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Overcoming Obstacles to Implementing Earthquake Hazard Mitigation Policies: Stage 1 Report

by

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16. Abstract (limit 200 Words)

This stage one report is the result of a project on overcoming obstacles to implementing earthquake hazard mitigation policies. The report identifies fundamental implementation concepts, followed by an overview of the implementation process. The results of an extensive literature review about implementation and decision-making, incorporating perspectives from political science, sociology, social psychology, organizational behavior, and general systems theory are presented. Special emphasis is given to implementing mitigation measures to reduce the risk of earthquakes. Organizational requirements for implementation, the implementation network, and propositions concerning barriers to implementation are also discussed.

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Enclosed please find 11 copies of MCEER's Monograph Series as follows:

MCEER-01-0004	"Overcoming Obstacles to Implementing Earthquake Hazard Mitigation Policies: Stage 1 Report."
MCEER-01-0005	"Updating Real-Time Earthquake Loss Estimates: Methods, Problems and Insights."
MCEER-01-0006	"Experimental Investigation and Retrofit of Steel Pile Foundations and Pile Bents Under Cyclic Later Loadings."

Enclosure

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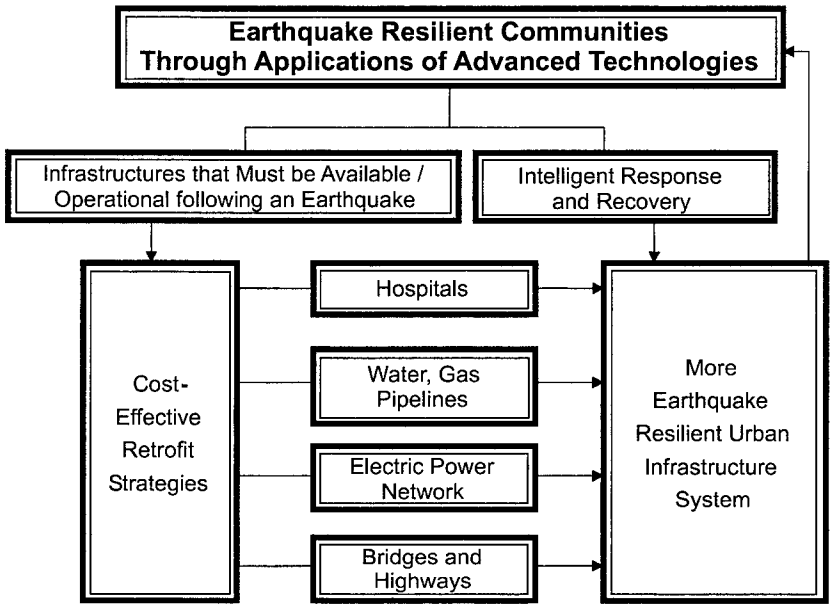
Preface

The Multidisciplinary Center for Earthquake Engineering Research (MCEER) is a national center of excellence in advanced technology applications that is dedicated to the reduction of earthquake losses nationwide. Headquartered at the University at Buffalo, State University of New York, the Center was originally established by the National Science Foundation in 1986, as the National Center for Earthquake Engineering Research (NCEER).

Comprising a consortium of researchers from numerous disciplines and institutions throughout the United States, the Center's mission is to reduce earthquake losses through research and the application of advanced technologies that improve engineering, pre-earthquake planning and post-earthquake recovery strategies. Toward this end, the Center coordinates a nationwide program of multidisciplinary team research, education and outreach activities.

MCEER's research is conducted under the sponsorship of two major federal agencies: the National Science Foundation (NSF) and the Federal Highway Administration (FHWA), and the State of New York. Significant support is derived from the Federal Emergency Management Agency (FEMA), other state governments, academic institutions, foreign governments and private industry.

MCEER's NSF-sponsored research objectives are twofold: to increase resilience by developing seismic evaluation and rehabilitation strategies for the post-disaster facilities and systems (hospitals, electrical and water lifelines, and bridges and highways) that society expects to be operational following an earthquake; and to further enhance resilience by developing improved emergency management capabilities to ensure an effective response and recovery following the earthquake (see the figure below).



A cross-program activity focuses on the establishment of an effective experimental and analytical network to facilitate the exchange of information between researchers located in various institutions across the country. These are complemented by, and integrated with, other MCEER activities in education, outreach, technology transfer, and industry partnerships.

This is the first of three reports to be published resulting from a project on overcoming obstacles to implementing earthquake hazard mitigation policies. The project aims to bridge the three planes, from basic research, through enabling processes, to engineered systems. This report presents the results of an extensive literature review about implementation and decision-making from across the spectrum of social and behavioral sciences, drawing primarily on empirical scholarly research findings. The review resulted in four products: definitional issues and concerns, organizational requirements for implementation, the implementation network, and propositions concerning impediments to implementation. Each of these products is discussed in this stage one report.

ABSTRACT

Scientists and engineers have made remarkable advances in understanding seismic forces and their effects on structures over the past few decades. Yet, with few exceptions, converting that new knowledge to safer environments has proven to be slow and, difficult. The goal of the project reported here, is to learn how to overcome barriers and obstacles to the implementation of seismic risk reduction measures

This is a working paper. It is, in essence, a lengthy review and assessment of several bodies of literature having to do with implementation of policies and programs. The review is intended to provide the basis for further understanding of obstacles to implementation and means for overcoming those obstacles, with special emphasis on implementing mitigation measures to reduce the risk to earthquakes. Almost all reviews suffer from having missed some relevant literature and this report is no exception. Additional material has already come to our attention. It, along with an extended case study focusing on seismic safety and California hospitals and a more extensive assessment of the impacts of organizational decision making and behavior, will be incorporated into the final project report.

This review cuts across disciplines, incorporating perspectives from political science, sociology, social psychology, organizational behavior, and general systems theory. Our goal has been to identify and integrate, to the extent we could, variables affecting implementation from problem or issue formulation, through policy making, through program design and administration, down to the organizations where actions are taken, or not taken, by public and private organizations that reduce the risk of seismic losses.

In this report, we concern ourselves initially with fundamental implementation concepts, including an analysis of what constitutes successful implementation and an assessment of appropriate criteria for evaluating the extent to which implementation has been successful. This is followed by an overview of the implementation process, from problem identification through final actions by target organizations. An overall descriptive model is outlined as a multi-organizational, intergovernmental network.

The report then draws upon a wide-ranging body of literature to identify potential barriers to implementation, resulting in 36 propositions summarizing the literature we reviewed. We then stipulate conditions that must exist within an organization for it to implement risk reduction measures. The organization must, first, perceive itself to be at risk. Beyond that, the organization must believe it can take actions that reduce the risk, must see that taking action is in its best interests, and must be capable of taking the necessary risk reduction actions.

In the final project report, the obstacles and the requirements for implementation will be transformed into general recommendations on how to increase the probability that effective risk reduction measures will be implemented.

PREFACE AND ACKNOWLEDGEMENTS

This is a technical progress report. Its purpose is to review, distill, and attempt to integrate key bodies of literature concerned with implementing policies and programs, with special emphasis on seismic safety. It will be revised and incorporated into a final report. The final report will include a more extensive literature review, including new materials and material brought to our attention by reviewers and other colleagues who have graciously read earlier drafts and responded to us. The final report will also include an implementation case study focusing on seismic safety in California hospitals, recommendations concerning overcoming obstacles to implementation, and modifications to this technical report based on critiques by academic peer reviewers and practitioner panels.

We very much appreciate the assistance of many in the preparation of this report and want to acknowledge their support. The International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria, provided Dr. Petak with the use of its facilities and institutional support during a recent Sabbatical, during which he was able to conduct an extensive assessment of the literature. A panel of professional engineers, scientists, and scholars met in San Francisco, California, read preliminary drafts of our material, and provided straight from the shoulder assessments of its strengths and weaknesses. The members of that group were Marjorie Greene, EERI; Laurence Kornfield, Chief Building Inspector, City and County of San Francisco; Jay Love, Degenkolb Engineers; George Mader, Spangle Associates; Richard McCarthy, California Seismic Safety Commission; Chris Rojahn, Applied Technology Council; Daniel Shapiro, SOHA Engineers; Kathleen Tierney, Disaster Research Center at the University of Delaware; and Tom Tobin, Tobin and Associates, and especially Chris Poland for both participating and hosting the workshop at the offices of Degenkolb Engineers. In addition, we are appreciative of the opportunity provided by Dr. Robert Stallings, Professor at the University of Southern California, over a four-semester period to provide copies of the draft document for study and comment by his graduate students in public policy. Finally, we are especially appreciative of the constructive comments provided on an early draft by Dr. Daniel Mazmanian, Dean of the School of Policy Planning and Development at the University of Southern California.

MCEER arranged for anonymous peer reviewers who provided us with critiques of the draft document. Those critiques were supportive and thoughtful. The reviewers' comments were so insightful that we concluded it would be impossible for us to respond appropriately within the context of this preliminary technical report. Their comments suggest additional avenues of exploration for us that we will pursue and then incorporate into the final document.

We want, especially, to thank Jane Stoyle at the Multidisciplinary Center for Earthquake Engineering Research for her efforts to ensure that this report meets MCEER standards, was reviewed appropriately, and was published and distributed.

We appreciate the counsel of all those who read and commented on previous drafts, but, as always, any shortcomings reside with the authors.

Daniel J. Alesch, Green Bay, Wisconsin
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SECTION 1.
PROJECT INTRODUCTION AND OVERVIEW

1.1 The Problem

Scientific understanding of earthquakes, ground motion, and structural response has increased markedly over the past three decades. So, too, has our collective understanding of actions that might be taken by governments, organizations, and individuals to reduce losses from inevitable earthquakes. One would like to think that this increase in knowledge has reduced significantly the risk to life and property from earthquakes in the United States. Unfortunately, it is not at all clear that such is the case.

Losses to natural hazard events occur when people live in places where moderate and strong events occur, thus creating "exposure" to events. Exposure in areas subject to moderate and strong earthquakes continues to increase because of the rapidly growing concentration of people in those areas, including the west coast and mountain states (subject to frequent earthquakes), some central states (subject to less frequent, but strong earthquakes), and parts of the east coast (subject to relatively infrequent moderate earthquakes).

Exposure alone, however, does not result in losses to life and property in the event of an earthquake. For losses to occur, the forces exerted by the earthquake must exceed the ability of structures to withstand them. That is, for losses to occur, exposed assets must be vulnerable to the nature and magnitude of the forces exerted on them by the event. Vulnerability, then, is relative; a building may be robust against a small earthquake, but not a moderate one.

Means exist to reduce the vulnerability of buildings, building contents, and infrastructure to losses from even moderate earthquakes. Often, however, these precautions have not been put in place, even in areas susceptible to earthquakes. Indeed, individuals, organizations, and governments in dangerous places have been relatively slow to implement many risk reduction practices that have a high probability of reducing their vulnerability to earthquakes. Given the increasing concentration of the American population in dangerous locations, it is essential that individual organizations implement hazard risk reduction measures more quickly and more broadly than they are doing if we are to reduce the potential for massive losses to life and property from earthquakes.

This research project does not focus on the adoption of public policies by legislative or executive bodies. Nor do we address issues concerned with the inherent quality or probable effectiveness of public policies in reducing risks. Those are critically important topics, but they are not addressed here. For purposes of our research, we assume that the earthquake hazard

mitigation policy has been adopted by a legislative body or executive at the federal, state, or local level; our primary focus is on what happens after the policy is adopted.

Our focus is on implementation of public policy by both governmental agencies and private organizations. We believe that the majority of public policies are aimed at changing the practices and behavior of individuals and organizations. Consequently, our focus is on how to increase the likelihood that public policies intended to reduce the probability of losses from earthquakes do, in fact, change the behavior of the private and public agencies targeted to implement them.

Getting policies and programs implemented is not a trivial concern. Evidence continues to mount indicating that implementation lags sorely behind advances in scientific and engineering understanding. Frequently, policies are not implemented in accord with the policy makers' intent. Indeed, it may be that successful implementation is the exception rather than the rule. Calista reports that the most prevalent finding in implementation research is that outcomes are either disappointed or unwitting (Calista, 1994, citing Derthick, 1990). Similarly, Burby, May, and Paterson report: "A number of studies over the past decade have found severe slippage in compliance with rules promulgated by planners and code-writing agencies" (Burby, May, and Paterson, 1998). The Office of Technology Assessment refers to an "implementation gap." "Although many communities, especially in California, have taken steps to mitigate earthquake losses, a large gap still exists between what current knowledge says could be done and what actually is done. *Addressing this implementation gap is NEHRP's* (National Earthquake Hazard Reduction Program) ***greatest challenge*** (emphasis in original)" (Office of Technology Assessment, 1995).

One of the reasons that implementation lags so far behind advances in scientific and technical understanding is that relatively little attention has been focused on how to improve implementation. Consequently, we are faced with an inadequate understanding of the barriers and disincentives associated with implementing earthquake hazard mitigation technologies and of how to overcome them.

This research focuses squarely on the challenge of improving the likelihood that earthquake risk reduction measures will be implemented. The primary focus of our research is to gain greater understanding of why governments and private organizations do or do not implement available risk reduction measures and to learn ways to increase the likelihood that they will choose to take actions to reduce their vulnerability or exposure. We examine why organizations fail to take appropriate precautions and what might be done to increase significantly the proportion of them that do act to reduce losses to life and property from earthquakes. Our intent is to contribute to our collective ability to manage earthquake risk — to learn how to increase the probability that public policy, as expressed in statutes, codes, and ordinances, is actually carried

out consistently with legislative intent and, further, that the successful application of the policies actually results in the intended consequences.

1.2 The Approach

This research project has been designed to proceed through three stages. The results of the first stage are reported in this document. The objective of that stage of the project has been to identify and explore obstacles and impediments to implementing risk reduction measures — to learn why risk reduction measures are not implemented. We believe that the best way to learn how to increase the likelihood of implementation is, first, to learn more about what the impediments and obstacles to implementation are. Only then can we determine how to create effective means for overcoming those obstacles.

The second stage of the research will focus squarely on the individual public and private organizations that actually put risk reduction measures in place. It is clear that policies enacted by federal or state legislatures or posited by executives do not implement anything; they are necessary, but not sufficient. Nothing happens except when a public or private organization with operating responsibilities allocates resources and directs people to take action to reduce risks for the organization. "Street level" organizations include local government agencies that enforce an ordinance requiring private organizations to comply with earthquake risk reduction elements of a building code as part of the price of constructing a new building. They also include the private organizations faced with choices as to whether to institute risk reduction measures. The organization always has a choice. California has a state policy requiring hospitals to implement measures to improve seismic safety, but those risk mitigations must still be put in place by the hospitals and some of them are choosing to close rather than to comply. Consequently, the second stage of our research will consist of developing case studies of individual organizations and individuals in organizations that are faced with the choices associated with putting risk reduction measures in place. Field research will provide verification of the impediments to implementation and will provide insights into means for overcoming them. Our case studies will be hospitals faced with choices about implementing measures to reduce the adverse effects of earthquakes on patients, staff, hospital facilities, and the organizations that own and operate the hospitals.

The third stage of our research will focus on identifying effective means for overcoming impediments to implementation. That work will draw on the literature review and the case studies, identifying a variety of policy and program design features and other methods that might be employed to induce local governmental and private organizations to take action to reduce the risks from earthquakes. Stage three will result in a set of practical guidelines for those charged with reducing the risk of losses stemming from earthquakes.

Most of the research on implementation appears to be predicated on a top-down view of natural hazard mitigation, assuming a relatively linear process from policy development and adoption at a higher level of government through implementation by a local government. We are concerned with two aspects of that perspective. First, we are not persuaded that the relationship is linear. We see it more as a network that, in some manifestations, may embody some processes that might be viewed as linear. Second, we see implementation as typically involving private decision makers – those who make choices about taking risk reduction measures and who work to affect the regulations imposed upon them.

Our view of implementation causes us to approach the implementation problem from two perspectives. First, by looking broadly at the literature across disciplines, we have been able to develop an understanding of the policy implementation process from the top down. Second, by focusing on individual organizations as the unit of analysis, we will be able to develop a "bottom up" perspective. We believe this two-perspective approach will make it possible to identify critically important variables involved with reducing the "implementation gap" as well as affording an opportunity to assess the merits of what we believe to be a more synoptic view of the implementation process.

1.3 This Report

Our approach to the first stage of the research project has been straight forward. We began our work by conducting an extensive review of literature about implementation and decision-making from across the spectrum of social and behavioral sciences, drawing primarily on empirical scholarly research findings. The review resulted in four products, each of which is included in this report.

1.3.1 Definitional Issues and Concerns

The first product from the review consists of attempts to address knotty problems about what constitutes effective implementation. The question is not as simple as it might first appear. Lack of clear definitions in the literature of what constitutes effective implementation can lead to confusion. We have interpreted the literature and added our own perceptions to the mix.

1.3.2 Organizational Requirements for Implementation

The second product from this first stage of research is a simple taxonomy of basic conditions that must exist within an individual organization if it is to adopt and successfully implement earthquake risk reduction measures. The taxonomy provides us with a means for focusing our efforts in the second stage of the research, as well as providing a means for focusing an ex-

tended review of relevant literature on organizational behavior, organizational psychology, and organization decision making.

1.3.3 The Implementation Network

The third product from the first stage of the research is a relatively simple conceptual model of what we call the "implementation network," comprising the organizations and institutions involved in developing risk reduction policies and programs, as well as the public and private organizations intended to implement those policies and programs. The network concept provided us with means for organizing and summarizing the information generated through the literature review.

1.3.4 Propositions Concerning Impediments to Implementation

The fourth product from Stage One that stems from the literature review is an extended set of propositions about various impediments to implementation as they exist in the implementation web. These, too, are included in this document. The propositions developed in the first stage of the research project have to do mainly with the environmental context within which organizations make choices about whether or not to take actions to implement risk reduction measures.

1.3.5 Status Report

This document reports what we learned in the first stage of a three-stage project: literature review, case studies, and analysis and conclusions. Although the project is far from complete, this document is meant to stand alone. This document is not written primarily for practicing building officials, structural engineers, or others that we respectfully call end-use practitioners. That report comes later. This is written to an audience of scholars and analysts who, like us, are interested in more, better, and more timely implementation of risk reduction measures and who, we hope, will provide us with insightful critiques

The paper proceeds simply and directly. First, we address several questions central to implementation. What constitutes appropriate, successful implementation of public policies concerning earthquake hazard mitigation? We want to know how can we determine whether a policy has been implemented appropriately or successfully. Second, we present a simple taxonomy of what is required of organizations if they are expected to implement risk reduction measures. Third, we present a simple model of the implementation network. The model serves as a means for organizing the inquiry into barriers to successful implementation as well as suggesting a conceptual model of the overall process. Fourth, we summarize the most cogent literature in terms of the model and developed a set of operational propositions. The propositions are derived pri-

marily from the literature. Fifth, and finally, the paper concludes with a brief description of work that is planned and currently underway as the second and third stages of this project.

