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Road Safety in the Context of Urban Development in Sweden and California

by

Carolyn Ann McAndrews

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in the

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## Abstract

### Road Safety in the Context of Urban Development in Sweden and California

by

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Road safety is a serious public health issue throughout the world, with more than one million people killed in traffic accidents each year. Despite the severity of its health impacts, the World Health Organization says that traffic safety is a "neglected" topic. Perhaps this is the case in the US, where traffic accidents are the leading cause of death for people up to age 34, and where the traffic safety record is one of the worst among high-income countries. Other high-income countries such as Sweden have much better road safety performance.

Differences in road safety between countries could be explained by the quality of infrastructure, driving conditions, the culture of driving, or the power of enforcement. Each of these elements is shaped by institutional contexts such as design, planning, and policy-making processes. Moreover, research about other technical systems has shown the powerful effect of organization, norms, and communication on safety. This led me to ask: How do our cultural and professional interpretations of safety influence the way we plan, design, and manage streets? Based on field studies, statistical analysis of crash and injury data, and interviews with practitioners, I found that professionals in California and Sweden share similar ideas about road safety, such as the roles of driver behavior, the road environment, and the vehicle in producing hazards. Professionals in both cases also face similar conflicts in road safety planning, such as whether to provide greater mobility for cars, or to reduce the speed of traffic to prevent injury. These similarities reflect shared professional and disciplinary backgrounds and sources of information, as well as similarities in the issues that municipalities and regions face. The main differences are in the interaction between road safety ideas and larger institutional contexts such as suburban land development. For instance, in the middle of the 20<sup>th</sup> century, Sweden created a multi-modal transportation system that accommodated cars as well as transit, pedestrians, and bicyclists—even in the suburbs. A combination of architects, city planners, and transportation engineers supported this development. Multi-disciplinary policy communities in Sweden found traction for their safety-oriented designs in the relatively integrated transportation and land use planning system. In the US, such integration was not the norm, and efforts to use design and land use controls to create a safe transportation system often meet resistance from the established institutions of the car-oriented road transportation system. Improving road safety in California and the US requires addressing not only the dominance of automobiles, but also recognizing that sectors outside of, but related to transportation, such as housing, public health, and land use planning, need to be key participants in creating a safe road transportation system.

*I dedicate this work to my family.*

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## Chapter One—Introduction

### 1. The U.S. Underperforms on Road Safety

Road safety is a serious public problem throughout the world. Approximately 1.2 million people die each year in traffic-related accidents worldwide. (World Health Organization, 2004b) In addition to its absolute impact, road safety is also an issue of social equity. More than 90 percent of the victims of these accidents, about 1 million people, are in low- and middle-income countries. This disparity holds when accounting for the distribution of population; the traffic fatality rate in low- and middle-income countries is 20.2 deaths per 100,000 population, whereas the rate is only 12.6 for high-income countries. In addition, more than half of the victims are vulnerable road users, including bicyclists, pedestrians, and other unprotected travelers. (World Health Organization, 2004b)

Road safety is no less a problem in the US where motor vehicle crashes were the leading cause of death for people between age five and 34 in 2005, with over 40,000 casualties a year. (National Center for Injury Prevention and Control, 2008)

Comparing traffic fatality rates constructed with *population* as the measure of exposure shows that the overall traffic safety record is far better in many other developed countries with road networks, vehicles, and operations similar to those in the US. In 2002, countries such as Sweden, the UK, Japan, and Canada had traffic fatality rates below or about 8 per 100,000 population. Countries with traffic fatality rates greater than 10 per 100,000 population included the US, France, and Spain. (See Table 1.1)

Table 1.1 Traffic Fatality Rates with Different Measures of Exposure for Selected Countries and States, 2002

	Population ('000)	Auto-kilometers of travel (billion) <sup>a</sup>	Fatality rate per 100,000 population	Fatality rate per 1 billion auto-km of travel
<b>Sweden</b>	8,450	62	5.8	7.9
<b>UK</b>	57,127	405	6.4	9.0
<b>Japan</b>	121,752	529	6.9	15.9
<b>Canada</b>	26,056	289	8.2	7.4
<b>Australia</b>	16,294	171	8.3	7.9
<b>Germany</b>	78,811	584	8.5	11.5
<b>Italy</b>	57,058	374	11.8	18.1
<b>France</b>	55,635	401	13.7	19.0
<b>Spain</b>	38,468	172	14.3	32.0
<b>USA</b>	287,804	4,570	14.9	9.4
<b>California</b>	34,876	515	11.7	7.9
<b>Massachusetts</b>	6,441	85	7.1	5.4
<b>Texas</b>	21,711	354	17.6	10.8

Sources: World Health Organization, 2004a; Millard-Ball and Schipper, 2010; US NHTSA, 2010; US Census Bureau, 2002.

Note (a): Kilometers of travel for the US and US states includes all vehicles.

Although analysts commonly use population as a measure of exposure, fatality rates using this metric do not capture the full extent of exposure to traffic hazards. For this reason, analysts also use the total amount of travel in a region, measured as vehicle-kilometers of travel, to indicate exposure. Table 1.1 includes such figures, and they do present a different story. Countries with relatively more motorized traffic have lower fatality rates when using this metric.



For example, the traffic fatality rate in the UK was less than half that of the US when measured by population, but it is roughly similar when measured by the total amount of auto use. While safety experts criticize per-capita measures of safety for not representing the true risk of using the transportation system, safety experts also criticize rates based on vehicle travel because these measures treat the use of the transportation system as exogenous, when in fact it is the source of hazards. (Litman and Fitzroy, 2010: 7-8)

Among countries with advanced economies, Sweden stands out as a best performer with respect to road safety. In addition to its safety as indicated by traffic fatality rates, Sweden has a reputation for being a world leader in road safety policy. For instance, Sweden was the first country to adopt an official road safety target of zero deaths and serious injuries, the 1997 Zero Vision policy. An analysis of Sweden's road safety programs and policies by an international group of experts described the Swedish approach to traffic safety as "innovative", "inspiring", and "engaging". (Breen, et al., 2007: 4) Since I started working on traffic safety, I have participated in international conferences on traffic safety and find Swedish experts included regularly in discussion panels. When safety experts from, say, France or the US have wanted to appeal to best practices, they have pointed to the safety leadership of Sweden, noting in particular its enlightened policy, Zero Vision.

In contrast, when a Swedish traffic safety consultant moved to the US and conducted a study to discover what Sweden could learn about traffic safety from the US, she did not find any comparative strength in US road safety performance or policy making except for the transportation of school children. (Björklund, 2009) Thus, the US underperforms on road safety compared to other developed countries both with respect to its crash and injury record, as well as its reputation. It is genuinely puzzling that countries with similar transportation systems, including infrastructure, levels of mobility, and policy processes, would have such different outcomes with respect to road safety. It is also interesting that the fatality rates for selected states within the US—in this case Texas, California, and Massachusetts—are diverse. The fatality rates for Massachusetts, measured by population and vehicle-km of travel, are much lower than those for the US, and are similar to the low traffic fatality rates in Europe, Canada, and Australia.

## **2. Framing Road Safety as a Public Problem**

Given the poor traffic safety performance in the US and in many other parts of the world, one might infer that traffic safety is not an important policy issue in most countries, or that existing policy approaches are not satisfactory. Experts in traffic safety have suggested that the issue is "neglected" (World Health Organization, 2004b) and that it is "grossly underemphasized" (Evans, 2004). The 2007 *Global Report on Urban Settlements* included traffic safety in its analysis of urban safety and security. The report concluded that traffic accidents are "small disasters", not "large disasters", where small disasters affect only individuals, families, or households, and large disasters affect entire communities or groups at a larger scale. Moreover, according to the report, the small disaster does not affect a large territory, the way an earthquake would. (United Nations Human Settlements Programme, 2007) The implication is that large disasters command disproportionate attention because of their visibility and scale of impact, and that the cumulative impact of incremental disasters such as traffic accidents are not visible.

Hewitt, a geographer of disasters, presented a variation of this classification of risk that included four categories. The first category included chronic dangers, or “lifestyle hazards”, such as heart disease and traffic crashes. The second included disasters, or “‘crises’, emergencies, catastrophes” such as pandemics and floods. The third and fourth classes of disasters were less concrete events than processes: dangerous global changes such as biological extinctions and climate change, and novel dangers such as bioengineering and drug-resistant diseases. (Hewitt, 2000) Hewitt distinguished the different categories by their frequency, spatial-temporal dispersion, acceptability, and uncertainty. In this classification system, traffic safety is a function of individuals’ behaviors. Again, experts viewed traffic safety as something personal—as a private problem, not a public problem.

These taxonomies of public problems, framed as disasters, create an ordinal system where events fall along an axis with values ranging from the individual to the collective. I argue that traffic deaths should be considered a large disaster, not a small disaster, though one that has the characteristics of an incremental catastrophe, or a chronic problem, not a sudden crisis.

The language of the individual and society is prevalent in literature justifying intervention in problems where societal risk, harm, or nuisance arises from individuals’ private actions. The literature from policy, economics, and institutions discusses how even the most rational private interests can create negative externalities, and how these can be managed by regulation, or some other intervention that aligns the collective interests. (Pigou, 1932; Coase, 1960; Ostrom, 1990)

Public discussions of externalities can, in theory, have a philosophical basis in liberalism, where one does not need to be concerned with the substantive issues of the problems in question in order to manage them. For example, in the liberal context, externalities from pollution and traffic can be eliminated through the same mechanisms (e.g., pricing). But the liberal framework ignores the fact that many of these public problems, including traffic safety, as well as other public problems such as pollution and homelessness, have moral components that may not be remedied through pricing or other intervention. For problems such as traffic safety and homelessness, for example, this moral component centers on the idea of personal responsibility. Popular and expert discourses represent individuals’ actions creating the public problems as moral failings, poor decision making, or irrational behavior. (Mitchell, 2003; Mitchell 2010) For this class of public problem, where people have violated a social norm or failed to exercise personal responsibility, there is a tension between justifying public intervention (usually requiring some kind of personal reform) and *not* intervening because one’s private problems are not public problems. Motorcycle safety is another example of this. While most states in the US have some form of motorcycle helmet law, some do not, and motorcycle lobbyists contest all of these laws, both proposed and existing. Motorcyclists want the freedom to choose whether to wear a helmet or not. Some members of the public agree, arguing that motorcyclists choose to ride, and therefore accept the risk and should not be regulated. The counter argument states that motorcyclists do not internalize the true social costs of motorcycle riding, and therefore transfer some of these costs to the broader public.

Specifically for the case of traffic safety, one of the earliest explanations of traffic accidents was that some drivers were “accident prone”, a concept borrowed from the field of workplace safety. Historical research about early traffic safety policy explains that the first automobile owners were wealthy, and used the cars mainly for sport. Sometimes these early adopters sped through cities, causing accidents and crashing into people in the street. Often, these victims were children. Expert and popular opinion alike believed that recklessness caused accidents, and that individual drivers needed reforming. When cars became more commonplace

and traffic increased, it became clear that factors such as the quality of the vehicle and the road played a role in accident causation, and safety interventions began to include traffic control and road design. Despite the diversification of road safety interventions, the focus on driving behavior never waned. Cultural historians have found that driver behavior was institutionalized in the early 20<sup>th</sup> century as a criteria by which to judge and marginalize others, particularly immigrants, blacks, and people of low socio-economic status. (Albert, 1997) Albert found that progressive reformers believed motorization reflected an underlying chaos in modern society, and that immigrants, racial and ethnic minorities, and the poor contributed to the social chaos. The remedy for poor driving behavior, and resulting chaos, was two-fold. First, create and enforce laws focusing on behavior. Second, educate people and then test them on their training, granting them access to the transportation system only after they prove to be sufficiently skilled. This system created a link between driving and citizenship, where good drivers are also good citizens. (Packer, 2008; Albert, 1997)

Traffic safety still has ambiguous status as a public, rather than a private problem in contemporary research on traffic safety. Analyses of the causes of accidents point out that 90 percent of accidents are caused by road users' misbehavior. (Evans, 1996; Åberg, 1998, citing to Rumar 1985) Behaviors commonly associated with injury accidents include driving while drunk or on drugs, distracted driving, speeding, and not wearing safety belts and motorcycle/bicycle helmets. Traffic safety interventions have always focused on drivers' misbehavior, but they have also included non-behavioral interventions such as the design of road environments and vehicle safety improvements in recognition that accidents also happen to "good" drivers. One of the most common examples is the child who runs into the street. It is more difficult to blame a child for causing accidents, therefore, the built environment must have been inadequate.

Traffic safety researchers are also interested in drivers' rationality, and use the distinction between individual and collective rationality to justify regulation. Rumar (1988) argued that individuals do not accurately perceive the collective, statistical risk of their automobile travel because we feel that we are in control, and more skilled than the average driver. More recently, Elvik (2010) argued that speed limit laws are justified because drivers cannot select a driving speed that would be socially best. Thus, historically, and more recently, in both popular and technical literature, road safety been defined as a problem of driver behavior, a private problem, though one with consequences that justify public intervention.

Constructing public problems in this way creates a conceptual bad driver, a figure who represents anyone who is different from the average person using the roads. Simpson (2009) described the problem with this kind of reasoning using the case of crime and ideas from cybernetics. A first order cybernetic approach is one where "...the observer makes no connection between herself and the crime, the criminal, or the construction of either concept." She argues that in a more socially just world, "...second order cybernetics would recognize the observer as a (recursive) element in the system being observed—that is, anyone naming a criminal or crime is part of the self-creating system in which such elements exist." (Simpson, 2009: 12)

This concept from cybernetics can be applied to the situation with traffic safety where interventions to improve road safety are based on first order classifications rather than a more complicated, recursive understanding of the role of the designer and policy maker who takes part in crafting the environment in which people behave. The problem with attributing responsibility for public problems to private actions is that the logic constructs a universe where people are not influenced by a larger policy context that shapes choices and behaviors. For instance, the US

Federal Highway Administration (FHWA) budgets more than US\$ 9 billion per year on projects and programs related to road safety. (US Department of Transportation, 2009) This is more than the FHWA allocates to other performance goals, including security, and environment. Still, the investment in safety was less than the US\$ 23 billion that FHWA allocated to reduce congestion in the same year, the performance goal that received the most investment. These programs create the context in which people make decisions about travel and their safety.

The FHWA spends most of the safety allocation on the “three E’s” engineering, education, and enforcement, reflecting the long-held belief by American safety experts that driver behavior and infrastructure are the key components to creating a safe road transportation system. Traffic safety interventions include, in varying combinations, vehicle design, street design, traffic operations including automated monitoring and control systems, new materials for vehicles and roadways, road emergency deployment strategies, critical health care strategies, legal restrictions on motor vehicle operation, and enforcement.

I argue that safety interventions also include the institutional relationships that put these measures together to control and mitigate hazards and risk. How the various actors who design the transportation system construct their roles and relationships thus may be the critical determinant of safety outcomes.

Lessons from other social-technical systems such as aviation and nuclear power suggest that it is indeed the case that safety management practices play a crucial role in affecting safety outcomes, and in particular its role in inculcating safety values among all participants. In these other sectors, operators, managers, and regulators cultivate a set of pro-safety norms that is shared among members of organizations and across organizations in the industry. The way the actors in these sectors frame the safety problem—how they understand safety and enact it through their thinking and actions—affects how people practice safety management, and these management practices have a significant influence on the safety outcomes. For example, many private firms that design and operate hazardous technological systems consider safety a core value in their work rather than simply one priority among many. Employees maintain an awareness of the risks in their activities and environment, seek out and share knowledge about hazards to prevent accidents, and actively try to control their operating environments to minimize risks. These and other practices constitute a discipline around safety that goes beyond the identification of hazards, the development of policy, and enforcement of that policy – these professionals learn to internalize safety as a core value, to inculcate these safety values among their colleagues, and to modify their technologies and environments to minimize risk.

### **3. Research Problem Statement**

Safety is a fascinating subject to study; one reason for this is that it is subjective and evaluative, which contrasts with the assumptions of a science-based policy system. Situations are not inherently safe or unsafe, they must be assessed, and compared to alternative scenarios. This quality of safety is similar to the concept of acceptable risk. Do we accept this level of risk, or this level of protection? These sorts of questions create tension in our society where policy and administration should be based on science, an epistemological foundation based on the assumption of an objective reality, an assumption that is challenged by the inherent ambiguity and subjectivity of safety.

The study of traffic safety is equally interesting because cities and regions involve organizations and people from a variety of disciplinary backgrounds judging the safety of the

road transportation system and altering the system in accordance with other objectives. Professionals from different areas of specialization may have different ways of understanding the issues. Thus, people may understand what constitutes a safe road user, vehicle, or street in different ways. For example, experts in transportation debate the relative safety of traditional and modern street designs.



**Figure 1.1 Comparison of a Traditional Street and a Modern Freeway**  
Photos: (left) Norrköping, Sweden, 2009; (right) Stockholm, Sweden, 2009

Traditional streets were not designed for motorized traffic. They are often relatively narrow, lined with stores or vendors, and can be crowded with people walking, riding bicycles, or simply sitting and watching people pass by. Movement on these streets seems irregular compared to other facilities such as highways. There are many opportunities for automobiles to collide with people or objects on traditional streets. Moreover, perhaps the most significant drawback of traditional streets—for the motorist, that is—is the slow travel speed. Modern streets were designed for automobiles, and they are wide, have well-defined traffic lanes that organize movement, and enable vehicles to travel at high speeds. For safety reasons, because of the high speeds, the roads should not have fixed objects such as trees, parked cars, or light posts close to traffic. Some professionals believe that traditional streets are safer than modern streets because speeds are slow, and though there are many chances for collision, these collisions would not cause serious injury. By this logic, modern streets (including highways) are not safe because speeds are so high. The advocates of the modern streets view traditional streets as unsafe because people are constantly in harm's way. These professionals believe that modern streets are safe because engineers designed them specifically to accommodate the high speeds of automobiles. Codifying safe street design based on either traditional or modern streets creates controversy.

Dilemmas about the classification of ambiguous phenomena are a central question in sociology: What is normal social behavior and what is deviance? What is a mental illness and what is a biomedical problem? In the context of modern sociology, these questions were examined at least as early as the late 19<sup>th</sup> century. For example, Durkheim investigated the “Rules for the Distinction of the Normal from the Pathological,” analyzing the role of social norms in determining such a distinction. (Durkheim, 1895 [1982]) The fields of medical sociology and medical anthropology have investigated the definition of what constitutes illness and disease. Mental illness has only relatively recently become classified as a biomedical

disease. This new classification has affected the way practitioners manage such illnesses, as well as how society treats people with mental illness. (Horowitz, 2002)

As for accidents, these have also been constructed differently over time. (Green, 1997) Accidents, as a coincidental act of God, emerged as a catch-all for what could not be explained by reason and probability. Accidents became medicalized when the field of public health began distinguishing between internal and external causes of death. External causes of death that were deliberate and with moral content (e.g., suicide, murder, death in battle or drunken brawl) had individual classifications, and the rest were accidents. Nowadays, the prevailing belief among experts is that accidents can be prevented, for example, by knowing specific risk factors and intervening to control them. Among the remaining questions are: who is responsible for their prevention, how should such prevention be carried out, and for whom?

In the context of technical systems such as urban transportation, the dominant framework of planning and engineering has sought rational, non-political, non-controversial, fact-based decision making. But when it comes to road safety, safety is not easily rationalized. For this reason, the field of road safety may be more marbled with scientific controversy than other aspects of transportation that are certainly politically controversial, but not technically controversial. For this reason, the professional aspect of road safety is also uncertain. Latour (1987) suggested that the distinction between rational and irrational is based on the idea that rational things are self evident—that is, self evident to scientists, and that irrational things are beliefs held by non-experts. Within Latour's framework, in the area of road safety, there are many beliefs, and not very much knowledge. This is what makes it interesting, especially in a policy environment that requires science and evidence-based policies.

