1. Comments on the Meaning of Resilience

a. Eisner

A colleague just returned from a conference in Washington titled Resilient American Communities: Progress in Practice and Policy (Center for Biodiversity of UPMC). It seems we are being run over by everybody and anybody who has a definition and a "resilient" ax to grind. Many of the "ax grinders" are our colleagues, including Dennis Mileti, Adam Rose, Kathleen Tierney, Ellis Stanley, et al. Many of the players in this game are from DHS, the national labs, academies. The discussion is quite scholarly, but I fear that "resilience" will go the way of other faddish words (without a concept), including "robust," "sustainable," and the like. We have each attended two or three workshops on resilience(y) with multiple arcane definitions that do not inform. . . . Is there a "national resilience" or is national resilience the aggregation of the resilience of individuals, local community resilience, business and economic resilience, cultural resilience, plus the resilience of network (infrastructure) which connects the pieces?

b. Harris

Resilience: take a punch and recover—yes, but

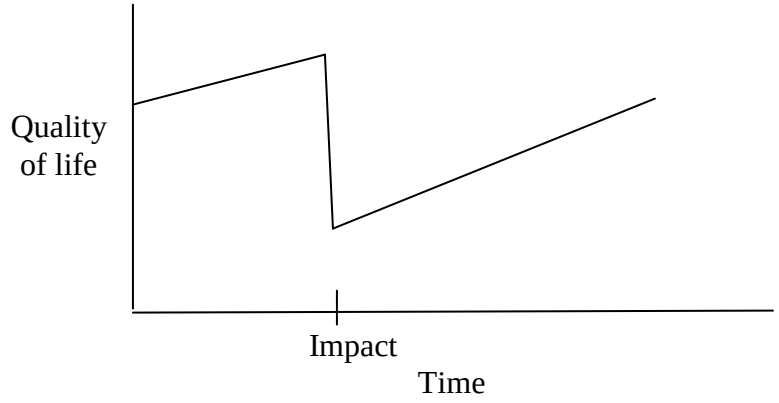
- How fast
- With how much outside assistance
- With what lasting effects

These are all a matter of degree and the fact that we now worry about them is great; it shows that society demands a higher degree of resilience than in the past.

c. Lindell

A community's hazard resilience is defined by its ability to absorb disaster impacts and rapidly return to normal socioeconomic activity. This definition requires an understanding of 1) what is meant by a community, 2) what are the major types of disaster impacts, 3) how communities absorb disaster impacts, and 4) how impacted communities return to normal socioeconomic activity. First, a community usually refers to a local political jurisdiction. Second, the major types of impacts are physical impacts and social impacts. The physical impacts are damage and casualties whereas the social impacts are psychosocial, demographic, economic, and political effects of the physical impacts. Third, communities can absorb disaster impacts when their physical structures (residential, commercial, and industrial) and their infrastructures (electric power, fuel, water, waste disposal, transportation, and telecommunication systems) are able to withstand disaster impacts with minimal damage or functional degradation. Communities are also able to absorb disaster impacts when they can minimize casualties and social impacts despite damage or disruption to physical structures and infrastructure. Communities cannot completely absorb the impacts of major disasters, so an important issue is the degree to which their physical structures and infrastructure are damaged or their functional capacities are degraded. This is indicated in Figure 1, which shows how a community's quality of life (QOL—measured, among other ways, by local economic

viability) increases over time until a disaster strikes. A community's ability to absorb disaster impacts is indicated by the magnitude of the decrease in QOL. Fourth, communities return to normal socioeconomic activity by relying on households' and businesses' undamaged assets (e.g., financial assets such as savings and investments), informal assistance from peers (friends, relatives, neighbors, and coworkers), increased labor (additional hours worked), decreased consumption (cutting unnecessary costs), and formal assistance from governmental agencies (at state and federal levels) as well as non-governmental organizations (NGOs). A community's rate of return to normal socioeconomic activity is indicated in Figure 1 by the slope of the line after the time of impact—resilient communities have steeper slopes and thus take less time to recover.



U.S. communities are generally quite resilient to most natural hazards. Part of the reason is that many households and businesses have significant financial and other assets (including hazard insurance) to support their disaster recovery. However, another important reason is that even the largest U.S. disasters have small impact ratios—geographic (percentage of the national land area affected), demographic (percentage of the national population affected), and economic (percentage of the national economy affected). In addition, disaster-stricken communities have horizontal and vertical socioeconomic linkages to extra-community institutions (higher levels of government and NGOs) that provide substantial amounts of resources needed for disaster recovery. . . .