This work reported here is based on a review of implementation literature developed in the social and behavioral sciences over the past three decades. Only a small portion of that literature addresses implementation of natural hazard policies, and only a small portion of that reports on empirical analysis of implementation. A rich body of research on implementation does exist within the social sciences, however, with most of it focused on implementing environmental and social programs. Consequently, we've drawn on that literature, too, for inferences about implementing earthquake hazard mitigation.

Our primary focus is at the local government, for, as one wag put it, "As luck would have it, we all live at the local level." The local level is where many of the earthquake hazard mitigation provisions are enacted and where most are implemented. We also, however, examine implementation problems associated with federal and state involvement in hazard mitigation. Both of those levels are involved in earthquake hazard mitigation policy making and, consequently, in implementation. Their involvement necessarily adds complexity to the system under study.

State roles already exist in developing earthquake hazard policy. California's Field Act dating to1933 requires special attention to school construction. California has a building standards commission and, by statute, municipalities are required to adopt the Uniform Building Code (UBC). And, after the 1971 San Fernando Valley Earthquake, the State enacted the Alquist-Priollo Act to prevent building structures on fault lines. At the federal level, an executive order requires that federal agencies ensure their new buildings meet certain seismic standards. That order trickles down to buildings the federal government leases — and they, of course, are all "at the local level." It makes sense, then, to consider state and federal government roles in policy implementation issues. Moreover, since so much of the research on policy implementation involves the states and the federal government, it makes sense to draw on that research to help understand implementation processes at the local level.

SECTION 2.
FUNDAMENTAL IMPLEMENTATION CONCEPTS

2.1 What Constitutes Successful Implementation?

2.1.1 Introduction

A policy is an authoritative statement — authoritative in that it comes from a party or parties with sufficient legitimacy to speak on behalf of its constituents on the matter. Policies are typically intended as decision rules to guide action with respect to a set of phenomena — statements that outline desired means for achieving desired ends. A policy may consist of or include an allocation or reallocation of resources applied toward the desired end state or set of outcomes, and a policy may focus on input, process, or output values.

At the simplest level, "implementation represents the faithful fulfillment of policy intentions by public servants"(Calista, 1994). Newcomers to business and government often assume that a policy, once adopted, will be implemented in accord with the policy makers' intent. An increasingly rich body of research confirms what old hands know – that is just not the case. Practitioners and scholars have come to understand that policy adoption is simply one milestone in a continuing process of addressing an issue. It may be that successful implementation of the intent of the policy is the exception rather than the rule. Calista reports that the most prevalent finding in implementation research is that outcomes are either disappointed or unwitting (Calista, 1994, citing Derthick, 1990). Some researchers, in fact, have concluded that implementation is itself a critical part of policy making process. Policy implementation, according to Majone and Wildavsky (1978), is simply "the continuation of politics with other means." Calista's assessment of the field of study is that it has evolved from one of viewing implementation as simply the process of carrying out policy directives to where implementation "is now integral to the field of policy intervention, including recognizing its influence on policy formulation" (Calista, 1994).

The reality is that policy is adopted and adapted. It drifts and mutates and may or may not be implemented by the organizations that the policy envisions will put the policy in place. The extent of drift and mutation depends on a myriad of variables, only some of which can be controlled by policy makers.

2.1.2 Successful Implementation Is Not the Same as Solving the Problem

It is tempting to believe that, once a policy is articulated by a legislative or executive body, one can measure the success of implementation in terms of whether the policy had the effects intended by the policy maker. That, however, is too simplistic; it would ultimately confound a number of issues that should be kept separate. Conditions exist in which even faithful, effective, and efficient implementation could not achieve the policy's desired ends.

First, the policy may be based on inherently faulty premises. If the causal model underlying the policy does not link cause and effect appropriately, or does not take into account other variables that are critical to program success, then even successful implementation is unlikely to address the problem that gave rise to the policy. Second, it may be that the policy is based on a causal model that was sound in terms of relating cause and effect, but the problem changed out from under the solution; that is, cause and effect may have mutated during the policy making or implementation stages, rendering the policy ineffective. In short, failure to achieve the ultimate ends may be because the policy is faulty or because implementation is faulty.

One must consider, too, the possibility that the policy makers did not intend for anything to happen beyond the pronouncement of the policy. It is certainly not beyond the wiles of elected officials to try to quell disquiet from one corner by announcing a policy and then working to ensure that the policy is never implemented, either successfully or unsuccessfully, in order to meet demands from those in another corner.

2.1.3 Successful Implementation Is a Matter of Degree

In the case of a program that calls for voluntary compliance, one in which, for example, a local government provides incentives for action by private organizations, some will choose to participate and others will not. Suppose that, of those who participate, an overwhelming majority act positively so as to convince even the most jaded skeptic that the policy has been implemented. Suppose, however, that only 10 percent of those targeted by the policy and eligible to participate actually volunteer to participate in the program or implement the policy. Is policy implementation successful? Presumably not, because such a small proportion of the target was reached.

Diagnosis of the implementation process might focus attention on a specific aspect of the program, such as providing greater incentives or engaging in more effective campaigns to make members of the target audience aware of the program. Or, if that portion of the program is adequate, attention might be focused on the implementors themselves to assess whether they are im-

plementing that portion of the program effectively. Perhaps they need additional incentives or additional prodding.

The basic question is "how much is enough?" If each of the organizations in the implementation network does precisely what is called for, but, still, private citizens or organizations targeted for action fail to take the steps that bring about the clear intent of the public policy, is implementation successful or has it failed?

The problem is compounded when one considers the fanning out of responsibility for implementation. A federal agency looks to fifty states, each of which looks to hundreds of municipalities, each of which looks to one or more agencies, each of which looks to one or more employees who try to affect the behavior of some unspecified number of individuals or firms. What proportion of the several hundred thousand potential "implementations" in this example has to "take" for implementation to be judged successful?

Successful implementation is clearly, then, a relative concept. We have to think of it in terms of the *extent* to which it has occurred rather than *whether* it has occurred. Success, in the case of implementation, is not a matter of absolutes.

Whenever one talks about success being a matter of degree, the question must be asked: how good is good enough? That, too, is relative. A baseball player who gets three hits in every ten times at bat is considered very good. One who gets four hits in every ten at bats is considered exceptional. On the other hand, a surgeon who is successful at even seven of ten routine appendectomies would be judged a dismal failure.

2.2 By Which Criteria Should We Judge?

Assessing the extent to which implementation is successful requires criteria by which to judge that success. While one might expect the criteria to be explicit or implicit within the policy itself, that is not always the case. Frequently, the intent of a policy, and, hence, appropriate criteria are difficult to ferret out. Frequently, the analyst must assume a set of criteria against which to measure effectiveness of both policy and implementation. In this section, we explore several criteria that seem generally appropriate.

2.2.1 The Intent of the Policy

The first criterion we suggest is that implementation be judged in terms of the kind of effect the policy is nominally intended to bring about. Petak and Atkisson (1982) devised a classification scheme of public disaster policies that provides insights into the kinds of effects policies are intended to have.

One cluster of policies they defined focused on increasing awareness among those who might take action to reduce risks. They call these *attention-focusing policies*. A second set con-

sists of policies that help create means for reducing risks and for informing would-be hazard mitigators about them. These include *technology development and technology transfer policies.* Third, Petak and Atkisson define a cluster of policies that involve direct governmental action to bring about desired results: *disaster recovery policies, investment and cost allocation policies, and direct action policies.* Fourth, they include two policies employed by government to induce others to take actions. These *action-forcing policies* are "adopted by higher level jurisdictions and intended to force loss-reducing activities by lower units and jurisdictions of government." This category also includes *regulatory policies* – policies that employ police power sanctions to induce private parties to take actions to reduce losses associated with exposure to natural hazards. Such policies may force the use of avoidance, building strengthening, site preparation, and other mitigation methods.

Finally, they include two kinds of policies, *system management* and *system optimization*, that are intended to "fix responsibilities, specify the means used, and define the restrictions to be met by hazard mitigation programs" and to "ensure that other policies are effective, compatible with system goals, and internally consistent."

Policy implementation should be evaluated in terms of what the policy was designed to do. That is, one should not evaluate the implementation of a policy intended to focus attention on an issue because it failed to regulate building construction effectively.

2.2.2 Did the Policy Have the Intended Effect on The Intended Targets?

It is appropriate to consider how one might measure the extent to which a policy has had the desired effects. Defining the desired effects is often not as easy as it sounds. It is a rare policy that is phrased in such a way that one can refer to it for specific criteria to ascertain how good is good enough. President John Kennedy announced a policy of "putting a man on the moon within the decade and returning him safely to earth." Measuring the ultimate effectiveness of that policy is considerably easier than measuring the effectiveness of some other policies, such as "achieving racial equality" or "achieving equal employment opportunity" or even "creating an inventory of safe buildings."

Participants in the public policy arena still often operate, or, at least communicate, at a bumper sticker level of oversimplification. A pervasive sound bite mentality and a limited public attention span make it difficult to communicate nuances and gray tones; everyone seems to want it in black and white. For example, it is frankly a lot easier to say that we want to have "safe buildings" than it is to say that we want to reduce the probability of life loss by 50 percent for magnitude seven earthquakes with fewer than x seconds of shaking and lateral ground acceleration not exceeding y. Moreover, it is difficult for elected public officials to talk with the electorate about tough choices. It is easier to say we want safe buildings than it is to say that, for the

maximum credible earthquake in southern California, we are willing to suffer *n* fatalities rather than force actions that would cut losses to *n-5,000*, but that would make life uncomfortable in other ways.

The reality is that many public policies are aimed at complex, continually mutating problems. It is typically difficult to measure whether a problem is getting better or worse, much less measuring whether basic goals have been achieved. Consequently, elected and appointed officials often need the wiggle room that ambiguous policy statements provide.

Despite all this, a reasonable starting point for assessing the relative success of whether implementation was effective is to determine whether it resulted in the desired effects. This is not as simple as it may first appear. Many, if not most, policies are adopted to achieve multiple purposes. Some are clearly in the public interest while others serve a more limited range of interests. The U. S. Department of Agriculture's Food Stamp program provides a subset of low-income households with Food Stamps (chits) that can be exchanged for groceries at participating locations. Alas, a booming black market developed in Food Stamps, so they could be exchanged for cash, at a substantial discount, which could be used to buy other things, including narcotics. Cynics suggested that the USDA cares a lot less about the urban poor than it does about having urban Congressional representatives vote for agriculture appropriations bills; presumably including Food Stamps in the bill is enough to generate sufficient votes to ensure the USDA can pursue its other interests.

Similarly, state level welfare reform was initiated ostensibly because of an explosion in demand for Aid to Families with Dependent Children (AFDC). In fact, the proportion of American households receiving AFDC actually declined during the decade preceding the rush by states to change welfare policy. The policy changes were intended to reduce substantially the number of families receiving public assistance, but one can argue that the attack on welfare was triggered more by ideology than by a growing welfare problem. One could argue equally convincingly that the states, caught in a squeeze on Medical Assistance payments, funded only in part by the federal government, chose to create a little financial wiggle room in their budgets by reducing the number of welfare recipients receiving medical benefits rather than by reducing the number of senior citizens receiving those benefits. Medicaid expenditures have been increasing explosively, primarily because the number of elderly recipients is growing rapidly and because medical costs for elderly people, especially those near death, are extraordinarily high. But, seniors vote and so do their heirs, so no one pays much attention to research that suggests up to half of seniors receiving benefits became eligible for assistance by purposefully divesting their assets to their heirs in expectation of medical and nursing home expenses.

Public problems are rarely simple. Sometimes, we just do not know what to do or do not have the resources or political will to do what we think should be done. In such cases, it is not

beyond executives and legislatures to make policy simply to make it look as though something is being done. Creating a blue ribbon panel or study commission looks like a prelude to policy, but may be intended simply to buy time – substituting activity for action. Most of us know that rearranging your desktop is a lot easier than actually tackling a tough job.

Putting ulterior motives, delusions, and diversions aside, it is often still difficult to determine the desired effects of legislative or executive policies – at least with sufficient precision to ascertain the extent to which implementation has been successful. This is because we can generally tell the broad outlines of what is to be accomplished, but only rarely are we able to answer specific questions about how much, by when, where, and at what cost. Evaluation is easier when the policy makes explicit exactly what is intended and includes a statement of: the precise problem to be addressed, operational objectives, the means by which the problem is to be alleviated, the proportion of the problem to be alleviated, the standards or levels to be achieved, the time frame within which it is to be accomplished, and the costs within which it should be achieved. Illustratively, it is easy to say that we should reduce the number of unreinforced masonry buildings in California. It would not be hard to get agreement on that. It would be a lot tougher to create a policy that says, for example, that 80 percent of the unreinforced masonry buildings in California should be brought up to 75 percent of current seismic design standards within the next five years. Consequently, policies tend to have enough wiggle room in them to make life bearable for those who enact the policies and for those who try to implement them.

One can often begin to devise criteria for successful implementation by referring to documents setting forth the policy. Some starting points are preambles to legislation, hearings held prior to legislative consideration of the policy, and speeches in which an executive states a policy or issues a policy directive. A second source of policy goals is in the bureaucracy. As often as not, agencies write draft legislation or the materials on which the legislation is based. Policy intent can sometimes be found in agency reports to executives and legislative committees.

Given all this, including misdirection and guile, is it still sensible to talk about relative success of implementation? Of course. The absence of clear or complete statements of intent does not mean one cannot conduct an assessment. It simply means that an assessment of implementation has to focus on criteria stipulated by the analyst.

Failing clear, explicit, and sensible criteria in legislation or policy pronouncements, what criteria can we use to ascertain the extent to which a policy has been implemented effectively and appropriately? One might begin with the obvious. Did the policy result in some observable effects? Looking at direct effects can be informative, but only to a degree. At first glance, one would probably conclude that building code implementation in California has been a lot more successful than in Turkey, Greece, and Taiwan. Earthquakes in the Los Angeles and San Francisco areas resulted in far fewer deaths and injuries and property losses than in the recent events

in the other two locales. The earthquakes in those three foreign locales were, however, stronger than either Loma Prieta or Northridge. Moreover, even earthquakes that release equal amounts of total energy may differ significantly in terms of peak horizontal ground acceleration and duration. While one could hypothesize that building code implementation is better in Los Angeles and San Francisco than it is in those other locales, a reliable evaluation would have to depend on an assessment of the codes in those unfortunate countries, of implementation practices, and of the characteristics of the several temblors themselves. On the other hand, Florida communities are generally subject to contemporary building codes based on up-to-date model codes. In Florida, however, Hurricane Andrew ripped a 27-mile swath, tearing apart houses that, had they met code, might have survived the event, at least partially intact. It seems clear that construction, in many buildings, was sub par, not meeting code requirements. A strong case can be made for ineffective implementation of the ordinances.

At a finer cut of assessing the effectiveness with which implementation is carried out appropriately, the analyst would want to focus on both outputs and outcomes. Outputs are the means. Outcomes are the ends. Improved steel welds in buildings are an output, whereas reduced probability of structural loss given a stipulated earthquake event is an outcome. A fundamental test of implementation is whether the intended outcomes were brought about, but achieving the intended outcomes is not the test of successful implementation.

The desired effect might come about even if the policy is faulty and even if implementation is shoddy. The inventory of unreinforced masonry buildings in California would eventually diminish to an insignificant number even without legislation requiring that they be strengthened. Some would be torn down in favor of better investments, some would burn, some would collapse in earthquakes, and a few would be strengthened voluntarily because they are quaint or have historic value. As a result, knowing whether implementation has been successful requires attention to cause, as well as to effect. A critical question for the analyst is whether the policy generated or contributed significantly to generating the observed effect in the target population.

2.2.3 To What Extent Did the Several Nodes in The Implementation Network Comply With Policy Directives?

In case of unreinforced masonry buildings, it makes sense to begin with learning what happened to the inventory of such buildings. Has the inventory of URM buildings declined? Do retrofitted URM buildings survive earthquakes better than those than have not been retrofitted? At the same time, however, one must be concerned with what happened after a specific policy was adopted. Did the various sets of organizations and individuals charged with implementation act in accord with the conceptual approach inherent in the policy statement? If, for example, the policy called for providing incentives and letting the market do its job, and the implementors

chose to use heavy-handed sanctions to augment the incentives, the "success" of the implementation might be called into question on the grounds that, in fact, a different, perhaps unauthorized policy was being implemented.

A second compliance-related criterion is the extent to which the front line implementors did what policy makers, or those in higher levels of government, wanted done or said they wanted done. Were their actions consistent with the nominal intent of the policy makers? That is, did the implementors design programs, allocate resources, and mount an effort to do the job? To what extent did those charged with administering the policy actually engage in the activities needed to comply with the policy statement? To what extent did the intent of the policy mutate as it passed through various levels of government and across a multitude of organizations involved in the implementation process?

Yet another compliance-related criterion is whether the implementors complied with conditions contained in the policy. Policies often go beyond stipulating what should be done to include subsidiary statements about how it should be done. Political scientists refer to the matter of how it should be done as "process values." To what extent did the implementors comply with "process values?" Successful implementation is not only what they did but how they did it. One needs to learn whether stipulated procedures were followed. Were decision rules concerning program eligibility, for example, applied correctly and without bias? Did programs intended to produce collaboration among parties result in authoritarianism replacing collaboration? Despite the fantasy wishes of some mitigation zealots, it is not good form to obtain compliance with retrofit policies at gunpoint. Typically, this does not conform to acceptable process values.

2.2.4 What Proportion of the Target was Reached?

What proportion of a target must be reached for a program to be judged successful? Again, it is a matter of degree. One would probably not require that every unreinforced masonry building would have to be retrofitted for a retrofit ordinance to be judged successful. On the other hand, a program that resulted in retrofitting only a handful of buildings after having been in effect for a decade could hardly be judged a success.