Within this social constructivist framework, road users have a role in the creation of safe traffic, but their roles are shaped in part by the technology, design, policy, and social norms of the road transportation system. How these latter factors develop through the practices of experts is the subject of this study.

#### **4. Research Questions**

Given this framing of the problem, the research questions guiding this study are the following:

- (1) Who are the professionals who influence road safety and how do they frame the problem of road safety and understand their roles in shaping it? What training backgrounds do they have (e.g., public health, landscape architecture, law enforcement, transportation engineering, city planning, education, etc.)? Do professionals from these different disciplines have different ideas about road safety?
- (2) How do these professionals organize around the issue? How do they influence the design and implementation of road safety interventions in practice? Are there conflicts among these professionals and framings, what are they and how do they arise?
- (3) What is the relationship between the different conceptualizations of road safety and the organizational field that implements them?

This research design uses multiple methods and two metropolitan sites that are comparable in the context of this research: the San Francisco Bay Area in California and the Stockholm region in Sweden. The comparative case study approach enables me to associate local safety management practices to the local levels of performance with respect to safety. Across the cases, I am interested in how traffic safety becomes relevant to professionals in the local context, and the variety of institutions that arise to enable safety interventions in the broadly defined transportation system. Taken together, these questions investigate whether and how different organizing principles around road safety are related to different levels of safety performance.

Overall, this dissertation targets a missing piece in the literature: comparative studies of the social construction of traffic safety. In this work, I synthesize multiple literatures, including science and technology studies; organizational approaches to safety and risk in industrial sectors; metropolitan governance; and engineering, planning, and public health approaches to road safety that rely on analysis of quantitative data and design methods.

## **5. Literature and Theoretical Framework**

There is scant literature addressing any of these research questions directly. Gusfield's *The Culture of Public Problems* (1981) investigated the discourse of drinking and driving in the U.S., focusing on how unsafe drivers emerged as the key subjects in research, law, and policy addressing traffic safety. Other relevant issues such as the unavailability of transit and the role of the alcoholic beverage producers did not gain salience in these debates because of the focus on the moral dimensions of the problem. The construction of traffic safety as a matter of criminality has also highlighted the use of law and police enforcement as the policy mechanism of choice, rather than other sorts of interventions, because of the link between law and social order. (Gusfield, 1981)

But drinking and driving is only one aspect of the traffic safety problem. Historians have analyzed how other aspects of traffic safety has been framed over time. Peter Norton (2008), David Blanke (2007), and Daniel Albert (1997) drew upon the history of American cities and motorization to call out the role that traffic safety played in creating a motorized society. Norton and Blanke argued that creating a “safe” system—both technologically and culturally—was necessary for the growth of the automobile industry. Norton built on Clay McShane's argument that city streets were redefined to accommodate the automobile, and presented the story of how the automobile market expanded between 1910 and 1930, and how cities changed in response. (Norton, 2008; McShane, 1994) In doing so, different social actors such as mothers whose children had died in traffic, local chapters of the National Safety Council, local law enforcement and government, and automobile interests—each with a different stake in the definition of safe streets—struggled to define proper uses of city streets. Ultimately, the field of traffic engineering developed to organize traffic flows and separate different road users in order to create safer streets. In the process, these professionals redefined streets' socially acceptable uses, and police, as well as most of the public, accepted and enforced these new norms. Others did not accept the new definition of city streets as places for motorized traffic. Beginning around the 1960s, some popular and professional opinion criticized the re-making of cities to accommodate the car, particularly the pollution, noise, danger, anti-social environments, sprawl, and annoyance that it caused, particularly in older urban areas. (Great Britain Ministry of Transport, 1963; Appleyard, 1981)

These histories of the development of traffic safety describe and explain the variety of ways in which different professionals framed the issue of safety, which over time centered on three main areas or themes: road user behavior, the design of streets, and the control of traffic. Moreover, they highlight the roles of various groups involved, including the police, the engineering professions, and groups such as the National Safety Council. As I discuss in these chapters, for the cases of the San Francisco Bay Area and the Stockholm Region, how professional capacity developed around road safety over time, and the different ways in which safety has been framed historically has a significant influence on how we frame these issues today and create interventions to improve traffic safety.

O'Connell (1998) explored the approaches to road safety that developed in the UK, and found the same professional specialization with respect to drivers, vehicles, and the built environment, stressing that scientific approaches to safety were less intrusive than alternatives that might have limited the expansion of car-oriented transportation. Irwin (1985) found a similar pattern in the US and the UK, also noting the alignment—though not necessarily agreement—of professional groups around the three themes. Leichter (1991) made a comparative study of health promotion, policy, and culture in the US and the UK, and regarding the countries' approaches to road safety, noted the similar “indifference” toward the issue. (Leichter, 1991: 183, 206) Despite these similarities between the two countries, different cultural values and political structures have resulted in different approaches to public health policy. (Leichter, 1991) Williams and Haworth (2007) compared the traffic safety cultures in the US and Australia, concluding that Australia has a relatively strong highway safety culture, and the safety culture in the US is relatively weak. Williams and Haworth asserted that the three main contributing factors to the poor traffic safety outcomes and the weak safety culture in the US are apathy toward the problem, a government that is reluctant to regulate unsafe technologies such as guns (and cars), and the belief that driver behavior is the root of the problem. Apathy toward the problem results in under funding scientific research to address the problem, and focusing on driver behavior leads to relatively less effective interventions because education and other programs targeting behavior have a weak effect compared to targeting vehicles and the physical environment. While this may be an accurate description of the safety situation in the US, through this dissertation research I have found that similar logic of driver behavior is also present and important in Sweden, though the legitimacy of safety interventions that shape behavior through the built environment are important there, as they are in Australia.

These investigations focused on the US, the UK, and Australia, and with only two exceptions, none were comparative. In this dissertation, I combine their work with similar histories from Sweden to compare the way different professional groups have framed the road safety issues in the two countries. Though there is literature comparing the social aspects of motorization in different countries, for instance, roads and landscapes in the US and Europe (Mauch and Zeller, 2008), these do not highlight road safety.

There are country comparisons of traffic safety that analyze crash and injury data for different countries, and discuss the different policies and interventions that each country uses. For example, Becky Loo and her co-authors analyzed fatalities and death rates for six administrative regions: Australia, California, Great Britain, Japan, New Zealand, and Switzerland. In addition they set forth a normative framework for evaluating state safety planning that includes assessing the state's vision, objectives, targets, strategies, funding, planning, research and development, and capacity for quantitative modeling. California underperformed on each of the indicators, ranking either number five or six of the six regions.



(Loo, et al., 2005) The 2002 SUNFlower study compared road safety outcomes and policies in Sweden, the UK, and the Netherlands, which are among the best performing countries in Europe with respect to road safety. The objective was to identify underlying factors that might contribute to these countries' successful approaches. The report used analyses of crash and injury data for different types of crashes (e.g., by mode of travel), and compared policy approaches. (Koomstra, et al., 2002) The report found that although each of these countries has similar capacities with respect to road safety analysis and policymaking, and each has similar policy and design interventions, each country has a distinct crash pattern. For example, among these three countries the UK has the highest pedestrian risk of fatality, and Sweden has the highest risk car occupant fatalities. The authors of the SUNflower report expanded the study to include the Czech Republic, Slovenia, Hungary, Greece, Portugal, Spain, and Catalonia. (Wegman, et al., 2005) This is one analytical approach that I take as well in the analysis in chapter two.

### ***Science and Technology Studies***

#### *Social Construction of Science and Technological Systems and Policy Implications*

The social constructivist perspective theory of knowledge asserts that scientific knowledge is produced through social processes rather than through discoveries of the natural world. (Pinch and Bijker, 1987) Theories of the social construction of knowledge are not new, and relate to theories of knowledge that developed as critiques and descriptions of the positivist epistemology. (See Horkheimer (1932 [2004]); Kuhn (1962); Bourdieu (1990), Habermas (1984).)

This literature focuses on the practices by which this construction of knowledge occurs, and the institutions in which science and technology are produced. For example, the field focuses on scientific controversies because the conflicts demonstrate who is involved in the construction of knowledge and what ideas are contested. The history of science and technology can be presented as a series of these conflicts, their closure, and a population of technological artifacts accumulated over time. (Pinch and Bijker, 1989; Hughes, 1987) This perspective is useful for describing and understanding the development of safety practices and interventions in a technological system, particularly because the systems tend to change after major accidents and investigations of the causes. Indeed, the investigations are sometimes contested, and reflect how professionals and the public socially construct safety as a quality of a system. This feedback is also a function of the people who design the technological systems. (Hughes, 1983; Hughes, 1987)

But people are not the only important elements in technological systems. Scientific ideas, technological artifacts, social values, and institutions are also part of the system. Michel Callon uses the actor network as an analytical technique to map the relationships among these elements. (Callon, 1987) The concept of "heterogeneous engineering" also adopts the idea that social and non-social elements in a network have relationships with each other, and that the social relationship should not be privileged or separated from the material relationships in a technological system. This idea can be extended to endow non-human members of the system with agency. (Latour, 1993) Another facet of this connection is between scientific ideas, or facts, and their social environment. Social relationships, particularly those among experts, are a key ingredient in the creation of facts. (Latour, 1987)

These approaches to society and technology that preserve the physical, material relationships are useful for safety research because of how injury has been defined, and the fact that crashes are in fact physical, material events that would be under-specified if they were treated only as social events. But they would also be under-specified if they were treated only as material systems. Instead, to understand a technological system such as road transportation this study focuses on both the material and social aspects of road safety, and looks at how the work is produced. It is a study of “science in action”. (Latour, 1987)

Literature from policy discourses (e.g., environmental policy) includes Hajer’s research on discourses around acid rain in Europe and the UK. (Hajer, 1995) He used comparative case studies and discourse analysis to analyze the politics of environmental policy, specifically seeking an understanding of the ways in which policymakers construct environmental issues as problems, particularly as problems that can be solved through science-informed policy intervention. The underlying controversy turns on the assumption that scientific knowledge and rational policy making are not subject to political values because, according to some theories of science and administration, both are based on an objective reality. In the tradition of science studies, Jasanoff (1990) relaxed the assumption of objective science, and instead examined policy making in the framework of socially constructed scientific knowledge.

Risk and safety are important categories in regulatory policy and the science that supports it. Scholars such as Jasanoff focus their attention on biological and chemical issues such as genetic engineering, and others have focused on the hazards of energy production, for example. The similarity across the cases is that the fundamental regulatory mission is protection, and the social-physical phenomena of health, safety, and welfare are the concepts that the policy protects. Where the experts locate these concepts—in knowledge, processes, or bodies—is a question to explore. Summerton and Berner (2003) edited a book that brought a sociological approach to understanding safety and risk, health and welfare. Different communities (e.g., technical, political) negotiate the meaning of these concepts. Sometimes the meanings become codified in laws and policies. Other times, the meaning is created and re-created through work and everyday life, and is expressed through stories and rituals rather than categories and measurements. (Rochlin, 1999)

### *Automobility*

The automobile is a key ingredient in understanding traffic safety. When traffic safety experts analyze crashes, their gaze upon the automobile is limited to the moment of the crash, the drivers and passengers, and conditions of the crash. But the automobiles involved in crashes are only a few elements of a whole system of cars, drivers, laws, roads, and conditions that support a car-oriented transportation system. This investigation of road safety is an investigation of the relationships in the system of automobility that create and mediate risk in the system.

Historians of transportation technology have analyzed how the American car society developed through mutual adaptation of cars, policies, infrastructure, and institutions and the politics that arise through these interactions. John Burnham labeled this combination of factors “automobility” in 1961. (Burnham, 1961) Thus, behind every crash is the system of automobility. Cotten Seiler (2008) summarized how different scholars have used the concept of automobility. The theme is that automobility is a system, institution, or phenomenon that is social, emotional, global, mechanical, and political. It involves cars and infrastructure, industries producing cars and infrastructure, as well as fuel. It also involves landscape and mobility.

Municipalities, the engineering profession, land developers, transit operators, motor clubs, car manufacturers, and grassroots movements physically and metaphorically made room for the car in American cities, and in cities throughout the world, in the first half of the 20<sup>th</sup> century. This process is still happening. Through both coordinated and unintentional actions, these groups overcame popular and technological challenges to the automobile, and changed urban land use patterns, street designs, and transportation technologies. (Norton, 2008; Baldwin, 1999; McShane, 1994; Flink, 1988) In addition, American car culture developed during the 20<sup>th</sup> century, cultivating the desire for risk in driving (Blanke, 2007), the representation of modern ideals in car design and architecture (Wachs and Crawford, 1992), and the acceptance and promotion of women as drivers (Scharff, 1991).

### ***The Work of Safety Professionals***

The work of professionals has been critical to the development of the car-oriented transportation system, and it is also critical in shaping the safety of such a system. The role of operators in creating a safe environment, enterprise, or system has been a central question in both traffic safety and industrial safety. Designing engineered systems to prevent human error, including how to create fault-tolerant systems that prevent errors from escalating into injury, death, or failure, is at the heart of the field of human factors within psychology. Although designing systems with a concern for individual behavior is necessary, it became clear to human factors experts that managing human error alone was not sufficient for preventing large disasters. Large disasters, or potential disasters, such as the nuclear power accident at Three Mile Island in 1979, the deaths due to the Union Carbide Corporation chemical contamination in Bhopal in 1984, and the Challenger space shuttle explosion in 1986, transcend the focus on the individual because these accidents occurred because of characteristics of the larger social-technological system. The operators of nuclear power plants, space shuttles, and chemical processing plants may make mistakes or even violate rules, but the consequences of these actions depend on the larger context of regulations, relationships, and physical systems that can escalate errors into disasters, or mitigate them.

In response to such high-profile accidents, safety researchers expanded their traditional focus on individual behavior to examine the role of structural and contextual factors such as management, planning, organization, and design. The human reliability researcher, James Reason, addressed the question of error in complex engineered systems by defining two different kinds of errors: those occurring in the process of operations are “active failures” and those arising from a variety of contextual factors such as regulation and management are “latent failures”. (Reason, 1990: 59-60, 173-174, 199-212; Reason, 1994) Individuals (or groups of individuals) who work at the “sharp end” of operations commit active errors. For example, these individuals include pilots and crew members who have direct control over an airplane and its passengers, or healthcare workers to have direct contact with patients. In the context of traffic safety, the people at the sharp end are the various road users, including travelers and others in the public space of the transportation system. Latent failures, on the other hand, arise in the design, management, planning, and organization of systems. For example, designing a bridge that requires complicated construction techniques increases the chances of error in construction, which increases the possibility of bridge failure. Some of the root causes of such as design error may include inadequate management and oversight processes, a lack of knowledge about the

relationship between design, construction, and operations, or management error for approving the bridge design, for example.

The work of professionals in the transportation and land use system are the source of the latent failures that cause traffic accidents. In general, the work of professionals, designers, regulators, and managers “pose[s] the greatest threat to the safety of a complex system.” (Reason, 1990: 173) Although many safety interventions target the work of operators, “[r]ather than being the main instigators of an accident, operators [inherit] system defects created by poor design, incorrect installation, faulty maintenance and bad management decisions.” (Reason, 1990: 173)

Reason’s work on latent failures contributed to a larger discussion about organizational safety. Charles Perrow (1984) observed that the safety characteristics of large engineered systems are unique because of the way that their complexity propagates failures throughout them—quickly, with great scale, and without much capacity to mitigate them. Researchers at UC Berkeley investigated how some organizations operating engineered systems (e.g., air craft carriers, nuclear power generation) have prevented catastrophic accidents despite the persistent hazards and complexity. This body of work is known as the High Reliability Organizations literature, and its underlying motivation was to understand how operators working within the larger organizational and contextual factors in these technological systems contribute to the overall safety and reliability of the system. (Rochlin, et al., 1987; Roberts, 1990; Rochlin, 1999; La Porte and Keller, 1996) Although this literature focuses on the interrelationship between organizational and social environments and organizational behavior it does not emphasize the organizational behavior of the regulators, designers, and managers who would be the safety professionals making decisions about the road transportation system.

The question of how managers, regulators, and designers perform their work is a question of the role of experts (people in positions of authority, decision makers, and advisers) in social-technological systems. One organizational characteristic of expertise is the system of professions. Professions include architecture, engineering, planning, as well as law, medicine, teaching, accounting, nursing and so forth. Professions are groups that maintain areas of specialized knowledge by making them exclusive. (See Scott, 2003: 213-214, Abbott, 1988) Members of the profession maintain this exclusivity through various forms of selection (e.g., licensing, specialized training, passing exams, maintaining knowledge through additional study). The exclusivity results in premiums in terms of cultural, social, and economic status for its members, and power in terms of knowledge. Professions are also associated with codes of ethics to guide members in the ethical use of their professional power.

Abbott (1988) observed that the key to professions is that they compete with each other to control a “jurisdiction” (i.e., a body of knowledge) around what its members have constructed as a “professional problem”. Defining problems such that they can be addressed by a specific professional approach is a key element in the creation of professions—and problem definition. Scheppele (2003) explained that different professions (in the case of her paper, social science and law) have different “cultures of facts”, and therefore assign legitimacy to different sources and kinds of evidence and information. These professional dynamics—competition over jurisdictions and competing cultures of facts—may be factors influencing the professional field of road safety in Sweden and California, and the dynamics may contribute to differences across the cases.

## *Professionals in Transportation and Metropolitan Planning*

The larger fields of transportation and metropolitan planning shape the professional field of road safety in the San Francisco Bay Area and the Stockholm Region. The dominant model of decision making in transportation engineering and economics has been the techno-rational, or rational comprehensive, approach, which has influenced transportation policy and planning. (Wachs, 1985) In its idealized form, objective experts forecast demand for transportation and design efficient systems. They advise policy makers and elected officials who weigh this technical advice against political constraints. Critiques of rational planning and policy, and doubts of its similitude with reality are common, particularly among sustainable transportation advocacy groups, yet the traditional rational administrative style is prevalent in transportation planning and policy. (Wachs, 1995)

Bent Flyvbjerg (1998) has also investigated transportation planning practice, using the case of a public transport and revitalization project in Aalborg, Denmark. Flyvberg explained that the close relationship between technical and political decision making in the case study illustrated how power relations at multiple scales shape what is considered technically rational, and how that rationality recursively legitimizes political power. Thus, the techno-rational planning style prevalent in transportation planning and policy, and particularly in road safety, is interrelated with larger political questions in urban development. This is a key point for this research, because the different compositions of the road safety field in each case are related contexts of both modes rational decision making and political agendas.

Moreover, the field of transportation planning cannot so easily define its boundaries in order to exclude other influences. Using Abbott's model of professions, the road safety problem, or any other transportation policy issue, is not a jurisdiction unique to transportation, and it involves a number of complementary groups of experts from urban design and landscape architecture to economic development and environmental planning working in an intergovernmental system. (Christensen, 1999) Innes and Gruber (2005) studied regional transportation planning carried out by the Metropolitan Transportation Commission in the San Francisco Bay Area and observed ways in which multiple streams of practice styles interact. They found that tensions did not arise among participants around substantive issues, but often because of differences in their approaches to their work. Differences in these approaches, or planning styles, formed along lines of whether participants view their roles as detached advisors, advocates on behalf of causes, participants in a political process, or collaborative planners who seek to accommodate a range of interests. Innes and Gruber did not report on whether these different styles coincided with different professional or disciplinary backgrounds, but the mix of styles did coincide with different planning tasks, suggesting some partitioning of a heterogeneous field. For example, practitioners who created plans and made projections had a technocratic style. Practitioners who worked on regional decision making had a political style. Non-professional groups and organized advocacy groups engaged with a social movements style around issues such as environmental justice and on behalf of groups such as transit riders.

This heterogeneity is reflected in professional work on road safety. The problem of safety within the transportation field is addressed by some safety experts, but is influenced to a large extent by the broader organization of transportation by travel mode (e.g., public transit, private auto, bicycles, pedestrians) and the specializations in infrastructure (i.e., engineers, who are the predominant professional group in transportation especially with regard to road

infrastructure and operations) and travel behavior and forecasting (i.e., which often includes economists).