Finally, it is important to recognize that focusing narrowly on the aggregate resilience of a community ignores the differential distribution of disaster impacts across population segments and economic sectors. Current patterns of local disaster resilience are typically disproportionate because some population segments (e.g., low education/income) and economic sectors (e.g., small businesses) are usually affected much more severely than others. Not only do these vulnerable households and businesses lack economic reserves, they also tend to be disconnected from the institutions that do have these resources. These differences among population segments and economic sectors can produce an illusion of disaster recovery when highly visible population segments and economic sectors have recovered but vulnerable segments/sectors have not.

d. O'Rourke

Since Hurricane Katrina, there has been a notable shift in emphasis from protecting critical infrastructure to ensuring that communities are resilient. The concept of resilience is evolving. In its current form, the resilience of a community is an overarching attribute that reflects the degree of community preparedness and the ability to respond to and recover from a disaster. Resilience is starting to be viewed in an even broader context as involving community response to long-term stressors, such as drought, sea level rise, and a variety of sustainability issues. It is difficult to draw a boundary in time between short- and long-term capacity to respond and adapt to external pressures. What we should be looking for are ways to respond and recover from disasters, and draw lessons from this process to improve our survivability and sustainability in the long term.

e. Poland

Healthy cities continuously grow by driving economic development while protecting their cultural heritage. Success, in part, depends on a healthy built environment that is rooted in contemporary urban planning, sustainability, and disaster resilience. Disaster resilient communities have a credible disaster response plan that assures a place and ability to govern after a disaster has struck. Their power, water, and communication networks begin operating again shortly after a disaster and people can stay in their homes, travel to where they need to be, and resume a fairly normal living routine within weeks. The return to a "new" normal can then occur within a few years. While every building should protect its occupants from harm, a select few need to remain operational and a larger group needs to be at least usable during repair. Lifeline systems must be restored as quickly as needed to support response and reconstruction.

2. Comments on Components/Determinants of Resiliency

a. Resilience of Buildings and Lifelines

1) Bray

Earthquake professionals largely assess buildings in terms of what is called the "life safety" performance level. Through codes, engineers aim at designing systems that can withstand earthquake shaking without jeopardizing public health. The nation's current building code states "The purpose of this code is to establish the minimum requirements to safeguard the public health . . . and to provide safety to fire fighters and emergency responders during emergency operations."

An earthquake that strikes a city built in compliance with current codes may not kill many people. However, it is not resilient, because it may take years for the city to recover economically. Resilience is "the ability to take a punch and recover." The code-compliant city cannot recover, because it has not been designed in terms of performance. Instead, it has been designed to safeguard life.

More importantly, our nation's cities are filled with older buildings that were designed using previous versions of the building codes that contained deficiencies or were not constructed properly. A subset of these older buildings presents the greatest risk of collapse. These "killer" buildings need to be identified and retrofitted before the next major earthquake strikes. The "killer" buildings within each city cannot even take the punch from a major earthquake.

A city's resilience depends on its infrastructure, i.e., its mass transit, highways, electric power, water supply, etc. Yet, building codes ignore these critical systems. Lifeline systems are designed independently, although one system's performance depends on those of the other systems. A community's resilience will be tested when an earthquake damages one of these systems and a ripple effect through other lifeline systems endangers human lives. Lifeline system disruption also has a direct effect on business losses. The economic and social consequences of lifeline damage and loss of functionality are significant.

2) **Hooper**

For the majority of structures designed and constructed to national building codes after approximately 1975, or upgraded to rehabilitation guidelines or standards after approximately 1990, the intended seismic performance of the primary seismic force-resisting systems is to provide life safety for Design Earthquake (DE) ground motions and to result in a low likelihood of collapse for Maximum Considered Earthquake (MCE) ground motions. The intended performance of nonstructural damage is to provide life safety performance for typical systems and immediate occupancy performance for critical systems given the DE. The notable exceptions are essential facilities (e.g., hospitals, fire and police stations, EOCs, etc.) and high occupancy or high hazard facilities (e.g., large schools, facilities containing elevated levels of hazardous materials, etc.) whose designs are intended to provide up to Immediate Occupancy performance given the DE and Life Safety performance given the MCE for the primary seismic force-resisting systems and enhanced (relative to typical buildings) performance for the nonstructural systems.

Typically structures, both new and existing, that achieve the Life Safety performance level for the DE will sustain both structural and nonstructural damage—their design objective is to provide safe egress of the occupants. The damage sustained may take months to repair and, for some buildings, the repair may not be economical, resulting in a total economic loss and razing of the building.

3) **O'Rourke**

The concept of a "lifeline system" was developed to evaluate the performance of large, geographically distributed networks during earthquakes, and is currently being adapted to hurricanes and other natural hazards and human threats. Lifelines are frequently grouped into six principal systems: electric power, gas and liquid fuels, telecommunications, transportation, waste disposal, and water supply, but can easily be extended, for example, to levees and flood protection systems. Because lifelines are intimately linked to the economic well-being, security, and social fabric of a

community, the initial strength and rapid recovery of lifelines are closely related to community resilience.

