days	12/10/2012	12/19/2012
10. 2.9. Phase 9 - Assessment Plan	10 days	12/20/2012	12/29/2012
11. 2.10. Phase 10 - Assessment Plan	10 days	12/30/2012	1/8/2013
12. 2.11. Phase 11 - Assessment Plan	10 days	1/9/2013	1/18/2013
13. 2.12. Phase 12 - Assessment Plan	10 days	1/19/2013	1/28/2013
14. 2.13. Phase 13 - Assessment Plan	10 days	1/29/2013	2/7/2013
15. 2.14. Phase 14 - Assessment Plan	10 days	2/8/2013	2/17/2013
16. 2.15. Phase 15 - Assessment Plan	10 days	2/18/2013	2/27/2013
17. 2.16. Phase 16 - Assessment Plan	10 days	2/28/2013	3/7/2013
18. 2.17. Phase 17 - Assessment Plan	10 days	3/8/2013	3/17/2013
19. 2.18. Phase 18 - Assessment Plan	10 days	3/18/2013	3/27/2013
20. 2.19. Phase 19 - Assessment Plan	10 days	3/28/2013	4/6/2013
21. 2.20. Phase 20 - Assessment Plan	10 days	4/7/2013	4/16/2013
22. 2.21. Phase 21 - Assessment Plan	10 days	4/17/2013	4/26/2013
23. 2.22. Phase 22 - Assessment Plan	10 days	4/27/2013	5/6/2013
24. 2.23. Phase 23 - Assessment Plan	10 days	5/7/2013	5/16/2013
25. 2.24. Phase 24 - Assessment Plan	10 days	5/17/2013	5/26/2013
26. 2.25. Phase 25 - Assessment Plan	10 days	5/27/2013	6/5/2013
27. 2.26. Phase 26 - Assessment Plan	10 days	6/6/2013	6/15/2013
28. 2.27. Phase 27 - Assessment Plan	10 days	6/16/2013	6/25/2013
29. 2.28. Phase 28 - Assessment Plan	10 days	6/26/2013	7/5/2013
30. 2.29. Phase 29 - Assessment Plan	10 days	7/6/2013	7/15/2013
31. 2.30. Phase 30 - Assessment Plan	10 days	7/16/2013	7/25/2013
32. 2.31. Phase 31 - Assessment Plan	10 days	7/26/2013	8/4/2013
33. 2.32. Phase 32 - Assessment Plan	10 days	8/5/2013	8/14/2013
34. 2.33. Phase 33 - Assessment Plan	10 days	8/15/2013	8/24/2013
35. 2.34. Phase 34 - Assessment Plan	10 days	8/25/2013	9/3/2013
36. 2.35. Phase 35 - Assessment Plan	10 days	9/4/2013	9/13/2013
37. 2.36. Phase 36 - Assessment Plan	10 days	9/14/2013	9/23/2013
38. 2.37. Phase 37 - Assessment Plan	10 days	9/24/2013	10/3/2013
39. 2.38. Phase 38 - Assessment Plan	10 days	10/4/2013	10/13/2013
40. 2.39. Phase 39 - Assessment Plan	10 days	10/14/2013	10/23/2013
41. 2.40. Phase 40 - Assessment Plan	10 days	10/24/2013	11/2/2013
42. 2.41. Phase 41 - Assessment Plan	10 days	11/3/2013	11/12/2013
43. 2.42. Phase 42 - Assessment Plan	10 days	11/13/2013	11/22/2013
44. 2.43. Phase 43 - Assessment Plan	10 days	11/23/2013	12/2/2013
45. 2.44. Phase 44 - Assessment Plan	10 days	12/3/2013	12/12/2013
46. 2.45. Phase 45 - Assessment Plan	10 days	12/13/2013	12/22/2013
47. 2.46. Phase 46 - Assessment Plan	10 days	12/23/2013	1/1/2014
48. 2.47. Phase 47 - Assessment Plan	10 days	1/2/2014	1/11/2014
49. 2.48. Phase 48 - Assessment Plan	10 days	1/12/2014	1/21/2014
50. 2.49. Phase 49 - Assessment Plan	10 days	1/22/2014	1/31/2014
51. 2.50. Phase 50 - Assessment Plan	10 days	2/1/2014	2/10/2014
52. 2.51. Phase 51 - Assessment Plan	10 days	2/11/2014	2/20/2014
53. 2.52. Phase 52 - Assessment Plan	10 days	2/21/2014	3/2/2014
54. 2.53. Phase 53 - Assessment Plan	10 days	3/3/2014	3/12/2014
55. 2.54. Phase 54 - Assessment Plan	10 days	3/13/2014	3/22/2014
56. 2.55. Phase 55 - Assessment Plan	10 days	3/23/2014	4/1/2014
57. 2.56. Phase 56 - Assessment Plan	10 days	4/2/2014	4/11/2014
58. 2.57. Phase 57 - Assessment Plan	10 days	4/12/2014	4/21/2014
59. 2.58. Phase 58 - Assessment Plan	10 days	4/22/2014	5/1/2014
60. 2.59. Phase 59 - Assessment Plan	10 days	5/2/2014	5/11/2014
61. 2.60. Phase 60 - Assessment Plan	10 days	5/12/2014	5/21/2014
62. 2.61. Phase 61 - Assessment Plan	10 days	5/22/2014	6/1/2014
63. 2.62. Phase 62 - Assessment Plan	10 days	6/2/2014	6/11/2014
64. 2.63. Phase 63 - Assessment Plan	10 days	6/12/2014	6/21/2014
65. 2.64. Phase 64 - Assessment Plan	10 days	6/22/2014	7/1/2014
66. 2.65. Phase 65 - Assessment Plan	10 days	7/2/2014	7/11/2014
67. 2.66. Phase 66 - Assessment Plan	10 days	7/12/2014	7/21/2014
68. 2.67. Phase 67 - Assessment Plan	10 days	7/22/2014	8/1/2014
69. 2.68. Phase 68 - Assessment Plan	10 days	8/2/2014	8/11/2014
70. 2.69. Phase 69 - Assessment Plan	10 days	8/12/2014	8/21/2014
71. 2.70. Phase 70 - Assessment Plan	10 days	8/22/2014	9/1/2014
72. 2.71. Phase 71 - Assessment Plan	10 days	9/2/2014	9/11/2014
73. 2.72. Phase 72 - Assessment Plan	10 days	9/12/2014	9/21/2014
74. 2.73. Phase 73 - Assessment Plan	10 days	9/22/2014	10/1/2014
75. 2.74. Phase 74 - Assessment Plan	10 days	10/2/2014	10/11/2014
76. 2.75. Phase 75 - Assessment Plan	10 days	10/12/2014	10/21/2014
77. 2.76. Phase 76 - Assessment Plan	10 days	10/22/2014	11/1/2014
78. 2.77. Phase 77 - Assessment Plan	10 days	11/2/2014	11/11/2014
79. 2.78. Phase 78 - Assessment Plan	10 days	11/12/2014	11/21/2014
80. 2.79. Phase 79 - Assessment Plan	10 days	11/22/2014	12/1/2014
81. 2.80. Phase 80 - Assessment Plan	10 days	12/2/2014	12/11/2014
82. 2.81. Phase 81 - Assessment Plan	10 days	12/12/2014	12/21/2014
83. 2.82. Phase 82 - Assessment Plan	10 days	12/22/2014	1/1/2015
84. 2.83. Phase 83 - Assessment Plan	10 days	1/2/2015	1/11/2015
85. 2.84. Phase 84 - Assessment Plan	10 days	1/12/2015	1/21/2015
86. 2.85. Phase 85 - Assessment Plan	10 days	1/22/2015	2/1/2015
87. 2.86. Phase 86 - Assessment Plan	10 days	2/2/2015	2/11/2015
88. 2.87. Phase 87 - Assessment Plan	10 days	2/12/2015	2/21/2015
89. 2.88. Phase 88 - Assessment Plan	10 days	2/22/2015	3/3/2015
90. 2.89. Phase 89 - Assessment Plan	10 days	3/4/2015	3/13/2015
91. 2.90. Phase 90 - Assessment Plan	10 days	3/14/2015	3/23/2015
92. 2.91. Phase 91 - Assessment Plan	10 days	3/24/2015	4/3/2015
93. 2.92. Phase 92 - Assessment Plan	10 days	4/4/2015	4/13/2015
94. 2.93. Phase 93 - Assessment Plan	10 days	4/14/2015	4/23/2015
95. 2.94. Phase 94 - Assessment Plan	10 days	4/24/2015	5/3/2015
96. 2.95. Phase 95 - Assessment Plan	10 days	5/4/2015	5/13/2015
97. 2.96. Phase 96 - Assessment Plan	10 days	5/14/2015	5/23/2015
98. 2.97. Phase 97 - Assessment Plan	10 days	5/24/2015	6/3/2015
99. 2.98. Phase 98 - Assessment Plan	10 days	6/4/2015	6/13/2015
100. 2.99. Phase 99 - Assessment Plan	10 days	6/14/2015	6/23/2015
101. 2.100. Phase 100 - Assessment Plan	10 days	6/24/2015	7/3/2015



