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THORNS OF SEISMIC SAFETY:  
RISK MITIGATION POLICY

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**Thorns of Seismic Safety: Risk Mitigation Policy**

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**ABSTRACT:**

This paper's aim is to identify and discuss some societal problems that emerge in risk mitigation policy processes associated with earthquake, using the experience of California with SB1953, the state building code. The intent is to bring attention to the embeddedness of mitigation efforts in social processes and the often unexpected and unintended effects of such efforts. The California experience with SB1953 is an excellent example of how no mitigation action is possible without formal efforts at "changing the rules" by willing policy leaders and legislators who may not be able to estimate the unwelcome impact of their well intended actions, in this case the mandated retrofitting of hospital buildings. Earthquake mitigation policies imply the involvement of diverse stakeholders, such as owners and tenants, seismic experts, government officials and planners, land speculators and developers. Each of these categories of people has specific interests. Even when they share the values of "life safety" they may react differently to the social and economic rehabilitation costs. To understand these differences in perception of various categories of people involved in mitigation, in this paper we explore the logic of building retrofitting from the perspective of hospital administrators, to show that it is an important albeit only partial determinant of the ability of hospitals to perform their services. There is considerable uncertainty as to what is the most efficacious way for hospitals to invest money to protect against earthquakes, and doubt that structural retrofitting solutions are cost effective. There is also consensus among hospital administrators and managers that the vulnerability of their hospitals is not solely a matter of seismically unsound buildings but also results in part from the specific characteristics of the hazard and their linkages to the social organizations of communities. Hospitals in the sample did non-structural seismic retrofitting of their physical plant to improve the earthquake-related safety of buildings, and complied with seismic code requirements for all new buildings, but for lack of financial resources largely ignored seismic structural retrofitting of existing buildings. Hospitals incorporate seismic retrofitting as part of their programs, but they optimize rather than maximize, doing what they can with the resources they have available. All mandated disaster mitigation efforts should involve a comprehensive and detailed assessment of the multiple effects such laws could

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produce, with emphasis on the institutions that would be more directly impacted by the laws and regulations, as well as remedies to the collateral damage the mitigation could create.

TOPIC: Policies for risk mitigation in areas of high seismic risk.

## Thorns of Seismic Safety: Risk Mitigation Policy

Mitigation is commonly understood as actions that are intended to forestall known dangers and to render them harmless. Such action is very often the result of the social, collective behavior of people. Mitigation of shared, collective dangers involves changes in significant dimensions of the stratification systems of societies, power, prestige, and class (Weber). They are conflict-centered, political action. Mitigation is a multi-layered process involving the political instrumentalities of a community. In many cases, mitigation is expressed in and through state legislation and agency regulation. Thus, models of social problems as collective constructions are useful to understand the adoption of mitigation measures. The earliest of such models is H. Blumer's, which posits that the acceptance of social problems, mitigation in the present case, is negotiated and uncertain, that many problem claims are discarded, other claims gain legitimacy but are never acted upon, and those claims that make it into law are most often transformed in the process and subject to the vagaries of enforcement. It is also necessary to add that effective mitigation is not only the result of social construction processes, but also requires anticipating, to the extent that it is possible, unintended and undesirable consequences of the law.

The problematic nature of mitigation claims is nowhere clearer than in the adoption of earthquake resistant guidelines in California's building codes. In the next sections of this paper we use R. Stallings' authoritative account to provide a summary of the general features of the collective behavior that produced the current version of California's building code. This is followed by the analysis of California's SB 1953, the new state building code mandating retrofitting of hospital buildings to make them earthquake resistant, the difficulties of enforcing it, and the perception of hospital administrators.

Information comes from 13 focus groups in acute-care hospital organizations collected as

part of a hospital mitigation study. Included are hospitals in three regions of the United States facing different levels of seismic risk--Southern California, with a high level of risk, Tennessee, with a moderate risk of seismic activity, and New York metropolitan area, with a low level of risk. The population list of hospitals in these regions comes from the American Hospital Association's (AHA) Guide to the Health Care Field, an annual directory of hospitals and health-related organizations in the United States, which provided basic background information for hospitals, including bed count, type of ownership, and a list of facilities within hospitals such as trauma centers and maternity wards. Four criteria were used to select the hospitals in the study. First, the hospitals had to have acute-care facilities with emergency rooms or trauma centers. Second, hospitals in each region were selected based on the size of the hospital organization. Hospitals with less than 150 beds were considered small; those with 151 to 300 beds were considered medium-sized; and those with 301 or more beds were considered large. Third, hospitals with different types of ownership were selected. Included in the final sample are government-owned and operated facilities (3), for-profit organizations (3), and nonproprietary, not-for-profit organizations (7). Fourth, in each of the three regions selected for the study, hospitals were matched to represent hospitals in both major metropolitan cities and in smaller cities in the same counties, so as to be able to study the impact of city ordinances and building codes on hospital mitigation measures. Twenty-nine health care facilities satisfied these selection criteria, and thirteen agreed to participate: The rate of acceptance is four (out of six) in California, five (out of seven) in Tennessee, and four (out of 16) in New York. Primary reason some hospitals decided not to participate seem to have been lack of time by the staff, and the presence of overworked and understaffed hospital employees responsible for disaster related responsibilities. This study's results are preliminary, and would need to be replicated using a