4) Poland

Response planning is gaining in sophistication with each event. The planned-for recovery depends on the built environment that is quickly reusable. Unfortunately, engineering professionals are rarely clear about the level of damage that can occur to their buildings and lifeline systems when the natural hazards they are designing for occur. While this is a comfortable position to take because of the concern about liability, it has led to a significant misconception on the part of the public and the emergency response planners who believe that the built environment is generally "damage proof" and will be available for immediate reuse. In reality, most buildings and lifelines have been designed to protect their occupants from harm with inconsistent regard given to reusability. In fact, no community today would meet the resilient standard outlined above [see Poland paragraph 1(d)]. Enhanced standards for new construction and mandatory rehabilitation of the selected elements of existing construction are needed to meet the goals. Recent natural disasters have shown us that some communities eventually recover and others are essentially lost.

The San Francisco Planning and Urban Research Association (SPUR at www.spur.org) is tackling this problem and their Resilient City Initiative defines resiliency in a deterministic manner based on what the city needs from its buildings and lifelines to support response, recovery, and rebuilding. It is a set of goals that can be applied to any community facing any natural disaster. At the heart of the recommendations is the need for clarity in the expected damage from each disaster. SPUR's attached Table 1 [see Appendix A] defines the needed transparent performance measures. SPUR further defines response and recovery in three phases, the same often used by emergency planners. Their attached Table 2 defines the needed condition of the built environment to properly support the recovery.

In the first phase, the weeklong response and rescue period, only the emergency response centers are needed. The second phase of recovery focuses on restoring the neighborhoods within 30 to 60 days so that the workforce can be reestablished, their communities can be restored, and people are able to return to a normal lifestyle and back to work. The third phase of recovery covers the repair and reconstruction of the affected area.

5) vonWeller

One of the most effective ways to address resilience is to ensure our buildings are resistant to the effects of disasters. A resistant building stock mitigates the initial damage, minimizes harm to people and property, speeds a community's recovery, and conserves resources. In 1999 FEMA Director James Lee Witt stated, "When disaster strikes, no matter where or how, building codes and local code officials are America's first line of defense against tragedy . . . Communities that recognize the life-or-death consequences of building codes pick up the pieces and recover from disasters while communities that shirk those codes wallow in the damage for months and years."

Authority for building construction regulation is a responsibility that remains with the states; therefore it is regulated by state and local governments. There is no mandatory national building code, but there is an established mechanism to get strengthening provisions into buildings on a national basis. For almost a century the model building code system has been a convenient mechanism for state and local entities to remain current in addressing disaster specific hazards and transferring research into implementation. For much of that time NEHRP along with the structural engineering community has been working within the model code system improving seismic performance criteria for new buildings. During the last decade the major model codes in the United States have consolidated into a single set of consistent standards which incorporate current disaster resistant regulations.

While the contemporary code has been adopted in every state to some extent, state and local adoption is not universal or comprehensive. There is enormous diversity in the way codes are adopted in the United States from full attainment, to limited adoption, to areas that strip out disaster resisting provisions, to communities that actually prohibit building codes for homes.

The best code in the world is of little use if it is not adopted and enforced by well qualified inspectors. The most successful way to ensure buildings are actually constructed according to the code and built per the engineered plan is through competent public officials with sufficient resources to do thorough and accurate inspections.

b. Personal Preparedness

1) Tubbesing

President Obama is a strong proponent of personal responsibility. In his inaugural speech, he called on Americans to take responsibility for themselves, for others, and for the future of the planet—take charge of our futures and fulfill our potential—to invest in future generations. And he pledged to lead us there.

Disaster resilience is at the core of a strong nation and surely must be put in place today in all sectors of society to ensure that the future we leave for our children is not compromised by actions we have taken or failed to take. Of course global warming is the disaster that has gotten the most press, but it is all of a piece. You can't worry about global warming in isolation of other actions that contribute to the vulnerability of the country.

Obama has even linked his strong belief in personal responsibility to disaster preparedness: "True preparedness means having federal and state and local governments all coordinating effectively, and as you just heard, one of the most important things we can do is make sure the families have prepared appropriately. We just saw some statistics coming out of Florida indicating that a huge percentage of people in hurricane areas simply don't make plans. They don't have a plan, they don't

have a set of contingencies that will allow them to respond in an effective way. . . . So I hope that message of personal responsibility sinks in . . . As we enter into hurricane season, I hope that everybody who's watching is going to be paying attention and take seriously their responsibilities as citizens so that the entire country is ready."