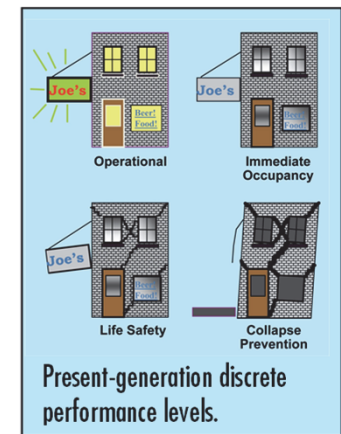
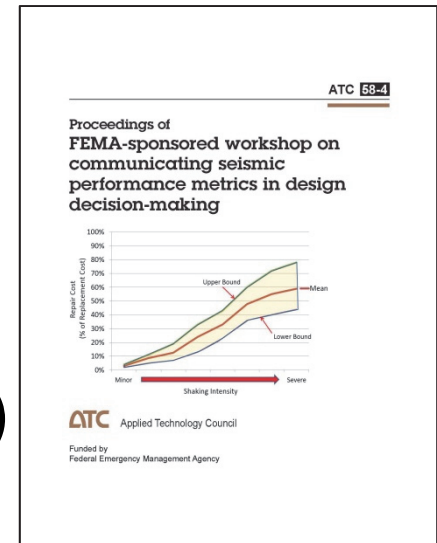
Stakeholder Interaction