### *Comparative Technological Systems*

From another angle, one can imagine that the technological landscape and its history, not only the dynamics of professional groups, have shaped how professionals organize around the issue of road safety. Based on the argument that context shapes technology, one might expect that transportation systems would be incredibly diverse. On the other hand, research on comparative social-technological systems shows how different sites share similar ideas and approaches.

For example, Clay McShane (1999) found that international interest in using traffic signals increased in the 1920s, and many European countries looked for information from the American experience with traffic control. Information was available through US and international traffic publications available in Europe, as well as professional meetings and conferences. McShane's work also found that traffic engineers in various cities (Tokyo, Stockholm) wrote to these international publications to inform them of their cities' new systems. (McShane, 1999: 395) Through significant international interest in how other cities were adjusting to the automobile, and information circulating about these topics, cities in different countries across the world converged on one way to organize automobile traffic.

For the case of Sweden in particular, Par Blomkvist and Per Lundin have investigated the development of Sweden's "car society" in the context of the growth in ownership and use private automobiles in Europe, as well as for the case of infrastructure planning. For example, Blomkvist (2004) investigated the International Road Federation (IRF) that formed in Europe after World War Two. It was founded by the US to promote highway building in Europe. Federations such as the IRF were venues for sharing technical ideas for developing a new European highway network, including both highway engineering and know-how for coping with growing traffic in cities, as well as for creating opportunities for economic development and trade. Lundin (2004) investigated the development of Sweden's car society by looking at how it created parking requirements and took on the policy issue of road safety. For parking requirements, and more generally too, Sweden, the US, and the UK exchanged ideas about transportation planning. Lundin argued that the Swedish engineers used their growing expertise in traffic engineering to further define urban transportation as a problem that only they were qualified to solve, thus supporting the development of a globalized traffic engineering profession.

Both Lundin (2008) and Hagson (2004) investigated the development of road safety expertise in Sweden, and in both cases showed that Swedish urban planners, architects, and engineers were involved in an international discourse about the modernization of cities, particularly around the automobile. British ideas about new towns and American community planning and suburb design ideas such as Clarence Perry's neighborhood unit and Radburn both informed local planning ideas. (Perry, 1929; Birch, 1980)

## ***Engineering, Planning, and Public Health Perspectives on Safety Policy and Safety Performance***

The traffic safety literature from engineering, planning, and public health is focused on solving traffic safety problems by developing technically sound policies and interventions that prevent accidents and mitigate their severity. This literature uses quantitative and design methods to identify the causes of crashes and injuries such that policies and countermeasures can be designed to address these root causes. With the exception of the urban design branch of this literature (and parts of the planning and public health professions), it focuses on victims, crashes, and vehicles; issues and explanatory variables that are quantifiable; and motorists over other road users.

The Haddon matrix may be traffic safety's most influential conceptual framework. William Haddon is an injury epidemiologist who was also the first administrator of the National Highway Safety Bureau in the 1960s. (See Figure 1.2 – the table is filled in with examples of possible content) Haddon's matrix has two dimensions. The first describes the phases of an accident: pre-event, event, post-event. The second dimension describes the relevant factors associated with the crash: the human occupants, the vehicle, and the physical and sociocultural environments. Haddon suggested that this matrix should be used to analyze the distribution of resources, knowledge, countermeasures, and policies across the different phase-factor combinations to ensure that the problem of traffic safety would be treated comprehensively. (Haddon, 1980) Haddon's matrix is explanatory because it associates causal factors with crashes, but it is also descriptive of the professional specializations, policies, and institutions that emerged to address traffic safety as a problem. For example, according to a history of the Emergency Medical Service System, post-crash medical treatment was not emphasized until the late 1960s when Haddon, then the administrator of the U.S. National Highway Safety Bureau, used his matrix to define the problem of traffic safety as one that required such a countermeasure. (US NHTSA, 2010b)

The underlying logic of the Haddon matrix has two parts. First, the concepts that form the matrix are rooted in the ecological approach to epidemiology. This approach explains disease and injury according to an agent-host-environment model. Second, the matrix is based on the understanding that injuries are the damage caused by transferring energy (mechanical, thermal, chemical) to the body. The result of these logical foundations is that the field of traffic safety and injury control is organized around problem solving (accident prevention and mitigation), and interventions generally involve the material separation between people and hazardous sources of energy. The Haddon matrix addresses accident prevention by allowing policymakers, researchers, and other actors identify the distribution of knowledge and countermeasures across the different phase-factors of the matrix.) The field is also organized around victims and agents as victims, and the ways in which these individuals interact with hazards in their environment. (Haddon, 1980)

Evans (1991; 1994) captured the breadth of the health-engineering-policy understanding of traffic safety in two books that use science and statistical methods to understand the "nature and sources" of traffic crashes based on data collected by public entities. (Evans, 1994) Part explanatory, but also part descriptive of the actual organization of the field, Evans's approach to traffic safety emphasizes vehicles and their safety features; drivers and their behaviors, skills, and relationship to risk; alcohol and driving; environmental factors such as weather and light; and policy approaches to safety such as enforcement.

	Human	Vehicles & Equipment	Physical Environment	Socio-economic Environment
Pre-crash	<i>Driver's vision</i>	<i>Headlights on?</i>	<i>Road condition</i>	<i>Licensed driver?</i>
Crash	<i>Victim's fragility</i>	<i>Speed of vehicle</i>	<i>Protection from secondary crashes</i>	<i>Vehicle design</i>
Post-crash	<i>Emergency treatment</i>	<i>Towing</i>	<i>Accessible to EMS</i>	<i>Enforcement of any violation</i>

Figure 1.2 Haddon's Matrix

"A logical system for the prevention of injury and death from motor vehicle crashes is based on the sequence of events (pre-crash, crash, and post-crash phases) and the types of factor involved (human, vehicles and equipment, physical environment and roadway, and socioeconomic environment). By forming a matrix, a variety of options and evidence for their effectiveness can be evaluated on a cell by cell basis." *Source: Haddon, 1980.*

One of Evans's main assertions is that traffic safety policy in the United States has failed. This is an echo of Ralph Nader's *Unsafe At Any Speed* (1965), which described domestic traffic safety problems as an engineering and regulatory disaster, at the heart of which was a conflict between economic production and protection. Evans argues that compared to other developed countries, the U.S. has more fatalities per registered vehicle, and the Evans posits that this difference in performance is due to "fundamental differences in philosophy and approaches to traffic safety." (Evans, 2006) One of Evans's arguments is that U.S. policy focuses too heavily on vehicles, but not on other factors that make a difference in terms of safety, such as road user behavior, accident prevention, and scientific evidence as a basis for policy making. (Evans, 2006) This suggests that although traffic safety researchers produce knowledge of traffic safety through scientific methods, other factors that are not as transparent in the literature are also relevant for policymaking.

Evans's criticism of a lack of science-based traffic safety policy is an echo of Ezra Hauer's message: roads and highways are not really designed according to scientific knowledge of safety, although the message behind highway design standards would lead one to believe that this is the case. (Hauer, 1988) According to Hauer, design standards based on scientific knowledge of safety would lead to roads with wide medians, few fixed objects, pavement with sufficient friction, large-radius turns, and bright lighting. Yet no road is designed to be absolutely safe; roads are only more or less safe, and the safety of design standards are a matter of judgment rather than scientific evidence. (Hauer, 1999) Furthermore, the magnitude of hazards is related to speed as well as the presence of fixed objects, and planning and design research about traffic calming proposes that fixed objects such as trees that define the roadway and limit sight lines slow speeds, therefore reducing the probability and severity of collisions. (Macdonald, et al., 2008)

Comparative approaches to road safety (either across countries, states, or other territories) use statistical models formulate road fatalities as a function of exogenous variables such as population, vehicle fleet, and economic factors that are measurable and that are independent of road safety outcomes. The endogenous and unobservable characteristics that explain the variation in outcomes—such as approaches to safety management, but also the universe of randomness that affects safety outcomes—are expressed by the residuals. Page (2001) pooled a time series of OECD traffic safety and other data and used it to estimate the relationship between various explanatory variables and road safety, but also used the residuals as an indicator of national road safety performance. According to this indicator, for the period 1980-1994,



Sweden, the Netherlands, and Norway were best performers, while the U.S. ranked among the lowest with Greece, Portugal, Belgium, and Spain.

The discourse of traffic safety in developing countries, or less-motorized countries, is different from the discourse in the United States and Europe. In less-motorized countries and emerging economies, road safety, particularly pedestrian safety, is linked to human rights. One opinion piece by Dinesh Mohan, Ian Roberts, and Kamran Abbasi titled, “War on the Roads,” describes pedestrian safety issues as a war between the powerful and the weak. This language is strikingly different from the language used in the U.S. (Mohan, et al, 2002)

In this context, Mohan raised the issue of institutional capacity. (Mohan, no date) He wrote, “...the expertise available in India in traffic management and safety research at all levels (central, state, city and departmental) is not adequate for the task at hand.” He cited little funding and few centers of specialization as barriers to building institutional capacity in India. The engineering, health, and urban design literatures allude to the roles of institutions, organizations, and governance in safety management, but the literature maintains its focus on the physical environment. When institutions are included in road safety discourse, they are usually presented as a solution to the road safety problem (i.e., strengthen the road safety institutions to improve road safety). This understanding should be made more complicated because hazards can be embedded in these institutions, policies, and safety management approaches as well as in the physical environment.

## 6. Methods

In this project I have asked: *Who* are the professionals involved in road safety and *what* are the links between them, and between them and the road system? I have also asked: *How* do members of this ecology of actors frame safety in their practices, how is safety represented, and how do these frames influence the professionals’ responses to road safety, intervention strategies, and the institutionalization of these responses.

The unit of analysis for my cases is the set of road safety actors and the way in which they frame safety in a metropolitan area. The metropolitan area is an appropriate scale because it encompasses institutions that arise to plan for policy across jurisdictions as well as institutions to facilitate the implementation of policy at the local level. The metropolitan area also captures a range of road safety professionals who interact with the transportation system in a variety of ways. Although my unit of analysis is metropolitan, it expands to include other jurisdictions when intergovernmental issues and institutions influence the professionals’ practices and strategies for interventions. National, state, and local policies are relevant to the cases when they are relevant to the practitioners who are the subjects of my study.

The criteria for selecting countries were: (1) differences in safety outcomes at the national and metropolitan level as measured by a variety of available metrics; (2) similarities in institutional, social, economic and political settings; (3) similarities in transportation system maturity and technologies; (4) mature and diverse population of road safety professionals. I selected Sweden and the US based on these criteria.

Next, I selected case metropolitan areas. For selecting case metropolitan areas I sought areas that large and diverse, but that are not so distinct from other metropolitan areas in each country that lessons from them would risk being irrelevant. The metropolitan areas for this study were (1) the San Francisco Bay Area, U.S. and (2) the Metropolitan Area of Stockholm, Sweden. San Francisco is large and diverse in terms of its urban form and economy, and its road safety is

not too unique from other major metropolitan areas in the U.S. Stockholm is the largest metropolitan area in Sweden and it is the most diverse in the country. Following Yin (1994) the multiple case study design followed a replication logic—I sought to replicate an experiment in each of my case metropolitan areas.

I used multiple methods for each case, including interviews with practitioners, analysis of archived crash and injury data, analysis of contemporary and historical road safety and transportation planning texts, and field studies. The details of specific methodologies are discussed separately in each chapter.

## **7. Organization of the Chapters**

The next chapter presents an analysis of the crash and injury data for the Stockholm Region and the San Francisco Bay Area, asking whether Sweden is safer than the US at this geographic scale. The analysis compares traffic fatality rates for different travel modes using different measures of exposure. The analysis also compares traffic fatality rates per 100,000 population for different age groups and modes. The main findings are that the Stockholm Region is safer than the San Francisco Bay Area when the measure of exposure is population, but when the measure of exposure is vehicle-kilometers of travel the differences are not statistically significant. However, the differences in fatality rates for pedestrians are statistically significant based on both measures of exposure. When comparing the safest counties in the two regions, San Francisco and Stockholm, the pedestrian fatality rate in San Francisco stands out as significantly higher. This is somewhat surprising because traffic speeds are low in San Francisco compared to other counties in the Bay Area. Another possible explanation is that pedestrian exposure is low in suburban counties because there are fewer pedestrians. Nevertheless, suburban counties in the San Francisco Bay Area, Napa, Sonoma, and Solano, have a different safety profile, and their fatality rates are generally much higher than in San Francisco, or in counties such as Santa Clara, Alameda, and Contra Costa that have a mix of urban environments ranging from dense urban cores to sprawl.

The third chapter is a discussion of the differences and similarities in professional safety thinking in Sweden and California. The story of motorization in both cases shows a similar pattern of development, as well as a similar pattern in the development of safety ideas centering on three components: road users, infrastructure, and vehicles. In general, road safety professionals in Sweden and the US have had similar ways of understanding road safety over time. In both cases, the professional field of road safety includes professionals from different disciplines, including psychology, engineering, city planning, public health, and law enforcement. Yet these professional groups often have different roles in these two cases. In Sweden, road safety professionals are included in mainstream transportation and land use planning, while in California, safety experts have a relatively marginal role, though often one of critique and advocacy.

The fourth chapter examines how professional ideas about safety became codified and implemented in design guidelines for subdivisions. It is interesting that similar professional fields with similar ways of framing the problem of road safety produced different ways of expressing these ideas through policy and intervention. In both cases, rapid urban development provided the opportunity for professionals to work out and implement their ideas, but the logic of safety in the urban built environment is different. In California, and more specifically in the Bay Area, creating a safe road transportation system meant creating safe traffic, that is, traffic needed

to be organized into homogenous flows and it needed infrastructure appropriate for its higher speeds. Safe traffic was compatible with demands for increased traffic capacity throughout the transportation system. In Sweden, traffic engineers also created homogenous flows of organized traffic, but this was not the recipe for safety. A safe transportation system is one where traffic is appropriate for surrounding activities and land uses. Architects, urban planners, and traffic engineers worked together to create design guidelines that prioritized pedestrian traffic, even within a framework designed to increase capacity for motorized travel and modernize streets and cities. Essentially, the approach created a multimodal transportation system, where cars could go fast on motorways in designated areas, but also one where cars should be slow and managed around residential and commercial areas, schools, and transit stops. This strategy integrated transportation and land use planning to create safe spaces by designing with a sense of how pedestrians (and, by extension bicyclists and other vulnerable road users) would be exposed to hazards.

The fifth chapter discusses contemporary practices in road safety in Sweden and California, and how these contemporary practices are an extension of historical road safety ideas. For example, influencing road user behavior is an important part of road safety strategies in Sweden, the US, and throughout the world. All of the work on drunk driving, wearing seat belts and helmets, and enforcing speed limits is based on the notion that safe behavior creates a safe transportation system. A key difference between Sweden and California is that California is much more likely to use police enforcement and education to modify behavior, whereas Sweden is more likely to use design approaches to modify behavior. Take speeding, for example. Sweden uses law enforcement approaches to prevent speeding, but it has also installed more than one thousand roundabouts on its larger roads to slow traffic at intersections. In more urban areas, Sweden has used traffic calming measures extensively. These interventions are conceivable in the Bay Area, and are used to some extent, but most of the official work on reducing speeds focuses on speed limits and their enforcement. This difference in design logics, coupled with Sweden's multimodal transportation system, has made it easier to implement "livable streets" ideas in Sweden. Although these ideas are known by professionals in the Bay Area, they meet resistance from the long-established norms of providing capacity for motor vehicles. California cities that have tried to create multimodal transportation systems have made more progress implementing these design measures. Redefining transportation systems as multimodal would be a significant step toward making safety improvements.

The sixth chapter presents more discussion of conclusions from the research and policy implications.

## Chapter Two—Is the Stockholm Region Safer than the San Francisco Bay Area?

### 1. Introduction

Based on national data, and for various measures of exposure, the US has relatively high traffic fatality rates, while most of Europe and other advanced economies such as Australia, New Zealand, and Japan have relatively low traffic fatality rates, and developing countries have the highest traffic fatality rates. Aggregated traffic crash and injury data typically provide the basis for such comparative analyses, and though using national-level data is valid, the same pattern does not always hold when comparing smaller geographic units. As discussed in the previous chapter, the safety performance of individual US states varies widely. At the state level, Massachusetts is about as safe as Sweden, and both have traffic fatality rates per capita that are roughly half of California's. The traffic safety story told at the national level becomes richer and more complex when smaller, more diverse units of analysis are compared.

Analyses that use national data describe territories that include heterogeneous traffic environments with characteristics that may differ in ways that affect safety. For example, average speeds are slower in urban areas because more travel occurs on slower local roads rather than high speed county or state roads. (Evans, 2004: 216) The traffic mix in cities also includes a higher share of travel by public transit and bicycle, as well as more pedestrian traffic. This logic leads to the question: Are some urban environments safer than others?

The objective of this chapter is to investigate the generalization, “Sweden is safer than the U.S.,” by analyzing safety data at the metropolitan scale. I do not dispute the validity of the claims based on aggregated data, but it is worth investigating whether cities in Sweden and California—both having their own versions of compact central business districts, older streetcar suburbs, and newer car-oriented subdivisions—present the pattern described in the standard narrative even at this smaller scale. Moreover, is the safety performance true for all types of road users, or only for some? Finally, how does the story change when alternate measures of exposure are considered?

### 2. Data

#### *Crash and Injury Data*

This analysis uses both official aggregated data for counties in the Stockholm Region and the San Francisco Bay Area and disaggregated crash and injury data from Sweden and California. The California Highway Patrol administers the archives of official aggregated crash and injury data by county for California. The Swedish Institute for Transport and Communications Analysis (SIKA, Statens Institut för Kommunikationsanalys) maintains a similar database that includes data for Swedish counties. Swedish counties and California counties are comparable administrative units. Both data sets include only police-reported traffic crashes, injuries, and fatalities.

Disaggregated crash and injury data sets were the best source for information about the age and travel mode of victims. For California, these data—SWITRS, or California Statewide Integrated Traffic Records System—are collected from local police departments and maintained by the California Highway Patrol. The traffic safety research center, SafeTrec, at UC Berkeley

provided these data. Similar disaggregated data are available for Sweden in a database called STRADA (Swedish Traffic Accident Data Acquisition). STRADA compiles both police-reported and hospital-reported injuries as well as crashes. These data are currently maintained by the Swedish Transport Agency (Transportstyrelsen), and were previously maintained by the Swedish Road Administration (Vägverket). I obtained a copy of the disaggregated data for Stockholm county from Vägverket. For this analysis, I am using only the police reported data because the hospital records for Stockholm County are incomplete (only two hospitals in Stockholm County were providing data to STRADA during the period analyzed).

Police reported road safety data in Sweden and California are essentially the same. There are only slight differences—the California data identify fault, and the Swedish data provide more specific information about the vehicles (or animals) involved in the crashes. Both data sets report on the characteristics of the collision, the parties involved, and the injuries. Collision information includes the date and time, location, environmental conditions (e.g., lighting and road conditions, weather), type of road, collision severity, details about the law enforcement circumstance (e.g., beat), and the behavior of the road users involved. Party characteristics include information about all persons involved in the crash, including their sex, age, sobriety, use of safety equipment, validity of driver's license, as well as vehicle characteristics. Only the California data includes details about fault, whether the parties were insured, and any reasons for inattention (e.g., cell phone use). The Swedish data include information about the nationality of the parties involved and whether they were a student driver or a driving instructor. The Swedish data also include a more detailed categorization of travel modes and transportation equipment. STRADA includes information about specific types of animals involved in crashes (e.g., deer, cow, domestic animal), different types of motorcycles and mopeds, buses, trains, and streetcars, and other transport modes. SWITRS data do not specify mode with such detail. With respect to injuries, the data sets include comparable information, including the role and position of the victim, and the degree of injury.