c. Sustainability of Recovery Practices

1) Lindell

Disaster-stricken communities have horizontal and vertical socioeconomic linkages to extra-community institutions (higher levels of government and NGOs) that provide substantial amounts of resources needed for disaster recovery. However, these transfer payments, which are ultimately obtained from less vulnerable communities throughout the rest of the country, become unsustainable if they exceed a disaster-stricken community's return contribution to the rest of the country. In many cases, an unsustainable pattern of disaster recovery arises because local "growth machines" of land developers and public officials have built large numbers of vulnerable structures within hazard-prone areas to increase short-term local economic prosperity. Developers have only brief exposure (typically less than one year) to potential disaster impacts so they are largely insulated from the financial consequences of their decisions to develop hazard-prone areas. Local officials support these developments because they contribute significantly toward an increase in the community tax base and, in addition, developers typically make major contributions to sympathetic local officials' political campaigns. The households and businesses that actually experience the disaster impacts purchase structures in hazard-prone areas because they are usually unaware of the hazards to which their communities are exposed and the degree to which the available structures are vulnerable to hazard impacts. In some cases, developers, realtors, and the hospitality industry (hotels, motels, and restaurants) even suppress information about the community's hazard exposure. The consequence of these local growth machines can be a steady increase in the amount of property and number of people occupying vulnerable structures located in a community's hazard-prone areas. In turn, this increases the financial vulnerability of the institutions, especially state and federal governments, that fund local disaster recovery.

3. Comments on How to Strengthen Resiliency

a. More Resilient Structures and Lifelines

1) Bray

Resilient cities form resilient regions which in turn build a resilient nation. While the nation can promote resilience through improved design codes and mitigation strategies, implementation and response occur at the local level. The nation cannot achieve resilience without motivating and supporting local measures that achieve resilience. Support for such activities is currently lacking.

If national resilience is to be achieved, the nation must enact legislation that empowers cities to build resilience neighborhood by neighborhood. State grants that support the identification and retrofit of "killer" buildings are required. Funds are required to develop the human infrastructure for responding to and recovering from natural hazards. A region's infrastructure needs to be seen as a combined system that must take the punch and respond effectively. Understanding and planning for effective lifeline response after extreme events is a key part of developing community resilience. Building codes need to move towards performance-based earthquake engineering so that resilience, not "life safety," is the primary objective.

2) **Hooper**

In order to achieve more resilient communities, the performance objectives for the design of new structures and the seismic rehabilitation of existing structures, including the performance of the nonstructural systems, need to be enhanced. The goals for establishing the level of resilience should be established at the national level, with the potential of augmenting the requirements at the regional and community levels. Performance-based seismic design tools are under development that will be able to provide performance results for the design of new, and for the rehabilitation of existing, structures with the intent of establishing appropriate design levels to achieve appropriate resiliency. Information such as the repair cost and the associated repair time related to earthquake damage will be able to be determined and appropriate design levels can be established commensurate with the intended resiliency.

3) **O'Rourke**

Planning for emergencies requires drills and emergency-response exercises, which can reveal weaknesses and lead to improvements in operations. The plan that emerges from any particular exercise, however, is not as important as the planning process itself, because as soon as a disaster unfolds, the reality of the event will diverge from the features of the most meticulously designed scenario. With good planning, however, emergency managers and lifeline operators can improvise, and skilled improvisation enables emergency responders to adapt to field conditions.

Significant advances have been made in high-performance computational models that can simulate complex lifeline networks. These models produce highly graphic, detailed scenarios that enable modelers and associated emergency personnel to visualize a wide range of responses from an entire lifeline system to a specific part of that system. By running multiple scenarios, with and without modifications of the system, operators can identify recurrent patterns of response and develop an overview of potential performance, helping them plan for many eventualities and improving their ability to improvise and innovate in the event of a real disaster.

Constructing and sustaining critical infrastructure requires both the financial resources and a long-term commitment to finishing complex projects. Retrofitting the California bridge system after the Loma Prieta and Northridge earthquakes has

required decades of continuous financial and political commitment. Similar lessons can be drawn with respect to the levee and flood protection systems in the Mississippi and Sacramento River deltas, the Los Angeles and New York City water supplies, and transportation systems in dozens of U.S. metropolitan areas.

We should be seeking the fusion of community resilience against hazards with a concerted plan to improve critical U.S. infrastructure. Earthquake engineering and science provide success stories and technologies to help accomplish this goal.

4) **Poland**

In many ways, the tools and procedures to create disaster resilient cities exist and are continually being refined. Achieving resiliency nationwide, however, will require a new application. Modifications to the current building codes, alignment of the lifeline systems around common performance objectives, and strong community support for adopting the policies are needed. Deficient buildings and systems need to be mitigated, new buildings and systems need to be designed to the performance levels needed.

Making such a shift to updated codes and generating community support for new policies are not possible without solid, unified support from all levels of government. The federal government needs to set performance standards that can be embedded in the design codes, provide financial incentives to stimulate mitigation that benefits the nation, and continue to support research that delivers new technologies that minimize the cost of mitigation, response, and recovery. Regions need to identify the vulnerability of their lifeline systems and set programs for their mitigation to the minimum level of need. Localities need to develop mandatory programs that mitigate their built environment as needed to assure survival.