- Workshop on Communicating Seismic Performance Metrics in Design Decision-Making (2013)
 - Owners, developers, lenders, insurers, institutions, corporations, building officials, civic managers, and design professionals



Workshop Findings

- What did we learn?
 - Probability concepts are not well understood
 - Some information (e.g., casualties) is not desirable (or actionable)
- In spite of our best efforts...
 - We still have communication challenges to solve



Brittle Society

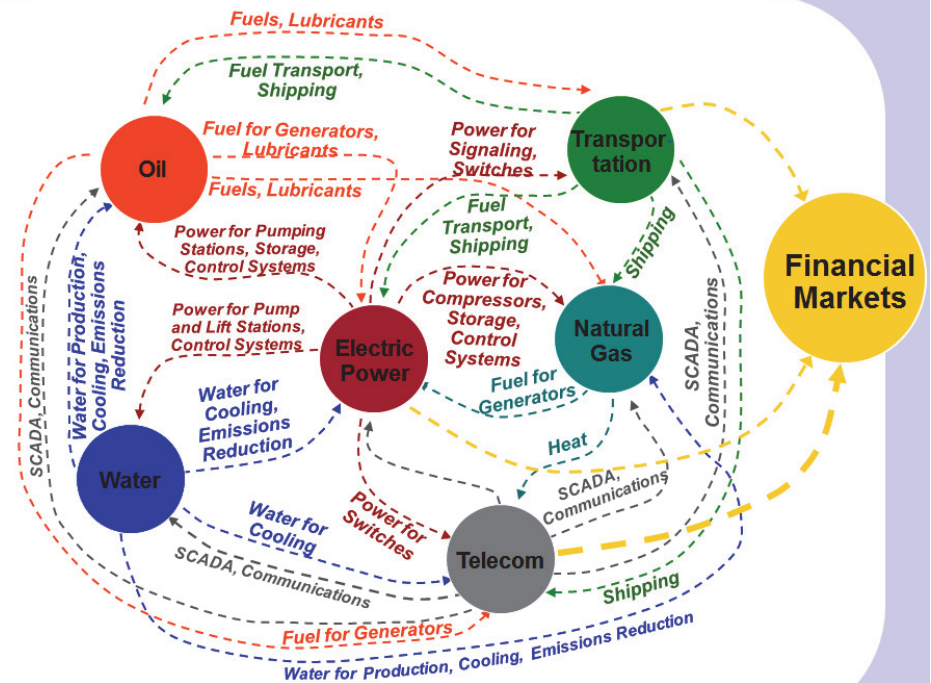
- Some (Edwards, 2009; McAslan, 2010) feel that society is getting increasingly brittle, rather than resilient
 - Depend on a just-in-time lifestyle
 - Fragile system of interconnections
 - Vulnerable to even the slightest disruption

What We Already Know

- Code-conforming buildings can become damaged
- Liquefiable soils can liquefy
- Tsunami inundation zones can become flooded



What We Already Know



Peerenboom, Fisher, and Whitfield, 2001

- Distributed systems are likely to be interrupted somewhere

Are We Avoiding What We Know?

- Is the promise of new technologies causing communities to wait?
- Is the hope for a good resilience rating just wishful thinking?
- Can high-fidelity modeling provide information that is reliable for design decisions?



How Can Engineers Help?

- Engineering is eliminating variables, bounding solutions, and controlling responses to achieve a desired result
- Engineering principles are needed to bridge the gap between new theoretical ideas and practical implementation
 - If power is critical, provide emergency power
 - If critical services are located in one building, build more than one (and build better)
 - Implement responsible land-use planning

How Can Engineers Help?

- Before performance-based design, engineers made decisions on behalf of society
 - Codes were made safe because we knew people wanted safety
- It is now obvious that society wants resilience
 - We need to create a code that offers a functional performance objective for buildings and infrastructure

Conclusions

- As communities seek to develop plans, and researchers advance our technologies
- Engineers must be called to action:
 - Insert themselves into the resilience conversation
 - Show how engineering principles can simplify resilience problems
 - Take a leadership role in implementing resilience concepts in the near term