When cleaning the data, I checked the disaggregated counts against the official statistics. The counts were the same in all but four years: 1999, 2001, 2002, and 2008. The differences between the fatalities in the official and the disaggregated data in 1999 and 2008 were too large to reconcile so I dropped these years from the analysis. The official fatality count for Stockholm County in 2002 was lower than the fatalities in the STRADA record by one fatality, which was the rider of either a motorcycle or moped. After checking the police descriptions of all the motorcycle and moped deaths (three of them in 2002 in the STRADA record, only two in the official statistics), and not discovering why any of the three would not have been included in the official data, I kept the one extra fatality. The counts in 2001 were off by only one fatality, which I found in the rail category. Based on the accident description, the fatality was a pedestrian who had been hit by a train on the tracks, which was likely a suicide that would not have been included in the official data. I dropped this observation from the data set for this year.

### ***Exposure Data***

This analysis uses population and two kinds of travel data to account for exposure. The population data for California are from the Department of Finance, the E-3 Race/Ethnic Population Estimates with Age and Sex Detail. These data are model estimates for California counties. The data rely on a combination of historical birth and death records and census data to

create the model estimates. The population data for Sweden are from Statistics Sweden (SCB, Statistiska Centralbyrån). The population data were by region by marital status, age and sex.

The two kinds of travel data are vehicle-kilometers of travel in each region, and person-minutes of travel. Vehicle-kilometers of travel data for counties in the San Francisco Bay Area are from model estimates by the Metropolitan Transportation Commission. These model data are for 1998, 2000, and 2007. I used California Department of Transportation annual highway travel data for Bay Area counties to scale the model data for other years. The vehicle-kilometers of travel data for the Stockholm region are reported by SIKÅ, and are based on annual inspections of vehicles, reported by county.

The second kind of travel data, person-minutes of travel, are from travel diary surveys. In Sweden, a consortium of transportation agencies conducts annual national travel surveys at the household level to collect information about the trips made by people between the age of six and 84 years old. (SIKÅ, 2007) Summaries of these surveys include information about the average trip length in minutes by mode, cohort, and other variables. The Metropolitan Transportation Commission conducts a similar, though less frequent, survey in the San Francisco Bay Area from which one can construct similar measures of exposure. (MTC, 2004) Travel diary data sources such as these are important because they provide information about travel times and distances for multiple modes. Yet travel diary surveys generally undercount pedestrian trips because people forget to include them as they list their daily travel, and because walk trips are not as easy to define as motor vehicle trips (e.g., they may be combined with transit, or motor vehicle trip chains, they may begin and end in the same area). (Agrawal and Schimek, 2007) This problem of undercounting would be present in both the Swedish and Bay Area surveys.

### **3. Methods**

For this analysis, I defined the Stockholm Region as the Stockholm-Målar Region, which comprises the five counties of Stockholm, Uppsala, Södermanland, Örebro, and Västmanland. This regional definition is based on a European Administrative unit established in 1995. These counties do not necessarily reflect a regional identity—people who live in Uppsala do not consider themselves part of the Stockholm Region, though they may commute to Stockholm County for work. Nevertheless, this is an economic region, and its composition is comparable to that of the San Francisco Bay Area. I did not have disaggregated data for all five counties in the Stockholm Region, and parts of this analysis use data for only Stockholm County, which is most similar to San Francisco County.

The San Francisco Bay Area has nine counties: Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma. These counties share a stronger regional identity compared to the Stockholm Region. Yet, as in the case of the Stockholm Region, residents of Bay Area counties do not necessarily identify with each other. Residents of Contra Costa, for example, would not say that they are from San Francisco. The San Francisco Bay Area also has a stronger administrative system compared to the Stockholm Region (as the EU defines it). The Metropolitan Transportation Commission, the Association of Bay Area Governments, and other groups recognize the Bay Area an administrative region and an economic region, which is reflected in commute patterns.

Though the San Francisco Bay Area is larger than the Stockholm Region, it also comprises counties with a range of populations of similar magnitudes. The population of the San Francisco Bay Area was about twice that of Stockholm Region in 2008. The populations were

about 7.25 million and 3.10 million respectively. (See Table 2.1) Stockholm County is the largest in the Stockholm Region with almost two million people. It is about six times as large as the next largest county, Uppsala, which has a population of about 330,000. In 2008, the four smaller counties in the Stockholm Region had populations between about 250,000 and 330,000. The largest county in the San Francisco Bay Area is Santa Clara. Its population in 2008 was about 1.80 million. Alameda and Contra Costa both have populations greater than one million. San Francisco's population is about 800,000. Napa is the smallest county in the Bay Area with about 140,000.

The Bay Area is a polycentric region. The cities of San Francisco, Oakland (Alameda County), and San Jose (Santa Clara County) are historically the largest of the core urban areas. Among counties in the Bay Area, the counties with the historic urban cores have relatively higher population densities. San Francisco has the highest density measured as population per square kilometer. Alameda, San Mateo, Santa Clara, and Contra Costa counties have mid-range densities, and Marin, Napa, Solano, and Sonoma are the lower density counties. At the aggregate level, the Bay Area counties has higher densities than counties in the Stockholm Region. This metric does not accurately reflect the urban form across regions, and it is best used to compare counties within their own regions. Swedish urban development is more compact, than development in the Bay Area, and the majority of residential units in Stockholm are in multi-family buildings. In the Stockholm Region, residents who live in the countryside live at rural densities.

These differences in density are reflected in the travel mode shares for each region. In the San Francisco Bay Area in 2006, 5.5% of all trips in the region are made by public transit, 1.5% are by bicycle, 9.3% are walking trips, and 83.7% of trips are made by private automobile. (See Table 2.2) The City (and County) of San Francisco has a somewhat different pattern. Its work trip mode shares for 2008 were 31.9% by transit, 2.7% by bicycle, 9.4% walking, and 48.6% by private auto or taxi. Mode shares for counties in the Stockholm Region are similar to those of San Francisco. In Swedish counties, roughly half or fewer trips are made by private auto, and walking and bicycling comprise larger shares of trips. These mode shares are related to safety outcomes because travel mode affects both exposure to traffic hazards and level of protection. Moreover, when densities are higher, trips are shorter, which is also reflected in traffic fatality rates that use distance of travel as the measure of exposure. This indicator then inflates the safety of low-density environments compared to high-density environments. Overall, the San Francisco Bay Area and the Stockholm Region are comparable cases with respect to population, the distribution of population across the region, and travel.

This analysis used traffic fatality rates to compare counties within and across regions. Fatality rates are among the most reliable indicators of road safety because crashes that result in fatalities are very likely to be reported to the police. Crashes with severe injuries are also likely to be reported, but coding what counts as a serious injury is not a reliable indicator and it may not be comparable across regions.

I used three different measures of exposure, population, distance traveled in vehicle-kilometers, and distance traveled in person-minutes. There is uncertainty in these data as well; some are estimates produced with models, and some are based on samples of the population. Moreover, none of these three measures fully describes travelers' true exposure to hazards in the transportation system. Population measures are widely used in the field of public health to compare the incidence of disease and injury across populations. Using vehicle-kilometers of travel is a useful exposure measure because it quantifies the actual experience of being exposed

to motor vehicles. Yet, it is not a very good measure of the quality of this exposure because it does not reflect speeds, which are directly related to the hazard. If pedestrian and bicycle flows were widely and reliably counted, these should be included to estimate the fatality rates for these other modes. Perhaps the best measure of exposure in this analysis is that based on person-minutes of travel because it accounts for differences in modes, and does so in such a way that non-motorized trips are not minimized by their relatively short distances.

#### **4. Analysis**

The proportions of fatalities by travel mode are similar across the two cases. Roughly 75 to 80 percent of all fatalities in each case are fatalities of occupants (drivers, passengers) of motor vehicles, about 15-20 percent are pedestrian fatalities, and between five and 10 percent of fatalities are bicyclists. (See Table 2.3) The county that stands out in this table is San Francisco because more than half of the fatalities there are pedestrians. In the Stockholm Region, Stockholm County is most comparable to San Francisco with respect to urban form, mode share, and travel experience. In Stockholm County, the proportion of fatalities that are pedestrians is only 20 percent (this is also the highest among the five counties in that Region).

Table 2.4 presents the distribution of fatalities in the San Francisco Bay Area by road type and mode, and Table 2.5 presents similar information for the Stockholm Region. Seventeen percent of pedestrian fatalities have occurred on interstate highways or US highways in the Bay Area, and eight percent of pedestrian fatalities occurred on motorways and expressways (comparable to US Interstate highways and other non-local undivided two- and four-lane roads) during the study period. This is surprising because these facilities have been designed to exclude, and therefore protect, pedestrians with features such as barriers and grade separation. The police reported data about these fatalities shows a mix of causes including excessive speed, the intoxication of the pedestrian, and pedestrian violation of traffic laws. Police reported data do not provide further insight into why the pedestrians were using highways to travel.

#### ***Fatality Rates by Population and Travel***

Although the proportion of fatalities by travel mode are similar across the regions, total traffic fatality rates by population are higher in the San Francisco Bay Area (8.1 traffic fatalities per 100,000 population) than in the Stockholm Region (5.5 traffic fatalities per 100,000 population). Table 2.6 and Table 2.7 present comparisons of total traffic fatality rates per capita as well as motor vehicle, pedestrian, and bicyclist fatality rates per capita for the San Francisco Bay Area and the Stockholm Region. In the San Francisco Bay Area the total traffic fatality rates are highest in Napa, Sonoma, and Solano counties. These counties are suburban and rural, with relatively low densities compared with counties with more population in the older, denser suburbs and central cities of San Francisco, Oakland, and San Jose. Both San Francisco and Stockholm Counties have the highest densities in their regions, and have the lowest motor vehicle fatality rates compared with other counties in their regions.

The differences in the total traffic fatality rates and motor vehicle fatality rates across the regions and across the counties within the regions are not due to chance and can be read as statistically significant. (See Table 2.6 and Table 2.7) I used a chi-squared goodness-of-fit tests to determine whether the differences in total traffic fatalities across counties within each region were statistically significant. For each year, the test compared the observed fatalities in each



county with the number of fatalities one would expect to have in each county based on its population. The test's null hypothesis was that the counties' fatalities in each year for each region had the same distribution as the counties' populations in each year. For counties in the San Francisco Bay Area, the tests for each of the years rejected the null hypothesis at the 0.05 significance level. The results were the same for counties in the Stockholm Region, where the test also rejected the null hypothesis at the 0.05 significance level. This test confirmed that the differences in total traffic fatalities and motor vehicle fatalities across counties in each region are not due to the underlying differences in population, nor are they due to chance. This statistical test was not appropriate for testing the distributions of bicycle and pedestrian fatalities because the expected number of these fatalities is too low in some cases (under five).

I also tested whether the traffic fatality rates per capita for each region as a whole were significantly different from each other over the entire period using t tests with equal variances. The differences in total traffic fatalities in the San Francisco Bay Area and the Stockholm Region are statistically significant with  $t=4.8$  and a p-value of less than 0.001. The differences in motor vehicle fatality rates per capita and pedestrian fatality rates are also statistically significant with t statistics  $t=3.5$  and  $t=6.8$ , respectively, and p-values less than 0.001. The difference in bicycle fatality rates per population across regions is not statistically significant at the 0.05 significance level. The t statistic was  $t=-1.5$ , the two-tailed p-value was 0.12 and the one-tailed p-value was 0.06. Thus over the periods 1995-2008 and 1999-2008, the Stockholm Region was safer than the Bay Area for motorists and pedestrians. For the case of bicyclists I could not reject the null hypothesis that the rates were equal.

Comparing the cases with fatality rates per 100,000 population provided a clear answer to the question whether the Stockholm Region is safer than the Bay Area, and the answer was yes. The story is more ambiguous when comparing the cases with fatality rates per billion vehicle kilometers of travel. The total traffic fatality rates per billion vehicle kilometers of travel in the Bay Area and the Stockholm Region are 7.5 and 7.1, respectively. (See Table 2.8 and Table 2.9) The rates for motor vehicle fatalities show a different pattern: the rate is higher in the Stockholm Region (5.7) than in the Bay Area (5.6). The T-tests of differences in these rates failed to reject the null hypothesis that they are equal. Thus, when measuring exposure in terms of vehicle-kilometers of travel, it is not possible to say that the Stockholm Region is safer than the Bay Area based on their total fatalities and motor vehicle fatalities. However, the differences in pedestrian fatality rates per unit of travel are statistically significant at the 0.05 significance level. This provides evidence that pedestrians are safer in the Stockholm Region than in the Bay Area. It is also interesting to see that the pedestrian fatality rate per unit travel is much higher in San Francisco than in Stockholm, which are both dense, walkable, transit-oriented cities. This suggests that all dense, walkable cities are not inherently and equally safe. Pedestrian protection, probably with some combination of separation and speed reduction, are important factors for pedestrian safety. The specific urban forms and interventions used in Stockholm County to protect pedestrians are discussed in the following chapters.

Table 2.10 presents the fatality rates using person-minutes of travel as the measure of exposure. These figures do not include the uncertainty around the estimates, so it is not possible to test whether the differences between regions are significant. Again, the differences in the rates between the Stockholm Region and the San Francisco Bay Area are small, but the differences for non-motorized travelers are marked. The pedestrian fatality rate per billion person-minutes of travel is 6.5 in the San Francisco Bay Area and only 0.6 in the Stockholm Region. This difference in pedestrian fatalities is even larger when comparing San Francisco and

Stockholm counties, where the rates are 12.9 and 0.6, respectively. Thus, it is possible that Stockholm at least as safe for motorists, and it is clear that the Stockholm Region is far safer for other travelers.

### ***Changes in Fatalities over Time***

A second question was whether the fatalities in each county were decreasing or increasing over time beyond what one would expect from the changes in population and vehicle-kilometers of travel over the same period. I tested three different hypotheses for total fatalities and motor vehicle fatalities (I could not test on pedestrian and bicycle fatalities because the values were too small for a valid test). The first test was the stronger test: are the observed total (and motor vehicle) fatalities in each county over time different from what one would expect if the number of fatalities per year were constant. This tested the hypothesis that despite increases or decreases in population and travel, the number of fatalities should stay constant over time. For this test, Solano was the only county the Bay Area with a chi square test statistic that was significant at a 95% confidence level. Unfortunately, the trend in Solano's total traffic fatalities was increasing. For this same test, three counties in the Stockholm Region, Södermanland, Västmanland, and Örebro, had test statistics that were significant at the 95% confidence level. These three counties have not maintained the same number of traffic fatalities over time and the trend in their fatalities is downward sloping. (See Table 2.11)

Using the same method, I also tested the hypotheses that total traffic fatalities and motor vehicle fatalities have changed over time in proportion to population and to vehicle-kilometers of travel. This tested the hypothesis that fatalities would increase if population or traffic were increasing, and that they would decrease when population and travel were decreasing. These tests produced significant test statistics for several counties. San Francisco, Alameda, Marin, and Santa Clara have experienced slower growth in total fatalities relative to the increases in population and travel over the study period. Again, the test confirmed that Solano's fatalities have been increasing faster than population and travel.

Swedish counties also showed improvements. In addition to the three counties with decreases in traffic fatalities beyond what would be expected if fatalities were constant over time, Stockholm County's growth in total traffic fatalities has grown proportionately to travel or population. In many cases, the slower growth was statistically significant for total fatalities, but not for motor vehicle fatalities implying that the slow growth in fatalities has been for the non-motorized modes. This could be the result of safety interventions, or to changes in travel behavior (e.g., fewer bicycle and pedestrian trips and lower exposure). Answering this question is outside the scope of this project, but is a question for future investigation.

### ***Fatality Rates by Age Cohort***

How do these similarities and differences in road safety in the Bay Area and Stockholm Region appear when analyzing traffic fatalities by age cohort? Are children in both regions equally safe as passengers and pedestrians? Do younger and older travelers face similar risks across both cases? To answer these questions I used the disaggregated data for counties in the Bay Area and Stockholm County (disaggregated data were not available for the other Swedish counties discussed in the previous analyses). The Bay Area data are for the period 1995-2008 and the data for Stockholm are for 2000-2007.

During the period analyzed, the overall pattern for both Stockholm and the Bay Area is that total traffic fatality rates are lowest for young children, and highest for teens around driving age through about age 25, and high also for older travelers 75 years old and older. (See Table 2.12) Pedestrian fatality rates are highest for people about 70 years old and older. (See Table 2.13) These patterns are what we would expect to see. Crash survivability decreases with age, and younger drivers have relatively high crash and fatality rates. (Evans, 2004: 132, 171) Fatality rates for older travelers in San Francisco are notably higher than for other cohorts, and compared to older travelers in other counties.

Based on chi-square goodness-of-fit tests comparing the observed distribution of fatalities with the expected distributions if they were based on the populations in each cohort, the differences in total traffic fatality rates and motor vehicle fatality rates across counties and across age groups within counties are statistically significant at the 0.05 significance level. For some tests expected fatalities for each age group were less than five. In these cases I combined age groups into ten-year cohorts. Even with ten-year cohorts, the age group from zero to nine years old includes cells less than five. Nevertheless, I conclude that the differences in rates across age groups within counties and across counties are not attributable to differences in underlying populations or to chance alone.

The differences in total and pedestrian fatality rates between San Francisco and Stockholm are small, and many of these differences are not statistically significant at the 95% confidence level. Using two-tailed t-tests with unequal variance, I could not reject the null hypothesis that the total fatality rates for some age groups were equal. Using a one-tailed t-test, I would reject the null hypothesis that the rates for the age group 65 to 69 were equal (p-value = 0.03). Similarly, the evidence for the 75-79 age group was weak. With a one-tailed t-test the p-value of the test statistic was = 0.08. Thus, based on a one-tailed test and using a significance level of 0.10 for the total fatality rates per 100,000 population, Stockholm was safer than San Francisco for ages 10 to 14, 35 to 39, 45 to 59, and 65 and above. This is interesting because Sweden is known for protecting its young children, particularly in cars with child restraints. In this comparison, children up to age 10 in San Francisco are not less safe than children in Stockholm.

The differences in pedestrian fatality rates were more consistent. A two-tailed t-test with unequal variance produced test statistics such that I could not reject the null hypothesis for only two age groups, 5 to 9 and 15 to 19. Otherwise, pedestrians of all other ages are safer in Stockholm than in San Francisco.

### ***Fatality Rates for Cities in the San Francisco Bay Area***

Table 2.14 presents the traffic fatality rates per 100,000 population for selected cities in the San Francisco Bay Area, and Table 2.15 presents similar rates for cities in the Stockholm Region. For motor vehicles and pedestrians, the table presents two versions of the per capita fatality rate. One rate includes the fatalities for each mode on all streets in the jurisdiction, and the second rate includes only those fatalities that occurred on local streets. The twenty cities listed in Table 2.14 have the highest motor vehicle fatality rates on local roads, among cities with populations greater than the median for the Bay Area in 2000. The purpose of calculating the rates this way is to compare cities based on the environments they control, not on the state-operated infrastructure, and not on the regional through-traffic. For example, the city of Fairfield in Solano County is in the outer suburban part of the Bay Area on Interstate 80, a major

commute corridor into the region, and its fatality rate per capita is 7 when considering all fatalities, but only 3 when looking at only local roads. More than half of the traffic fatalities in this city occur on road facilities that are not controlled by the local entity. Other cities have more dangerous local street environments, including Oakland. In fact, Oakland's fatality rates per capita are among the highest for motor vehicles *and* pedestrians. The traffic safety problem is not just about traffic calming on suburban arterial roads; traffic safety is also a big problem in older suburbs and larger cities with relatively high transit, walking, and bicycling mode shares. Oakland's high traffic fatality rates could indicate that speeds are too high for local streets, or that there are more conflicts in these transportation environments, or both. In contrast, the traffic safety problems on local streets in the Stockholm Region are not very significant compared to other types of roads. Again, this suggests that extensive traffic calming and lower speeds on local roads in Sweden contribute to its excellent safety performance.