more representative sample of hospitals in the states included in the study. The 13 focus groups included 76 respondents and at least one representative from each of the following four groups of staff dealing with crises and disasters: hospital administration, physicians, nursing, and engineers. Several of the focus groups included high-ranking members of the hospital administration. Respondents represented a diverse range of professions. Most were active members of their hospital's safety committee and had been involved in safety issues and crisis preparedness policies in their hospitals, embracing continuous quality improvement. This selectivity should be kept in mind in the interpretation of the results. Respondents are not a random sample of the hospital staff but have a strong interest on preparedness and mitigation activities. While we cannot claim that their concerns for these issues represent all hospital staff, nevertheless they are ideally situated to comment on the larger patterns of organizational life of interest to us. The focus group interviews consisted of open ended questions on hospital experiences and perceptions of internal and external risks, emergency plans and programs, the importance for emergency response of operational units in the hospitals, internal physical systems such as heating, and external lifeline systems such as transportation routes, and various emergency preparedness measures. Repeated analyses of the texts allowed us to extract from them recurrent codes or themes. We also derived codes to organize the texts deductively from the literature on high reliability organizations and closed systems (Morgan). The cultural dimensions identified in the analysis satisfied the criterion of repeatability, for they appeared in most if not all of the transcripts. The quotes are slightly edited when needed to shorten them, remove repetitive phrases and improve their readability. Statements of different respondents in a focus group that amplified and or gave examples of the same subject matter are presented as one quote, although the original meaning is preserved.

**California's Earthquake Mitigation as Social Construction**

DELTA NOW YOU PUT STALLING, ETC HERE, TO MAKE THE ARGUMENT  
THAT THE START OF MITIGATION IN CALIFORNIA WAS A POLITICAL ACT

Compliance Deadlines Based on Overall Reduction of Risk to the Public:

## **Earthquake Retrofitting of Hospital Buildings and California**

**SB1953.** Following the 1994 Northridge earthquake, which caused an estimated \$3 billion in damage to Southern California hospitals, state lawmakers passed California Senate Bill (SB) 1953 that same year (see Holmes, 2002; Alesch and Petak, 2001). It impacts approximately 2,507 buildings, 975 of which are SPC-1 rated (see below) on 475 hospital campuses (California Healthcare Foundation, 2007). It requires existing hospitals to meet increasing levels of seismic safety beginning in January 2002. Buildings are rated by seismic safety, from SPC-1, the lowest, for buildings which pose a significant risk of collapse and will be a danger to the public after a strong earthquake, buildings rated SPC-2, judged not to be a risk to life, but presumed to be non-functional following a strong earthquake, and so on, ending in SPC-5, the highest safety category for buildings in full compliance with the structural provisions of the law, and assumed to be able to continue to provide services to the public following a strong earthquake.. The time frame for implementation of structural mitigation measures were: January 1, 2008—hospital building would meet a minimum of SPC-2 or no longer could provide acute care services; and January 1, 2030---hospital buildings would meet SPC-4 or no longer could provide acute care services. For a number of important reasons the 2008 date was not met by any hospital in the state. Instead, they closed or found refuge in an extension to 2013 mentioned in the law, for hospitals that could demonstrate that the area they served would suffer a diminished health care capacity.

Over the next 28 years close to 50 percent of California's hospital buildings will be retrofitted, reconstructed, or closed to meet the requirements of SB 1953; and about 75 percent of the buildings will undergo non-structural renovations (Meade, Kulick, and Hillestad, 2002),. Rand's second report (Meade and Kulick, 2007) on the economic effects of the law, showed that almost half of the hospitals needing retrofitting would not meet the 2013 deadline and that many



construction projects would not meet the final 2030 deadline. It may take more than 30 years, and as much as \$110 billion, to fully implement the law. Rand's earlier report had estimated that the total cost of compliance with SB 1953 would be \$41 billion. However, justifying the much higher estimate since 2002 is inflation, the small number of qualified engineers and contractors, and the higher costs of building materials (Dauner, 2006). He reports that the estimated building costs have doubled-from 1 million to up to \$2 million per bed.