When considering what proportion of the target population has been reached, it is important to distinguish between the proportion of the target that has been acted upon and the proportion that has been affected. In the early days of policy and systems analysis in the defense arena, analysts were concerned not only with the probable number of missile sites that would be reached by manned bombers and ballistic missiles, but also with the probability that a site, once attacked, would be rendered inoperative. And, not to put too fine a point on it, they were concerned with whether the missile site still contained a missile. Destroying an empty silo isn't nearly as useful as destroying one in which the missile remains, not yet launched. Thus, effec-

tive implementation goes beyond making contact with the target; it requires that the target experience the intended effects. In the missile example above, one would be concerned with joint probabilities: the probability of destroying the target is the product of the probability of reaching the target times the probability, once having reached it, of having the desired effect. If, for example, 70 percent of the targeted children receive appropriate vaccinations and the vaccinations have the desired effect 80 percent of the time, then the desired effect occurs in only 56 percent of the targeted children.

Criteria for measuring the effectiveness of implementation appropriately include assessing both the proportion of the target population reached and the effectiveness of the policy in achieving desired outcomes by the part of those reached.

2.2.5 Was the Program Implemented Within a Reasonable Time Frame

It has been suggested by eminent scholars who have focused on evaluating implementation that a public policy really needs to have been in effect for seven to ten years for an assessment of implementation effectiveness to be appropriate and reliable (Mazmanian and Sabatier, 1989). In our experience, that number seems appropriate for complex policies with long or involved implementation networks. Implementing public policies is not as simple as it is for the owner/operator of the local print shop. He may tell his employees that a new operating policy will be in effect and, presumably, he will be able to judge the extent to which the new policy is being carried out within the next week or month. In the public sector, policies often require budgetary authority. Budget cycles are annual or biennial. Program design often takes a year or more. Developing administrative regulations, policies, and procedures, in some federal agencies, takes years, especially with required reviews by interested organizations. If a federal program depends on state governments to implement them, then the process has to be repeated at the state level and it almost always happens sequentially rather than simultaneously. In short, it can take years before well-intentioned, hard-working public officials can mount the processes and the organizations needed to implement a program — even if everything goes right. Unfortunately, things do not always go right.

2.2.6 Were the Costs of Implementation Reasonable

The authors of this report subscribe to the maxim that one should never spend more to solve a problem than the problem costs. That is well and good, but how much should one spend? Theoretically, one should spend up to as much to solve a problem as the problem would other-

wise cost, but not one penny more. Consequently, policy analysts frequently apply benefit-cost analysis to ascertain, *ex ante* or *ex post*, whether a program makes sense. Programs with a ratio of benefits to costs of less than one do not make sense.

It is often difficult, however, to measure costs and benefits. Both are elusive. Some cannot be expressed in monetary terms with any confidence or appropriateness. In those cases, it is usually better to employ cost-effectiveness analysis. We can set some desired level of effectiveness and seek the least-cost means for achieving it. Or, we can set some level we are willing to pay and seek to maximize benefits within that budget.

In implementation analysis, we may have to work backward to ask whether the actual cost of implementation appears reasonable, given what was accomplished. Within this general question, it is appropriate to ask whether resources that were used were applied effectively or whether some of the resources were diverted to other activities or otherwise wasted either because of poor management or poor program design. In his long-forgotten doctoral dissertation, one of the authors of this paper demonstrated that the design of grants-in-aid programs makes a difference in whether the money was applied to problems in addition to local effort or whether the grant funds substituted for local expenditures (Alesch, 1970). Grants requiring matching monies typically result in more money being spent on an activity than do flat grants. Flat grants frequently simply free up local money to be allocated to some other activity.

2.2.7 What Were the Unintended Side Effects?

It takes some doing to drop a rock in a puddle without getting at least some mud on your shoes. Almost every program has some unexpected side effects. Sometimes they are serendipitous. Other times they are noxious and adverse. A program intended to cause hospitals in buildings with structural deficiencies to be brought up to contemporary seismic standards could cause some hospitals to close. This would, in turn, reduce the total amount or the distribution of health care available, probably most often in underserved, poorer parts of the city. That's a tough trade-off.

The side effects may be caused primarily by program design. They can also come about because of the way implementation proceeds. Consequently, one criterion for judging the effectiveness of implementation should be the extent to which it generates either adverse or beneficial side effects.

2.3 With Which Implementers Are We Concerned?

A complete evaluation of policy implementation would require examining each step in the process, each element in a complex network, and each set of organizational actors involved. Not every organizational element will exist in every implementation network and some networks will be longer and more complex than others. Generally, the networks include some or all of the following participants:

- a public entity that adopts and authoritatively states the policy;
- the organizations charged with designing programs to implement the policy and either mandating others to take action, including sanctions for not taking action, or providing others with incentives to take action;
- the organizations that may be an additional stage between the policy makers and/or program designers and the agencies that employ the street level government employees expected to implement the policy;
- the organizations charged with program implementation; that is, the organizations expected to allocate resources, including time and personnel, to bring about the desired effects in the target community;
- private organizations, like financial institutions or insurers, that are targeted to take actions that affect the ultimate target, such as builders or building owners; and
- those organizations and individuals, such as builders, building owners, and private corporations that are expected to take the risk reduction measures envisaged in the policy and who, ultimately, are the targets of the policy.

SECTION 3.
THE IMPLEMENTATION NETWORK

The primary focus of our work is overcoming obstacles that private and public organizations face in implementing risk reduction — organizations that have employees and property exposed to risk and that could act to reduce losses to them. These include both public and private organizations that build and/or operate and maintain buildings and infrastructure subject to effects from earthquakes: manufacturers, wholesalers and retailers, water and waste water treatment agencies, highway departments, the postal service, port authorities, power utilities, dry-cleaning establishments, and so forth.

The problem is that the organizations that own and/or operate in buildings are not the only organizations that have an important role in implementation. Ensuring that a particular risk reduction technique is put in place appropriately by the public or private organization where the risk manifests itself often requires implementation of a variety of policies and practices by a whole cluster of actors. We refer to this as the implementation network.

3.1 Toward Understanding the Implementation Process

3.1.1 The Need for a Multidisciplinary View

Understanding the ins and outs of adopting and implementing policies and practices is a subject of inquiry in several of the behavioral and decision sciences – psychology, organizational psychology, sociology, political science, cultural anthropology, management science and operations research, individual and group decision processes, and rational decision making. Each of these fields contributes to our understanding of individual and group behavior in organizations, the behavior of organizations themselves, and the interplay of multi-organizational systems, all of which are directly relevant to understanding barriers to implementing earthquake hazard mitigation practices.

The implementation literature in political science focuses mainly on policy making and interorganizational variables affecting implementation. The organizational behavior literature focuses mainly on intra-organizational variables affecting implementation. We have chosen to concentrate our attention on those two bodies of literature, notwithstanding the contributions of the other fields, but recognizing that their focus is typically on other aspects of the process.

Students of policy making and implementation have offered many models and variants of those models in an attempt to usefully organize our growing understanding of the processes. For the most part, the models of interest to us fall within two arenas of intellectual endeavor: policy

studies and organizational behavior. As one might expect, however, the people writing in the organizational behavior literature rarely reference work done by political scientists and others writing in the policy studies literature, and *vice versa*. The policy studies literature focuses mainly on inter-organizational aspects of implementation, whereas the organizational behavior literature focuses mainly on intra-organizational processes and characteristics. Calista, writing in the *Encyclopedia of Policy Studies*, does an admirable job of summarizing the policy studies models (Calista, 1994). Similarly, although it was written more than two decades ago, Schultz and Slevin (1975) summarized research models employed in empirical research into implementation within organizations, with a focus on implementing management science and operations research applications.

3.1.2 An Open Systems Model

We have been unable to find a model in the literature that embraces the valuable contributions of both organizational behavior and political science concepts, constructs, and analysis. Therefore, we have chosen to create a model based on general systems theory to try to embrace the breadth of social science research on implementation. We do not pretend to have made a conceptual breakthrough with this model. We simply use it as a convenient, useful way to organize a diverse, complex body of research.

We view organizations as open systems. They comprise elements related to one another in such ways that perturbations of one element have ramifications for the others. Organizations exist within an environment with which they inexorably interact. Environments vary in complexity. Organizations require inputs from the environment, they transform those inputs, and generate outputs to the environment. Organizational systems, we believe, are inherently unstable, requiring continual resources from the environment to survive and requiring continual adjustment simply to maintain their relative position.[1]

3.2 Organizations with Implementation Roles

We've identified six organizational types that constitute nodes in implementation networks. Not all of the nodes are present in all the networks.

1. Primary Target Organizations — The primary targets of policy, such as architects, engineers, developers, builders, building owners, agencies, and organizations whose

[1] There a several excellent summaries of organizations as open systems. Perhaps the best known of these is "Characteristics of Open Systems,"by Katz and Kahn, found in Daniel Katz and Robert L. Kahn, The Social Psychology of Organizations, 1966, published by John Wiley & Sons, Inc. It is also found in *Systems Thinking* by Fred Emery and Eric Trist, a classic compendium of articles based in general systems theory as it is applied to organizational and multi-organizational artificial systems.

actions or inactions are the targets of policies intended to get them to reduce risks to themselves and other members of the community from natural hazard events.

2. Market Intermediary Organizations — Private organizations and public agencies that provide mortgage loans, mortgage insurance, or insurance against losses from natural hazard events including, especially, those whose policies and practices affect the behavior of Primary Target Organizations.

3. Front Line Implementing Organizations — The (typically) public agencies charged with program implementation — that is, the organizations expected to allocate resources, including time and personnel, to bring about the desired effects in the target organizations through incentives and regulation — and the individuals within those organizations assigned to take action directly with the target population to cause members of that population to either take actions or refrain from some practice. These include public agencies that regulate activities of public and/or private organizations in terms of the location, design, and construction of buildings and other structures. It also includes agencies that provide financial incentives for Primary Target Organizations to engage in mitigation or that may employ financial sanctions against those organizations for having failed to take appropriate actions to mitigate risk. These agencies can exist at the local, state, or federal level. Sometimes, they are a branch of an organization primarily performing other roles in the implementation network.

4. Indirect Implementing Organizations — Governmental agencies typically at the state and federal level that exist as an additional stage between the policy makers and the Front Line Implementing Organizations. These also include organizations charged with designing programs to implement a policy and either mandating others to take action, inflicting sanctions for not taking action, or providing others with incentives to take action; These might be state agencies responsible for ensuring that municipalities administer one or more federally-sponsored programs, that oversee administration of various codes by local governments, or that provide funding to local governments for risk reduction activities. California's Office of Emergency Services would be such an agency. At the Federal level, FEMA would be such an agency, as would other agencies, such as the Small Business Administration, that are charged with providing funds, encouragement, or program design services to induce governments at other levels to comply with policy initiatives.

5. Nongovernmental Policymaking Participants — Private organizations that participate or seek to participate in policy development. These include organizations, such as professional associations, with high levels of technical expertise concerning earthquake hazards and means of reducing risk. This group also includes private interest groups that seek to influence policy and its implementation to benefit specific private parties. Depending on the issue arena, some Nongovernmental Policymaking Participants are fully engaged in public policy formation to the extent that they are almost indistinguishable from authorized public policymakers.

6. Policy Making Organizations — The public legislative, executive (or occasionally judicial) entity that adopts and authoritatively states a policy intended to reduce risk to life and property from natural hazard events.

3.3 From Policy Adoption to Implementation: A Complex Network

Policy implementation can be thought of in terms of actions taken by different participants involved in a complex web that resembles a network more than a rationally designed, sequential process. This multi-actor, multi-step, multi-role network typically comprises a host of different actions to be taken by various organizations and individuals within those organizations. For example, at the simplest level, a policy that emanates from a city council generates a relatively small, simple network. Municipalities typically assign responsibilities to one or more departments which assign responsibilities to individuals within them. Actions by these individuals may require subsequent actions by private citizens and nongovernmental organizations to actually effect the desired actions or changes in behavior.

The network, in this case, comprises the council, the policy it generates, the implementing agency and the program it generates to implement the policy, the staff assigned to the program, and the target population, such as builders, and the target's response to the policy initiative. One could focus attention on the council, the implementing department, the implementing staff, the target population; each has a hand in implementation.

Successful policy implementation presumably requires successful implementation by each constituent element in the "implementation network." Each constituent actor has a different set of responsibilities and tasks, so evaluating the implementation process requires separate analysis of how each of the various elements performs its role.

One can also think of policy implementation as the sum of the actions taken by various participants in a complex process leading to desired risk reduction measures in place in real organizations. While the process contains multiple steps, it would be a mistake to think of it as an orderly, linear sequence of actions taken sequentially by organizations from federal to state to

local government and ending there. We find it useful to think of implementation processes as variable rather than fixed and as existing within complex, shifting, and relatively ephemeral networks of relationships among governments at various levels and private organizations.

It is particularly useful, we think, to distinguish among the various roles and actions that comprise implementation. A federal earthquake mitigation policy, for example, might be designed so that it gives state government agencies federal grants provided they take certain actions to induce policy adoption by local governments. The local governments, in turn, enact programs designed to induce behavior by private organizations doing business within their municipal boundaries. The private organizations choose whether to comply with the policy, fight the policy in city hall or the state house, or do business in some other locale. Private not for profit organizations representing structural engineers, architects, municipal governments, building owners, and businesses may be involved at each level of government, attempting to influence choices about how the policy might manifest itself as action steps at each level of government. This commonplace illustration serves to emphasize the differentiation of roles by organizations and institutions throughout the network as each works on its part of implementation. Implementation of earthquake hazard risk reduction measures will typically require a set of actions by each of a significant number of organizations if it is, in fact, to be implemented successfully. Those actions are the result of interactions among the participants – interactions including negotiations, collaborations, and conflict.

While one might like to see predictable, sequential patterns of sequential actions leading to street level implementation of risk reduction measures, it rarely happens that way, at least in the United States. The more common experience is one in which policies morph through time and among places as they pass sequentially through institutional and organizational filters, molded by shifting and ephemeral political alliances among public agencies and private organizations, and resulting, ultimately in implementation mutation.

Each kind of node in the network has a different set of responsibilities and tasks, so a complete evaluation of the implementation process would presumably require an analysis of how each of the various nodes performed its expected role, examining each step in the process, each node in the network.

There are barriers and obstacles to implementation within and between the network nodes, but those impediments often coexist in the network with powerful incentives that are pushing implementation forward. Sometimes the incentives are directly relevant to the best intentions contemplated during development of the policy. Sometimes the incentives have little or nothing to do with the intent of the policy and everything to do with organizational and inter-organizational political agendas.

3.4 Characteristics of Implementation Networks

Three characteristics of implementation networks are critically important: size, complexity, and coupling. Networks can be larger or smaller, shorter or longer, and simple or incredibly complex. Networks that start with a federal policy, go through state governments, through local governments, through market intermediaries, and then have a hoped-for effect on private organizations are the longest and most complex networks. Long, complex networks present more opportunities for failure than smaller and shorter networks; there are simply more chances for something to go wrong.

Network complexity has to do with the number and diversity of actors and check points that exist within and between the nodes comprising the network. Other things being equal, the greater the complexity, the more difficult it will be to achieve successful implementation.

The nature of the coupling between nodes is also important. Nodes can be tightly or loosely-coupled. The nodes of the network are not forged and welded as they are, for example, in a logging chain. In the world of intergovernmental relations, nodes that are individually strong may be tied to one another with a length of yarn, with fervent hopes, or with a promised stream of cash that the receiving node may hope to divert to some other use. Loosely-coupled networks present more opportunities for variance in outcomes than there is in networks that are tightly-coupled and highly defined. Programs that rely on voluntary participation to implement a policy are particularly loosely-coupled. Voluntary implementation is an implementation network that terminates with a hoped-for response by someone beyond the mandate. Consequently, one must be concerned with both the individual nodes and with whatever it is that holds them together. That is, we have to be concerned with what is passed from one element of the implementation process to the next and with how it is passed.

3.5 A Relatively Simple Systems Model

The model we have devised, based on our understanding of an implementation network, is depicted in Figure 3-1. The model comprises several kinds of elements. First, it includes **organizational components**. These are the kinds of organizations that typically participate in policy development and implementation — the organizational "nodes" identified earlier in the paper as components in the implementation process. These include the policy makers, the program designers, the program implementing agency, the staff assigned to implement the program, and the target population.

Second, the model contains non-organizational variables that give it substance. We call these simply **substantive elements**. This model contains the following substantive system elements: the problem giving rise to the policy, the policy itself, the characteristics of the system, and the characteristics of the system's environment.

Third, the model incorporates **dynamic elements**. These are characteristics of the system that affect in the model. Four points about the model are particularly important. First, the entire process is dynamic and, typically, iterative; policies are often revisited after having been enacted. Second, policy gets defined and redefined at each step in the implementation process as it is interpreted and reality-checked by the participants in that organizational node. Third, obstacles to implementation can arise at each node in the implementation network. They can also arise at the points at which nodes are joined with one another. Fourth, the nature of the entire network itself may engender obstacles to implementation, particularly if the network is long and complex, involving lots of actors and transactions.

While the nodes in our model consist of the organizations and other actors in the policy making and implementation process, the model is organized in terms of the flow of information and ideas among those organizational and institutional actors. In our model, the individual nodes in the implementation network are held together (and sometimes apart) by information flows that take place within a context of mutual expectations, and formal and informal relationships. In terms of the model components, these information flows are addressed as substantive elements.

We use the model in the following section as a means of organizing our discussion concerning barriers to implementation. The discussion begins with consideration of the earthquake hazard — the public problem — that gives rise to a particular public policy under consideration. It then moves through the system from the authorized policy makers to the intended target population and back to the policy makers through a variety of feedback mechanisms.

3.6 Added Complexity: a Multi-organizational, Inter-governmental Network

Earlier in the paper, as we described nodes in the implementation chain, we focused on implementation situations that involved primarily local actors. Although many of the policies aimed at reducing risks from earthquakes are generated at the local level, others are generated by the state or federal government. Consequently, our model has to embrace those actors as well. It also has to include transactions among the actors as well as characteristics of the entire process and the nature of the system's environment.

The network becomes much larger and more complicated as other levels of government are added. If Congress enacts a policy having to do with earthquake hazard mitigation, it would presumably result in one or more federal agencies designing a program to implement it. The policy may involve grants in aid to states or mandate some action by states. The individual states usually design their own programs or administrative procedures to guide implementation. As often as not, the actual implementation is left to municipalities, for, as luck would have it, we all live at the local level. The network becomes larger and more complex as each level of government becomes involved.