5) **vonWeller**

Creating disaster resilient buildings is a long-term proposition. It is a wasted opportunity if we do not insist that all new buildings are constructed in ways to limit future damage and conserve resources. Code compliant new buildings can be accomplished with minimal initial expense while providing considerable enduring benefit. Existing buildings present greater challenges. It may not be practical to retrofit all existing structures in disaster-prone areas, but essential buildings and those that represent a substantial hazard must be analyzed and strengthened.

In order to secure better outcomes after natural or man-made disasters it is essential the federal government be adamant that states adopt contemporary building codes including provisions for vigorous enforcement, offer assistance to retrofit critical existing buildings, and create incentives for voluntary rehabilitation of other buildings at risk.

b. Federal Action

1) Eisner

If "resilience" is going to be more than the "sustainability" of the past decade, there needs to be a full court press from the White House. . . . What should we urge the White House to do? It should fill the definition gap by formulating and championing a general model of what "resilience" or "resiliency" is. The definition that the Fritz Institute is using is: Being Able to Rebound from Disruption and Resume a Limited Set of Critical Services to Clients in a Defined Time. If we can agree that "resilience" starts with individuals, families, and communities, includes organizations, businesses, and local and state governments, and includes supply chains and infrastructure, then the picture becomes broader than structures. Everyone in this country has a stake in creating "resiliency." I would argue that "resilience" of the physical is only a part of the challenge. It must also include the socioeconomic and cultural aspects of community.

If the White House has a role (and I am not sure what it is), it could be as ringmaster in the resilience circus, giving visibility to the multi-dimensional and multi-sector aspects of the challenge, and challenging the various sectors to join the resiliency movement.

2) Tubbesing

Here are several things I would suggest to the President:
If you are serious about disaster mitigation and risk reduction then as the leader of the federal government you need to make sure the government serves as a model, that our government has a plan for disaster preparedness and mitigation, and that the federal government demonstrates its commitment through its own actions.

- At the federal level this might include examining and estimating the cost to strengthen the federal building stock (which we know it has already done for earthquakes) and developing a plan to address those areas of greatest vulnerability to ensure that government functions are resilient—that they function effectively after a major disaster, with minimal disruption, so that the impact on government operations is not itself a contribution to the problem. *(This might open the door for us to go to the highest levels and ask that the cost report be released and form the basis for an action plan.)*

- The federal government is in a position to not only model mitigation behaviors but must help state and local governments by providing incentives to develop mitigation, response, and recovery programs. Project Impact demonstrated that it doesn't take a lot of money at the local level to bring community members together to contribute their expertise, to make their communities and universities disaster resistant. The federal government must target incentives to enable state and local governments to develop and implement mitigation programs. Some programs exist, such as the State Hazard Mitigation Grants, but they are tiny. They need meaningful funds.

- Implementation is currently the weakest link. Hazard mitigation can be dramatically advanced by placing greater emphasis on putting into practice the knowledge we have gained over the past several decades and by employing the technology and tools that have been created through NEHRP and other hazards programs. Unfortunately Congress has consistently underfunded agencies such as NIST and FEMA that transfer research into practice, codes, etc. I suggest a line item at a level comparable to that spent on research be put in the President's budget to fund programs that implement knowledge in all the hazard areas through national codes, standards, training, education, guidance materials, and technical and continuing education. If the President wakes up worrying about earthquakes, then he needs to make sure that every level of government is addressing the issue of hazard vulnerability. A resilient society requires that we take charge, that people at every level of society have a sense of personal responsibility coupled with a sense of effectiveness. We need to be able to show how we can reduce risk, that we have the tools or can develop the tools with adequate funding so that individuals and communities understand that there are practical and doable steps they can take to secure their homes, communities, and governments.

- With current high unemployment we need a program that will put people back to work in our communities in meaningful employment. Why not create a jobs program that would put people to work on projects that reduce vulnerability of our communities, homes, and schools? In the 1930s the WPA built bridges and highways, buildings, etc. Our infrastructure is in terrible shape. Why not train workers to work on the failing infrastructure and build it at high performance levels to reduce damage from the next hurricane, earthquake, or flood? A jobs program would go a long way towards reducing the risk in communities all over the country. Homes and schools could be secured against earthquakes, hurricanes, and storm surge (flooding may be a bit more of a challenge). A job corps could also educate people throughout the community about personal preparedness actions to protect their homes and families, giving them a sense that their actions can make a difference. People could be encouraged to purchase insurance and take other steps to secure their property. Such a program would, of course, incorporate the 10 steps developed in conjunction with the 100th Anniversary Conference on the 1906 San Francisco Earthquake to making communities safer [see Appendix B].