California Office of Statewide Health Planning and Development (OSHPD) estimated that 56 percent of California's hospitals are operating in the red, and the Shattuck-Hammond Report commissioned by the California HealthCare Foundation (<http://www.chcf.org>) found that over half of the State's hospitals were losing money in 1999. The costs associated with the disruption and losses in productivity associated with retrofitting of buildings were very high. More than 70 California hospitals have closed in the past decade, 10 in the past two years, this in a state with a growing population, a decline in the number of emergency rooms, a greater percentage of non-ambulatory patients, and fewer available hospital beds. For example, San Francisco General Hospital, an important teaching hospital, was rated SPC-1 as of January 1, 2002, and this was true of all other San Francisco hospitals, except Chinese Hospital and Kaiser Hospital. In fact, the California Health care Association (CHA) warned that non-compliance with SB1953 would most likely result in the closure of one, two, or three acute care hospitals in San Francisco between now and 2013, with a concomitant loss of beds. Apparently, the assumption made when SB 1953 was enacted was that the hospitals would rely on their own resources and replace and modernize their facilities in the normal course of business. This has not happened.

The inability of the hospitals to satisfy the law has brought about efforts to in effect, change it. In May 2006 the California Building Standards Commission adopted a new method to

reclassify SPC-1 buildings to SPC-2 based on collapse probability assessment calculated using the HAZUS-MH MR-2 methodology developed by the US Federal Emergency Management Agency and the National Institute of Building Sciences. Separately, hospital owners who promise to build new hospital buildings instead of retrofitting the existing buildings (it takes 10 years to build a new hospital in California (*San Francisco Business Times*, February 15, 2002)) will also be able to extend the 2008 deadline. Most certainly, unless state and federal funds are mandated to facilitate this effort we can expect more changes in the law.

Apparently the real vulnerability of hospitals is exaggerated. Not one patient has died from a hospital building collapse in more than 30 years. (Dauner, 2006), and Schultz reminds us that the last deaths took place during the 1971 San Fernando earthquake (Los Angeles, California, USA), in which 50 of the 64 deaths were due to hospital building collapse, and 4 hospitals with structural failure were closed. The real calculation is then not only the estimated number of lives saved by seismic resistant hospital buildings but the net effect of such mitigation effort, in light of its negative impact on the public health system of the state. Any such calculations would have to have a good understanding of the institutions of hospitals, how they work and what makes for resilience in these settings based on the opinion of the people and administrators that work in them.

**Taking Care of Patients.** While changes in the law regulating buildings reflect the influence of mobilized professional associations (Stallings, ), from the perspective of hospital administrators and staff, if compared to a seismic engineers, architects, and other constituencies, the seismic readiness of the existing physical plants of hospitals is an important albeit only a partial determinant of their ability to continue to perform their services during emergencies, crises, and disasters. Other considerations, such as the availability of equipment and trained staff,

are also important. In the words of one respondent, "It all depends on the type of damage that we would sustain and our internal capabilities. We may not have sustained any structural damage but our capabilities could be low, so that we would be in a situation where a disaster hitting us would only compound the issue, but that may have nothing to do with the infrastructure." Caring for patients is the dominant rhetorical justification used by hospital personnel, so that all decisions, including structural seismic retrofitting of existing buildings, are linked to this value. There is little ambiguity among our respondents about what constitutes failure of the organization: inability to deliver patient care. This value is quite different from the quality and outcome of that care, and whether the patients recover or not, the responsibility for which resides in a different circle of activities and specialties.<sup>1</sup>

In the words of one respondent, "If I'm looking to replace the chairs in this room versus a new defibrillator, the defibrillator is going to come first." Another respondent added that investment in new equipment is not only a matter of how old they are but also of whether or not they can be repaired, "...the level of importance to patient survival determines our purchasing the equipment. We make sure that that piece of equipment needs to operate basically no matter what happens. So, say it needs to be tied to the emergency generator system, we look at the level of importance of the equipment: Is it life saving equipment or is it something else?" Another respondent added that investment in the rehabilitation or retrofitting of non structural elements

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<sup>1</sup>Egregious errors take place in hospitals and are the cause of the patient safety movement sweeping the United States--it is estimated that close to 7000 people die each year as a result of medical errors, and various efforts such as voluntary reporting of medical errors are now being instituted (Margaret O'Leary, personal correspondence, July 31, 2003). Nevertheless, our respondents were concerned with providing the resources of energy, space, and material that the medical staff would need to treat patients.

involved two lists, "One is what we must have, and then we have the things like the tube system that are ten years ago old but it keeps going, so it is less important to replace it."