We deal with state and federal actors in the policy/implementation process simply by adding them into the system. The agencies typically become intermediary implementors. If the initial policy is made at the federal level, then a federal agency typically designs an implementing program. That program, in turn, is usually intended to induce states to adopt or develop similar programs. Usually, the states end up designing a program similar to the federal program but adjusted to meet its needs while still being close enough to federal guidelines to qualify for grants-in-aid, should they be available. The model can be easily adjusted to deal with federal and state agencies if they are, indeed, primary implementors. More than likely, however, relevant state agencies will remain as intermediaries in the policy/implementation chain.

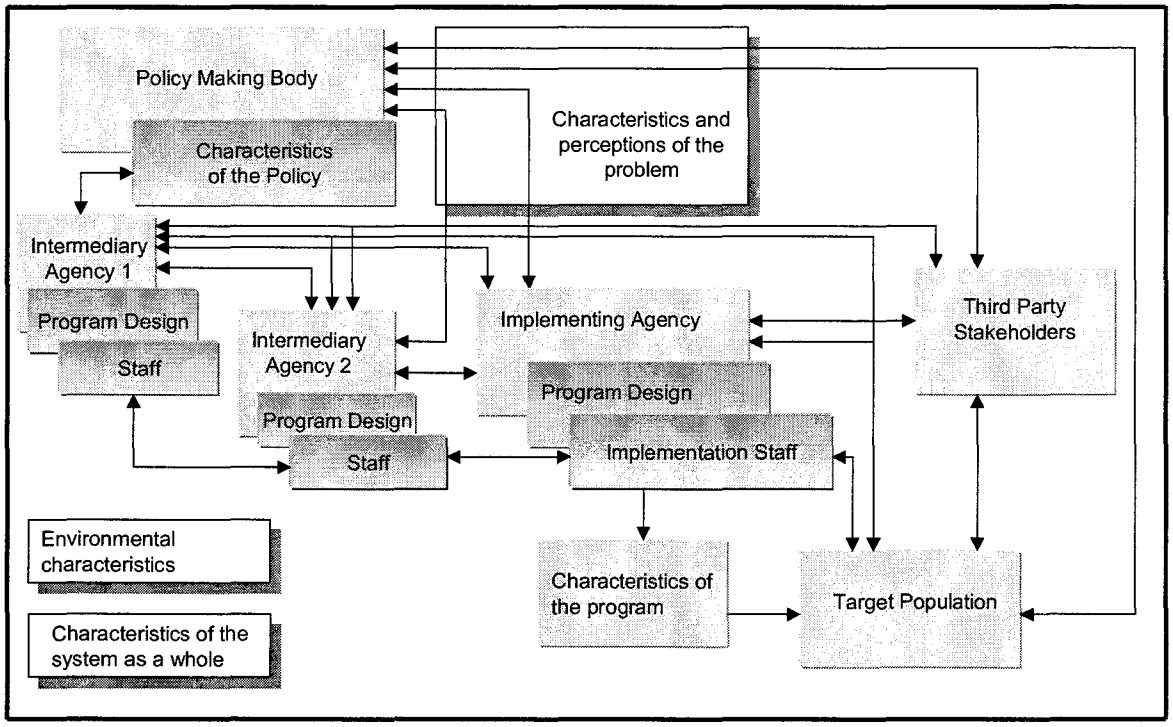

Figure 3-1. Implementation In a Multi-Level Governmental Setting Involving Private Parties

SECTION 4.
BARRIERS TO EFFECTIVE IMPLEMENTATION

4.1 Introduction

If it were not such a long and cumbersome title, this section could be called "Barriers to Effective Implementation: A Set of Propositions Developed by the Authors Based on Relevant Empirical Research by Others." What we have done in the following pages is to set forth research findings from a large number of investigations into the policy making and implementation process. Then, for each of the component parts of the model, we have devised propositions about barriers to effective implementation. Propositions can be thought of as "pre-hypotheses" or "hypotheses not quite ready for prime time." To become hypotheses, they must be converted into a form that can be tested. Propositions can be stated more generally than hypotheses. Indeed, each proposition could spawn a number of hypotheses.

4.2 Substantive Component: The Problem And The Problem Definition Lens

The starting point we've chosen for describing barriers to implementation is the problem that gives rise to the policy under consideration. Problems are best seen as disparities between what one desires and what one perceives as reality or pending reality. It is a serious mistake to assume that, because something is a problem to you, everyone else sees it the same way. It is also a serious mistake to assume that, since they do not see things the way you do, that something is seriously wrong with them. Petak and Atkisson (1982) state that "the public policy process begins when some state of affairs is perceived as being intrinsically or instrumentally unsatisfactory by an element of society and is perceived by it to qualify as a 'public problem.'"

In this model, we treat the problem through means of an allegorical "lens." The lens is simply a means of characterizing how much or how little agreement exists on the definition of the problem. For our purposes, it is enough to know whether the lens has focused the problem. Has the lens created a single, tight focus? Are there several problem foci that do not overlap one another? Is the problem in sharp focus or is it diffused? Does the focus change quickly from one place to another? Or, does it disperse perceptions about the problem and the implications for policy to the extent that there is agreement or disagreement about what actually constitutes the problem.

It is often difficult for the actors concerned with policy making to reach agreement on an unambiguous statement of any important problem for several reasons. First, people do not always share the same perceptions of what is or what is likely to be. Second, people do not all have the same desires, nor do we place equal value on various possible states of affairs. Third,

people do not always share a common understanding of causal relationships. Fourth, in most cases, people are forced to employ subjective estimates of probabilities concerning the probable outcomes resulting from a set of conditions; those subjective probability estimates range widely. Consequently, it is difficult to achieve agreement of a critical mass of actors concerning problem definition. It is equally difficult to maintain the critical mass over time, especially as conditions and perceptions change.

We have not found anything in the implementation literature that addresses what we call "the problem definition lens." Problem formulation processes are typically examined by those who focus their attention on policy formation, but not on how policy may be changed during implementation. We believe, however, that how the various actors in the implementation process perceive the problem makes a significant difference in how the program is implemented.

4.2.1 The Policy/Problem Lens

The lens metaphor leads to the first of our propositions concerning barriers to implementation. If all or most of the actors in the process perceive the problem similarly, we think it is more likely that the actors are to work toward implementing the policy.

> **Proposition 1. The probability of successful implementation of a policy diminishes to the extent that actors in the policy making and implementation elements of the process have divergent perceptions of the problem toward which the policy is directed.**

Illustratively, it was extremely difficult for Long Beach and Los Angeles to pass unreinforced masonry (URM) building retrofit ordinances and make them stick. And, in the case of Los Angeles, it took an additional ten years after Long Beach passed its ordinance and it took California more years to adopt a model ordinance for other municipalities. One important reason was that most of those with a stake in the outcome of the proposed policy had divergent perceptions of the problem. Building officials, looking at unreinforced masonry buildings, saw a public safety problem. URM owners saw the same buildings as a source of income and URM retrofit proposals as a serious threat to their income flow and the value of the asset. Occupants valued the buildings as a place to live or do business and saw the policy proposals as an increase in rent or as a threat to continued occupancy.

We think the likelihood of successful implementation depends on the extent to which all those involved in the implementation network have shared perceptions of existing conditions, have compatible perceptions of desirable end-states, and generally agree on the appropriate means for achieving the desired end-state. The likelihood of complete concurrence is, of course,

lower than your chances of winning the lottery next week. One would certainly expect divergence in goals and perceptions among levels of government, but one would also expect that members of the city council may have different motives and evaluative criteria than members of the building department staff. Indeed, the council's motives and criteria are likely to more closely mirror those of the target population.

Harold Lasswell contributed genuine insight into the difficulties in obtaining agreement on ends and means when he elaborated his theory concerning rationality to different value bases (Lasswell, 1976). Lasswell suggests rational decision making should be judged in terms of the "base" to which one is rational. Not everyone, he suggests, is rational "to the base economic efficiency." Politicians, he says, are more rational to the base "power." That is, they have a tendency to evaluate alternatives, not in terms of economic efficiency, but in terms of how many votes each of the alternatives is likely to capture or hold. Urban planners might be rational to a base of "civic beauty and order," and clerics might be rational to a base of "rectitude" by which they would evaluate alternatives in terms of how they squared up with what is right in terms of God's law.

Lasswell helps us understand why it is so difficult to get agreement on a statement of the problem: the problem looks different to each of those peering at it through their own respective prism in a clouded crystal.

4.2.2 Organizational Suboptimization

Organizations have a tendency to suboptimize in terms of the breadth of their responsibility. Building departments can define problems in terms of their responsibilities without paying a great deal of attention to other concerns in the city. That is, they can think in terms of removing buildings with relatively low seismic resistance from the housing stock without giving too much thought to the possible displacement of lower income households. The city planners cannot. The city council cannot. Building owners can similarly suboptimize to focus the problem definition on their building and their bank accounts.

Implementation may proceed more smoothly, to a point, if only functional counterparts at various levels of government deal with one another, primarily because they share values and levels of suboptimization. When policies have to pass from specialty agencies through officials with broader responsibilities, program implementation is more likely to drift or be pulled or pushed into slightly different directions. This leads to a second proposition. It does not derive directly from the literature; it is a product of our having assimilated and synthesized the literature.

> **Proposition 2. The probability of successful implementation in either a multi-organizational setting or in a single organization diminishes to the extent that ele-**

ments of the system have different goals with respect to the set of phenomena associated with the problem.

It seems clear that government agencies at different levels may have somewhat different goals driving them in the development and implementation of policy. May and Williams (1986) observe that central staff in FEMA, for example, focused more toward Congress and the President, while program staff and those in regional offices tend to have slightly different goals. If the policy being implemented is one in which regional or field offices work to state and local governments that are actually responsible for actual hands-on implementation, it is likely that the federal program staff will work toward ensuring accomplishment of procedural goals more than substantive goals. That is, they are more likely to work to ensure that procedures are followed and actions are documented than they are to actually ensure substantive implementation. This is not to say that central staff and field staff are not concerned with reducing losses to life and property. It simply suggests that the "goal mix" and the payoffs to participants are different at different levels in the implementation process. We think that the more goals are focused on the ultimate objective, the more likely it is that implementation will proceed apace and that the policy will remain relatively consistent through the implementation chain.

Proposition 3. The probability of successful implementation increases to the extent that actors in the implementation process perceive congruence between means and ends; that is, they will work harder to ensure implementation if they perceive that the policy and the programs designed to implement the policy are appropriate, given their perception of the problem.

The implementation problems with which we are concerned are not unique to earthquakes or even to natural hazard events. They are equally applicable to technological hazards. A technological hazard helps to illustrate the relevance of Proposition 3. In northeastern Wisconsin, for example, a 39-mile stretch of the Fox River contains dozens of hot spots — areas with sediments contaminated by PCBs. PCBs are a serious health hazard, if ingested in some as yet unknown quantities. The long-lived chemical also causes birth defects and cancer in water birds and fish. The PCBs are the result of waste water discharges during the period when PCBs were still thought to be a miracle chemical. For all practical purposes, discharges ceased when laws were passed to ban the chemical. Although the water column is clean of the contaminants, sediments holding the PCBs continue to drift downstream to Lake Michigan where they will remain intact for centuries in various concentrations, many of which will be harmful. The Environmental Protection Agency and Fish and Wildlife at the federal level are determined to remove the contaminated sediments. The State's Department of Natural Resources and virtually all of the municipal governments in the area agree that removal is essential. While key parties generally agree on the ends, they do not agree on the means. The Federal agencies have a tendency to

suboptimize within their spheres of interest. They are responsible for seeing that the sediments are cleaned, not for the economic health of the region. The State and local governments are interested in removing the pollutants, but want a means employed that leaves the area economy relatively whole. Third parties are not in agreement about either ends or means. Environmental zealots want every PCB molecule removed from the sediments and broken into its constituent elements. Of the firms responsible for putting the PCBs into the waste water chain, two argue continuously that nature should be allowed to take its course; that in less than a century the PCBs will be flushed into Lake Michigan, sink to the bottom and be gone. The struggle will continue until the chemicals are gone because of the almost insurmountable problems associated with developing a critical mass of actors with a shared vision of ends and means, and because our political and legal systems provide means, through litigation and legislation, to continue policy struggles long after an authoritative policy statement is made.

With respect to the earthquake hazard, a similar situation exists concerning land use. Losses to life and property can be reduced if people do not build in close proximity to fault lines. Everyone is in favor of reducing losses to life and property, but few who enjoy the Mediterranean climate of California are interested in state or municipal laws that would preclude construction in the specific locations in which they want to live.

4.2.3 Dynamic Problems and Circumstance

Individual problems are rarely static; our definitions of problems continually mutate as we learn more and as our attitudes and circumstances shift. Consequently, the problem focus may shift, converge, or diverge in a relatively short period of time.

> **Proposition 4. Problems often shift out from under solutions, rendering policies obsolete, ineffective, or dysfunctional. To the extent that an existing policy is perceived by implementors to be no longer effective or appropriate, efforts at implementing the policy will diminish and efforts will be made to alter the program at the end-user implementation level.**

Following the Northridge earthquake, inspectors found failed welds in relatively new steel frame buildings. These failed welds and the associated dilemmas are a classic illustration of a shifting problem focus. When failed welds were first found shortly after the earthquake, the problem was not in sharp focus. Initially, some observers thought that weld failure at joints in building frames was a consequence of a misguided belief by structural engineers in the robustness of steel buildings. Then the problem focus began to shift quickly. Perhaps the problem was that welders, in an attempt to keep up to normative expectations concerning welds per hour, simply failed to weld the joints as called for by the structural engineer. Or, someone else offered, perhaps the welding process itself changed the molecular structure of the steel, making it more

brittle. Or, interjected someone else, perhaps the steel just doesn't meet specs. Someone, of course, had to offer the suggestion that maybe the engineering designs were somehow faulty and, finally, someone else suggested that the welds might have failed before the earthquake, simply as a function of the way the buildings were designed or built. The problem focus shifts, sometimes quickly, and policies that are devised too quickly are often aimed at the wrong target or at an inadequate array of targets.

4.2.4 Intractable Problems

Mazmanian and Sabatier (1989) remind us that some public problems are simply much easier to deal with than others. They define several dimensions affecting tractability: technical difficulties, the diversity of behavior being regulated or of service being provided, the relative size of the target population, and the extent of behavioral change sought. Successful implementation, they suggest, depends on "an ability to develop relatively inexpensive performance indicators and an understanding of the principal causal linkages affecting the problem" (1989).

> **Proposition 5. The more intractable the problem a problem toward which a policy is directed is perceived, the less likely it is that implementation will be successful. Intractability can result because we are ignorant about a phenomenon that concerns us, because the target population is large and diverse, or because the challenge of changing behavior in a large segment of a large target population seems overwhelming.**

Clearly, both continued ignorance or somewhat improved scientific or technical understanding can be major obstacles in the policy formulation process. The failed steel welds phenomenon is a good example. Sometimes, it takes considerable time before any level of agreement can be reached concerning whether a problem exists at all. Some hold, for example, that global warming is well underway and has dire consequences. Others argue that there is inadequate evidence of global warming. Still others argue that global warming could trigger a new ice age. Unfortunately, we are sometimes unable to agree that a problem exists until it is too late to do anything about it.

The drive for performance-based seismic design standards provides another illustration. Performance-based seismic design standards make lots of sense. The approach embraces several excellent concepts, including the notion that performance specifications are superior to specifications-based standards to the extent that they provide an incentive for innovation in design, materials, and construction. Moreover, buildings intended for different uses should probably be built to different standards. Recent proposals, however, suggested that in California, performance requirements might decline in some proportion to the distance between the site and known faults.

That idea became less compelling as it became clear that Northridge and some other damaging earthquakes in California took place on previously unknown faults.

New knowledge and new perceptions often render policy recommendations or existing policies irrelevant – ideas that made a lot of sense at the time they were proposed or enacted. Sabatier and Mazmanian (1979) believe that shifting conditions can undermine implementation even after a policy is enacted, because the shifts may lead to new public policies that conflict with existing policies. Hence, we offer Proposition 6.

> **Proposition 6. The relative priority of statutory objectives may be significantly undermined over time by the emergence of conflicting public policies or by changes in relevant socioeconomic conditions that undermine the statute's "technical" theory or political support, leading to ineffective problem-solving, even though implementation is adequate.**

4.3 Organizational Component: The Policy Makers

The initial policymaking body in our network model is an authoritative governmental organization that gives formal, legal status to the policy in question. Assuming for the moment that the model is crafted at the local level of government, the policy making body is presumably the city council or the mayor. Alternatively, the mayor or the council may have delegated policy making authority to a citizen board or commission or to a department head. Nothing, however, is ever as simple as it first appears: several local governments may, and often do, have jurisdiction over the same geographic space. Consequently, the policy maker might also be the governing body of an autonomous special district or authority.

If one looks at the state or federal level, the official policy making body is likely to be the legislature or Congress, the governor or the president, an agency charged with rule-making, or a commission or authority.

4.3.1 Ambiguity and Implementation

Old hands in the government and analysis understand, as Hage (1982) says, "policymakers are not particularly careful about specifying the organizational assumptions that shape their recommendations." Moreover, Hage suggests ideological interpretation of existing policies may affect the level of support given by policy makers. Nevertheless, observers seem in accord that unambiguous policies with high levels of support by policy makers are more likely to be implemented than those with low or ambiguous support.

> **Proposition 7. "Decisions will be faithfully implemented when the . . . (policy maker's) involvement is unambiguous, his words are unambiguous, his order is widely publicized, the men who receive it have control of everything needed to carry**

it out, and those men have no apparent doubt of his authority to issue the decision" (Bardach, 1977).

Unfortunately, in the rush of legislation following a devastating natural disaster, policy expressed in new and hastily devised legislation often lacks clarity, is ambiguous, and does not have unambiguous support. Moreover, those responsible for implementation rarely have the resources needed to carry it out. As a consequence, "A reciprocity emerges . . . between vagueness in policy formation and inconsistency in implementation" (Calista, 1994).

4.3.2 Policy Making Is Inherently Political

For those who despair of politics, wishing instead that hazard mitigation were simply given to technical experts, it is important to remember that mitigation involves allocating and reallocating resources; it is inherently political. Since a significant portion of politics involves manipulating symbols for purposes of gaining political support, one should not be surprised when policy is enacted that few policy makers expect to be implemented or when policy outputs do not resemble the result you might expect, given the inputs you thought you saw.

> **Proposition 8."Hazard mitigation is not a technical exercise; it is inherently and often intensely political because mitigation usually involves placing cost burdens on some stakeholders, and may involve a redistribution of resources. Hazard mitigators must, therefore, develop political as well as technical solutions"** (Alesch and Petak, 1986).