Overall, the traffic fatality rates in the *cities* in the Bay Area are low compared to the fatality rates in the *unincorporated areas* of counties. The traffic fatality rate for motor vehicles in unincorporated areas (calculated as average traffic fatalities in these areas over the period 1995-2008 divided by the population in these areas in 2000) range from 8.5 in Marin County and 9.5 in Alameda County, to 44.0 and 67.9 in Napa County and Solano County respectively. Moreover, the proportion of a county's population living in unincorporated areas is often substantial. The share of population living in unincorporated areas was 11% in 2000 in Alameda, 17% in Contra Costa, 23% in Napa, and 5% in Solano. Unincorporated areas are also the location of large county roads, highways, and other road types that facilitate through-traffic. For these areas, traffic fatality rates based on population overstate the risk of death compared to a rate based on the traffic volume, but it is important to know that residents in such areas are exposed to large volumes of high-speed traffic, which increases risk.

## **5. Discussion and Conclusions**

When accounting for exposure with population, total traffic fatalities in the Bay Area are higher than in the Stockholm Region. Whereas Stockholm County's total traffic fatality rate is 3.0 per 100,000 population, the rate in San Francisco—the most comparable county in the Bay area—is 5.2, and the difference is statistically significant at the 0.05 significance level. Still, the total fatality rates for the other counties in the Stockholm Region have rates comparable to the safest counties in the Bay Area. The story is similar for motor vehicle fatalities.

Evaluating the differences in safety across the regions gets murkier when using vehicle-kilometers of travel as the measure of exposure. With this indicator, the differences in total traffic fatality and motor vehicle fatality rates are not different across the two regions overall, though the intra-regional safety disparities are large. The suburban counties in the Bay Area are two to three times as high as the inner counties.

Though the total fatality rate comparisons are ambiguous depending on the measures of exposure used, the pedestrian fatality rate differences are clear. Counties in the Stockholm Region are far safer than those in the Bay Area for pedestrians. The two most comparable counties, Stockholm and San Francisco show a clear difference. Pedestrian fatality rates in San Francisco are three to five times as high as those in Stockholm. Pedestrians over 65 years old in San Francisco, and in particular those over 85 years old, have especially high traffic fatality rates. Over the 14 year period studied in this analysis, 86 pedestrians over age 85 were killed in San Francisco. Some of these pedestrian fatalities were due to special circumstances, such as a

period when older Laotian-Hmong immigrants were killed in traffic. This particular group did not have had any experience navigating city traffic.

Bicycle fatality rates were not statistically significant across regions. It is complicated to analyze this subset of fatalities across the regions because bicycling is a more common travel mode in Sweden. The infrastructure for bicycles is also different in the Stockholm Region. Often, bicycles have separate lanes, and in many cases these are separated from motorized vehicles with planting strips or parking. The rates in this analysis do not show significant differences in safety across the regions, but if the measure of exposure where bicycle flows, I expect that Sweden would be safer.

Two interesting things emerge from this analysis. First, pedestrians are much safer in Stockholm than in San Francisco—the dense, walkable, transit-oriented central cities of these regions. Walking is an important travel mode in both cities. Yet, pedestrians are killed at much higher rates in San Francisco. A key determinant of these fatality rates is speed, and speeds may be higher in parts of San Francisco. Based on my field studies in Stockholm, I found that high-speed urban arterial streets (e.g., 30 miles per hour or higher) are rare in urban areas of Stockholm County, and I did not find a single one lined with residential or commercial uses with access directly onto the street. The speeds of motorized vehicles in San Francisco may be higher than speeds in Stockholm, but compared to other counties in the Bay Area, San Francisco speeds may well be lower because of its urban form and congestion. Another factor may be the network design. San Francisco has a gridiron street network without a strong hierarchy. On most streets, pedestrians and motor vehicles share the right of way, with pedestrians on sidewalks and motorized traffic in travel lanes. Stockholm has areas like this—and these are areas that local planners have flagged for safety problems—but it also has residential and commercial subdivisions designed with a Corbusien separation of motor vehicles and pedestrians, where pedestrians walk in plazas and garden paths and cars travel on roads. These design differences may indeed make a difference in safety, as they are intended to.

Finally, the Swedes have been innovative with respect to child restraint devices and laws, and their road safety planning targets children so that they can safely explore their environment. In fact, Sweden is known to have extremely low rates of child injury and fatality. (Jansson, et al., 2006) I expected to see significant differences in the safety of children up to about age 10, but these differences were not statistically significant between Stockholm and San Francisco (they were significant across the larger Bay Area). This similarity may reflect the effects of children's traffic safety programs (for both children and parents) in California.

Still, the very high traffic fatality rates for older travelers in San Francisco, the high fatality rates in Oakland, and the relatively high fatality rates in suburban counties, particularly in unincorporated areas, are areas that require additional attention.

**Table 2.1 Population and Population Density of the San Francisco Bay Area and Stockholm Region, by County, 2008**

<b>Region</b>	<b>County</b>	<b>Population 2008</b>	<b>Population density 2008 (persons/km<sup>2</sup>)</b>
San Francisco Bay Area		7,247,279	404
	Alameda	1,530,697	801
	Contra Costa	1,053,710	565
	Marin	253,331	188
	Napa	138,956	71
	San Francisco	810,078	6,699
	San Mateo	731,633	629
	Santa Clara	1,809,774	541
	Solano	431,525	201
	Sonoma	487,575	119
Stockholm Region		3,103,681	90
	Stockholm	1,981,263	304
	Södermanland	267,524	44
	Uppsala	327,188	40
	Västmanland	249,974	49
	Örebro	277,732	33

Sources: California Department of Finance, 2010; US Census Bureau, 2010; Statistika Centralbyrån, 2010.

**Table 2.2 Mode Shares by County and Region**

<b>County</b>	<b>Private auto</b>	<b>Transit</b>	<b>Bike</b>	<b>Walk</b>
Stockholm	0.41	0.25	0.05	0.26
Uppsala	0.47	0.12	0.12	0.25
Södermanland	0.57	0.07	0.08	0.25
Örebro	0.55	0.06	0.13	0.24
Västmanland	0.56	0.06	0.13	0.22
San Francisco	0.49	0.32	0.03	0.09
Bay Area	0.84	0.06	0.02	0.09

Source: Metropolitan Transportation Commission, San Francisco MTA, SCB.

Notes:

1. San Francisco County mode shares for work trips. Bay Area and Swedish counties mode shares for all trips.

**Table 2.3 Summary of Traffic Deaths by County,  
San Francisco Bay Area 1995-2008 and Stockholm Region 1999-2008**

Region	County	Average annual total traffic fatalities		Proportion of fatalities		
		N		Motor vehicle	Pedestrian	Bicycles
San Francisco Bay Area		14	54	0.74	0.22	0.04
	Alameda	14	102	0.72	0.25	0.03
	Contra Costa	14	65	0.78	0.17	0.04
	Marin	14	13	0.77	0.19	0.03
	Napa	14	18	0.88	0.08	0.04
	San Francisco	14	47	0.45	0.51	0.05
	San Mateo	14	40	0.72	0.22	0.06
	Santa Clara	14	104	0.69	0.27	0.05
	Solano	14	40	0.84	0.14	0.01
	Sonoma	14	53	0.85	0.12	0.04
Stockholm Region		10	24	0.79	0.14	0.07
	Stockholm	10	55	0.73	0.20	0.07
	Södermanland	10	15	0.90	0.05	0.05
	Uppsala	10	16	0.79	0.15	0.06
	Västmanland	10	16	0.77	0.14	0.09
	Örebro	10	20	0.74	0.17	0.08

Sources: California Highway Patrol, 2010; SIKA, 2010.

Notes

1. Motor vehicle fatalities include private automobiles, light and heavy trucks, motorcycles, mopeds, and buses.

**Table 2.4 Traffic Deaths by Type of Road and Mode, San Francisco Bay Area, 1995-2008**

Mode	Road type					County road line	County road area
	Local	Interstate	US highway	State route			
<b>Motor vehicle</b>	0.36	0.19	0.09	0.18		0.10	0.08
<b>Pedestrian</b>	0.72	0.12	0.05	0.05		0.03	0.03
<b>Bicycle</b>	0.75	0.01	0.00	0.06		0.07	0.11

Source: California Highway Patrol, 2010

**Table 2.5 Traffic Deaths by Type of Road and Mode, Stockholm Region, 2000-2007**

	Local street	Highway	Expressway	Other public road	Private road	Other road type	No information	Unknown
	<b>Motor vehicle</b>	0.14	0.08	0.06	0.65	0.00	0.02	0.02
<b>Pedestrian</b>	0.40	0.07	0.01	0.35	0.01	0.09	0.05	0.01
<b>Bicycle</b>	0.29	0.00	0.00	0.35	0.03	0.12	0.06	0.15

Source: Statistika Centralbyrån, 2010.

**Table 2.6 Total Traffic and Motor Vehicle Death Rates per 100,000 Population, San Francisco Bay Area 1995-2008 and Stockholm Region 1999-2008**

Region	County	N	Total traffic fatalities / 100k population				Motor vehicle fatalities / 100k population			
			Mean	SD	95% confidence interval		Mean	SD	95% confidence interval	
San Francisco Bay Area		14	8.1	0.3	7.5	8.7	6.2	0.3	5.6	6.8
	Alameda	14	7.0	0.2	6.6	7.4	5.1	0.2	4.7	5.5
	Contra Costa	14	6.7	0.2	6.1	7.2	5.2	0.2	4.7	5.7
	Marin	14	5.2	0.4	4.2	6.1	4.0	0.4	3.1	4.9
	Napa	14	14.3	0.8	12.7	16.0	12.6	0.8	11.0	14.3
	San Francisco	14	6.1	0.3	5.4	6.8	2.7	0.2	2.3	3.1
	San Mateo	14	5.6	0.2	5.1	6.0	4.0	0.2	3.7	4.4
	Santa Clara	14	6.1	0.2	5.7	6.5	4.2	0.2	3.9	4.5
	Solano	14	10.0	0.6	8.8	11.3	8.5	0.6	7.2	9.8
	Sonoma	14	11.5	0.4	10.6	12.4	9.7	0.4	8.9	10.5
Stockholm Region		10	5.5	0.3	4.8	6.2	4.4	0.3	3.8	5.1
	Stockholm	10	3.0	0.2	2.6	3.4	2.1	0.1	1.9	2.4
	Södermanland	10	7.5	1.0	5.1	9.9	5.1	0.6	3.7	6.6
	Uppsala	10	6.6	0.8	4.7	8.4	4.3	0.5	3.2	5.4
	Västmanland	10	8.1	0.9	6.1	10.1	5.0	0.7	3.5	6.6
	Örebro	10	10.1	1.1	7.7	12.4	5.6	0.8	3.8	7.4

Sources: California Highway Patrol, 2010; California Department of Finance, 2010; SIKa, 2010; Statistiska Centralbyrån, 2010.

Notes:

1. Motor vehicle fatalities include private automobiles, light and heavy trucks, motorcycles, mopeds, and buses.



**Table 2.7 Pedestrian and Bicyclist Death Rates per 100,000 Population, San Francisco Bay Area 1995-2008 and Stockholm Region 1999-2008**

Region	County	N	Pedestrian fatalities / 100k population				Bicyclist fatalities / 100k population			
			Mean	SD	95% confidence interval		Mean	SD	95% confidence interval	
San Francisco Bay Area		14	1.5	0.1	1.4	1.7	0.29	0.03	0.23	0.35
	Alameda	14	1.7	0.1	1.5	1.9	0.20	0.02	0.15	0.26
	Contra Costa	14	1.1	0.1	1.0	1.3	0.30	0.06	0.16	0.43
	Marin	14	0.9	0.2	0.6	1.3	0.17	0.07	0.02	0.32
	Napa	14	1.1	0.2	0.7	1.5	0.57	0.21	0.11	1.03
	San Francisco	14	3.1	0.2	2.6	3.6	0.28	0.04	0.19	0.36
	San Mateo	14	1.3	0.1	1.0	1.5	0.31	0.04	0.23	0.39
	Santa Clara	14	1.6	0.1	1.4	1.9	0.28	0.03	0.22	0.34
	Solano	14	1.4	0.1	1.1	1.6	0.13	0.04	0.05	0.20
	Sonoma	14	1.3	0.2	1.0	1.7	0.40	0.06	0.27	0.52
Stockholm Region		10	0.7	0.7	0.6	0.8	0.38	0.05	0.28	0.48
	Stockholm	10	0.6	0.1	0.4	0.8	0.21	0.04	0.12	0.30
	Södermanland	10	0.5	0.2	0.0	0.9	0.40	0.16	0.03	0.77
	Uppsala	10	0.9	0.2	0.5	1.4	0.37	0.16	0.00	0.73
	Västmanland	10	1.0	0.2	0.5	1.5	0.65	0.13	0.36	0.94
	Örebro	10	1.5	0.2	1.0	1.9	0.80	0.15	0.45	1.15

Sources: California Highway Patrol, 2010; California Department of Finance, 2010; SIKA, 2010; Statistiska Centralbyrån, 2010.

Notes:

1. Motor vehicle fatalities include private automobiles, light and heavy trucks, motorcycles, mopeds, and buses.

**Table 2.8 Total Traffic and Motor Vehicle Death Rates per Billion Vehicle-Kilometers of Travel, San Francisco Bay Area 1995-2008 and Stockholm Region 1999-2008**

Region	County	N	Total traffic fatalities / 1 billion vkt				Motor vehicle fatalities / 1 billion vkt			
			Mean	SD	95% confidence interval		Mean	SD	95% confidence interval	
San Francisco Bay Area		14	7.5	0.3	6.9	8.1	5.6	0	5.1	6.2
	Alameda	14	5.7	0.2	5.3	6.2	4.1	0.2	3.8	4.5
	Contra Costa	14	6.4	0.2	6.0	6.9	5.1	0.2	4.6	5.5
	Marin	14	3.9	0.4	3.0	4.8	3.0	0.4	2.2	3.9
	Napa	14	14.0	0.8	12.3	15.6	12.3	0.7	10.8	13.8
	San Francisco	14	10.6	0.7	9.1	12.1	4.7	0.3	4.0	5.4
	San Mateo	14	4.4	0.2	4.0	4.7	3.1	0.1	2.8	3.4
	Santa Clara	14	5.3	0.2	4.8	5.8	3.6	0.2	3.2	4.0
	Solano	14	7.0	0.4	6.2	7.8	5.9	0.4	5.1	6.8
	Sonoma	14	10.3	0.6	9.1	11.5	8.7	0.5	7.7	9.8
Stockholm Region		14	7.1	0.4	6.3	8.0	5.7	0.4	4.9	6.5
	Stockholm	10	4.0	0.3	3.4	4.7	2.9	0.2	2.5	3.4
	Södermanland	10	7.3	1.0	5.0	9.7	6.5	0.8	4.6	8.3
	Uppsala	10	6.9	0.6	5.5	8.3	5.6	0.6	4.2	7.0
	Västmanland	10	8.0	0.9	6.0	10.0	6.4	0.8	4.5	8.2
	Örebro	10	9.3	1.1	6.9	11.7	7.2	1.1	4.7	9.6

Sources: California Highway Patrol, 2010; California Department of Transportation, 2010; Metropolitan Transportation Commission, 2010;; SIKA, 2010.

Notes:

1. Motor vehicle fatalities include private automobiles, light and heavy trucks, motorcycles, mopeds, and buses.
2. Vehicle-kilometers traveled (vkt) for the Stockholm region based on annual vehicle inspections. Vkt for the San Francisco Bay Area based on model estimates of vkt for 1998, 2000, and 2007. Used annual measurements of vkt on highways in each county to estimate the total vkt in other years. Assumed weekend vmt = 0.75 weekday vmt.

**Table 2.9 Pedestrian and Bicycle Death Rates per Billion Vehicle-Kilometers of Travel, San Francisco Bay Area 1995-2008 and Stockholm Region 1999-2008**

Region	County	Pedestrian fatalities / 1 billion vkt				Bicyclist fatalities / 1 billion vkt				
		N	Mean	SD	95% confidence interval	Mean	SD	95% confidence interval		
San Francisco Bay Area		14	1.6	0.1	1.3	1.9	0.28	0.03	0.22	0.34
	Alameda	14	1.4	0.1	1.2	1.6	0.16	0.02	0.12	0.21
	Contra Costa	14	1.1	0.1	0.9	1.3	0.28	0.06	0.16	0.41
	Marin	14	0.7	0.1	0.4	1.0	0.13	0.05	0.02	0.24
	Napa	14	1.1	0.2	0.7	1.6	0.57	0.21	0.11	1.03
	San Francisco	14	5.4	0.4	4.5	6.3	0.48	0.07	0.33	0.62
	San Mateo	14	1.0	0.1	0.8	1.2	0.24	0.03	0.18	0.31
	Santa Clara	14	1.4	0.1	1.2	1.6	0.24	0.03	0.18	0.30
	Solano	14	1.0	0.1	0.8	1.2	0.09	0.03	0.04	0.14
	Sonoma	14	1.2	0.2	0.9	1.6	0.35	0.05	0.24	0.45
Stockholm Region		14	0.9	0.1	0.7	1.1	0.49	0.06	0.36	0.62
	Stockholm	10	0.8	0.1	0.6	1.1	0.28	0.05	0.16	0.40
	Södermanland	10	0.4	0.2	0.0	0.9	0.39	0.16	0.03	0.75
	Uppsala	10	1.0	0.2	0.6	1.3	0.40	0.17	0.01	0.79
	Västmanland	10	1.0	0.2	0.5	1.5	0.65	0.13	0.36	0.94
	Örebro	10	1.3	0.2	0.9	1.8	0.74	0.14	0.42	1.06

*Sources:* San Francisco Bay Area: California Highway Patrol; California Department of Transportation; Metropolitan Transportation Commission; Stockholm Region: SIKÅ.

Notes:

1. Motor vehicle fatalities include private automobiles, light and heavy trucks, motorcycles, mopeds, and buses.
2. Vehicle-kilometers traveled (vkt) for the Stockholm region based on annual vehicle inspections. Vkt for the San Francisco Bay Area based on model estimates of vkt for 1998, 2000, and 2007. Used annual measurements of vkt on highways in each county to estimate the total vkt in other years. Assumed weekend vmt = 0.75 weekday vmt.

**Table 2.10 Traffic Fatality Rates by Person-Minutes of Travel by Mode, Stockholm Region and the San Francisco Bay Area**

	Average traffic fatality rates per 1 billion person-minutes of travel		
	Motor vehicle	Bicycle	Pedestrian
<b>Stockholm Region</b>	1.4	1.5	0.6
<b>San Francisco Bay Area</b>	1.6	4.2	6.5
<b>Stockholm County</b>	1.0	1.6	0.6
<b>San Francisco County</b>	1.4	3	12.9

Sources: SIKA, 2007; MTC, 2004.

Notes:

1. Fatality rates based on average annual traffic fatalities. For Stockholm counties the fatalities are averaged over 1999-2008; for San Francisco Bay Area counties the fatalities are averaged over 1995-1008.
2. Total person-minutes of travel by mode calculated with regional travel surveys for the Sweden (2005) and the Bay Area (2000) and population data for the year of the survey.
3. Travel survey for Sweden includes only residents age 5-84. The population for the Stockholm Region and County include only this age range, and for this reason these estimates are conservative.