Yet another distinction hospital personnel make in their purchasing decisions is between what they need now and what they may need later. The earthquake risk is so uncertain that it tends to fall into the later category of concerns,

"Our job is to take care of patients on our day-to-day basis. We really cannot expand on what might happen, such as an earthquake, because of the bad financial situation in the health care industry... We have been batting back and forth about whether to buy decontamination technology for a large group. What we have is not very good for a large group, unless we are warned, because we just have one decontamination shower. If it is not cold weather we could get out there and hose them down. There are tents and things available that we could purchase, but that has just not been a high priority to purchase. Plus we have not had a need; there is always that maybe, and what if, and so far decontamination equipment has not been a high priority."

**Uncertainties.** Seismic retrofitting of their physical plant is only one of a number of issues hospital administrators must respond to, and each of these issues involves different audiences and different sets of often mutually contrary expectations. Ambiguity and uncertainty impact their decision-making. In these contexts of high uncertainty and great expense, they follow a strategy of limited action and optimization of benefits (Simon, 1982; see also Kahneman and Tversky, 1979). In matters of seismic retrofitting, they make decisions not by "maximizing" the possible benefits they may obtain but rather by "satisficing", i.e. setting their aspiration levels to minimize risks rather than maximize profits, so as to be able to live with the results even if their aspirations are not obtained. They attempt to optimize results, doing what they judge is possible to do within their resource availability. Hospital administrators and staff realized that the outcome of investing in many of the seismic structural retrofitting measures on existing buildings is often uncertain. They are a number of reasons for this. They technology to determine the magnitude and location of the earthquake hazard as well as the best way to

mitigate its effects is evolving, often depending on the imperfect knowledge of multiple disciplines. Nor do they have the resources (Ruef and Scott, 1998) to pay for every technical and structural innovation mandated or suggested to improve the seismic safety and efficiency of existing buildings. In the words of one respondent,

Seismic technology is still a mystery. Until the Northridge earthquake they talked about shaking this way and that way. That baby went this other way, and it totally changed structural engineering techniques... So how do you engineer it? Who engineers it? What are the appropriate seismic retrofit techniques? And how should they be done? There are many differences in terms of how people are thinking about these issues, and it creates difficulties for us.

They also understand that their vulnerability from earthquakes is not solely a matter of having seismically unsound buildings, but results in part from the specific characteristics of the hazard that may materialize, itself a difficult matter to discern and plan for. In one hospital they have built a state-of-the-art trauma center satisfying stringent seismic code requirements. Yet they think that it will collapse if it was

An 6.0 earthquake, our building probably would not stand. It would not make any difference if it could withstand an 8.0. You may have the walls standing but what is inside may not be. The Japanese are probably the most earthquake conscious nation in the world and yet we found out that the generators for the hospitals in Kobe were all cooled by city water so they lost all of their generators because the city water interrupted during the most recent massive earthquake. The generators in the hospitals were useless. So you can do all of this stuff and there are very often hidden problems.

They are also aware of the impact on their operation of their linkages to the social organizations of their communities that have their own set of vulnerabilities and that cannot be modified by the hospitals to any significant extent. Examples often related to municipal utilities and local transportation systems, "In a disaster we might be in trouble. A lot of our utilities are underground, in a tunnel system. So in a big earthquake I don't know what would happen (in the tunnels), nor do we know what would be the magnitude of the event."

**The Regulatory Environment.** The inability to know with any certainty when, where,

and how severely the earthquake hazard will impact the physical facilities of hospitals, maximizes the political dimensions of the implementation of seismic building codes. Whether or not hospitals are in compliance with the seismic components of the building code is to some extent a process of negotiation. In these negotiations, architects and engineers often help hospitals determine how best to seismically retrofit their facilities, and what they need to attend to in the building codes. In one hospital in California,

We have an architect that is real familiar with our facility. He actually attends all the meetings of the state agency with jurisdiction over the new building code, actually sits in on those meetings on the planning and designing aspects. Then from there the only other people who are involved at this time are the actual structural engineers. We just sent out an RFP to try to get information from three different engineering firms about the cost of doing our entire compliance plan. They will be probably the only other people who will be pulled in. The rest of the work is handled in house by our staff.