It didn't take 50 years for Los Angeles to pass a URM retrofit ordinance because the structural engineering problems were so difficult to address. It took that long because hazard mitigators continued to offer technical solutions to a problem that inherently involved a redistribution of costs, income, and wealth. The ordinance passed only when the redistribution problems were addressed in a way that a critical mass of support could be assembled and held together until after the vote. Lester Thurow (1980) makes the point in his *Zero-Sum Society* that we have created a society with so much access to public policy makers that anybody can stop anything. And, anybody is often willing to very work hard to stop a policy that threatens his or her financial well-being.

4.3.3 Policy Makers are Often Reluctant

March and Olsen (1976) observe that policy makers are generally reluctant to take on tough problems and try to develop substantive solutions to them. It is far easier and more politic to find ways to take actions that work to delay the necessity for tough choices. This often takes

the form of transforming a substantive problem into a procedural issue: "Oh, we can't address that issue, which is of great concern, until we address the question of whether that subject falls within the jurisdiction of *x* or *y*." Policymakers are also adept at taking minor corrective action on problems of immense importance, such as redesigning Social Security or requiring significant retrofitting in buildings, while, presumably, hoping something will happen that will preclude the necessity to make tough choices on the subject or that the problem will go away.

Every once in a while, however, circumstances develop that require action. Decisions cannot be deferred except at great political cost. Quick action may ensure political benefits. For example, most hazard policies are enacted in a rush in the period immediately following a low-probability/high consequence event (Alesch and Petak, 1986). The spate of earthquake related legislation passed in California in the immediate wake of the Loma Prieta earthquake was greater than all earthquake legislation passed in the previous three decades. In the rush to legislate, policy makers are likely to give little thought to whether a policy can be implemented; implementation is not what is foremost on their minds. Policy makers often have multiple objectives when proposing the policy: they may want to look like they are doing something useful for the voters back home, they may sincerely want to do something useful, and they may have deep concerns about reducing the number of future victims. In the rush to legislate, clarity and good sense sometimes suffer.

Typically, legislation is the outcome of bargaining among parties. The parties to the bargaining are not necessarily those with a substantive stake in either the problem, giving rise to the policy or in the outcome of the policy itself. Elmore (1978) reminds us that "bargained decisions proceed by convergence, adjustment, and closure among individuals pursuing essentially independent ends." Policies ostensibly aimed at addressing one concern may, in fact, be aimed at addressing a number of unrelated ends of those engaged in the bargaining process and are likely, therefore, to create ambiguities and uncertainties for implementors.

Finally, we should remember another element of the March and Olsen garbage can model of decision making. March and Olsen argue convincingly that problems and solutions exist quite independent of one another. We can infer, then, that policy making consists largely of trying to match a plausible solution with a credible problem. Unfortunately, the match is not always particularly good.

We acknowledge that elected policy makers are typically good at arriving at bargained outcomes; at least the ones who get reelected must have some skills in that area. With notable exceptions, however, we believe that "most elected policy makers are relatively naive about contemporary methods of policy analysts that can provide information about the consequences of alternative choices available to them" (Alesch and Petak, 1986). We also believe that "policy makers tend to look at relatively simple data about financial costs and the allocation of cost bur-

dens, rather than at more sophisticated and complex analyses concerning economic impacts, optimality, net present value, and cost-effectiveness . . ."

Given the discussion above, we offer the following propositions:

Proposition 9. Policy is typically a bargained outcome in which an available solution is matched with an available problem at the insistence of persistent actors at a time convenient to most of the policy makers. Consequently, policies are often, inadequate to the problem, and sometimes foggy if not irrelevant to the underlying problem they nominally address. In those cases, the probability of successful implementation is, at best, unlikely.

Proposition 10. Faced with public problems for which solutions require difficult choices involving the redistribution of income and the reallocation of costs, policy makers will typically attempt to find alternatives to making those difficult choices, resulting in policies that either do not address the critical issues or that address it in such a fainthearted way as to render the policy ineffective in addressing the problem.

Following the Loma-Prieta earthquake, the California legislature enacted the Alquist-Prillo Act, prohibiting development on known earthquake faults. This was major legislation in California, but from an objective view, it was about the least that could be done to regulate development in inherently dangerous locations. A structure need not sit astride the fault line to be destroyed in an earthquake; proximity is usually enough. Some Americans seem to regard their desire to build anything anywhere as a fundamental right guaranteed by the Constitution and mandated by God. Consequently, most policy makers struggle to avoid added land use regulation policies rather than to reduce substantially the inevitable loss to life and property that goes with building almost anything almost anywhere. In that light, passing the Alquist-Priollo Act was an act of legislative bravery.

4.4 Substantive Component: The Policy And The Programs Designed to Implement it

The second substantive, non-organizational element in the system is the policy itself. The policy may have been generated from within the city council or the mayor's office, but it may just as easily have been initiated by someone in the target population, a third party with a considerable interest in the problem, or by the agency charged with implementing the policy once adopted. The policy may be clear or murky, precise or general, and based on a plausible cause and effect model or on sheer speculation about the relationships giving rise to the concern. Typically, the policy is transmitted to the agency charged with implementing it for fleshing out; that is, typically, the policy has to be turned into a program before it can be implemented. Successful implementation is, in part, a function of how the policy and program are designed.

4.4.1 Adequacy of the Causal Model

Pressman and Wildavsky (1973) argue that poorly designed programs – those with internal inconsistencies or that put impossible or silly requirements on the target population – are unlikely to work. Moreover, policies must be based on a valid causal model if they are to work. Sabatier and Mazmanian (1979) agree and state the proposition succinctly.

> **Proposition 11. "For a policy to be implemented effectively, the . . . (policy must be) based on a sound theory relating changes in target group behavior to the achievement of the desired end-state" (Sabatier and Mazmanian, 1979).**

4.4.2 The Number of Check Points in the Implementation Process

Based on their research in Oakland, Pressman and Wildavsky (1973) conclude, too, that the more actors there are involved in program implementation, and the more checkpoints and vetoes that exist in a program, the less likely it is that the program will be implemented. They refer to this latter feature as "the complexity of joint action." This conclusion gives rise to the twelfth proposition.

> **Proposition 12. The likelihood of successful implementation of programs varies inversely with the number of organizations involved in implementation, the number of levels of government involved in implementation, and the number of checkpoints required before action is taken.**

4.4.3 Adequacy of Policy Tools

Weale (1992, p. 43) steps back for an overview and suggests that government is reluctant to address some policy problems and, even if policy makers do address an issue, government typically has limited means at its disposal to address the problem. Weale suggests that policy making takes place within constraints of political acceptability, administrative feasibility, and within constitutional-legal constraints. Moreover, there is an imperfect link between the policy instruments available and the problem. That is, we do not always have the tools we need to deal with the problem at hand, so we often use tools that are at hand, even though they are not entirely suitable.

> **Proposition 13. The probability of successful implementation is a function of the extent to which known solutions embodied in the policy are congruent with the problem.**

The Long Beach URM hazard mitigation program suffered numerous setbacks early in its life because, for all practical purposes, it called for demolition of unsafe unreinforced masonry buildings. In the eyes of the target population, and some members of the city council, the solution did not match up with the problem. Early in the deliberations, before the Los Angeles URM retrofit ordinance was enacted, the Structural Engineers Association of Southern Californian (SEASC), working with engineering faculty and students from UCLA, tested some retrofit provisions on URM buildings scheduled to be demolished for a freeway extension. By creating an inexpensive retrofit alternative to demolition, it was possible, politically, to match a solution with the extant problem (Alesch and Petak, 1986).

Sabatier and Mazmanian (1979) speak directly to the point of policy and program design as potential barriers to implementation. Proposition 14 is phrased positively in a way to give guidance to program designers.

> **Proposition 14. Successful implementation is more likely if "the statute (or other basic policy decision) contains unambiguous policy directives and structures the implementation process so as to maximize the likelihood that target groups will perform as desired"** (Sabatier and Mazmanian 1979).

4.4.4 Program Design

Program design makes a significant difference in the likelihood that the program, and hence the underlying policy, will be implemented successfully. Anyone can design a program, but a well-designed program is rare and a thing of beauty – at least for those of us who care about such things.

Sabatier and Mazmanian (1979) developed several corollaries to Proposition 14 having to do with program design. Their statements are paraphrased below.

> **Proposition 14, Corollary 1:** Implementation is more likely to be successful if policy objectives are precisely stated and clearly ranked, both by the policy makers and in the implementing agencies.
>
> **Proposition 14, Corollary 2:** Implementation is more likely to be successful if sufficient resources are made available to the implementing agencies for hiring staff, developing regulations, administering and permit and service delivery programs, and monitoring compliance by the target group.
>
> **Proposition 14, Corollary 3:** Implementation is more likely to be successful if the basic policy decision "provides substantial hierarchical integration within and among implementing agencies by minimizing the number of veto/clearance points and by providing supporters of statutory objectives with inducements and sanctions sufficient to assure acquiescence among those with a potential veto."

Proposition 14, Corollary 4: Implementation is more likely to be successful if the basic policy decision "provides ample opportunity for constituency (interest) groups and sovereigns supportive of statutory objectives to intervene in the implementation process through, for example, liberal rules of standing to agency and judicial proceedings and requirements for periodic evaluation of the performance of implementation agencies and target groups."

One of the most important characteristics of program design is that policy makers have a tendency to reach for mechanisms and approaches they've used before when designing programs. Not only that, but Calista concludes that policy makers also prefer to use mechanisms over which they can exercise control, thus giving rise to Proposition 15.

Proposition 15: "Faced with a problem, policymakers frame solutions using the elements over which *they* exercise the greatest control. The content of policy at any given level of the system is a function of the implements people control at that level and the effects they are trying to produce at other levels. Implements include resources and information that participants command as well as knowledge about what instruments appear to serve them best" (Calista, 1994).

May and Williams (1986) examined a somewhat different aspect of the program design problem. We usually think about our government as a three-tiered structure, but every undergraduate student who took political science 101 learned to think of it more as a "marble cake" with the tiers intermingled sometimes almost incomprehensibly. Governments at different levels often work with one another in various degrees of "partnership" in attempts to accomplish (generally) mutual objectives.

Illustratively, the Federal Emergency Management Agency (FEMA) issued *NEHRP (National Earthquake Hazard Reduction Program) Recommended Provisions for Seismic Regulation of Buildings.* The original NEHRP provisions were based on work done in 1985 by a private organization, the Applied Technology Center (ATC). The NEHRP provisions are not binding on states and local governments, but do offer guidance to them. At the other end of the spectrum, the Federal government engages directly in program administration by owning and operating the National Flood Insurance Program. In between, there are scores of other arrangements. In some, the Federal government acts as a general partner with states or local governments. In other cases, the federal government takes a more hands-off approach, acting like a limited partner. May and Williams address the issue:

Proposition 16: "Greater difficulties in determining and managing responsibilities under shared governance are experienced when the federal agency is a general rather than a limited partner" (May and Williams, 1986).

Pressman and Wildavsky (1973), writing more than a decade earlier, hammer the point home. Their study of a large social program in Oakland involving many agencies from all levels of government results in our Proposition 17. They observe that the sheer number of participants makes it unlikely that implementation will proceed effectively. "If one assumes the best – and 99 percent for each and every clearance point appears to be about as close as one can go without assuming away the problem entirely – the odds are still against implementation (Pressman and Wildavsky, 1984).

> **Proposition 17: "(T)he multiplicity of participants and perspectives combined to produce a formidable obstacle course . . . When a program depends on so many actors, there are numerous possibilities for disagreement and delay . . . (G)iven a large number of clearance points manned by diverse and independent participants, the probability of a program achieving its goals is low** (Pressman and Wildavsky, 1984).

There is every reason to believe that diverse agencies from several levels of government will disagree about one or another policy or practice in a specific program. Pressman and Wildavsky (1984) list seven: (1) direct incompatibility with other commitments, (2) no direct incompatibility, but a preference for other programs, (3) simultaneous commitments to other projects, (4) dependence on others who lack a sense of urgency in the program, (5) difference in opinion on leadership and proper organizational roles, (6) legal and procedural differences, and (7) agreement, but a lack of power to do much about it.

Some kinds of policy need very little in the way of program design while others require elaborate programs with complex, extensive administrative rules. Illustratively, a decision to remove a locally imposed retail sales tax on one or another service or commodity does not require elaborate program plans. Presumably, it requires notification to those retailers who collect the tax and little more. On the other hand, the federal clean water act, as it filtered through the states and local governments, led to the creation of dozens of programs and required thousands of pages of administrative regulations. Even at the local level, a program intended to result in retrofitting buildings with less than the desired level of seismic resistance could result in several programs and complex regulations to guide street level administrators and building owners. In California, State legislation requires municipalities to adopt the most recent version of the Uniform Building Code. The State, therefore, does not need an elaborate bureaucracy to ensure that the codes of individual communities comply with bureaucratic provisions and elaborated program regulations.

We believe that the complexity of the program required to implement a given policy affects the probability of successful implementation. That does not mean we argue for simplicity

for the sake of simplicity, nor does it mean that we believe any simple program has a better chance of being successful than any complicated program. It means this: programs should never be more complex than they have to be or involve more actors than are absolutely needed. Socio-technical systems analysts refer to designing things to only those essential specifications as "minimal critical specification." Needlessly complex programs with needlessly numerous checkpoints are difficult to administer and to implement.

Proposition 18. To the extent that programs are designed beyond minimal critical specification, they are less likely to be implemented successfully in the eyes of the program designers.

4.5 Organizational Component: Street Level Implementing Agencies

Another element in the model is the set of organizations charged with ensuring that public agencies and private organizations put the risk management practices embodied in the policy in place. Public organizations at the local level are sometimes charged with designing detailed programs to induce private organizations to put risk reduction measures in place. Local government agencies are almost always the organizations that are charged with allocating their resources to ensure that private organizations within their jurisdiction implement the desired policies and practices.

Most of the political science literature that addresses obstacles to effective implementation centers on multi-level, multi-organizational systems. A relatively small amount of attention is given to the internal workings of the street level implementing organization itself. Organizational behavioralists who are concerned with implementation, on the other hand, focus their attention on what goes on inside organizations. We drew on both sets of literature to create three sets of propositions having to do with the relationship between the characteristics of the implementing organization and the relative success of implementation. The first of these is the extent to which there is congruence of values and beliefs between the implementing agency and those values inherent in the policy the agency is asked to administer. The second has to do with organizational capacity. The third focuses on characteristics of the organization that determine how it approaches its work.

4.5.1 Congruence with Organizational Values, Beliefs, and Focus

We believe that organizational "buy-in" is important. That is, the extent to which an organization internalizes the goals of the policy affects the extent to which it dedicates itself to implementing that policy. When a policy is enacted that is not congruent with the value set or expectations or desires of those expected to implement it, then it is like sending the directive into

the dense medium of the bureaucracy where it is likely to wither. Sabatier and Mazmanian (1979), too, argue that implementation will proceed more directly when implementation is assigned to agencies that are supportive of statutory objectives. They will give the new program high priority. Similarly, successful implementation is more likely with the decision rules of the implementing agencies are supportive of policy objectives. Godschalk, *et al*, agree, stating that program commitment and capacity are key variables "expected to influence the quality of state mitigation plans and hazard mitigation outcomes" (Godschalk, 1999).

Proposition 19: Policies are more likely to be implemented successfully when they are entrusted for implementation to organizations that embrace the same goals and values as those implicit or explicit in the policy.

Sometimes, even organizations that are committed to a policy or program experience overload or other phenomena. May and Williams, examining federal agency involvement in natural hazard mitigation programs, observe that federal agencies themselves have problems focusing on mitigation programs.

Proposition 20: The combination of the diversity of program mix and the short tenure of top agency executives in the major federal agencies makes successful and consistent federal management of grants to states and localities extremely difficult.

We conclude that jurisdictions for which earthquake hazard mitigation is a high priority and have mitigation as a core value are likely to be more successful in program implementation than those with lower priorities and mixed values.

4.5.2 Organizational Capacity and Capability

Organizational capacity refers to the resources available to the organization to apply toward program implementation. Resources include all those elements necessary to achieve implementation. Among these are adequate numbers of staff persons with sufficient talent to carry out the necessary activities required for implementation. Resources include, too, sufficient time to implement the program, sufficient financial support, sufficient technology, and sufficient authority to do what is required.

Organizational capacity also includes an attention span. Organizations with a full agenda, working under pressure, are unlikely to be able to give enough attention to a new program to mount a successful effort unless that program has an exceptionally high priority.

Proposition 21: Implementation proceeds more effectively when "the leaders of the implementing agencies possess substantial managerial and political skill and are committed to statutory objectives" (Sabatier and Mazmanian, 1979).

Proposition 22. Other things being equal, successful implementation depends on entrusting implementation to organizations with sufficient capacity to administer the program.

Students of organizational behavior understand that organizations take on a life of their own. They do not simply react to outside stimuli, but, instead, develop goals, norms, and expectations that are more than the sum of those of the individual members of the organization. Organizations have a tendency to direct and redirect externally-generated directives and resources to meet their own needs.

Proposition 23: Where a decision leaves leeway for the organization that is implementing it, that organization will act so as to maximize its organizational interest within constraints. (Allison and Halperin in Bardach, 1977).

Moreover, organizations do not like to accept responsibility for things that go wrong. Bureaucracies, particularly, whether public or private, have a tendency to try to protect themselves from potential downside effects.

Proposition 24: "The . . . politics of the implementation process are highly defensive. A great deal of energy goes into maneuvering to avoid responsibility, scrutiny, and blame." (Bardach, 1977).

Finally, Mays and Williams (1986) observe that "Federal officials have limited managerial control over shared governance programs. What so often passes for control in the field is a compliance mentality concentrating primarily on procedures rather than substantive issues."

Proposition 25: Agencies that direct other agencies that are charged with implementation typically focus more on compliance with procedures than with substantive issues and accomplishments.

The consequences for implementation from Propositions 23 through 25 are that agencies spend a considerable amount of energy on programs that is not directed toward program implementation. Agencies frequently try to redirect the goals of programs to serve needs that they believe have higher priorities. If the agency is not convinced of the efficacy of a program or sees the possibility of some serious downside outcomes, it will spend considerable energy covering its posterior. Finally, local agencies implementing programs funded or mandated by an agency at

the state or federal level will consume high levels of resources to comply with procedural steps required by the funding or directing agency. For earthquake hazard mitigation, this means that funds and energy are likely to be diverted from mitigation to other activities unless care is taken in program design to focus squarely and unequivocally on the primary objectives.