3) Wang

ACEHR/We believe that a rapid acceleration of the current NEHRP program, combined with a new mitigation implementation program, is necessary to build a resilient nation.

Among other ideas, we propose xxx (workshop, etc.).

4) Woodworth

Successful collaboration and a unified message are important elements of a sound national resilience policy. We are encouraged by the leadership [that Richard Reed and his colleagues have] demonstrated in this area and are hopeful this effort will continue to help unify the multiple federal departments and agencies that have included sustainable and resilient practices within their operations. Building a collaborative and consolidated position across these agencies would be of great benefit.

Long-term resiliency requires investment. When considering such an investment business leaders and government officials want to know the benefits and costs associated with their expenditures. We encourage the conducting of an independent study to determine the costs and benefits associated with commercial business investment in resiliency (structural and nonstructural). An independent study (validated by OMB and CRO) would give business leaders the hard dollar justification needed to make such investments in long-term resiliency for the benefit of their companies and communities.

c. Governmental and Market Mechanisms

1) Lindell

Truly sustainable community disaster resilience can be achieved only if higher levels of government and market mechanisms can limit the influence of local growth machines by requiring hazard mitigation in exchange for disaster assistance eligibility (ex ante) or actual disaster assistance (ex post). When only part of a community is exposed to a hazard, land use practices are feasible (e.g., limiting liquefaction-prone sites to recreational uses). When the entire community is exposed to a hazard, building construction practices are more appropriate (e.g., requiring seismic bracing in all homes constructed in a community that is prone to seismic shaking). In addition, hazard insurance can contribute to community hazard resilience if premiums are proportional to hazard exposure. This provides a market signal of the true cost of land development in hazard-prone areas, thus forcing property owners to prepay the cost of disaster recovery rather than transfer it to other taxpayers after the fact.

d. Use of NEHRP Approaches, Insights, and Lessons Learned

1) Arabasz

On November 24, 2009, Richard Reed, Special Assistant to the President for Homeland Security and Senior Director for Resilience Policy, spoke to us in our role as the advisory committee to the National Earthquake Hazards Reduction Program (NEHRP). He described the Administration's goal of making our nation resilient, and aptly described resilience as "the ability to take a punch and recover." Experiences and successes in NEHRP offer useful insights into managing natural disasters—before, during, and after. We believe policy-making for national resilience can learn from NEHRP, and NEHRP can benefit by interacting in that policy-making.

Four relevant circumstances:

- Because of the widespread nature of the earthquake threat in the United States (42 states are at some degree of risk), and because a large earthquake can directly impact a multi-state region, NEHRP's strategic planning for earthquake preparedness, response, and recovery has had to be broad.

- Dozens of specific U.S. metropolitan areas are at high to moderate seismic risk, so a targeted approach has been needed.

- The scales of planning and action necessarily range from national to regional to state and local.

- NEHRP is underpinned by a community of dedicated earthquake professionals—notably, scientists, engineers, building code officials, emergency managers, and social scientists—but the engaged stakeholders are greatly diverse (consider the 6.9 million participants in The Great California ShakeOut of 2009).

So what can be learned from NEHRP about achieving resilience?

- The "rubber hits the road" at the local and state level. National policy-making starts with federal agencies, but there has to be a coherent interaction between those federal agencies and individual states, which are key political jurisdictions. In the long term, effective local resilience depends on enabling local activists under a state program.

- NEHRP's Advanced National Seismic System (ANSS) is a model example of a hazard-monitoring system (built from community consensus) that (1) effectively integrates national-scale, regional-scale, and local-scale elements; (2) actively engages stakeholders in the multi-level management structure; (3) is a catalyst for interactions among scientists, engineers, and emergency managers; and (4) provides critical information for pre-disaster planning, rapid post-event response, and (in the near future) early warning of imminent impact.

2) Eisner

NEHRP challenged federal agencies, the professions, states, and local governments to "reduce earthquake hazards." It was conceived as a multidisciplinary and interdisciplinary endeavor that addressed many of the attributes of vulnerability. It recognized that there was a social, political, and economic world beyond earth science and engineering. NEHRP provided a focus nationally on earthquake hazards and then funded interventions in the code, engineering, architectural, and emergency management professions to reduce risk. Simultaneously, there was a Presidential order /directive requiring federal agencies to build and lease facilities that met seismic standards. You could argue that this action by the White House created economic incentives, created a market for codes and engineers, and created a "standard of care" for new construction. The NEHRP State and Local Program (SLP) provided funds to

the states to establish what were essentially political action programs to promote application of the science and preparedness among communities, individuals, schools, hospitals, and businesses. At the same time Ugo Morelli was cranking up the development of the NEHRP guidelines—documents that answered the question: "How do we do this?" This was all in 1980, well before Project Impact, which I suspect was modeled after the SLP programs.