Some of the hospitals had their own planning and design groups, which,

Drew up the specific areas we want altered. They make plans that are code compliant; they are responsible for making sure we adhere to the appropriate building codes. A building expediter is involved to make sure that we do it right. They will decide if the sprinkler system can be grandfathered, or if a particular piece of property has to be upgraded. They are responsible for making sure we adhere to the appropriate building codes, such as rehabilitating or retrofitting non-structural elements to ensure they will not fail.

These negotiations are highly technical. There are multiple regulations, building codes, and enforcement agencies monitoring the seismic worthiness of the buildings of hospitals, and at times it is not clear what building code is applicable and what regulatory agency is involved with what specific type of hospital function, and what specific segment of the built environment. It is in this context that hospital administrators and staff have some flexibility in how they respond to earthquake-related structural retrofitting code requirements for existing buildings. There were a number of federal, states, county, and local agencies enforcing various types of regulatory codes often having relevance to building code requirements,

...if it gets into a clinical renovation, involving patient care, the state steps in. They do a final inspection. Their guidelines for clinical renovations are a little more stringent. If it is patient care and if we are spending more than one million dollars or even less than that, then we are going to have state inspections instead of the local inspections. In this county we are fortunate that most of our codes requirements are higher than the state requirements, so if we make it past the local, we won't have any problem with the state. If our county inspectors have already signed off, the state never challenges it. Especially our fire codes are extremely high.

Multiple codes and multiple agencies regulating multiple functions of hospitals usually mean that the hospitals have some leeway to negotiate with building code inspectors, for it is a regulatory context that facilitates the emergence of common sense rules,

Every little area is going to be upgraded because it is a big building. However, they said that instead of having to retrofit the whole facility, for now they are going to insist only on the critical care units. So the emergency room, surgery, and radiology we will be supporting what they call the bowling ball effect. Anything over twenty pounds above the ceiling has to be seismically secured--that would be the ceiling, all the light fixture and what have you. So, we are getting a little bit of a reprieve.

**Existing Buildings.** When decisions involve the seismic structural retrofitting of existing buildings, full compliance with seismic building codes is generally not observed among the hospitals in this study. The opposite is true for the construction of new hospital buildings, for they adhere to all structural seismic building code regulations, "When the new parking garage was built, which has a lot of different levels of concrete, it was built according to the new seismic code. It has expansion joints, and whatever else it needed. Nowadays we are building new operating room suites, and you can see some of the seismic building codes that they are implementing." Another example, "The trauma center was a newly constructed, free-standing building. We have in it state of the art seismic elements such as phase isolators. Whatever the industry had out at that particular time is on it. The facility could withstand a certain magnitude earthquake."

Importantly, it is not always possible for hospital administrators and staff to determine whether and to what extent their existing buildings are in compliance. Many of the hospitals in this study had multiple buildings at different levels of seismic readiness, which made it difficult to develop a comprehensive assessment of the extent to which they met seismic code exigencies, as the following quote illustrates,

We have one building now that is seismic. Everything else is in various stages, so that we go from poor to bare minimum maybe in terms of seismic readiness. One of our building was built in 1942, the other was built about 1944, a third building was done in the late 1950s, a fourth was built in 1981, a fifth was done in 1991, a sixth was built in 1994, and that is the one that is seismic compliant. The other buildings are not seismic, so that we don't have Z-bracing on the structural parts. However, we do have locks on pipes and other things that are suspended, and they got the teetered cables so they will not fall on people's heads. The non-structural outlets have been strengthened. The 1994 building was built from scratch, that way it has Z-bracing throughout.

Another respondent in another facility expresses a similar difficulty,

Is there a seismic code? Yes and no. There is one code in the new facilities and then there are the old facilities built on different codes. Our counterparts in the city, when they were inspected, were made to do certain things, such as raising shelving and some other things that we have never been required to do when we have submitted plans. It has to do with the age of the building and its location. This building is supposed to be "earthquake resistant." The label comes from the building code established in the early 1970s. It is supposed to have some flex in the structure. This was one of the first hospitals built in the city to meet the code guidelines related to earthquake specifications.

Often buildings built under different building codes are connected among themselves. Their physical adjacency, and the networks of communication, utilities and critical systems existing among them diffuses their respective differential seismic vulnerability throughout the system of buildings in a hospital campus,

We have ten buildings. One was built in 1927. And attached to it, I mean as part of the 1927 building, there is a 1952 building. They tend to separate. They do come apart. They came apart in the last earthquake. Then we have a fourth building that is this building. Then we have the fifth building. Then we have the conference center. The fifth building is also connected to the 1927 building. We have the ICU building that is connected to this building and was built in 1989. We also have a parking garage building. We also have other buildings done in the early



1920s. These buildings are primarily on a one square block, except for two buildings that actually are across the street.