4.5.3 Organizational Characteristics: Other Lessons from Theory and Behavior

wenty-five years ago, Schultz and Slevin (1975) reviewed the literature focused on the extent to which operations research models were implemented in organizations. Implementing operations research is certainly not the same as implementing earthquake hazard mitigation policies, but there are still lessons to be learned from their work. Their search of empirical studies of implementation revealed a broad set of variables that affect implementation: top level organizational commitment to implementation, the extent to which organizational culture supports innovation and change, the agency's sense of urgency concerning the problem the policy is intended to address, the agency's relationship with the organization that proposed the policy or adopted it, and, of course, the quality of the structure and processes of the organization.

The great dilemma with the information from Shultz and Slevin, rich despite its age, is how to summarize it into a few cogent propositions. After considerable thought, it makes sense to us to try to capsulize the work in a single proposition. That proposition is derived from Vroom's Expectancy Theory (Vroom, 1995). Expectancy theory addresses motivation. It addresses primarily individual motivation, but it can be applied to an implementation organization. Simply stated, the theory states the following. One is motivated to the extent that one expects an adequate payoff from accomplishing an objective. One must also expect to be able to accomplish the objective. The causal chain is simple: I expect that by doing certain things, I can accomplish the task. I expect that I can do those things. I expect that, upon successful completion, I will obtain the specified, desirable reward.

We think it is sensible to apply expectancy theory in the case of organizational implementation. The organizational behavior literature's relevance to whether implementation is successful is incredibly rich – too rich to capsulate in this piece. However, our interest is primarily in capturing the most salient aspects of the organization as they relate to implementation. We think that is motivation. We think, too, that expectancy theory does an admirable job of explaining organizational motivation. Hence, we offer proposition 26.

> **Proposition 26. Organizations will work toward achieving successful implementation to the extent that they believe they can implement the policy, that implementing the policy will achieve desired program objectives, and that achieving the program objectives is consistent with and supportive of the organization's primary objectives.**

It is clear, too, that organizations adopt innovations at different rates. Some relish innovative approaches while others are dragged, kicking and screaming, from the old ways, even if the old ways have proven ineffective. We, therefore, submit the following proposition.

Proposition 27. Successful implementation of new policies and approaches is less likely to occur in organizations that traditionally resist change or have a culture that resists innovation.

4.6 Organizational Component: Assigned Staff

For almost 30 years, social scientists have singled out for special attention the "street level bureaucrats" whose job it is to actually administer the policy to the target population (see Lipsky, 1971, for an early discussion of street level bureaucracy). The first line administrators are those whose job is to cause members of the target population to either take or refrain from some specified behavior.

There is, we think, a tendency for outsiders to assume that front line administrators eagerly embrace new challenges and opportunities to do their job. One need only look at his or her own place of employment to conclude that the level of eagerness is a function of many factors associated with the individual doing the job, of the job itself, and of the social and technology processes involved in doing the job. Weale (1992) argues, for example, that the psychology of enforcement is complex. Street level implementors "may negotiate compliance rather than enforce rules." The "norms of behavior develop in the ongoing relationship between regulator and regulated." Bulloc (in Mazmanian and Sabatier, 1981) suggests that bureaucrats may "restrain themselves from embracing policy intentions fully." And Lipsky (1947) says that successful implementation comes down to how "street level" administrators use their discretion to implement or not implement the policy. Lipsky goes further to suggest that control over implementation "goes to those who gain power over determining how worker discretion is defined and to those who determine how operation routines are changed" (Calista, 1994). Allison and Halperin (Bardach, 1977) agree. They suggest that new departures in policy stem from some decision by central players, but the specific details are determined in large part by standard operating procedure and programs existing in the organization at the time.

A great deal of research, too much to be cited here, has been directed in the field of organizational behavior toward understanding what motivates individuals and groups to achieve. Expectancy theory was discussed briefly above. Contemporary thinking is that motivation comes from within, but that it can be energized and focused by providing opportunities for individuals to meet their personal needs and to achieve their personal goals and by helping them to

see that the mechanism and opportunities are in place and that they do work. Hence, we offer the following propositions.

> **Proposition 28. The likelihood of implementation increases when the organization satisfies the workers' basic psychological and social needs and when workers derive autonomy and fulfillment from organizational identity** (Calista, 1994).

> **Proposition 29. Those in the field feel less obliged to faithfully implement decisions . . . (if they) . . . have not been involved in the decision game . . . they feel they know . . . what actions one should want . . . and how to get those actions** (Bardach, 1977).

It is clear that the success of implementing building codes, retrofit programs, and other regulations affecting what people build and where they build it depends heavily on the commitment and prudent judgment of those who are ultimately charged with meeting the regulated party and ensuring compliance. One need look only at the inadequacies of building code enforcement in the parts of Florida devastated by Hurricane Andrew to grasp that. Without the buy-in of street level administrators, the best intentions remain only intentions.

4.7 The Target Population

The third set of organizations in the model is the target population, consisting of the organizations, both public and private, that are expected to actually put the risk reduction measures in place so they protect lives and property. These include, among others, builders and building owners. The target population is the object of implementation policies. The policies and the programs they spawn are intended, typically, to change some aspect of the targets' behavior.

In the simplest version of our model, we include intermediate targets in this group. Intermediate targets are typically private organizations, like financial institutions and insurers that are targeted to take action that affect the ultimate target. Lenders, for example, might be induced or required to take the seismic safety of a building into account when determining whether to make a loan, the term of the loan, and the interest rate charged. In such a case, the building owner or builder is the ultimate target, but the lender is the immediate, intermediate target of the program.

The program, or some variant of it, may be implemented effectively or not very effectively, depending on how the target population responds to it. Regardless of whether the targets are owners of tilt-up buildings, expectant mothers, or homeowners in the path of a category four hurricane, program implementation may or may not be successful depending on the extent to which it is successful in triggering the desired response in a sufficient number of cases within an appropriate time frame.

Gardiner and Balch (1980) describe variables of what they call "the adoptive decision" – the decision as to whether to adopt or comply with a specific new policy or program. They suggest that individual members of the target population look at the perceived relative value of compliance or adoption to them. What will compliance cost, what is the likelihood that they can find a means for complying, and what is the potential of success for them. Their ideas appear to be a variation of Expectancy Theory; that is, they ask what they are likely to get out of this given what they think they will have to put into it. Their ideas relate, too, to our prerequisites for organizational implementation: to wit, the organization must believe that it is in the organization's interests to put the risk reduction measure in place at this time.

Gardiner and Balch (1980) list additional questions for would-be implementors. Is the policy or program compatible with existing goals for the organization? Is the policy or program too complex to be implemented with reasonable assurance of success? Can we test the policy or program before committing fully to it? That is, is there some level of "trialability" to see whether or the extent to which the program works? And, finally, to what extent is the policy or program divisible? Can we take some parts without others? Or, if some parts work and some don't, are we stuck with the whole package?

The Long Beach unreinforced masonry ordinance was enacted despite stiff opposition from local business. "(That) . . . case illustrates that it is not necessary to reach a consensus to pass a hazard mitigation ordinance, nor is it necessary to make sure that the primary stakeholders' needs are taken care of. In some cases, advocates may be able to rely on raw political power to enact hazard mitigations and make them stick, but we think those are rare" (Alesch and Petak, 1986). This leads us to our next proposition:

> **Proposition 30. Unless the interests of the various stakeholders, especially those of the target population, are accommodated at some minimally acceptable level, it is likely that mitigation policies and programs will face guerilla action, be subject to subsequent watering down, and face court challenges.**

In our work on mitigating the threat posed by unreinforced masonry buildings, we concluded that stakeholders who occupy different roles in connection with an earthquake hazard have significantly different perceptions of the situation and have different values of risks and probable outcomes. We concluded that reaching agreement on a mitigation policy would require tradeoffs among a considerable array of concerns. These include, among others, trading off between the extent of building strengthening against the costs of mitigation, as well as trading off the increased safety for building occupants against the higher rents required to cover the costs of building improvements. The nature of the bargaining and the takeoffs affects not only the probability of passage, but the probability that members of the target population will comply. And,

noncompliance, while often a problem in program design, is typically construed as ineffective administration.

We would be remiss if we did not discuss, at least briefly, another element of perception that affects policies, programs, and implementation. That element is the time frame one takes when looking at problems. It is analogous to the difference in the kinds of perspectives and choices one would make if one were concerned primarily about profits in the next quarter compared with profits over the next decade or two. Depending on whether one takes the short or long term view, or the broader or narrower view, changes the decision making frame of reference and, hence, usually changes the outcomes of policy deliberations.

4.8 Third Party Actors

A final set of organizations and individuals in the network are third parties who have an interest in the programs, processes, or outcomes related to the policy under consideration. These may include associations composed of members of the target group, professional associations of builders or engineers or seismologists, citizen groups, or any of a host of other kinds of interests typically referred to in the literature as third party stakeholders. These third party interests may, of course, either support or oppose all or part of the policy.

Private groups are thought to be so important in policy formation and implementation that they hold a significant and long-lasting place in political theory. Groups and "latent" groups (groups that might form around an issue if enough people become sufficiently aroused to action) have even formed the basis of a theory developed several decades ago and known, appropriately as Group Theory. Today, observers understand that some issues generate groups both in support and in opposition to policy, but other issues may have long-standing group involvement coupled with only sporadic involvement by other groups.

In some cases, the third parties may actually write policy for official enactment by a public body. This is the case with the major means of earthquake hazard mitigation for new construction. In California, for example, the State amended the charter city and general law municipal code in 1974, requiring municipalities to adopt and implement the current version of the Uniform Building Code (UBC). The UBC is essentially drafted by persons outside government in a collaboration between government and professional societies. For many years, the Structural Engineering Association of California (SEAOC) essentially wrote the seismic provisions of the UBC. SEAOC developed and regularly updated a document familiarly known as "The Blue Book." The Blue Book contained approved practices for seismic design for structures. The UBC was the product of the International Congress of Building Officials (ICBO) and, because earthquakes were viewed primarily as a California problem, the California professional society,

working in a "symbiotic relationship" with ICBO, simply wrote their own codes. The Blue Book was essentially adopted by ICBO.

Hamburger (1999) reports that this began to change about 20 years ago "when the Federal government decided that earthquakes were a national problem." Today, the process is more involved, but still relies heavily on non-governmental actors to develop seismic provisions of the UBC. FEMA, the Federal Emergency Management Agency, issues *NEHRP (National Earthquake Hazard Reduction Program) Recommended Provisions for Seismic Regulation of Buildings.* The original NEHRP provisions in 1985 were based on work done by a private, professional organization, the Applied Technology Center (ATC). Today, most of the updates and changes are essentially developed by the BSSC (Building Seismic Safety Council), a private, not-for-profit organization with substantial financial support from FEMA. The BSSC operates under the auspices of the National Institute for Building Safety (NIBS), a publicly funded, governmental organization. The federal NEHRP provisions are working their way into the model UBC and then into public policy as new versions of the code are adopted by local governments. Changes are made through a thorough process of review involving professional engineering, architectural, and building associations employing a sophisticated consensual process. That process is undergoing change, as representatives of the three model code generating associations in the United States created a joint council, the International Code Council (ICC) with the goal of generating a single code. If successful, this will presumably require some modification to the process by which the seismic elements of the code are developed.

The development of building codes and their seismic elements is a remarkable example of the relationship between private professional groups and governments at all three levels working together to develop complex policy regulating not only the conduct of the professions, but also the behavior of building owners, developers, and builders. It is an exceptional illustration of the important role of third parties in the development of policy.

Third parties can also oppose policies. When Los Angeles was working to enact an ordinance to require retrofitting of unreinforced masonry buildings in the early 1980s, Howard Jarvis, best known for introducing and supporting California's Proposition 13 and president of an association of apartment building owners, took on the task of ensuring that the ordinance would not be passed (Alesch and Petak, 1986). He feared that the ordinance would impose significant cost burdens on apartment owners. His actions helped to stall passage of the ordinance for a decade.

In earthquake hazard mitigation, a few groups that have a huge stake in policy spend a lot of time and energy affecting national, state, and local policy. Apart from structural engineers, building officials, and the property and casualty insurance industry, few groups find earthquake hazard mitigation policy very salient most of the time. Sometimes, however, as in the case of

Howard Jarvis and unreinforced buildings, a stakeholder group will fear that its ox will be gored and becomes zealously involved in a policy debate and, should the policy be adopted, continued infighting to slow or alter implementation.

Proposition 31: Third party, nongovernmental organizations are often key actors in policy development, even to the point of actually drafting policy statements in formal and informal collaboration with governmental agencies.

Proposition 32: Not all third party involvement is collaborative. Often, third parties concerned with a policy are in considerable disagreement with one another concerning policy and struggle to affect the outcome of governmental action.

Proposition 33: Policies are more likely to be implemented if they are "actively supported by organized constituency groups and by a few key legislators (or the chief executive) throughout" (Sabatier and Mazmanian, 1976).

4.9 Whole System Characteristics

Our model has two non-organizational components. The first of these has to do with the characteristics of the policy making/implementation system as a whole. The second, the system's environment, is discussed in the following section. The system's characteristics have to do mainly with the linkages between the organizations in the system; it addresses the multi-organizational aspects of the process. Characteristics of the process include the sheer number of linkages, characteristics of communication, and the nature and quality of inter-organizational relations.

Some have suggested that bureaucratic politics is typically the reason that program implementation fails, but the literature suggests that bureaucratic politics is only one among many potential obstacles to successful implementation. We understand from the literature that implementation is not subsequent to policy making, but, instead, an inherent part of it. Consequently, implementation must be inherently political.

The political aspects of implementation are probably essential and inevitable. Policies are continually redefined from formulation through implementation and, then, often back around the cycle again. Wildavsky (Calista 1994) suggests that one reason is that "desirable policies are rarely self-evident." Calista goes on to suggest that implementation outcomes appear slowly and unevenly; continual adjustments, therefore, presumably make sense. Implementation, Calista suggests, is a "gradualist phenomena" (1994). As a consequence, students of policy implementation have reflected on how policy changes in implementation. Majone and Wildavsky (1978) say policy choices *evolve*. Berman (1980) says policy choices *adapt*. Rein and Rabinowitz (1978) say policy choices *drift*.

The difficulties associated with effective implementation go beyond the political characteristics of the process. The complexity of the individual policy making/implementation system affects the implementation as well. Pressman and Wildavsky (1984), considering the complexity of the implementation process in the Oakland studies, observe that the actors find they must create "joint actions" from the "interactions of previously unrelated actors and agencies – not always committed to constructing common outcomes."

Albert Weale (1992) suggests that one reason for great complexity and exacerbated difficulties in multi-agency implementation efforts is that there are considerable informational asymmetries within a policy system. These asymmetries exist when one set of agents has access to information that is typically unavailable to another set of agents involved in the process.

Feldman (Calista, 1994) seems to concur. "Flawed outcomes," he suggests, "Are usually attributed to the systemic effects of the dispersal of power across institutional contexts. The result is a reduced consensus in both posing and solving problems."

It seems clear that implementation studies must examine the many elements of the system we have been describing in our attempt to identify major potential obstacles to effective implementation. We have to look at the interrelationships among organizations as well as within individual organizations and at key actors in the process. We must also look at the "medium" within which the process takes place. Given that implementation has political elements, the level of politicization, the number of actors, and the value of the stakes all make a difference in outcomes and process.

Proposition 34: The probability of successful, timely implementation of natural hazard mitigation policies is inversely related to the complexity of the policy and implementation process, the number of actors participating in the process, the number of sign-offs required, and the diversity of interests and priorities among the actors.

Analysts have described the policy making and implementation process in a number of ways. Calista (1994), for example, describes the process as a bargaining model and a multi-organizational bargaining model. Quoting Elmore, he describes the process as one in which bargained decisions are made by "convergence, adjustment, and closure among individuals pursuing essentially independent ends." Implementation, he suggests results from "the relationship between compromise, intention, and implementation . . . ". Grin and Van De Graf (1996) describe the process as "communicative action, with each group in the chain interpreting policy language, legislative intent, and implementation actions." They suggest that learning occurs between policy makers and implementors, that is, between the actors in the policy and implementation process.

4.9.1 Environmental Characteristics

The second non-organizational overarching element of the system consists of its environment – the milieu within which it operates and with which it interacts. Policy making and implementation obviously take place within a context. What is happening within the environment affects the system's priorities, how it performs, and the outcomes of its actions. In the case of a policy implementation system at the municipal level, the environment includes state and federal actions, the nature of the local economy, the potential seismicity of the locale, and similar phenomena that create a dynamic setting within which policy making and implementation take place. Calista (1994) adds public opinion and interpretive institutions, like courts, to the system's environment. Mazmanian and Sabatier (1984) conclude that changes in socioeconomic conditions sometimes undermine the causal theory or political support for specific policies.

It all makes sense. We believe that the priorities of the Great Depression and World War II delayed serious concern of unreinforced masonry buildings in southern California, for example. We subscribe to the notion that environments range from highly predictable to highly unpredictable and that the "texture" of the environment affects how the system functions, the nature of its output, and the effects generated by its output.

> **Proposition 35: The environment -- the decision making context -- within which the policy making and implementation system operates can and frequently does affect the process, as well as the inputs to policy making and the outcomes of programs. The environment affects the timing within which policies are implemented as well as the resources available for the process and the policies and programs it generates.**

4.9.2 Dynamic Characteristics in the Model

Four characteristics of the systems model we have used are particularly important. First, the entire process is dynamic and, typically, iterative; policies are often revisited after having been enacted. It is a mistake to assume that the model cranks once and that implementation is the outcome of that crank. Second, policy gets defined and redefined at each step in the implementation process as it is interpreted and reality-checked by the participants in that organizational node. Third, obstacles to implementation can arise at each node in the implementation network. They can also arise at the points at which nodes are linked with one another. Fourth, the nature of the entire network itself may engender obstacles to implementation, particularly if the network is large and complex, involving lots of actors and transactions.

Finally, we would be seriously remiss if we did not acknowledge that the simple model portrayed in Figure 1 is anything more than a simplified representation of an extremely complex process. In our society, anyone can talk with anyone and often does. Communication and power relationships rarely follow tightly prescribed organizational and inter-organizational channels.