**Table 2.11 Distribution of Traffic Fatalities Over Time: Are They Growing With Population and Travel?**

County	Total traffic fatalities			Motor vehicle fatalities		
	Changing with...			Changing with...		
	<i>increasing fatalities (+) or decreasing (-)</i>			<i>increasing fatalities (+) or decreasing (-)</i>		
	Population	Travel (vkt)	Constant	Population	Travel (vkt)	Constant
<b>Alameda</b>		no (-)				
<b>Contra Costa</b>						
<b>Marin</b>		no (-)			no (-)	
<b>Napa</b>						
<b>San Francisco</b>	no (-)	no (-)				
<b>San Mateo</b>						
<b>Santa Clara</b>		no (-)			no (-)	
<b>Solano</b>	no (+)		no (+)	no (+)	no (+)	no (+)
<b>Sonoma</b>		no (-)			no (-)	
<b>Stockholm</b>	no (-)	no (-)				
<b>Södermanland</b>	no (-)	no (-)	no (-)	no (-)	no (-)	no (-)
<b>Uppsala</b>						
<b>Västmanland</b>	no (-)	no (-)	no (-)	no (-)	no (-)	no (-)
<b>Örebro</b>	no (-)	no (-)	no (-)	no (-)	no (-)	no (-)

Notes:

1. Based on chi squared goodness of fit tests where the null hypotheses were:  
Do total/motor vehicle traffic fatalities have the same distribution as population/travel/uniform?
2. A "no" indicates that the null hypothesis was rejected and fatalities are not distributed in such a way.
3. A blank cell indicates that the null hypothesis could not be rejected.

**Table 2.12 Total Traffic Fatality Rates per 100,000 Population by Age and County**

Total traffic fatality rates / 100,000 population										
Age	Alameda	Contra Costa	Marin	Napa	San Francisco	San Mateo	Santa Clara	Solano	Sonoma	Stockholm
0 to 4	1.9	0.8	0.0	5.1	1.5	0.9	1.1	1.5	2.2	0.5
05 to 9	2.2	1.0	0.5	3.2	0.5	1.1	1.5	1.8	1.1	0.3
10 to 14	1.7	1.3	1.5	1.6	2.2	0.5	1.5	3.6	0.9	0.5
15 to 19	10.0	10.8	8.8	19.8	4.3	9.5	8.6	17.6	17.7	4.5
20 to 24	14.1	15.8	14.2	34.3	7.1	11.3	11.7	19.8	23.3	6.0
25 to 29	8.4	8.8	12.3	21.1	5.7	7.6	8.2	15.9	15.7	4.3
30 to 34	8.2	7.4	6.2	16.0	2.9	5.7	5.6	9.1	14.3	3.5
35 to 39	6.1	6.8	4.4	17.6	4.7	4.4	5.1	8.9	13.1	2.5
40 to 44	7.3	7.3	5.3	13.5	2.9	5.0	4.5	11.4	13.9	1.9
45 to 49	6.8	6.3	2.9	10.5	5.7	5.1	5.8	9.4	10.2	2.5
50 to 54	7.0	6.0	4.3	14.5	4.9	5.7	6.4	9.6	8.8	3.0
55 to 59	5.8	6.1	4.8	12.5	6.5	4.2	5.0	10.0	10.5	2.6
60 to 64	6.9	4.1	1.6	20.8	5.2	6.9	6.2	7.8	11.1	3.7
65 to 69	6.1	6.9	5.1	10.6	5.4	6.5	5.7	11.3	8.7	3.2
70 to 74	8.4	7.7	4.4	11.6	9.6	9.3	11.1	13.5	10.3	3.9
75 to 79	9.8	9.1	5.3	16.4	9.5	9.3	10.5	14.9	17.0	6.4
80 to 84	15.3	16.0	9.9	16.1	12.5	11.4	15.4	18.6	23.5	5.2
85 +	17.4	14.4	13.3	21.5	67.1	9.4	35.7	13.3	21.4	6.1

Sources: California Department of Finance, 2010; Statistika Centralbyrån, 2010; California Highway Patrol, 2010; Vägverket, 2010

Notes:

1. Data for counties in the San Francisco Bay Area for 1995-2008. Data for Stockholm County for 2000-2007.

**Table 2.13 Pedestrian Fatality Rates per 100,000 Population by Age and County**

Pedestrian fatality rates / 100,000 population										
Age	Alameda	Contra Costa	Marin	Napa	San Francisco	San Mateo	Santa Clara	Solano	Sonoma	Stockholm
0 to 4	0.8	0.2	0.0	1.7	1.2	0.3	0.5	0.5	0.5	0.1
05 to 9	1.1	0.5	0.0	0.0	0.5	0.3	0.5	1.2	0.0	0.1
10 to 14	0.2	0.2	0.0	0.0	1.5	0.2	0.4	0.4	0.2	0.1
15 to 19	0.9	0.9	0.0	0.0	0.6	0.9	0.6	0.9	0.9	0.5
20 to 24	1.9	0.5	0.0	1.8	2.1	0.9	1.8	2.8	1.4	0.6
25 to 29	1.5	1.4	0.6	0.0	1.3	0.6	1.0	2.6	0.5	0.4
30 to 34	1.8	1.0	0.9	0.0	1.1	1.5	1.3	0.7	1.9	0.3
35 to 39	1.3	0.8	0.4	0.0	2.1	1.0	0.9	0.7	2.1	0.3
40 to 44	1.7	1.3	1.3	0.8	1.3	0.8	1.2	2.2	1.0	0.3
45 to 49	1.7	1.0	0.3	1.5	2.5	1.4	1.6	1.2	1.9	0.3
50 to 54	1.7	0.6	2.0	1.6	2.5	1.3	2.2	2.2	1.0	0.8
55 to 59	1.3	1.9	1.6	2.9	3.4	0.5	1.8	1.4	1.6	0.4
60 to 64	2.6	0.3	0.0	2.4	3.4	2.6	2.5	0.5	2.6	0.6
65 to 69	1.9	1.6	2.2	0.0	4.4	2.1	2.1	1.9	1.4	0.7
70 to 74	4.6	4.0	0.9	0.0	6.5	4.8	5.8	0.7	1.1	1.7
75 to 79	4.5	4.2	3.2	7.3	6.6	3.6	5.1	2.8	3.0	2.1
80 to 84	7.8	6.2	1.4	4.6	11.1	4.4	6.1	1.3	4.7	3.7
85 +	8.3	3.6	1.5	2.4	40.1	2.9	15.9	1.7	3.4	4.8

Sources: Sources: California Department of Finance, 2010; Statistika Centralbyrån, 2010; California Highway Patrol, 2010; Vägverket, 2010

Notes:

1. Data for counties in the San Francisco Bay Area for 1995-2008. Data for Stockholm County for 2000-2007.

**Table 2.14 Cities with the 20 Highest Traffic Fatality Rates per 100,000 Population by City, Mode, and Road Type in the San Francisco Bay Area, 1995-2008**

City	County	Motor vehicle		Pedestrian	
		All roads	Local roads	All roads	Local roads
Oakland	Alameda	6.2	4.2	2.6	2.1
Morgan Hill	Santa Clara	6.0	4.0	1.3	1.5
Pittsburg	Contra Costa	4.8	3.9	1.8	1.3
Antioch	Contra Costa	4.4	3.6	0.7	0.8
Santa Rosa	Sonoma	4.0	3.5	1.3	1.1
Union City	Alameda	4.1	3.5	1.3	1.2
Fairfield	Solano	6.7	3.2	1.1	0.8
Gilroy	Santa Clara	4.3	2.9	2.6	2.2
Concord	Contra Costa	4.0	2.8	1.3	1.2
Napa	Napa	2.4	2.8	1.0	1.0
Vallejo	Solano	4.5	2.8	1.8	1.1
Livermore	Alameda	4.9	2.7	0.6	0.3
Richmond	Contra Costa	4.1	2.5	1.7	1.1
Hayward	Alameda	3.4	2.3	1.7	1.3
San Leandro	Alameda	4.2	2.2	1.4	1.3
San Francisco	San Francisco	2.5	2.0	2.8	2.8
San Jose	Santa Clara	3.2	1.9	1.8	1.5
South San Francisco	San Mateo	2.9	1.9	1.7	1.7
Menlo Park	San Mateo	5.1	1.9	1.9	1.2
Burlingame	San Mateo	2.0	1.5	1.5	1.0

Sources: CHP, 2010.

Notes:

1. Rates based on 2000 population.
2. Cities included in the ranking included only those with populations greater than the regional median in 2000: 29,973.
3. Fatalities on local roads include only those categorized as "local" in the CHP crash data. These do not include US highways, Interstate highways, or county roads.

**Table 2.15 Cities with the 20 Highest Traffic Fatality Rates per 100,000 Population by City, Mode, and Road Type in Stockholm County, 2000-2007**

City	County	Motor vehicle		Pedestrian	
		All roads	Local roads	All roads	Local roads
Sollentuna	Stockholm	2.3	0.8	0.4	0.0
Södertälje	Stockholm	2.3	0.8	0.9	0.2
Haninge	Stockholm	3.9	0.7	0.4	0.0
Lidingö	Stockholm	0.9	0.6	0.3	0.0
Huddinge	Stockholm	3.3	0.6	0.9	0.1
Botkyrka	Stockholm	2.8	0.5	0.3	0.2
Danderyd	Stockholm	1.3	0.4	0.4	0.0
Sundbyberg	Stockholm	1.1	0.4	0.4	0.4
Sigtuna	Stockholm	5.2	0.3	1.0	0.3
Österåker	Stockholm	2.8	0.3	1.4	0.3
Tyresö	Stockholm	1.2	0.3	0.3	0.3
Stockholm	Stockholm	0.9	0.3	0.6	0.4
Norrtälje	Stockholm	5.8	0.2	0.7	0.5
Järfälla	Stockholm	1.2	0.2	0.0	0.0
Nykvarn	Stockholm	16.6	0.0	0.0	0.0
Nynäshamn	Stockholm	9.2	0.0	1.0	0.0
Vallentuna	Stockholm	7.6	0.0	1.4	0.5
Upplands-Bro	Stockholm	7.1	0.0	1.8	0.0
Ekerö	Stockholm	4.8	0.0	0.5	0.0
Vaxholm	Stockholm	3.8	0.0	0.0	0.0

Source: Statistika Centralbyrån, 2010.

Notes:

1. Rates based on average population, 2000-2006.
2. Fatalities on local roads include only those categorized as "local street" (*gata*).



## **Chapter Three—Safety Thinking is Similar, but Not the Same, in Sweden and California**

### **1. Introduction**

Road safety problems from years ago, and the interventions people made then, are both the material and intellectual foundations of contemporary road safety problems and interventions. Design standards, laws, organizations, and infrastructure, for example, are relics of prior conditions that road safety professionals work with today.

This chapter describes the history of the professional groups that have addressed road safety problems in the San Francisco Bay Area and the Stockholm Region since about 1900, answering three components of the main research questions. First, who are the professionals who have participated in decision-making that affects the safe design, management, and operation of the road transportation system? Second, how have these professionals framed the issue of road safety in their work? Third, how have they understood their roles in creating a safe transportation system? The analysis focuses on professionals and organized groups, not the roles of individual road users or driver culture.

The main findings are that Sweden and California have similar professional groups working on road safety issues. For example, some of the key professional groups working on road safety in each country include people from disciplines such as health, law enforcement, education, engineering, and planning. Surprisingly, within professional groups across these two different geographic and cultural sites people share common understandings of safety and frame the problem in similar ways. Traffic engineers, for example, working on traffic safety in California and Sweden are more similar than different in terms of their expertise and approaches to the problem.

What is different across the two cases is the composition of the field of professional groups whose expertise shapes road safety decision making. In the Stockholm Region, both historically and in contemporary safety work, architects, urban designers, and city planners have had a significant role in making decisions about road safety. In contrast, in California traffic engineers and law enforcement professionals have had the leading roles in road safety decision making. In California, the road safety expertise of architects, urban designers, landscape architects, and city planners has not been dominant, and on many issues, professionals with these backgrounds challenge the conventional approaches to road safety and are dismissed as non-experts by the dominant disciplines.

### **2. Data and methods**

This chapter relies primarily on documentary sources, including both primary sources and secondary studies of the history of urbanization, transportation, and road safety in the US and Sweden, and specifically in the Stockholm Region and the San Francisco Bay Area.

Secondary sources of information include histories of the Swedish and US transportation systems and histories of urban development in Stockholm and cities in the US. Primary sources include design guidelines for streets and highways in Sweden and the US, city plans for Stockholm and other cities in the region, as well as plans and subdivision ordinances for cities and counties in the San Francisco Bay Area. In addition, the research makes use of planning handbooks and guides for professionals, published research on road safety, published evaluations of road safety, articles in contemporary media, and other published sources.

For the case of Sweden, some documents were in English while others were in Swedish. When documents were in Swedish, I used electronic translation programs to help translate them.

### **3. Bad Drivers, Bumpy Roads, and Unsafe Vehicles—the Development of Road Safety Thinking**

In the US and Sweden, both in practice and in the literature, road safety is partitioned into three categories of specialization: the vehicle (or occupant protection), the road user (or driver), and the road environment. The elements of this triad developed during different phases of each country's experience with increasing motorization and its consequences, including injury and death. The road environment as an area for safety intervention was not the first to emerge in this triad. Drivers were the first area targeted for safety improvements, followed by roads, and then vehicles. This was the pattern in the US, Sweden, and in other countries that motorized early in the 20<sup>th</sup> century. (O'Connell, 1998; Irwin, 1985) The balance among the three elements of the triad, however, has shifted over time, but all three elements are still the main organizing principles behind professional work in road safety in Sweden and the US.

#### ***Road Safety Thinking in Sweden***

At the turn of the 20<sup>th</sup> century, Sweden's population was about five million, and more than 70 percent lived in the countryside. Sweden was a poor, agrarian society, not fully industrialized, and few people owned automobiles. In 1898 a resident of Stockholm owned Sweden's first car. (Hasselberg, 2001: 33) In 1902, Scania, a Swedish carriage, rail car, engine, and bicycle manufacturer, produced a car and a truck, among the first Swedish-made motor vehicles. (Scania, 2009)

Early in the Swedish experience of motorization, common knowledge held that drivers—and their poor driving, lack of driver training, and general audacity—caused most traffic accidents. Desirable interventions were those that would not limit traffic or restrict the freedom to drive. Motorists and other supporters of automobile transport were willing to accept requirements to train and test drivers, but little more. (Anshelm, 2005: 125-126; Lundin: 2008) In 1906, Swedish counties required drivers to obtain a permit to operate a car, issuing them to those who knew both how to operate a car and how the car worked, and gradually required drivers to perform practical driving tests. (Jonsson, et al., 2003: 7; Svenson, 1984: 489) In 1916, counties required drivers to take a medical exam, and a few years later the exam required drivers to have “a reputation for sobriety.” (Jonsson, et al., 2003: 7; Ross, 1975: 286) Beginning in the early 1920s, counties also required drivers to demonstrate knowledge of rules of the road, and the risks of drinking and driving. (Jonsson, et al., 2003: 7) In response to the temperance movement's strong lobbying, drinking and driving became illegal in 1925, and rules against it became stronger over the years. In 1934, the penalties for drunk driving were strengthened to include prison sentences. (Ross, 1975: 286-288, 291)

From the motorists' perspective, the real hazard was the poor quality of the roads, which needed upgrading to better accommodate auto travel. Roads in Sweden had been mostly a local affair. Since the Middle Ages, landowners and peasants constructed and maintained roads locally. Traffic comprised mainly wagons, carriages, horses, and pedestrians, and unpaved roads followed the contours of activities in towns, while commercial traffic traveled by waterways and railroads, which were considered to be engineered modes. (Westlund, 1998) Recasting roads as

modern rather than traditional was one successful strategy car lobbyists used to promote their cause, and roads gradually became recognized as having national significance worthy of engineering. The Swedish Road Federation, an automobile club, promoted the automobile and lobbied for infrastructure suited to cars—in other words, for paved, wide, and straight roads designed for speed. (Blomkvist, 2004: 277-278) They succeeded, and in 1922, Sweden introduced a car tax, and in 1924 a fuel tax to fund more road building. With road building came traffic, and with traffic came traffic engineering experts employed by county governments. (Blomkvist, 2001; Westlund, 1998; Vägverket, 2009)

During this early period of motorization, simply paving roads, straightening curves, and upgrading infrastructure was considered a safety improvement. Later, in the 1960s and 1970s, safety principles for road infrastructure integrated ideas from traffic engineering, such as separating different transportation modes, either in time with traffic signals, or in space with sidewalks and grade-separated intersections. Beginning in the 1980s, transportation planners and engineers began to rely more on spot interventions such as crosswalks, raised medians, and traffic calming strategies to modify the car-oriented streets such that traffic speeds would be slower in order to protect bicyclists and pedestrians. In about the past 15 years, engineers and safety experts took another look at highway infrastructure and major roads and implemented new designs to improve safety. For instance, roundabouts have become common on main, high-speed roads, and some high-speed undivided two-lane roads with wide shoulders were converted into divided three-lane roads, where the third lane alternates direction to facilitate passing. Thus, infrastructure is still an area for safety intervention, in urban, suburban, and rural areas, as well as for both motorized and non-motorized travelers.

Volvo, a ball bearing manufacturer, entered the car market in 1927. (Volvo Car Corporation, 1991) Early on, Volvo emphasized the quality and safety of its cars, and its management understood these two things as being interrelated. (Svenson, 1984: 489) Sweden is a small country, and exports have been important to its economy, and quality was a factor that designers believed would help their product compete in the European and world markets. (Paulsson, 1919 [2008]: 87-91) Volvo cultivated these attributes of its vehicle and its brand, maintaining its image as an organization with a deep safety philosophy. (Svenson, 1984: 489)

During the first two decades after World War II, Volvo introduced ergonomic seat designs that it developed in collaboration with “medical experts”. (Volvo Car Corporation, 1991: 52) For safety reasons it introduced a split circuit braking system, front and rear ends that absorbed crash energy, a divided steering shaft, and safety latches on the doors. (Volvo Car Corporation, 1991: 54)

In 1954, when Volvo introduced a five-year damage warranty on vehicles sold in Sweden, insurance companies sued the company in response, leading to four years of litigation. The Swedish Supreme Court dismissed the suit in 1958. (Volvo Car Corporation, 1991: 42) Volvo used the program as a source of information about vehicle performance during the first five years of their use, which informed the design of new vehicles. (Svenson, 1984: 498)

In 1959, after medical professionals in Sweden lobbied for better occupant protection in cars, Volvo began including three-point seatbelts as standard equipment on three of its models (Lundin, 2008: 154-155); it was the first car company to include seatbelts as standard equipment. (Volvo Car Corporation, 1991: 48) Saab followed in 1961. (Lundin, 2008: 155) The company also conducted a long-term study of effects of the seat belts on safety. The Volvo research on seat belts informed seat belt legislation in Sweden in the 1970s, as well as the debates among the

US National Highway Safety Bureau, American auto manufacturers, and the US Federal Highway Administration. (Svenson, 1984: 493)

In 1965, Volvo started its own accident investigation program to inform the design of its cars. (Svenson, 1984: 493) Sometimes the information from accidents revealed problems that were not detected in the test crashes. (Svenson, 1984: 493) In 1967, when the US adopted new vehicle safety regulations, some models of Volvo cars met them without any changes. (Volvo Car Corporation, 1991: 56)

Despite Volvo's interest in safety, and conviction that a competitive advantage in safety would help the company sell cars, vehicle safety did not emerge as a public concern or a matter of regulation in Sweden until the 1960s and 1970s. Volvo marketed its cars as safe in the 1960s, and in the 1970s this aspect of its cars became central for its brand—without the nudge of regulators. (Svenson, 1984: 489) This interest in safety branding coincided with US regulation of vehicle safety, the US being one of Volvo's most important export markets. The regulatory approach in the US was based on William Haddon's systems representation of safety, which also influenced Volvo's decision making. (Svenson, 1984: 489, 490) When Sweden created its own auto safety regulations, they were similar to the regulations found in the US, Japan, and Australia. (Svenson, 1984: 488)

Vehicle technology became a growing area of research, funding, and capacity building in Swedish road safety in the 1980s, and the research led to vehicle safety innovations that “favorably influence[d] its global competitiveness” by becoming part of the “Swedish trademark” and export strategy. (Kolbenstvedt, et al., 2007: 10, 19) These developments have been good for Sweden, and for its car companies, Volvo and Saab (no longer owned domestically, but locally important nevertheless). In addition to automakers, Sweden's reputation for safety also supports related businesses such as Autoliv, a car safety equipment (e.g. seat belts, airbags, electronics) designer and manufacturer. (Kolbenstvedt, et al., 2007: 20) In recent years, the focus of vehicle safety has grown to include not only crashworthiness and occupant protection, but also support for drivers and other intelligent transport systems (ITS) in vehicles. (Linder, et al., 2007) Currently, the majority of public road safety research funding in Sweden is allocated to developing commercially viable vehicle technologies. (Kolbenstvedt, et al., 2007)

### ***Professional Groups Establish Different Domains of Expertise***

Though there is a physical logic to partitioning road safety into the specializations of road users, vehicles, and the road environment, professional groups and government-sponsored committees also shaped these divisions.