So what does this have to do with "resilience?" Well, right now "resilience" is just a word that is not defined, but seems to be owned by a lot of people. What NEHRP created was a political movement. If "resilience" is going to have traction, we should think "movement." What will it take to motivate changes in behavior to achieve resilient communities?

3) **Harris**

NEHRP is both an example of how the federal government is helping to build some resilience and an example of how more federal assistance and leadership is necessary:

- Real progress on understanding the hazard.
- Real progress on protection of life in new buildings.
- Real progress on information for immediate response.
- Real needs on many things (here is your challenge—don't get too long winded). I would say something about performance based earthquake engineering, but that is my perspective. You would (and should) hit existing buildings, perhaps as Jon suggested. Tom wants lifelines. Walter wants ANSS. I particularly liked Brent's point about information on costs and benefits to improve private-sector decision making—a perfect circumstance for federal leadership.

4) **O'Rourke**

There is much to be learned from the earthquake community with regards to resilience. The earthquake community has developed technologies for reinforcing and monitoring the built environment, loss assessment methodologies, and emergency response procedures. The earthquake community also involves a unique, multidisciplinary culture that integrates basic and applied research into design codes, construction methods, and public policy.

5) **Wang**

Thanks for welcoming our comments to guide the nation towards improved security and resiliency. We are looking forward to collaborating [with the Obama Administration] to reach our common goals. As we agreed at our November 23, 2009, meeting, like terrorist attacks, earthquakes pose a serious and real threat to the nation's security on multiple scales—national, regional, and local. Earthquakes and other hazards threaten our people, our physical infrastructure, and our economy.

Since NEHRP's inception in 1977, NEHRP has been committed to protecting lives through many tools, such as building codes. NEHRP and these tools provide a solid framework for varied disaster planning. Yet, many serious gaps exist. The vast

majority of physical infrastructure was constructed to inadequate standards well below our current standards. As an example, one-third of buildings are prone to major damage and critical lifelines (such as highways, ports, electricity, telecommunications) will not be able to provide their intended services in a major earthquake.

Appendix A (from Poland Statement)

SPUR Table 1: Performance Measures that Support Disaster Resilient Cities

CATEGORY	BUILDINGS
A	**Safe and Operational.** This describes the performance now expected of new essential facilities such as hospitals and emergency operations centers. Buildings will experience only very minor damage and have energy, water, wastewater, and telecommunications systems to back up any disruption to the normal utility services.
B	**Safe and usable during repair.** This describes performance for buildings that will be used to shelter in place and for some emergency operations. These will experience damage and disruption to their utility services, but no significant damage to the structure. They may be occupied without restriction and are expected to receive a green tag[4] after the expected earthquake.
C	**Safe and usable after repair.** This describes the current expectation for new, non-essential buildings. Buildings may experience significant structural damage that will require repairs prior to resuming unrestricted occupancy, and therefore are expected to receive a yellow tag[5] after the expected earthquake. Time required for repair will vary from four months to three years or more.
D	**Safe but not repairable.** This level of performance represents the low end of acceptability for new, non-essential buildings, and is often used as a performance goal for existing buildings undergoing rehabilitation. Buildings may experience extensive structural damage and may be near collapse. Even if repair is technically feasible, it might not be financially justifiable. Many buildings performing at this level are expected to receive a red tag[6] after the expected earthquake.
E	**Unsafe.** Partial or complete collapse. Damage that will likely lead to significant casualties in the event of an expected earthquake. These are the "killer" buildings that need to be addressed most urgently by new mitigation policies.
	LIFELINES
I	**Resume 100% of service levels within 4 hours.** Critical response facilities, including evacuation centers and shelters, need to be supported by utility and transportation systems. This level of performance requires a combination of well built buildings and systems, provisions for making immediate repairs or activating back-up systems as needed, and redundancy within the networks that allows troubled spots to be isolated.
II	**Resume 90% service within 72 hours, 95% within 30 days, and 100% within four months.** Housing and residential neighborhoods require that utility and transportation systems be restored quickly so that these areas can brought back to livable conditions. There is time to make repairs to lightly damaged buildings and replace isolated portions of the networks or create alternate paths for bridging around the damage. There is time for parts and materials needed for repairs to be imported into damaged areas. These systems need to have a higher level of resilience and redundancy than the systems that support the rest of the city.
III	**Resume 90% service within 72 hours, 95% within 30 days, and 100% within three years.** The balance of the city needs to have its systems restored as buildings are repaired and returned to operation. There is time to repair and replace older vulnerable systems. Temporary systems can be installed as needed. Most existing lifeline systems will qualify for Category III performance.