SECTION 5.
ORGANIZATIONAL REQUIREMENTS FOR IMPLEMENTATION

Most of the literature we reviewed addressing policy implementation focuses on explaining why implementation was ineffective or inadequate in one or another settings. This is valuable information. It is important to understand why organizations do not implement risk reduction practices so one can better understand how to increase the probability of implementation. Understanding the impediments to implementation is essential if one is to fully understand how to overcome those obstacles. However, at the same time one identifies impediments to implementation, it is appropriate to focus on the other side of the equation; that is, under what conditions will organizations choose to implement earthquake hazard risk reduction measures? This section focuses on that question.

Our work was inspired by March and Olsen's garbage can model of organizational decision making (March and Olsen, 1976). That model suggests that decisions are not made, nor is action taken, unless four independent streams come together simultaneously. The four consist of a problem (about which there is general agreement within the organization), a solution to the problem (which is a credible solution for a critical mass of actors within the organization), space on the organizational agenda, and one or more persistent advocates for matching the available solution with the existing problem.

That model triggered us to think about what the prerequisites might be for successful adoption and implementation of risk reduction measures within an individual organization. We have found the March and Olsen model useful in previous work where we attempted to understand why it took several municipalities in California so long to adopt retrofit ordinances for unreinforced masonry buildings (Alesch and Petak, 1986). Rather than simply adapt the model to a somewhat more complex problem and rather than begin building a new model from the ground up, we found that it was helpful to augment the March and Olsen model to further our understanding.

Our analysis suggests four fundamental organizational prerequisites for adoption and implementation of earthquake hazard risk reduction measures. The four prerequisites are sequentially cumulative. The reason will become obvious to the reader.

The first prerequisite for successful implementation is that the individual organization must perceive that it is at risk from the earthquake hazard. This equates to the March and Olsen requirement that there be a recognized problem. Second, once the organization perceives itself at risk, it must also be convinced that an acceptable solution exists to reduce that risk. This prerequisite equates roughly with the March and Olsen prerequisite for a solution, except that we do

not require a solution. We require simply that the organization believe a solution with a good fit to its problem exists. Third, even if the organization perceives the risk and sees that an acceptable solution exists, the organization must conclude that implementing the risk reduction policies and practices is in its best interests at this time. It is here where we believe we have elaborated the March and Olsen model to explicate both a temporal dimension and a proactive solution-seeking element. Finally, in addition to perceiving the risk, believing solutions exist, and having a solution that matches the organization's needs at this time, it is necessary that the organization has the capacity and the ability to implement the risk reduction measures at this time.

These prerequisites form the basis for our planned efforts to convert our findings from the literature and the case studies into practical guidelines for hazard mitigators. The prerequisites are elaborated in the pages that follow. The discussion incorporates "Implementation Propositions" about what is required to ensure successful implementation. These "Implementation Propositions" are based on some of the propositions put forth in the preceding SECTION, but stated in positive terms as ways to help ensure successful implementation.

5.1 Prerequisite 1. The Organization must Perceive Itself at Risk

We've known for a long time that not much happens unless someone experiences some physical, financial, or emotional discontent and decides they want things to be better. Problems exist for individuals and organizations only when there is a difference between what the organization's policy makers desires and expect for the organization and their perception of the state of affairs in which they find or expect to find the organization. There has to be a disparity between the desired and perceived reality. Consequently, we don't expect an organization to implement risk reduction behaviors unless a critical mass of decision makers in that organization is dissatisfied with their perceptions of the current or projected situation and decides that a problem exists.

In the traditional model of risk assessment, we look at the hazard, exposure, vulnerability, and probable losses from events of various magnitude. For organizations to perceive themselves as having an earthquake problem, a critical mass of authoritative decision makers must understand and accept that a credible earthquake hazard exists, that it is likely to occur within a relevant time frame, and that, should it occur, the organization will suffer more than trivial losses. The prudent mitigator from outside the organization should be concerned, therefore, with how organizations define the earthquake problem — how they perceive the risks they face in terms of exposure to the hazard, vulnerability, and the losses that are likely to result from an earthquake. We cannot expect target organizations to take action unless they know the hazard exists and can relate that hazard to potential adverse effects for them.

5.1.1 Communicating the Hazard

Most of us understand earthquakes reasonably well, but every earthquake of consequence teaches us things we didn't know. If those of us who spend much of our time studying the phenomenon continue to be surprised at what we learn from each earthquake, what of the lay person who only thinks about earthquakes when they occur or when they watch some inaccurate, misleading, and fatuous motion picture depicting one? For people to take appropriate action, they must internalize information about the hazard that is relatively simple to understand and that is relatively consistent over time.

A second key element in risk perception and problem definition has to do with timing. Obviously, we do not know enough to be able to predict earthquakes in anything but a geologic time frame. Lay people have a hard time understanding return periods and understanding that we don't know the location of all the faults that might generate earthquakes. We have to learn how to say, "Large earthquakes are not low probability events; the probability of occurrence is nearly one. They are, however, rare in any given decade. That means the chances of one occurring in your neighborhood this year are pretty slim. You can bet the farm, however, that, one of these days, one will occur right where you are standing. Now, how lucky do you feel today."

We've all had the misfortune of hearing someone say, "Thank God, I survived the hundred-year flood. I'm safe for another 99 years," or "We haven't had an earthquake here since 1812. It's just not going to happen in my lifetime." Even if one accepts the inevitability of a damaging earthquake, if the threat is not perceived as likely within one's relevant time frame, the salience of the risk is minimal because the individual or organization does not perceive a risk that justifies action.

And we've heard people say, "I live more than 10 miles from the San Andreas fault; we're safe from earthquakes here," even though California's most recent damaging earthquakes occurred on unmapped faults. In recent field research on flood hazards in the Tar River, North Carolina, one of the authors heard business owners sitting amidst ruined inventory and massive financial losses, teetering on the edge of ruin, say, "I didn't think I needed flood insurance. I'm in the 500-year flood plain." If individuals and organizations believe the event will not occur where they are, or damage them, they do not perceive a risk.

Those of us in the hazards business find it hard to believe that there are organizations in California and other dangerous places who do not understand the inevitability of medium and large earthquakes and the consequences for life and property. We have a tendency to believe they underestimate the risks to which they are exposed. Many of them believe we continually overestimate the risks.

It is also the case that we still don't know as much about the risks as we would like to know. We're still learning about the nature of the hazard, including the characteristics and ex-

pected magnitudes of ground motion and structural response. Even within the field, disseminating new knowledge takes some time; communicating new knowledge about the earthquake hazard to people who may or may not be interested in that information takes much more time. And, it is difficult to communicate risks in ways that people can understand it. Hence, the challenges are, as we learn more, to move information more quickly and accurately from the science community to the lay community when the communication channels are already jam-packed. In short, we need to spend a lot more energy figuring out how to communicate the earthquake risk, especially in areas where they are rare.

Preliminary Implementation Conclusion 1. If a basic obstacle to taking precautions is an inaccurate assessment of risks by the target organization, then the hazards professional, if he or she expects to have a significant impact, must provide that organization with a clear, compelling statement of the risks to the organization.

5.1.2 Perceptions of Exposure, Vulnerability, and Probable Effects

It is not enough for vulnerable organizations to buy into the likelihood of a moderate to large earthquake. If you expect an organization to take actions to protect itself, the organization has to understand its exposure, vulnerability, and the likelihood of adverse consequences when the event occurs. There must be an expectation of loss.

Knowing that there will be damage from an earthquake is not the same as expecting adverse consequences from it. "Why did you have earthquake insurance on your business?" I asked a small businessman in the Northridge area. "I couldn't get the SBA loan without it," he replied matter of factly. "Why *didn't* you have earthquake insurance on your home?," I asked him, knowing that his house had been condemned following the event. "We thought the government would pay for our losses," he replied, just as matter of factly. "We were wrong."

Expectations of loss also depend on how much one has to lose. If your business is just hanging on and you do not have a lot to lose, then your definition of the problem is altered. "What, me worry?" Or, perhaps you just feel lucky; "I've been doing business here for 35 years and nothing has happened yet." Or you may feel protected by one or another deity. Or, perhaps your internal calculus concerning the joint probability of occurrence, imminence, proximity, intensity, and consequent damage, just says to you that this is not something you have to be concerned with.

Preliminary Implementation Conclusion 2. Risk reduction measures are more likely to be implemented when organizational decision makers make a conscious link between the potential hazardous event and likely effects on them and their businesses.

5.2 Prerequisite 2. The Organization must Believe it Can Take Action to Reduce the Risk

Assuming that a critical mass of policy makers in the organization perceives the earthquake risk and attendant problems, they will take precautions against the hazard only if they believe they can do something to reduce the risks to them. There must be a perception that there is an acceptable solution to the problem or nothing will be done. A number of obstacles can exist that would keep an organization's policy makers from believing they can take action.

5.2.1 The Decision Maker's Mind Set

A fatalistic mind set is perhaps the most difficult obstacle to overcome when trying to stimulate risk-reducing behavior: "If it's going to happen, it's going to happen. It's God's will and there's nothing I can do about it." Some people have strong feelings of an external locus of control, while others believe in their own efficacy – that they are confident they can do something to alter what is otherwise likely to happen in the future.

> **Preliminary Implementation Conclusion 3. For an organization to take steps to reduce its exposure or vulnerability to earthquakes, key decision makers in the organization must believe that practical steps exist to reduce the risks associated with the event or condition and that those steps are congruent with the problem and the organization's best interests.**

5.2.2 A Slim or Unknown Inventory of Acceptable Risk Reducing Actions

A solution isn't a solution unless decision makers know it exists and believe that it will be effective within their organizational context. There are several perfectly valid reasons an organization might not be aware of workable solutions.

First, a solution may not yet exist. We do not know, for example, how to immunize people against the AIDS virus. New problems, like broken steel welds, continue to surface, often as side effects of employing new technologies. It took quite a while to come up with means to strengthen unreinforced masonry buildings that were cost-effective for owners.

Second, the actual inventory of workable solutions may be slim. Those of us old enough to doing business before xerographic copying machines remember how we got to choose between carbon paper and wet process copiers. Innovative ways to deal with the need to create multiple copies were developed, but, at first, they were too expensive for all but the most affluent organizations to afford. As costs dropped, more organizations were able to adopt the innovation. Now, many of us have sophisticated copying machines in our homes for personal use.

Third, despite the Internet, disseminating innovations still takes time. Dissemination especially takes time when the innovation has been developed as proprietary property by a firm not

in the business of selling its mitigation techniques. Even when solutions are not secret, there are obstacles to innovation dissemination and technology transfer.

Preliminary Implementation Conclusion 4. The prudent implementor does not assume that the private organization or government agency expected to make the earthquake hazard mitigations understands the range of solutions available to it and the possibility of modifying solutions to match the specific needs of the individual organization.

5.2.3 Intractable Problems

Some problems are perceived by organizations as intractable and, when that happens, organizations sometimes simply stop seeking to understand them, much less continue efforts to find a solution to them. One can imagine hearing, "We can never build a structure to withstand an earthquake of X magnitude." or "I believe planet Earth will, someday, collide with an asteroid or space object of great mass, but nothing can be done about it, " or "Global warming is inevitable and, with it, great dislocation and difficulty, but, since nothing can be done, we're just along for the ride."

Intractability, of course, varies from time to time and place to place. Intractability often has less to do with complexity than it has with being locked into a perceptual paradigm that keeps one from seeing familiar things in new ways — new ways of seeing things that make obvious a solution to a situation that was otherwise an enigma. So, what is intractable to some is not to others. Moreover, intractability changes to tractability with changes in the social, legal, or organizational environmental. Sometimes it changes with the availability of new technologies. And, sometimes it changes when looked at by someone with a novel perspective. In any event, as long as an organization perceives a problem as intractable, little can be done to move it toward implementing a solution.

Preliminary Implementation Conclusion 5. The more an organization views the problem toward which a policy is directed as intractable, the less likely it is that a proposed solution will be implemented.

5.3 Prerequisite 3. The Organization Must See That Taking Action Now Is in Its Best Interests

Almost half a century ago, March and Simon created a simple, yet robust model of organizational decision making to explain a set of choices (March and Simon, 1994). The model suggests that organizations seek alternatives to what they are doing when they are dissatisfied with the way things are going. They keep searching as long as they believe there is a decent solution out there somewhere that can be found for less than the cost of the search, or when they find an

acceptable alternative, or when they come to believe they cannot do better than they are doing now. Organizations take action when a critical mass of decision makers believes either they or the organization will be better off taking the action now than either deferring the action or not taking it at all.

5.3.1 Weighing Sure Costs Against Possible Benefits

An 85-year-old woman testified before a Committee of the Los Angeles City Council that was deliberating what was to become the city's unreinforced masonry building retrofit ordinance. "Let me understand this," she said. "You want to increase my rent by $50 a month for sure, forcing me to choose between medicine and food, because there might be an earthquake that might damage my building and I might be injured. Are you gentlemen playing with all your marbles?"(Alesch and Petak, 1986).

Frankly, this woman put her finger squarely on a critical issue. Everyone has more ways to use resources than he or she has resources. When given a choice of how to use those resources, most people are rational. That is, given their preferences and their perception of the probable payoffs from alternative courses of action to realize those preferences, they will, for the most part, spend appropriately. Some people and organizations are better than others in making good choices. Anheuser-Busch assessed the risks to its business in southern California and decided it made good sense to strengthen parts of its brewing process against earthquakes. The mitigations were completed only about six months before the Northridge Earthquake. Prudent. Lucky.

Implementation problems for public policy occur when governments enact policies dictating that some specific risk reduction measures be taken by a class of organizations regardless of the calculus of those individual organizations concerning risk and potential payoff. Organizations will resist implementing those policies if their own estimates of the risks, payoffs, and relative priorities do not coincide with those of the governmental policy makers.

Public policy makers tend to concern themselves with aggregate measures of well-being. They care about events in which lots of buildings are damaged and the public has to bear great costs. Public policy makers are less likely to concern themselves with the judgements made by individual firms concerning the marginal utility of a dollar spent to reduce the earthquake risk to the firm compared with the marginal utility of a dollar spent elsewhere. Often, businesses have different uses for money on matters of higher priority and more urgent concern.

5.3.2 Congruence with Organizational Culture, Goals, and Priorities

The individual firm's economic analysis of the financial benefits of reducing risks by employing one or another risk reduction technology is important, but only part of the story. Or-

ganizations do not implement policies unless those policies pass several tests. Not only must a proposed risk reduction policy make financial sense, it must also be congruent with organizational culture and values, not detract from attaining central goals, and fit in with organizational priorities. Culture, values, goals, and priorities are unique to specific organizations. Consequently, one size does not fit all – a risk reduction practice that makes lots of sense to one organization may be an anathema to another.

Preliminary Implementation Conclusion 6. Successful implementation of new policies and approaches is more likely to occur promptly in organizations that are traditionally amendable to change or have a culture that embraces innovation.

5.3.3 Matching Organizational Motivation

Students of organizational behavior have devised half a dozen plausible theories to help explain variations in motivation among members of formal organizations. Much less effort has been aimed at trying to explain what motivates the behavior of formal organizations. We believe that the behavior of organizations is different from the aggregation of behaviors by people within them. It may be possible, however, to draw some parallels between what motivates individuals and what motivates organizations.

There is no single theory of motivation that explains variations in motivation adequately. In general, contemporary motivation theory is based on a belief that individuals, and presumably organizations, respond to several kinds of needs or desires that typically extend beyond making money. Some organizations are motivated to do good, to fulfill personal needs of participants, or to have some other affect on organizational participants.

One may argue convincingly that organizations are motivated into courses of action when they expect adequate rewards for doing so. The greater the potential rewards, the greater the motivation, unless, of course, the means for following the path are beyond the ability of the organization.

Finally, one would expect that formal organizations that are closely or privately held will reflect the value set of the owner or owners and be responsive to whatever it is that motivates them.

Preliminary Implementation Conclusion 7. The probability of successful implementation increases to the extent that actors in the implementation process perceive congruence between means and ends.

Preliminary Implementation Conclusion 8. The probability of successful implementation increases to the extent that organizations in the network have similar goals with respect to the set of phenomena associated with the problem.

Preliminary Implementation Conclusion 9. Implementation will proceed when decision makers are committed to the proposition that the organization has a problem and can do something about it.

Preliminary Implementation Conclusion 10. Unless the interests of powerful stakeholders are accommodated at some minimally acceptable level, it is likely that mitigation policies and programs will face guerilla action, be subject to subsequent watering down, and face court challenges.

Preliminary Implementation Conclusion 11. Hazard mitigations are more likely to be implemented when they account for political as well as technical concerns.

Preliminary Implementation Conclusion 12. Policies are more likely to be implemented successfully when they are entrusted for implementation to organizations that embrace the same goals and values as those implicit or explicit in the policy.

Preliminary Implementation Conclusion 13. Organizations will work toward achieving successful implementation to the extent that they believe they can implement the policy, that implementing the policy will achieve desired program objectives, and that achieving the program objectives is consistent with and supportive of the organization's primary objectives.

5.4 Prerequisite 4. The Organization Must Be Capable of Implementing The Risk Reduction Measures at This Time

Assuming the organization's key decision makers are aware of the earthquake threat, know there are measures they can take to reduce their risks substantially, and are convinced that it makes sense, the organization may still not implement risk reduction measures. In the competition of issues and ideas for time, reducing natural hazard risks may not reach the top of the organizational agenda. It may be because other issues continue to crowd it off, because the organization lacks the capacity to do what it perceives necessary, or because the environment within which the organization would attempt implementation is itself dysfunctional.

5.4.1 Space on the Organizational Agenda

"It's important, but we just have too much on our plate right now." How often have you heard or said that in the context of a formal organization faced with an array of important, urgent, and involved initiatives? Like individuals, organizations have to set priorities and must address issues based on some criteria concerning what comes first. Often, unfortunately, tactical concerns take time better spent on strategic assessment, so risks from hazards perceived as having relatively low likelihood this week are pressed onto the back burner so today's emergency

can be dealt with. Organizations with more resources are generally better able to devote resources to both today's problems and tomorrow's vision.

> **Preliminary Implementation Conclusion 14. Private organizations are more likely to implement risk reduction practices when they see that the risk poses a clear and present danger to their enterprise. To the extent that natural hazard risk reduction can be coupled with routine business concerns, such as property and casualty insurance and related risk management concerns, it is more likely to come to the attention of the organizational decision makers.**

5.4.2 Organizational Capacity: Financial Considerations

Small businesses starting out, working to develop products and markets, usually try to keep overhead low. Newer buildings with greater earthquake safety charge higher rents than older buildings that are not as safe. Usually, the tradeoff is to go to the less costly building, other things being equal. The business may, in fact, be marginal, either because it is just starting out or for other reasons; the cash that might be spent on risk reduction is needed for inventory or something else. It is usually only when organizations have a very high commitment to earthquake safety or are well-established and profitable that they are willing to allocate sufficient resources to obtain space with substantial resistance to earthquakes.