None of the buildings in this complex have been evaluated for their seismic worthiness. The diffusion of vulnerability among buildings is also apparent in the following response from another focus group,

The general view around here is that the high school building will sit down like a pancake when it folds. One of our buildings would probably remain standing. It is a fairly stiff compact building, a lot of mass for its type, so that it would probably do fairly well. Everything else would crumble, and the problem is that as they crumble they will impact other structures, for all of our buildings are connected by breezeways and utilities. It would not be pretty. The general citywide thinking is that the hospital is on the earthquake fault. If it shakes, it shakes, and there is nothing that you can do. The soil that we are on right here will become like quicksand, and we will be gone. We would have to rebuild under the new seismic codes.

The physical links among buildings built under different building codes at time create permanent incompatibilities in their structures to which hospital personnel and patients must adjust<sup>2</sup>,

**Strategies of Corporate Adjustment.** The end results of these uncertainties is that it is not always clear to hospital administrators what is the most efficacious way of investing money to protect existing facilities against earthquakes. Over time they have developed four general strategies to deal with the structural demands of seismic building codes:

1. **Non-Structural.** There is the strong perception that non-structural seismic retrofitting solutions are more cost effective (Whitney et al., 2001): Respondents mentioned that they were doing non-structural seismic retrofitting of their existing buildings. In the words of one of our respondents, “We have done the non-structural seismic elements. We have allocated dollars and staffing to address things like piping, fire alarm systems, and medical gasses. There is no way we

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<sup>2</sup>It results in the constant monitoring of the relative safety of various buildings, known in some hospitals as “environmental rounds” in which different people from different departments in the hospitals (6, 9, 10) check for safety and the environment, such as fire doors, elevators, to make sure that things are working as expected.

can do the structural improvements.”<sup>13</sup>

Most of these non-structural retrofitting efforts involved the strengthening of *systems* in existing buildings rather than retrofitting entire buildings, as the following cases illustrate,

Do you bring the building up to the current code, regardless of its age? We run into more of that with sprinklers, because our buildings do not have this safety feature, so if we do any major renovations we are going to have to add sprinklers and those types of things (emphasis added). We're not a fully fire-sprinkle building. We haven't been required by code, but we are, on our own initiative, going to sprinkle the entire facility to meet code over the next couple of years (emphasis added).” For existing buildings, say that they have a stairwell that is x number feet wide and the code requires it to be larger, nobody is going to push us to do because that would require tremendous amounts of money to change it. But any other thing that we do within the space available in the building, we will be in compliance with the code, like establishing handicap access. For example, in a hallway that is in an exit path, if we do any construction that requires changing the hallway, depending on how many feet are involved, we will have all the problems corrected to satisfy code; everybody must be able to see the exit signs, and then we do extra drills so people become familiar with the new exit signs. We call it life safety measures (emphasis added).

Other systems involved in these changes are signs showing the proper direction for exits, replacement of generators to make them code compliant, restraints for piping systems, ceilings and light fixtures that are seismically anchored to the building, new decontamination areas, and new doors. In one hospital, “We will gut that whole area, remove all those hollow clay tiles, and then everything will go back together to satisfy the non-structural performance code. It is just a small section of the building that we have to worry about right now (emphasis added).” In another hospital,

From the building maintenance perspective, we upgraded all of our boilers and our chill rooms recently, so we are pretty much guaranteed heat and air conditioning throughout the years. Whenever we get money we upgrade our equipment to clean the environment, our operating rooms. If there are certain materials and equipment needs that the physicians need to have, it goes through a product evaluation committee and those systems are upgraded. Our X-ray department was up-graded. Structurally, we are in the process of re-pointing the building and ceiling.

2. Moving Things Around. Another mode of adjustment to the demands for seismic

structural retrofitting of existing hospital buildings is moving functional units around different buildings in a hospital complex, as the following examples indicate,

If you are remodeling about 40 percent of an area of the hospital, then the code department will require you to bring everything else up to standards. A fine example would be when we were going to put in the Radiology Department. We found that if we built it in a certain area then we had to bring the entire radiology department up to code, because of the amount of space that was involved. But fortunately when we expanded the hospital and built a section of it, the radiology department was expanded, so part of the radiology department was inspected and brought up to code at that time. What we had to do was redesign the program, and in that way we avoided at that time the additional expense of bringing the entire radiology department back into code.

◆ Actually, to avoid expenses, there is a space in this building where the kitchen could actually be put in this building if we needed to do so.