By the 1950s, separate professional groups had established the field of road safety around a single main theme: human factors, which paralleled popular opinion that road users caused traffic accidents. In 1945, the first national road safety commission in Sweden bolstered this particular framing of road safety by selecting experts from medicine, psychology, law, and workplace safety to participate in curing what was, metaphorically, a “new disease.” (Anshelm, 2005: 15-16; Lundin, 2008) Interventions associated with this approach included training, testing, and licensing drivers; speed limits and enforcement; drinking-driving laws and enforcement; and public education campaigns to inculcate safe behaviors and values in drivers. (Lundin, 2008) The committee concluded that accidents were caused by bad driving, alcohol consumption, negligence, other human errors, and accident proneness. (Lundin, 2008: 155, 158)

In the 1950s, during a time when Swedish motorization had increased rapidly, the traffic safety problem worsened and Swedish road safety experts published new reports supporting policies to train new drivers, reform bad drivers, and remove the worst drivers from the roads. According to experts' research from the 1950s, these accident-prone drivers were the working class who had recently acquired cars. Lacking the education and social position of the elite drivers, the experts viewed their behavior as the root of the safety problem. (Lundin, 2008: 163-164) In addition to their social analysis, these reports also recommended reinstating speed limits (which had been imposed in the 1920s but removed later), and this occurred in urban areas in 1955 and on highways in 1967 (the same year that Sweden switched to driving on the right-hand side of the road and established the National Road Safety Administration, *Trafiksäkerhetsverket*).

Thus, in the postwar period, one of the main approaches to improving traffic safety in Sweden was to regulate it, and these regulatory approaches to road safety focused attention on the driver. (Åberg, 1998: 205) The regulatory or rule-oriented strategy is based on the theory that drivers are a key component to preventing accidents, and that because drivers cannot judge the social consequences of their own risk taking, they must be subject to rules. (Åberg, 1998: 213) On the other hand, a significant body of research and practice has focused on understanding driver behavior, attitudes, and decision-making in a different framework, one which does not assume that a regulatory approach is the best or only possible way to promote safe behavior. An alternative is to design communication strategies that inform people about safety in ways that harmonize with the social and cultural aspects of the driving culture. (Delhomme, et al., 2009)

Since the 1950s, three elements in the driver behavior research and practice area have received the most attention: the use of safety equipment (e.g., seat belts, child seats), speeding, and drinking and driving. (Åberg, 1998: 206) Most of the research that went into developing the seatbelt occurred before the 1970s (Vinnova, 2007: 16), but between 1971 and 1974 there was a "massive" campaign in Sweden to increase the use of seat belts. The result was that seat belt use increased from 15 percent to 35 percent. In 1975, Sweden passed a law to make wearing seat belts mandatory, and its use increased to 85 percent. (Åberg, 1998: 206)

Speeding has been a more challenging issue in Sweden. A study from 1991 (Nilsson, 1991 cited in Åberg, 1998: 207) found that a significant proportion of Swedish drivers drive faster than the posted speed limits (between 37 and 85 percent faster, depending on the type of road). In interviews with Swedes—both professionals and regular road users—most said that speeding is among the most serious safety problems the country has. Many offered the same explanation: that it was socially acceptable to speed. Many also contrasted this with drinking and driving, which is absolutely *not* socially acceptable in Sweden.

In 1990, Sweden passed a law to lower the limit for blood alcohol content from 0.05 to 0.02 percent. (Åberg, 1998: 212) This change happened in combination with a change in the policy to eliminate its mandatory jail time penalty for offenders with BAC over 0.15 percent, apparently without any negative effect on the incidence of drinking and driving. (Ross and Klette, 1995: 151) These changes were brought about because studies at the time found that alcohol was involved in a high proportion of crashes with fatalities. (Laurell, 1991 cited in Ross and Klette, 1995: 153)

Developments in this area also include improving the effectiveness of police enforcement against speeding and drunk driving, the development of the driving simulator at VTI, speed adaptation devices to assist drivers, driver training research, children in traffic, studies of traffic

conflicts, and the development of the power model that shows the relationship between vehicle speeds and injuries. (Kolbenstvedt, et al., 2007: 14-15)

In the 1960s, once experts had established that road safety was a function of driver behavior, road safety began to draw expertise from the transportation profession and road safety became a problem of transportation infrastructure too. Lundin (2008) argued that these two models of road safety—driver behavior and infrastructure—and the experts associated with them, competed for the privilege of defining road safety. Each group of supporters worked inside their respective professions and sought ways to institutionalize their perspective. In 1968, the infrastructure model of road safety became the national standard for road safety intervention. (Lundin, 2008; Hagson, 2004) The influence of the social, political, and professional context of the 1950s and 1960s on this development of road safety in Sweden cannot be overstated. Under this model, road safety investments aiming to create safe urban and suburban environments for cars, bicyclists, and pedestrians were prioritized over safety investments seeking to modify the behavior of individual road users. At that time, infrastructure improvements followed a modernist pattern, and focused mainly on classifying roads and road environments and separating different road users, including separation with traffic signals. Traffic calming and other ideas associated with livable cities and new urbanism would not become a mainstream safety intervention until the 1980s.

After World War II, Europe looked to planning as a path to recovery, and the professional field of city planning enjoyed a period of prominence. Mid-century planning in Europe, and particularly in Sweden, was rooted in a strong state government. (Judt, 2005: 69) Planning ideas and practices—and *rational* planning ideas in particular—influenced policies and plans for cities and infrastructure, housing, education, and health. (Judt, 2005: 72) Sweden did not experience the physical destruction of World War II the way other European countries had, but it did share the post-war economic, demographic, and social shifts that had spatial implications: a baby boom, rapid urbanization, and rising incomes. (Judt, 2005: 327) The Social Democratic party, which was strong in Sweden even before the War, had broad support for its social agenda, which centered on urbanization and the production of housing. These circumstances created a powerful role for city builders in the middle of the century, particularly those with science-based professional expertise, and road safety was among the problems framed within this context.

As Per Lundin explained (2008), experts in planning, architecture, and engineering recast road safety as an infrastructure problem, but more importantly they reframed the issue around a dichotomy between the individual and the society: was the problem really about driver behavior, or was the problem a lack of planning? They argued that the way forward—in road safety and in myriad other aspects of modern life—was with collective approaches predicated on an idea of social welfare and operationalized through expert-driven planning and interventions in the build environment. Thus, the safety experts reframed the debate by making it part of the larger effort to build the Social Democratic Swedish state.

If the first third of the century emphasized basic rules for drivers and crashworthiness, and the second third addressed road infrastructure, the last third of the 20<sup>th</sup> century introduced vehicle safety technology and a research-focused approach to road safety. Vehicle technology was one of the growing areas of research, funding, and capacity building in Swedish road safety, and the research led to vehicle safety innovations that “favorably influence its global competitiveness” becoming part of the “Swedish trademark” and export strategy. (Kolbenstvedt, et al., 2007: 10, 19)

The trends in road safety research funding illustrate this point. From 1971 to 1989, the Swedish Transport Research Delegation funded road safety research, and its portfolio focused mainly on road users (e.g., drivers, pedestrians, children, etc.) and planning (e.g., infrastructure, evaluation, etc.), with only about 15 percent of funding going toward the business and technologies of road safety. This trend continued when the Swedish Transport Research Board (later the Swedish Transport and Communications Board) took over its road safety research portfolio. Between 1971 and 1993, the Boards' combined grants for road safety research funded nearly 400 projects with more than SEK \$330 million, much of that going toward planning- and infrastructure-related work. (Kolbenstvedt, et al., 2007: 13-14)

In the early 1990s the research mix changed to include more research on intelligent transport systems (ITS) and vehicle technologies. In 1994, the Program Council for Vehicle Research began funding road safety research, focusing mainly on business and technology research. In 2001, the Transport Research Board became Vinnova, and at that time, the mix of road safety research also targeted road safety business and technologies, reducing road user- and planning-related research to less than 40 percent of its portfolio. Most of the grant funding supported university-based research in psychology, biomechanics, and engineering at Chalmers Technical University, Lund Institute of Technology, Uppsala University, as well as research at the Swedish National Road and Transport Research Institute (VTI). (Kolbenstvedt, et al., 2007: 13-14)

### ***Beyond Drivers, Roads and Vehicles: Zero Vision and Systems Thinking***

A key innovation in road safety policy was Sweden's Zero Vision. Zero Vision (*Nollvisionen*) is both a concept and Swedish road safety policy adopted by the Swedish Parliament in 1997. The concept is based on a dose-response understanding of road safety (i.e., Human bodies tolerate a certain amount of hazardous kinetic energy, and they should not be exposed to more than this amount). (Tingvall, 1995: 44-49) It asserts that no one should die or be seriously injured in the road transportation system, and that it is the responsibility of the system designers to ensure that the transportation system is designed according to this vision. (Tingvall, 1995: 40-43)

Zero Vision does not fit neatly within the vehicle-driver-road framework because it frames road safety as a problem of ethics and system design, which is similar to how the architects, engineers, and planners justified their work on road safety in the 1960s. On the other hand, Zero Vision also employs the vehicle-driver-road framework, combining existing models and strategies in each of these areas to create its own model of road safety. For example the key interventions that result from Zero Vision include speed reductions (speed being one area in which the vehicle-driver-road triad unites), and separating traffic by mode. In keeping with the vehicle technology and design focus of Swedish road safety research in the 1990s, Zero Vision innovates in recasting the role of auto manufacturers as responsible transportation system designers and therefore part of the governance of the road system.

Zero Vision was the brainchild of a small group of road safety professionals working in the National Road Administration, research centers, local governments and local government associations, the police, and other organizations. They met informally, outside of their official work capacities. This group included members with a range of educational and professional backgrounds, from city planning and epidemiology, to nuclear safety, vehicle design research, and law enforcement. The composition of this membership explains how Zero Vision drew on

ideas from systems safety and epidemiology, as well as why it included roles for a variety of practitioners, including those working in national and local infrastructure as well as vehicle and driver assistance technologies. Research on the development of this policy has asserted that it was consistent with the Swedish interest-group and bureaucratic politics model policy development that occurs in transportation policy as well as in other policy areas. (Andersson and Pettersson, 2008: 7-10)

Zero Vision has been controversial in Sweden (Andersson and Pettersson, 2008; Elevebakk, 2007). Its critics, including people inside the National Road Administration and politicians, have argued that the goal of zero deaths and serious injuries is irrational, economically infeasible, technically infeasible, and inequitable because it draws health and protection funding away from other causes and transportation funding away from other projects. (Andersson and Pettersson, 2008: 2, 3, 12; Roos and Nyberg, 2005: 24-25) Others have sought to understand the political aspects of the policy, suggesting that it was promoted as a way for the National Road Administration and other infrastructure, mobility, and vehicle interests to maintain the share of the national budget allocated to the transportation sector as this share has been decreasing with the neoliberal reforms of the welfare state. In this sense, Zero Vision is unlike other contemporary Swedish transportation policies that focus on diminishing the state's direct involvement in transportation operations. (Andersson and Pettersson, 2008: 4, 6)

But Zero Vision has also been an influential and intriguing policy. Other countries have adopted it (e.g., Norway, Denmark), and considered adopting it (e.g., the UK). (Andersson and Pettersson, 2008; Elevebakk, 2007: 425, 426; Nihlén Fahlquist, 2006: 1113) It has received attention in the 2004 World Health Organization report, which was coauthored by one of the creators of Zero Vision, where it was associated with a “shift of paradigms...among traffic safety professionals around the world.” (WHO, 2004: 15, 31, 43-45) Within Sweden, research reports, design guidelines, and other publications dealing with road safety start their introductions by situating their work in Sweden's Zero Vision policy.

### ***Road Safety Thinking in the US***

Despite Sweden's particular history, its pattern in professional development was not unique. O'Connell (1998) explored the approaches to road safety that developed in the UK, and found the same pattern: that separate professional groups specialized in road user behavior, vehicle safety and crashworthiness, and the built environment, and rarely considered these three things together in an integrated way. In general, there is also a general perception among these professional groups that technical solutions to safety as less intrusive than regulatory or other alternatives that might have limited the “freedoms” of automobility. Irwin (1985) found a similar pattern in the US and the UK, also noting the alignment—though not necessarily agreement—of professional groups around the three themes. This section discusses how road safety has been framed over time in the US, with an emphasis on California and the San Francisco Bay Area.

### ***Transportation Safety before the Automobile***

The growth of the American railroads, their regulation, and their safety technologies are important starting points for analyzing attitudes toward transportation safety in the US. The first railroad was built in England in 1814, and construction on America's first railroad began in



1829. (Ely, 2001: 1) In the US, railroads were associated with economic development and increasing land values. Municipalities and states wanted railroads to serve their territories, and supported their construction directly through gifts of land, financial support and charters, and indirectly through granting them competitive advantages over alternate forms of transportation such as canals and turnpikes. Despite being privately owned and operated, railroads were quasi-public and were called “public highways.”

States initiated the first regulation of railroads, focusing on rates, safety, and services. The main safety problems included killing livestock, setting fires with sparks from the engines, collisions with other trains, and employee injuries and fatalities—in that order. States required railroads to fence their tracks to prevent collisions with livestock, and required them to equip trains with safety equipment such as automatic couplers. Railroads resisted the regulations, but through litigation, courts increasingly protected property owners and victims, framing the issue as an economic tradeoff between investments in safety and economic development. This framing maintained a dichotomy between safety and productivity within the framework of a firm’s production decision making.

This economic framing of safety set a precedent for road safety in two ways. First, by framing safety in terms of liability, asking whether railroads or other parties were at fault and liable for damages, the definition of safety was appended to include the matter of who is responsible for the damages. Second, by framing safety as being in opposition to economic goals, safety was defined as a costly endeavor subordinate to production. (Ely, 2001) Aldrich (2006) argued that railroads succeeded in their opposition to regulation. Though the Interstate Commerce Commission, the first federal regulatory agency, could regulate rates, oversee train controls, and inspect operations, it did not create and enforce a rail safety code. Instead, safety operations were left to the railroads. Aldrich described this as a tacit agreement between Congress and industry—if industry could provide adequate safety performance, then it did not require government oversight. (Aldrich, 2006: 180-181, 307) Under this model, railroads focused their safety efforts on human factors, rather than infrastructure (unless the infrastructure was required by regulation, in the case of fencing or grade crossing protections). This is one of the antecedents of the human factors approach to safety that is so dominant in road safety.

In terms of safety technologies, devices for regulating motor vehicle traffic were based on railroad signals. (Norton, 2008: 59) The precedent for understanding and regulating motor vehicle traffic did not come from railroads, but from horses. In cities, horse drawn carriages were a safety problem, and cities regulated horse traffic with speed limits, parking ordinances, and driving rules. (McShane, 1994: 51)

Before the automobile, the major transportation externality in cities was not safety in the sense of injury, but in the sense of health and sanitation. (McShane, 1994: 7, 51) Streets were dirty with horse manure and sometimes the carcasses of horses that had died in the street. Residing on a major arterial street with heavy horse traffic was not desirable. These were among the motivations for sanitary reform in US cities, and the development of professional capacity in municipal engineering, public health, and municipal government administration. (McShane, 1994: 53-54)

### ***Approaches to Road and Automobile Safety***

As in Sweden, the first car owners in the US were wealthy elites who were accustomed to owning horses and carriages. Owning a car was similar to owning horses because both types of

transportation required space, and sometimes even a staff of drivers and others to care for the fleet. (McShane, 1994: 45-50) In the San Francisco Bay Area, people owned their first automobiles by 1897, around the same time Swedes had their first cars. (Scott, 1985: 90) Also in parallel to the Swedish experience, the demand for smooth roads suited for cars increased with the growth in automobile ownership. Following the example of Los Angeles, in 1901 Bay Area counties began paving some roads with a mixture of crude oil, sand, and gravel. (Scott, 1985: 91)

In 1914 there were about 12,000 automobiles in San Francisco and about 11,000 horse drawn vehicles. The number of autos more than doubled by 1916, and in 1924 there were about 84,700 autos in San Francisco and only about 1,500 horse drawn vehicles. (McClintock, 1927: 29) The beauty of the automobile was that it could travel at relatively high speeds (especially given the surrounding environments). But in the early 1900s, streets were crowded with a mix of traffic ranging from streetcars and pedestrians to horses and wagons. This chaotic mix of traffic, as well as the fact that most drivers were rather green, cried out for restrictions on traffic and driving. (McShane, 1994: 173-175) Auto clubs lobbied to prevent restrictions, which included speed limits and licensing drivers and vehicles. Cities responded by increasing police surveillance of traffic, but patrol was insufficient. "Urban streets needed new rules and behavior to augment familiar traffic customs." (McShane, 1994: 185)

In 1913, California passed the Motor Vehicle Act requiring automobile drivers to have a license, cars to pay annual registration fees and have license plates. The Act also set forth requirements for driver behavior, road traffic behavior, and the condition of the automobile, including the use of various safety devices. For example, the Act prohibited drivers from operating a car while intoxicated. With respect to driving, the Act elaborated procedures for driving among pedestrians, horses, and streetcars. Drivers should have "due regard" for the "safety and convenience" of pedestrians, proceed carefully to prevent frightening horses, and provide ample space for transit riders boarding and alighting from streetcars. Drivers should maintain speeds lower than 30 miles per hour, and always a "prudent" speed, and never race. In addition to this advice, the Act provided instructions for passing other motor vehicles, and for turning movements at intersections (turning around the center of the intersection). (California, 1913)

With respect to the safety of motor vehicles, the Act specified that the State may elect to deny registration to vehicles it deemed unsafe. It also specified that vehicles must be equipped with multiple safety devices including working brakes and mufflers, as well as headlights and tail lights to be used at night, dusk and dawn. In addition, it required cars to have a "bell, gong, horn, whistle, or other device" to warn pedestrians and travelers riding animals of the approaching car. (California, 1913) In 1923, the state authorized inspectors and traffic officers to enforce the Motor Vehicle Act. (California Department of Motor Vehicles, 2010)

The requirements of the Motor Vehicle Act begin to illustrate the main safety concerns at that time: the quality of the automobile and the skill and behavior of the driver. Throughout the US, and in the Bay Area, auto ownership and use grew through the 1900s and 1910s. By the early 1920s, automobile ownership was more widespread, and so were the consequences in the form of traffic congestion and accidents. (Scott, 1985: 178)

A striking feature of the traffic safety problem in cities was the fact that so many of the victims of traffic accidents were children. In 1926 in San Francisco, 67% of all automobile accidents were collisions with pedestrians, and 16% of the total number of deaths were children under age 10. (McClintock, 1927: 64-65) More generally throughout the county, this pattern

shaped public perceptions of the road safety problem, and their responses to it. Women became leading organizers of the road safety reform movements in the early and middle 1920s. Often, they worked with local affiliates of the National Safety Council, transforming these groups “from business-dominated industrial safety bodies into something resembling and organized social movement.” (Norton, 2008: 29)

As in Sweden, at the peak of the road safety reform movement in the 1920s, both popular and professional opinion held that road safety was a problem of speeding and driver behavior rather than bad roads or “primitive” cars. (Blanke, 2007: 24; Norton, 2008: 30-31) Urban residents did not blame the city government for their lack of oversight, but targeted motorists instead. (Norton, 2008: 25) Scorn for drivers’ speeding, alcohol use, their so-called “technological ignorance” and inability to control their automobiles, and disregard for others’ safety colored public perceptions of the automobile. (Blanke, 2007: 15-16, 99) Progressive reformers diagnosed the problem with the automobile as chaos, and the fix was to for more self control on the part of individuals. (Albert, 1997: 2) In its strongest, and somewhat oversimplified form, road safety was about keeping the “socially irresponsible off the road.” (Albert, 1997: 6)

These safety reform efforts relied on education, public campaigns, and enforcement to improve road safety, which had been the dominant strategies used in the industrial safety reform efforts up to the early 1920s, setting a precedent of placing the burden on workers to adopt safer practices.