SPUR Table 2: Resilient Performance Requirements for the Built Environment

Phase	Time Frame	Condition of the Built Environment
1	*1 to 7 days*	*Initial Response and staging for reconstruction*
	Immediate:	Mayor proclaims a local emergency and the City activates its Emergency Operations Center. Hospitals, police stations, fire stations, and City department operations centers are operational.
	Within 4 hours:	People who leave or return to the city in order to get home are able to do so. Lifeline systems that support critical response facilities are operational.
	Within 24 hours:	Emergency response workers are able to activate and their operations are fully mobilized. Hotels designated to house emergency response workers are safe and usable. Shelters are open. All occupied households are inspected by their occupants, and less than 5% of all dwelling units are found unsafe to be occupied. Residents can shelter in place[3] in superficially damaged buildings even if utility services are not functioning.
	Within 72 hours:	90% of the utility systems (power, water, wastewater, power, natural gas and communication systems) are operational and serving the facilities supporting emergency operations and neighborhoods. 90% of the major transportation system routes, including Bay crossings and airports, are open at least for emergency response. The initial recovery and reconstruction efforts will be focused on repairing residences and schools to a usable condition, and providing the utilities they need to function. Essential City services are fully restored.
2	*30 to 60 days*	*Housing restored – ongoing social needs met*
	Within 30 days	All utility systems and transportation routes serving neighborhoods are restored to 95% of pre-event service levels, public transportation is running at 90% capacity. Public schools are open and in session. 90% of the neighborhood businesses are open and serving the workforce. Medical provider offices are usable again.
	Within 60 days	Airports are open for general use, public transportation is running at 95% capacity, minor transportation routes are repaired and reopened.
3	*Several Years*	*Long-term reconstruction*
	Within 4 months	Temporary shelters are closed, with all displaced households returned home or permanently relocated. 95% percent of the community retail services are reopened. 50% of the non-workforce support businesses are reopened.
	Within 3 years	All business operations, including all City services not related to emergency response or reconstruction, are restored to pre-earthquake levels.

Appendix B (from Tubbesing Statement)

Earthquake Professionals' Top Ten Actions for Northern California

The people, businesses, and government agencies in Northern California risk suffering life, structural, and financial losses when major earthquakes strike. Scientists, engineers, and emergency management experts gathering for the 100th Anniversary Earthquake Conference call on the region's citizens, businesses, and policymakers to take the following actions to increase safety, reduce losses, and ensure a speedier recovery from the next major earthquake.

Develop a Culture of Preparedness

1. Every household, government agency, and business must know the seismic risks of the buildings they occupy, the transportation systems they use, and the utilities that serve them, as well as the actions they can take to protect themselves.
2. Every household, government agency, and business needs to be prepared to be self-sufficient for at least three days (72 hours) following a disaster.
3. Citizens and governments need to take steps to ensure adequate response care for special-needs and vulnerable populations.
4. Government agencies, the region's major industries, and earthquake professionals have to work together to prepare the region to respond to and recover from major earthquakes. This can be done through region-wide, multi-organizational plans, training, exercises, and coordination assessments, as well as continuing improvements in our collective understanding of seismic risks.

Invest in Reducing Losses

5. Building owners, governments, and the earth science and engineering professions must target potential collapse-hazard buildings for seismic mitigation, through retrofit, reduced occupancy, or reconstruction.
6. Governments and other relevant agencies must retrofit or replace all facilities essential for emergency response to ensure that they function following earthquakes. These facilities include fire and police stations, emergency communications centers, medical facilities, schools, shelters, and other community-serving facilities.
7. Governments and other relevant agencies must set priorities and retrofit or replace vulnerable response and community-serving infrastructure, including cellular communications, airports, ports, roads and bridges, transportation, water, dams and levees, sewage and energy supplies, to ensure that functions can be resumed rapidly after earthquakes.

Ensure Resiliency in Recovery

8. Government agencies, the region's major industries, and earthquake professionals have to plan collaboratively for the housing, both short- and long-term, of residents displaced by potential fires, large numbers of uninhabitable buildings, and widespread economic and infrastructure disruption following a major earthquake.
9. Every household, government agency, and business has to assess and plan for financing the likely repair and recovery costs following a major earthquake.

10. Federal, state, and local governments, the insurance industry, and the region's major industries have to collaborate to ensure adequate post-event funding to provide economic relief to individuals and communities after a major earthquake, when resources are most scarce yet crucial for recovery and reconstruction.

In conclusion, the earthquake professionals of the 100th Anniversary Earthquake Conference believe that, based on our current understanding of the hazards, local planning, stronger building codes, and ongoing mitigation have substantially reduced the potential loss of life and property that a major Northern California earthquake could cause. Many areas are better prepared than ever before, yet the region is still not sufficiently ready for the next major earthquake. The social and economic consequences could prove to be long-lasting and ruinous to communities. With these actions and a renewed emphasis on safety, Northern California can safeguard its extraordinary cultural and economic vitality and rebound quickly following the next major earthquake.