Moreover, earthquake insurance becomes expensive and hard to get in areas that have experienced temblors in the recent past. In addition, earthquake policies have onerous deductibles. Organizations have to make the choice between using scarce resources for building the business or for spending money trying to protect it against an earthquake that might happen within the next few years.

At a more basic level, insurance is often a poor means for achieving risk reduction. It won't keep the building from falling on you or your customers. It won't save an inventory of unique art pieces or equipment or a historical building. Real protection may require redundancy, such as multiple geographic locations. It may require product or customer diversity. It may require some basic changes in how the organization does business. In short, real risk reduction may go far beyond buying insurance and moving to a safer building and may very well be beyond the capacity of the firm. In such instances, protection against catastrophic events may be viewed as beyond organizational financial capacity

> **Preliminary Implementation Conclusion 15: Public policies intended to induce private parties to reduce natural hazard risks to the organization and to the public at large are more likely to be implemented when the financial concerns of the private parties are acknowledged explicitly in the policy and provisions are made to alleviate financial burdens associated with implementation.**

5.4.3 Organizational Capacity: Available Skills

Relatively few organizations employ risk managers. Fewer yet employ risk managers who know much of anything about risks associated with natural hazards; most are much more at home talking about product liability and the woes associated with sexual harassment. The professional services marketplace doesn't provide much help. Scratch someone who lists himself or herself as a risk management consultant and you are likely to find someone interested mostly in selling you insurance.

Smaller organizations, especially, are not likely to have much knowledge about risk reduction, about natural hazards, or about how to ensure that appropriate risk reduction steps are taken. This is not to say that small business people are ignorant. Research on changes in small business practices following the Northridge Earthquake found small business people using "folk base isolation" designs to keep glass cabinets upright during shaking, instituting just-in-time acquisition and shipping to reduce the exposure of manufactured products in their facilities, making sure that first aid kits were near the cash register instead of buried in the back room, and devising a host of self-help risk reduction methods. The point is that not everyone did take steps, but those who did could benefit from simplified guides as to the risks they face and what they might do to further reduce those risks. The guide might even include a simplified description of the risks associated with various kinds of structures. "Everyone should know that," you think to yourself, but at the same time, you remember seeing URM buildings on Fairfax in Los Angeles with newly-installed wall anchors advertised as "earthquake proof" and the point is made.

Concerns about organizational capacity are not limited to private organizations that ought to undertake risk reduction measures. Those concerns often extend to governmental building departments in both larger and smaller jurisdictions. Building departments are often understaffed. They are particularly likely to be understaffed when assigned new tasks, such as implementing a new program aimed at reducing a specific risk in a large set of privately owned buildings. Not having the capacity may be as simple as not having enough inspectors to do the job within a reasonable time frame, but it can also mean not having the equipment or software or staff expertise to deal with especially complex cases.

> **Preliminary Implementation Conclusion 16. Other things being equal, successful implementation depends on entrusting implementation to organizations with sufficient capacity to administer the program. If local government agencies are called upon to implement risk reduction programs, they should be provided with the resources necessary to do the job.**

Preliminary Implementation Conclusion 17. Implementation proceeds more effectively when "the leaders of the implementing agencies possess substantial managerial and political skill and are committed to statutory objectives" (Sabatier and Mazmanian, 1979).

Preliminary Implementation Conclusion 18. Smaller organizations may need competent technical assistance, in the form of consultants or self-help instructional materials, to develop sufficient understanding to employ nonstructural risk reduction practices and to make prudent choices concerning risk reduction for buildings and structures.

5.4.4 The Organizational Environment

The environment within which either a private organization attempts to reduce its natural hazard risk or within which a public organization attempts to implement a program to get those organizations to take action is critically important to successful implementation. Organizational environments can range from placid and predictable to convoluted and chaotic.

When organizational environments are highly unpredictable and extremely complex, the chances of successful implementation diminish appreciably. Scholars of implementation concluded this long ago. In 1973, Pressman and Wildavsky concluded that "the multiplicity of participants and perspectives combined to produce a formidable obstacle course . . . When a program depends on so many actors, there are numerous possibilities for disagreement and delay . . . (G)iven a large number of clearance points manned by diverse and independent participants, the probability of a program achieving its goals is low" (Pressman and Wildavsky, 1984). We agree. The probability of successful, timely implementation of natural hazard mitigation policies is inversely related with the complexity of the policy and implementation process, the number of actors participating in the process, the number of sign-offs required, and the diversity of interests and priorities among the actors.

Programs are more likely to be implemented effectively if the environment is generally supportive rather than openly hostile toward the program and its goals. Not all third party involvement is collaborative. Often, third parties concerned with a policy are in considerable disagreement with one another concerning policy and struggle to affect the outcome of governmental action. We agree with other observers that policies are more likely to be implemented if they are "actively supported by organized constituency groups and by a few key legislators (or the chief executive) throughout" (Sabatier and Mazmanian, 1976).

Preliminary Implementation Conclusion 19. In complex organizational environments characterized by instability and change, it may be useful to test implement public risk reduction programs aimed at private organizations in pilot projects in a

variety of settings. This may help avoid implementation pitfalls that could come from immediate, widespread implementation.

Preliminary Implementation Conclusion 20. If the purpose of a public program is to induce private organizations to implement risk reduction policies and practices, the public sector organizations involved should work to maximize simplicity and ease of access for those private organizations.

SECTION 6.
NEXT STEPS

6.1 Project Work Plan

This paper reports on what we have learned in our initial efforts to understand and communicate to others how to overcome the gap between scientific and technical understanding and implementation of earthquake hazard risk reduction measures. We expect to produce more reports as we complete our project.

The project work plan calls for a sequence of activities. We are scheduled to conduct several case studies of California hospitals. California law calls for all hospitals in the State to meet exceptionally high standards of seismic resistance within the next few years. Our focus will be on learning how the hospitals choose to respond to the new requirements. Our research emphasis will be on the individual organizations and how they respond to this particular risk reduction initiative. We will, of course, also be attentive to the response of other nodes in the implementation network to decisions made by hospitals and to the activities of other nodes in the network with respect to this particular State policy, since it makes little sense to study the response of individual organizations apart from the environmental context within which they operate. The case study effort will include an extensive review of critical literature in organizational decision making and behavior.

The case studies will be a basis for evaluating the validity and robustness of the propositions and the Implementation Propositions presented in this report. We expect to further develop and explicate the systems and network model presented in Section 3 of this report as a part of that effort.

6.2 Expected Products

We expect to produce three reports beyond this initial document. The first will be a scholarly manuscript intended to withstand rigorous peer review. The report will embrace an expanded version of this literature review to include new research by others and a review of additional research and theory in organizational behavior and decision making. The report will also include the hospital case studies, including an analysis of each case and a comparative analysis. It will link our work with closely allied MCEER research being conducted by others. A revised set of Propositions and Implementation Propositions will be incorporated as well.

A second report will provide practical advice to those who devise policy and develop programs on how to help ensure the policies and programs are implemented effectively. Our research thus far indicates that program design is often an impediment to implementation. As we uncover information about incentives and design features that are relevant to individual organizations, we will be in a position to suggest means for improving program design.

A third report will be aimed at reaching managers in, first, the organizations with responsibility for seeing to it that private and government organizations actually put risk reduction practices in place and, second, in those private and government organization themselves. We hope to learn how they can increase the likelihood that they will make prudent implementation choices and convey that information to them.

SECTION 7
REFERENCES

Ackerman, B. A. and W. T. Hassler, (1981). *Clean Coal/Dirty Air*, New Haven, CT: Yale University Press.

Alesch, D. J., (1998). "Adopting and Implementing Performance-Based Seismic Design Standards," A paper prepared for the Earthquake Engineering Research Institute, Oakland, CA.

Alesch, D. J. and W. J. Petak, (1986). *The Politics and Economics of Earthquake Hazard Mitigation*, Boulder, CO: Natural Hazard Research and Application Center, University of Colorado.

Alter, S., (1979). "Implementation Risk Analysis," in R. Doktor, R. L. Schultz, and D. Sleven (eds.), *TMS Studies in Management Sciences* Vol. 13, Amsterdam: North Holland Publishing, pp. 103-119.

Bardach E., (1977). *The Implementation Game: What Happens After a Bill Becomes Law*, Cambridge, MA: The MIT Press.

Berman (1980) "Thinking about programmed adaptive implementation: Matching strategies to situations." In *Policy Implementation in Federal and Unitary Systems*. K. Hanf and T. A. J. Toonen (eds.) Martinus Nijhoff, Dordrecht, The Netherlands.

Boehmer-Christiansen, S., (1992). "How Much Science Does Environmental Performance Really Need?" in E. Lykke (ed.), *Achieving Environmental Goals*, London: Belhaven Press, pp. 135-156.

Brigham, J. and D. W. Brown (eds.), (1980). *Policy Implementation: Penalties or Incentives*, Beverly Hills, CA: Sage Publications.

Burby, R. J., P. J. May, and R. C. Paterson, (1998). "Improving Compliance with Regulations: Choices and Outcomes for Local Government," *APA Journal* 64 (3): 324-334.

Calista, D., (1994). "Policy Implementation," in Stuart Nagel (ed.), *Encyclopedia of Policy Studies*, New York: Marcel Dekker, pp. 117-155.

Calista, D., (1986). "Linking Policy Intention and Policy Implementation: The Role of the Organization in the Integration of Human Resources," *Administration and Society* 18: 263-286.

Cyert, R. and J. March, (1963). *A Behavioral Theory of the Firm*, Englewood Cliffs, NJ: Prentice Hall.

Downing, P. B. and Hanf, K. (eds.), (1983). International Comparisons in Implementing Pollution Laws, The Hague: Kluwer-Nnijhoff.

Drabeck, T. E., A. H. Mushkatel, and T. S. Kilijanek, (1983). *Earthquake Mitigation Policy: The Experience of Two States*, Monograph 37, Boulder, CO: Institute of Behavioral Science, University of Colorado.

Dror, Y., (1971). *Design for Policy Sciences*, New York: Elsevier.

Dror, Y., (1994). "Basic Concepts in Advanced Policy Sciences," in S. Nagel (ed.), *Encyclopedia of Policy Studies*, New York: Marcel Dekker, pp. 1-30.

"Incentives and Impediments to Improving the Seismic Performance of Buildings," no author, (1988). Oakland, CA: Earthquake Engineering Research Institute.

Elmore, R. F., (1982). "Backward Mapping: Implementation Research and Policy Decisions," in W. Williams (ed.), *Studying Implementation*, Chatham, NJ: Chatham House.

Elmore, R. F., (1978). "Organizational Models of Social Program Implementation," *Public Policy* 26 (Spring): 185-288.
Fischer, F., (1980). *Politics, Values and Public Policy: The Problem of Methodology*, Boulder, CO: Westview Press.

Fischer, F., (1995). *Evaluating Public Policy*, Chicago: Nelson-Hall.

Gardiner and Balch (1980). Policy Implementation: Penalties or Incentives, Sage. SEE "Brigham & Brown" *delete this entry*

Ginzberg, M. J., (1979). A Study of the Implementation Process, in R. Doktor, R. L. Schultz, D. Sleven (eds.), *TMS Studies in Management Sciences* Vol. 13, Amsterdam: Norh Holland Publishing, pp. 85-102.

Godschalk, D. R., T. Beatley, P. Berke, D. J. Brower, E. J. Kaiser, C. C. Bohl, and R. M. Goebel, (1999). *Natural Hazard Mitigation: Recasting Disaster Policy and Planning*, Washington, D. C.: Island Press.

Grin, J. and H. Van De Graaf, (1996). "Implementation as Communicative Action," *Policy Sciences* 29: 291-319.

Hamburger, Ronald O. (1999). *The Future of Building Code Development*, Plan Review, Newsletter of the Structural Engineers Association of California, Sacramento, CA, December 1999.

Hawkins, K., (1984). *Environment and Enforcement*, Oxford: Clarendon.

Kingdon, J. W., (1984). A*gendas, Alternatives and Public Policies*, Boston: Little Brown.

Lasswell, H., (1976). *Power and Personality*, New York: W. W. Norton & Company, Inc.

Lindblom, C., (1959). "The Science of Muddling Through," *Public Administration Review* 19: 79-88.

Lipsky, M., (1971). "Street Level Bureaucracy and the Analysis of Urban Reform," *Urban Affairs Quarterly* 6: 391-409.

Lorange, P., (1979). *Implementation of Strategic Planning*, Englewood Cliffs, NJ: Prentice Hall, Inc.

Majone, G. and A. Wildavsky, (1978). "Implementation as Evolution," in H. E. Freeman (ed.), *Policy Studies Annual Review* Vol. 2, Beverly Hills, CA: Sage.

March, J. G. and J. P. Olsen, (1976). *Ambiguity and Choice in Organizations*, Bergen: Universitetsforlaget.

March, James G. and Herbert A. Simon (2nd Ed.) (1993). *Organizations*, Cambridge, MA, Blackwell Publishers.

Mazmanian, D. A. and P. A. Sabatier, (1989). *Effective Policy Implementation*, Lexington, MA: Lexington Books.

Mazmanian, D. A. and P. A. Sabatier, (1989). *Implementation of Public Policy*, New York: University of America Press.

May, P. J. and W. Williams, (1986). *Disaster Policy Implementation: Managing Programs Under Shared Governance*, New York: Plenum Press.

Mintzberg, H., (1979). "Beyond Implementation: An Analysis of the Resistance to Policy Analysis," in K. B. Haley (ed.), *Operational Research '78*, New York: North Holland Publishing.

Palumbo, D. J. and D. J. Calista, (1990). "Opening up the Black Box: Implementation and the Policy Process," in D. J. Palumbo and D. J. Calista (eds.), *Implementation and the Policy Process*, Westport, CT: Greenwood.

Pressman, J.L. and A. Wildavsky, (1973). *Implementation*, Berkeley: University of California Press.

Pressman, J. L. and A. Wildavsky, (1984). *Implementation*, 3rd ed., Berkeley: University of California Press.

Rabinovitz, F., J. Pressman, and M. Rein, (1976). "Policy Implementation: Guidelines," *Policy Sciences* 7 (Winter).

Rein, M. and F. Rabinovitz, (1978). "Implementation: A Theoretical Perspective," in W. D. Burnham and M. W. Weinberg (eds.), *American Politics and Public Policy*, Cambridge, MA: MIT Press.

Rahardjo, K. and M. A. Dowling , (1998). "A Broader Vision: Strategic Risk Management," *Risk Management* 45 (9): 44-50 (September 1998).

Sabatier, P. A., (1986). "What can we learn form Implementation research?" in K. X Kaufman, V. Ostrom, and G. Majone (eds.), *Guidance, Control and Performance Evaluation in the Public Sector*, Berlin: De Gruyter, pp. 315-325.

Sabatier, P. and D. Mazmanian, (1979). "The Conditions of Effective Implementation; a Guide to Accomplishing Policy Objectives," *Policy Analysis* 5: 481-504.

Sabatier, P. and D. Mazmanian, (1981). "The Implementation of Public Policy: A Framework of Analysis," in D. Mazmanian and P. Sabatier (eds.) *Effective Policy Implementation*, Lexington, MA: Heath.

Sabatier, P. A., (1986). "Top-Down and Bottom-Up Approaches to Implementation research: A Critical Analysis and Suggested Synthesis," *Journal of Public Policy* 6: 21-48.

Scheirer, M. A., (1981). *Program Implementation: The Organizational Context*, Beverly Hills, CA: Sage Publications.

Schon, D. A., (1983). *The Reflective Practitioner: How Professionals Think In Action*, New York: Basic Books.

Schon, D. and M. Rein, (1994). *Frame Reflection, Toward the Resolution of Intractable Policy Controversies*, New York: Basic Books.

Schultz, R. L., and D.P. Slevin, (1975). *Implementation Operations Research/Management Science*, New York: American Elsevier.

Strieb, G. and W. L. Waugh, Jr., (1991). "Administrative Capacity and the Barriers to Effective County Management," *Public Productivity and Management Review* 15 (Fall 1991).

Taylor, C., E. Mittler, and L. Lund, (1998). *Overcoming Barriers: Lifeline Seismic Improvement Programs*, Monograph No. 13, Reston, VA: American Society of Civil Engineers.

Thurow, L., (1980). *Zero-Sum Society: distribution and the possibilities for economic change*, New York: Basic Books.

U. S. Congress, Office of Technology Assessment, no author, (1995). *Reducing Earthquake Losses*, OTA-ETI-623 Washington, D.C.: U. S. Government Printing Office, September 1995.

Weale, A., (1992). "Implementation Failure: A Suitable Case Review," in E. Lykke (ed.), *Achieving Environmental Goals*, London: Belhaven Press.

Van Meter, D. and C. Van Horn, (1974). "The Policy Implementation Process: A Conceptual Framework," *Administration and Society* 6: 445-488.

Vroom, V. H., (1964) 1994. *Work and Motivation*, Reprint, San Francisco: Jossey-Bass.

Weale, A., (1992). "Implementation Failure: A suitable case for review?" in E. Lykke (ed.), *Achieving Environmental Goals: The Concept and Practices of Environmental Performance Review*, London: Belhaven Press, pp. 43-66.

Weatherly R. and M. Lipsky, (1977). "Street Level Bureaucrats: Implementing Special Education Reform," *Harvard Educational Review* 47: 171-197.

Williams, R., (1992). "Transformation of Scientific Data into Policy Relevant Information," in E. Lykke (ed.), *Achieving Environmental Goals*, London: Belhaven Press, pp. 121-134.

Williams, W., and R.F. Elmore (eds.), (1976). *Social Program Implementation*, New York: Academic Press.

Wilson, G. K., (1984). "Social Regulation and Explanation of Regulatory Failure," *Political Studies* 32 (2): 203-206.

Wolf, C., Jr., (1979). 'A Theory of 'Non-Market Failure': Framework for Implementation Analysis," *Journal of Law and Economics* 22: 107-139.

Wolman, M. G., (1995). quoted by K. Keatley, "Wolman Recognized for Eclectic Array of Expertise" in *The Gazette, The Newspaper of the Johns Hopkins University*, 30 May 1995.

Yin, R. K., (1982). "Studying the Implementation of Public Programs," in W. Williams (ed.), Studying *Implementation*, Chatham, NJ: Chatham House.

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