◆ Yes we have a computer on the second floor. We have all of our computers situated up there, and the building is a non-acute care facility. However, if those computers serve the acute care facility we have to either rate that building as an acute care facility or to relocate the computers. So we have decided to relocate them. We are going to relocate them to a building that had been approved (emphasis added).<sup>11</sup>

3. Outsourcing. Yet another adjustment is outsourcing, (Kirkman-Liff et al., 1997), in effect eliminating the activity altogether,

Are you considering trying to move those critical systems out of that building? The architects will be looking at that as part of an overall plan, but there is also the possibility that we can outsource those services where deliveries will be made to the hospital and therefore we are not responsible. By outsource I mean remove them from the hospital so that they are no longer considered part of the hospital. That is another possibility that is also being discussed with the architect.

4. Timing. In some rare occasions, another way to get around the problem of stiffer regulations is to have building elements inspected prior to the effective dates of new seismic codes,

We have upgraded our power plant, which is the source of power to the whole facility. This is where we get all of our steam generation and all of our chilled water so we were very fortunate to have that completed before our evaluation started. We also had our emergency generators already under permit and they had already been upgraded, so we were very fortunate in that respect also (emphasis added).

In sum, hospitals are constantly doing non-structural changes to improve the earthquake-related safety of their buildings. However, they do not attempt to modify all of the structural components of existing buildings that new seismic building codes may prescribe. It is not entirely because they lack knowledge of the importance of seismic retrofitting (Russell et al., 1996) or because inspectors lack education (EERI, 1996). Rather, it is because of the uncertainties associated with the decision, the tremendous financial expenses of doing so, the multiple dimensions of implementing safety in hospitals, and the complex regulatory environment in which they operate. Instead, they spend what they must to ensure a reasonable degree of occupant safety, while building new structures to fully comply with the new seismic codes.

**California.** According to our respondents California's SB 1973 demands exceed the resources of many hospitals in the state. It is perceived as an unworkable and unreasonable law resulting from pressure on the state legislature by special interests such as structural engineering professional associations, "It is another example of a very specific group of professionals trying to make big bucks, out of making the public happy and the politicians happy. I am talking about structural engineering groups, and you also see it with attorneys every day. Obviously, it is unrealistic cost-wise."

The widespread expectation was that it will be rescinded or modified once the economic impact on the health industry was understood and hospitals started to curtail services or go out of business,

We all agree that we have to maintain the highest standards, but where does the money come from? That was never really considered when they passed the bill. The public is going to get hit with it eventually. And then somebody is going to be upset about how all this ended. So there is a lot of jockeying going on right now about how we do this. How do we minimize the amount of effort and the amount of expense that we have to have? There is a lot of procrastination going on intentionally

because if you spend the money now, before all this is filtered out, you might end up spending money needlessly (emphasis added).

The new code caused great uncertainty among hospital administrators. They tried to influence the legislature to change SB 1973. There is also the recognition that existing government facilities could not enforce it if it was left unchanged, as reflected in another focus group respondent's comments,

There are a lot of hospital associations working on it, a lot of lobbying going on right now. We still don't know how this is going to be enforced. It is \$24 billion worth of work that has to happen. California's regulatory agency at its current rate approves about \$1.2 billion a year. It will be a 20-year process for them to be able to get through all this. And we have less than ten years to get it done. That means that they're either going to have to contract out some work or there will be some major changes in their office procedures to approve that much work. Whom are they going to contract it out to? There are just not enough architects out there. They are still trying to figure out how they are going to do all this. Nobody took that into perspective when they passed the bill.

Moreover, the uncertainty was also reflected on the suspicion that SB 1973 eventually would be changed, so that hospitals satisfying its present-day requirements for the retrofitting of existing buildings would have mismanaged their funds; and the fear is that it would create competitive disadvantages for some hospitals,

◆ They say if you don't meet code we are going to close your doors by such and such a date. Approximately 40% of the hospitals in the state won't make it. And then probably somebody will say, well, wait a moment, we can't afford to lose 40% of the hospitals! What do we do now? Then all of a sudden everybody would say, well, I guess maybe we are going to have to change this regulation. Now, what happened to the facilities that spent that money and met the regulations? They will be out of pocket with that money and have to operate at losses and will be trying to compete with other hospitals that did not comply and are not operating under the same set of rules.

Needless to say, this hospital did not try to comply with the seismic structural retrofitting elements mandated by the new code. It took a wait and see approach. As one respondent put it, "what CEO can make the decision to take a large part of his capital budget and put it into something that is a black hole?" Side by side with the uncertainty is the opposition to SB 1973.

The consensus among our respondents is that it cannot be made part of the social organizations of the hospitals in the state without severe effects on the industry, as the following quotes illustrate,

This hospital is subjected to a sixty million dollar increase in seismic structural retrofits, at the end of which we are still left with the eighty year old building: the infrastructure that serves utilities and fiber optics is not there; the modern conveniences are not there. The end result is negative. We believe in the seismic compliance of new buildings, but to go back to the old buildings and make them seismic compliant is an awful lot of hardship on a lot of hospitals. It is not feasible. We would get more return on our money if we put it in the bank in a savings account. It is cheaper when you build new ones. While no one is arguing that you do not need to treat patients in a safe environment, still, the question is: do you bankrupt the hospital that is trying to treat them, put it out of business? I do not think that should be the objective.

Well, the first thing is the cost. It is going to be a humongous cost. We have some preliminary numbers by the architect and he estimates by the time the project is 100% complete it will cost this hospital in the neighborhood of around 12 million dollars to do this building, and this is a fairly new building built to 1974 codes. It has fairly new technology. We do have an older building that was built in 1927 with an addition in 1953 and at this point we are considering tearing that building down when the point comes to that, and doing something else with the land.

It was recognized that the smaller hospitals that were built prior to the 1950s would have to be closed to satisfy the code requirements regarding the retrofitting of existing buildings.

Looking at this from a health-planning question, if you look at the smaller hospitals that were built prior to when they changed the code, they basically will be closed; they cannot afford to change. It is going to do a tremendous shift in the way people access healthcare in California. These small doctor-owned or doctor-sponsored hospitals are basically going to go away and even some of the older large hospitals. All of these older hospitals that are still sitting around will be gone. Their retrofit bill is huge.

where do those funds come from? 60% of the hospitals operationally are losing money. If they have to comply with the new state code, it will mean that they will have to go out for bond money and grant money. It will impose as much as a five percent load on their bottom line. It is going to mean the closing of an estimated 40% of hospitals that maybe are making a bit of a profit now. 90% of the hospitals will have a loss after enforcing the new code because they will have to pay back bonds and loan money.

Unsurprisingly, the hospital administrators “satisfied,” selecting from the new building code what to enact in their seismic retrofitting efforts. They made decisions about what to include

and what to ignore for the time being, hoping that their associations can successfully lobby to change the law.

We spent money to satisfy the short range retrofitting required by the new seismic building code. It was a major priority. It took up a major chunk of capital. I would say it was the highest priority, it involved investing and retrofitting or rehabilitating the non-structural elements such as piping systems, steam generation, heating and cooling. We did it in order for the hospital to protect its patients and to continue service to those who are injured. However, there is no way we can do the structural improvements.

### **Conclusion**

In their decisions regarding the adoption of seismic structural retrofitting measures mandated in building codes, hospitals use a satisfying approach, incorporating retrofitting as part of their programs to the extent that they can. Structural and non-structural seismic retrofitting of buildings of hospitals are integral parts of an established institutionalized change process in the organization of hospitals that increases their resilience and preparedness. When these changes cannot be made part of their organizations, as in hospitals in California facing the seismic structural retrofitting requirements of the new building code, they then become important threats to the industry. Seismic structural retrofitting measures would have much greater chance of being implemented in California and elsewhere if they would incorporate in their creation the usual way that hospitals react to emergencies and the usual way that they make decisions, a matter that we have tried to document elsewhere (Aguirre et al., 2005). Ignoring these matters, and assuming that values and relevancies in use in engineering disciplines and in other professional settings can be used as the main criteria to write the law and then make hospitals adopt such measures, are bound to be much less efficient. It would be more effective to integrate multiple interests and to provide room for slippage and the unique needs of various hospitals, finding out what hospital administrators and staff think will work in retrofitting their buildings and taking into

considerations what they can afford to spend.

Resources are finite and the threat of earthquakes is real even if the readiness of hospital buildings to respond to certain types of earth movement is inadequate. What is needed is optimizing systems for existing hospital buildings that alleviate their seismic structural vulnerabilities and do not have devastating economic impacts on so many of the hospitals. Alesch and Petak's (2001) "dark crystal phenomenon" in which different constituencies with different interests look at a given problem and perceive quite different solutions must be superseded by a "Hubble Telescope" view, namely by integrative, comprehensive perspectives bringing about solutions that incorporate the concerns of the major players in the policy setting process. The Hubble Telescope approach would incorporate and place priority in the legislative process in understanding the institutions that are impacted by mitigation legislation. It is not good enough to try to do good without understanding and minimizing the bad that comes with it.

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