Daniel Albert investigated the education of automobile drivers in the US (1925-1965) and found that cities in the US had in fact attempted different road safety strategies focusing on vehicles and roads relatively early in the development of the field (before 1930), but these approaches were not as readily accepted as those that focused on driver behavior. Emphasizing the role of the driver was consistent with popular opinion, the opinions of industrial safety experts, as well as legal doctrines preventing government regulation of manufactured goods and placing the safety burden on consumers. (Albert, 1997: 12-14) As in Sweden, certain professions such as medicine, psychology, and law enforcement provided expertise that shaped public responses to road safety in the US. (Albert, 1997: 179) Thus, the field of traffic safety in the US professionalized around the problems of driver behavior just as it did around the same time in Sweden. Similar groups were involved, including driving educators, law enforcement, and psychologists. (Albert, 1997: 16)

California required education about traffic safety in elementary and secondary schools in 1929. The manual used to educate children in traffic safety is introduced with the idea that “...the automobile—and its operator—is the most important single factor in traffic safety.” (California, 1936: iii) The manual covers topics such as the safety mechanisms of the automobile (e.g., the steering mechanism and windshield wipers), driving rules and instruction, speed, city traffic and parking, highways, liability, and what to do if one is in an accident. The list of references includes several from the National Safety Council and the American Automobile Association, as well as some produced by insurance companies. The end of each chapter lists questions for students such as, “What are the most commonly violated rules of the road?” and, “Is courtesy of the road a factor in avoiding accidents? Illustrate.”

In addition to the great attention given to educating individuals, according to the National Safety Council, traffic safety fell into the category of public safety, which implied that it was the duty of city government to address the problem. (Norton, 2008: 32-35) Thus, it was also necessary for city and state governments to create a system of laws promoting safe behavior, and

the capacity to enforce violations of these laws. Local police departments had much of the responsibility for trying to control motorists' behavior. Police approaches to road safety focused on enforcing speed limits, creating orderly traffic, and keeping pedestrians out of the road—usually by taking up a post at an intersection and monitoring traffic. One of the few tools that cities had to intervene in the traffic safety problem was the police. Police approached their role in traffic safety as keeping order in the streets, and this translated to keeping streets “safe *from* motorists”. (Norton, 2008: 53) In general, police blamed accidents on drivers and the behaviors that led to violations of laws.

By the middle 1920s, the grassroots road safety movement was waning, and the public attitude toward road safety was increasingly ambivalent. (Blanke, 2007: 104) Blaming drivers did not fade away, and identifying the accident prone drivers and reforming them through driver education was still the main way that people sought to improve road safety. (Blanke, 2007: 106-108) Then, as the various groups interested in road safety realized that it was not possible to reform everyone, the 3Es—Education, Enforcement, and Engineering—became the dominant strategy for dealing with traffic safety, though it had developed several years earlier, in 1915 by the National Safety Council. (Blanke, 2007: 120; Albert, 1997: 76) The main idea behind the new approach was to separate road users through traffic engineering and infrastructure. (Blanke: 103-104) These two approaches—road user behavior and the three Es—are the most common ways that many engineering-based road safety experts in California frame the issue today.

### ***The Role of Traffic Control in Accident Prevention***

Between about 1910 and 1915 the number of cars in the major cities doubled, and the effect was a radical change in the nature of traffic. (Norton, 2008: 49) Municipal engineers who had been responsible for providing public utilities took on the traffic problem and developed the field of traffic engineering. Instead, engineers separated the different road users into homogeneous streams of traffic. (Norton, 2008: 105-6; Albert, 1997: 47) Because of their charge to create space in cities for automobile traffic, the role for engineers in government expanded. In 1919, 48 percent of city managers were engineers. (Norton, 2008: 110-111)

The work of traffic engineer Miller McClintock exemplifies the traffic control approach to road safety in the first part of the 20<sup>th</sup> century. McClintock worked in cities across the country, and he made a traffic survey for San Francisco in 1926-1927 at the request of its mayor. The automobile, city streets, and traffic were important political and economic concerns at the time. The committee overseeing the survey included regional industrial interests who would benefit from both organized traffic and increasing motorization, including California Packing Corporation and Standard Oil. With respect to motorization and traffic, the committee included members from the National Automobile Club, the Motor Car Dealers Association of San Francisco, the California State Automobile Association, and the Market Street Railway Company. The composition of the committee also highlighted the growing importance of regional planning in the US and in the Bay Area, and included Fred Dohrmann, a leader of the Regional Plan Association of the San Francisco Bay Area.

In addition to its oversight committee, the 1927 McClintock report for San Francisco had an advisory council including representative from a number of business associations with an interest in city traffic and urban growth. These advisors represented real estate interests, downtown businesses, as well as a variety of goods manufacturers whose distribution costs depended on local traffic policies. (See Table 3.1)

The study began with a photograph of San Francisco, taken from the east looking west. The ferry building is in the foreground and Mount Sutro in the background. The authors of the report noted that between these two landmarks was “San Francisco’s Area of Traffic Concentration.” Controlling traffic in such an area was the matter at the heart of the study, and the authors were also careful to note that “There [had] been no attempt on the part of the Survey in this study to enter the field of city or regional planning,” despite the fact that a prominent regional planning advocate was an advisor of the study. Instead, its premise was narrower, that “an ultimate requirement for the solution of street and highway congestion [was] to be found in the creation of more ample street area.” (McClintock, 1927: 1) The authors did not propose to reconstruct streets to create this additional space. The tools of traffic engineering create space by putting “the present street area to the most effective use” by considering issues such as traffic flow, volume, speed, concentration of traffic. (McClintock, 1927: 2)

The study focused on the streets of San Francisco, but the second illustration in the document is a map of the nine-county Bay Area region. The text explained that there was “no real distinction between the streets of San Francisco and the streets of bordering communities” and that “increasing development of automotive transportation not only brings persons and commodities from neighboring communities but from points hundreds of miles away.” (McClintock, 1927: 3-4) According to the traffic engineering perspective, the metropolitan region was not only spatial and economic, a third important geography was the “entire automotive area.” (McClintock, 1927: 4) According to the study, the problem of traffic was directly related to the growing population and the fact that “a large number of workers must travel to and from their work over the same streets where only a few traveled when the district was more sparsely populated...” (McClintock, 1927: 4) Thus, the underlying theme of traffic engineering is the growth of this “automotive area” or “automotive region”. Though at the time only about 17% of trips in the central business district were automobile trips, these experts forecasted the need for a car-oriented transportation system.

The fifth chapter of the report was devoted to the subject of traffic accidents. The focus was not on the design of streets (though there were recommendations on this subject), but instead on using data collected about accidents to inform traffic engineering, and to create and enforce traffic rules that would establish “sound community habits in street use”.

According to traffic fatality and population data for 1914 through 1926 the average traffic fatality rate was about 16 per 100,000 population. (McClintock, 1927: 62) Data collected about these accidents emphasized driver and victim behavior, not the physical environment. The police reports indicated the type of accident (Was it a collisions with a pedestrian, another vehicle, a fixed object, etc.), whether the accident occurred in an intersection or not, and what was the victim doing at the time. Was the motorist speeding or driving recklessly? Did the driver fail to signal? Did the pedestrian run or walk into the vehicle? Was the pedestrian jaywalking or crossing against a signal? Most accidents, about 75%, happened at intersections. About 57% involved speeding. About a third of pedestrians walked into the vehicle, about a third were jay walking, and a quarter crossed where there was no signal. (McClintock, 1927: 64-67)

Overall, more than 60% of collisions involved pedestrians and the report included a special chapter about pedestrian protection. (McClintock, 1927: 75) Pedestrians presented a problem both in terms of their own safety, and because they caused congestion when they walked in the street. A contributing factor to the problems in pedestrian movement is that sidewalks were sometimes obstructed, forcing pedestrians to walk in the street. Pedestrians had

the right to walk in the street, and McClintock cited the “English Common Law rule which provides that all users of the highway have equal rights to its use, subject only to care that in the exercise of this right they shall not unnecessarily jeopardize the safety of the user of the way.” (McClintock, 1927: 133-134) Thus, the real issue at hand with pedestrians and their safety was the need to “readjust” the “rights and obligations of walkers and drivers.” (McClintock, 1927: 135) The traffic engineer’s response was a new system of “pedestrian control”, requiring certain behaviors from pedestrians such as using sidewalks and crossing only at intersections or specified places (this is the origin of the crosswalk). Despite the justification, these controls were not politically or practically supported—pedestrians did not easily give up their road space to make it easier for motorists to drive.

Table 3.1 Advisory Committee Members for a  
1927 Study of Traffic In San Francisco, CA

Apartment House Owners and Managers Association
Associated General Contractors of America
Builders Exchange
Building Owners and Managers Association
California Association of Ice Industries
California Bakers Association
California Hotel Association
Down Town Association
Draymens Association
Furniture Exchange
General Contractors Association
Gravel, Rock, and Sand Producers Association
Manufacturers and Wholesalers Association
Pacific Coast Paper Trades Association
Retail Grocers Association of San Francisco
San Francisco Bureau for Governmental Research
San Francisco Laundry Owners Association
San Francisco Milk Dealers Association
San Francisco Restaurant Association
Shipowners Association off the Pacific
Steam Shovel and Trucking Contractors

Source: McClintock, 1927: xii.

With respect to street design, a key point was that many accidents were caused by small curb radii that forced drivers onto the left side of the road to make wide right turns. (McClintock, 1927: 53) Other physical interventions to promote safety included traffic signals, warning signs, safety zones marked with paint, and cross walks. (McClintock, 1927: 79-80) The report also recommends making pedestrian bridges and tunnels, and safety zones for transit passengers boarding and alighting from public transit vehicles. (McClintock: 1927; 142-143)

McClintock created another study of San Francisco in 1937. This second report was prepared for the San Francisco Director of Public Works, and was jointly funded by the Works Progress Administration (\$140,000) and the City of San Francisco (\$20,000). Again, the main theme is the limited transportation capacity of the city of San Francisco. The Bay Bridge was completed in 1936, and the Golden Gate bridge was completed in 1937. Both bridges supported the growth in the region and increasing auto use and mobility, and because they brought traffic into San Francisco, they contributed to its traffic congestion. Despite the traffic, “the automobile ha[d] increased the trade area of San Francisco, [and] the street system of San Francisco must carry the motor vehicles from the surrounding metropolitan area.” (McClintock, 1937: 50-51)

In 1937, SF had a traffic fatality rate of 15.5/100,000 population, which was not very different from the average rate the decade before, but compared to other cities, San Francisco’s rate was lower. (McClintock, 1937: 19) In 1937, only 25% of all motor vehicle accidents involved a pedestrian. (McClintock, 1937: 161) Between 1927 and 1937 the road safety recommendations had not changed. Moreover, in both instances the safety treatments devised by traffic engineers relied heavily on traffic interventions.

The underlying logic was that organizing traffic according to traffic rules, signalization, and channeling streams of homogenous traffic into predictable flows would create a safe traffic environment. If traffic was organized, then it was safe. These interventions were also consistent with demands for increasing traffic, reducing congestion, and facilitating regional growth.

As traffic control was a key strategy for improving road safety, it was also important to spread the message about best practices in traffic planning as well as practices for driver behavior, and control. In 1936, the state of California established a State Traffic Safety Advisory Committee to support the work of individual groups and communities who were addressing the problem independently. The motivation was to share widely the local experiences with road safety in California. A second motivation was that during a six-year period in the 1930s accidents, deaths, and injuries increased faster than automobiles and their use. (The Traffic Safety Commission of California, 1936: 1) The organization created committees to spearhead projects on promoting local organizations, organizing more generally, education, enforcement, traffic schools, operators’ licenses, engineering, research, and statistics.

The members of the Committee included: leaders of local safety councils who, collectively, had connections with government, industry, members of the automobile business, insurance associations, utility corporations, women’s organizations, veterans’ organizations, service organizations, and representatives from press, radio, education, labor and religion. These groups were important for the Committee because they were potential participants in new programs, and because they help maintain popular interest in the cause. A second group of representatives included larger organizations, those civic, industrial, and business organizations operating statewide with an interest in traffic safety (i.e., the business, such as insurance companies, suffer losses because of traffic accidents). Participating organizations included the California Congress of Parents and Teachers, Automobile Club of Southern California,

Firemen's Fund Indemnity Co., Service Clubs' Council of Los Angeles, National Bureau of Casualty and Surety Underwriters, California Railroad Commission, and the Department of Motor Vehicles.

The suggestion here was that local chapters would "analyze the accidents in the community....[asking] Where? When? What driving blunder was committed that caused the accident? What violations of vehicle laws precipitate the greatest number of accidents?" (The Traffic Safety Commission of California, 1936: 5)

The organization also elected to maintain the education approach to preventing traffic accidents. One explanation for this strategy was that the group wanted to discover "the most practical, inexpensive and immediate projects for the reduction of automobile accidents." Under these criteria, the group chose to emphasize education because they could build on existing capacity in that area. (The Traffic Safety Commission of California, 1936: 5) According to the Committee, Californians needed to know the rules for safe operation of cars and of streets. One of its major programs was teaching traffic safety in schools, and requiring that students take the course. Another intervention was traffic school "for violators" because "any violator brought before the court is in some degree ignorant of automobile operation or traffic laws". (The Traffic Safety Commission of California, 1936: 5)

Perhaps one reason for this mixed approach was that in the 1930s, traffic engineering was just beginning to become its own profession. At a traffic safety conference in California in 1950, Joseph Havenner of the Automobile Club of Southern California called for placing more traffic engineers in city administrations, particularly in cities with populations greater than 50,000. According to Havenner, in 1950, the California Roster of Public Officials listed only three city traffic engineers, and only 11 cities in California had full time traffic engineers on staff (Los Angeles, San Francisco, Long Beach, Pasadena, Glendale, San Diego, Burbank, Fresno, Sacramento, Oakland, and Berkeley). This implied that other staff members, generally public works engineers were carrying out the functions of traffic engineers, which Havenner found lamentable because they were more concerned with pavement thickness and drainage than the movement of traffic. (Governor's Traffic Safety Conference, 1950)

In 1955, the Engineering Division of the Governor's Traffic Safety Conference conducted a survey of cities and counties asking who in the city or county government had responsibility for traffic engineering. The results supported Havenner's assertion that traffic functions were being carried out by municipal engineers, but this was not entirely true. In 45% of the responses, cities had not assigned traffic engineering responsibilities. In the 55% of cases where these duties were assigned, 43% of the time they were assigned to the chief of police, 40% to the city engineer, 14% to the traffic engineer, and 11% to the director of public works. Overall, the functions of traffic engineering were the duty of the police or public works departments. In cases where traffic engineering responsibilities were not assigned, 60% of the time they were given to the chief of police. (Governor's Traffic Safety Conference, 1955: n.p.). This organization of traffic engineering work, and therefore traffic safety work, within police and public works departments may explain the strong current of driver behavior strategies in Californian traffic safety planning, and the elaboration of control and enforcement strategies to prevent accidents, even if many of the individuals carrying out the work had training in a field of engineering (e.g., civil engineering, municipal engineering). These were the tools of the professions that had been given responsibility for the problem. This also signals that McClintock's sophisticated traffic analysis for San Francisco would not have been the norm for cities in the Bay Area. Larger cities undertook such studies and had traffic engineering capacity,



but smaller cities relied more on police enforcement of code than design and traffic interventions.

### *The Role of Infrastructure in Accident Prevention*

If traffic engineering was the first wave in the application of the 3Es, highway engineering, or more generally, and infrastructure-oriented approach to traffic safety was the second wave. Making traffic more efficient through traffic engineering interventions did not keep up with the growth in traffic, and cities began to reconfigure their streets for the volume and speed of automobile traffic (streets had been reconfigured in the past to accommodate pre-automobile traffic). (Weinstein, 2002) Where traffic engineers worked with intersections, highway engineers worked with grade-separated exchanges. (Albert, 1997: 71-75) Before highway engineers began to work on full-scale highways, their work focused on reconfiguring city streets to accommodate the incredible growth in automobile traffic.

The Engineering Division of the 1950 California Governor's Traffic Safety Conference captures a good example of the infrastructure approach to preventing traffic accidents. In 1950, California cities and counties had experience building new infrastructure for the motor age. Though it had not yet started building the Federal Interstate Highway system, the engineers at the conference were looking to the future and they saw limited access, high speed highways. The title of the conference in 1950 was "Safety is in Freeways." The conference participants' main idea was to turn sharp curves into flat curves, and blind vertical curves into curves with ample sight distance. They wanted to widen pavement in places where it was narrow, and turn undivided highways into divided highways. Where they could, they wanted to turn busy intersections into grade separated intersections. With respect to land use, they wanted to take "ribbon businesses" along the roadside and separate them from traffic by creating two classes of roads: restricted access roads for through traffic and access roads that would connect to roadside businesses. (See Figure 3.1) The main point behind these designs was to "build safety into the road system". (Governor's Traffic Safety Conference, 1950)

The issue of speed is one of the links between road design and driver behavior. J.H. Mack, a road commissioner in San Diego County said that speed was the major source of accidents, and the role of the county engineer could prevent accidents through the "proper design of new highways for modern speeds, and by correcting our existing bad curvature and narrow roadways...on our [county's] 'horse and buggy' road[s]..." (Governor's Traffic Safety Conference, 1950: 10-11)

Of course, speeding is an example of dangerous driving behavior, and though these engineers were making a case for better road engineering, they were convinced that a significant part of the safety problem was due to driver behavior. J.H. Mack said that in San Diego County, only five percent of police reported accidents were caused by a highway design defect, and that 86 percent of the county's accidents in 1949 were caused by driver behavior. (Governor's Traffic Safety Conference, 1950: 10-11) J.C. Young, a traffic engineer with the State Division of Highways said that national statistics showed that driver error caused more than 75 percent of all accidents, though he added that "in [his] opinion, the percentage is much higher." (Governor's Traffic Safety Conference, 1950: 14) The role, then, for the highway engineer was to "so design and construct highways that it is difficult to have an accident." The roads should be designed so that a drunk driver could survive an accident. (Governor's Traffic Safety Conference, 1950: 14)

Pedestrian safety was another area of concern for the highway engineers because, at the time, more than half of traffic fatalities involved pedestrians. (Governor's Traffic Safety Conference, 1950: 3) One participant in the conference, Ross T. Shoaf, a traffic engineer from the City and County of San Francisco, asserted that the pedestrian safety problem was essentially a conflict between "the Pedestrian and the Motorist." He explained that "Both are of the same flesh and blood", though they are "very different animals." The difference is "a sort of traffic schizophrenia", the "split personality...of a pedestrian and...a motorist." He continued with a different simile: "Think if you will of the Pedestrian...as a woman, and the Motorist as a man." In Shoaf's analysis, pedestrians, like women, are "dainty and soft—they bruise easily", they change their minds "at will", they "assume the privilege of being independent...[and] less susceptible to regulation", and because of their frailness they "expect special privileges." A different participant in the conference, A.J. Napier, a traffic engineer from Long Beach, extended this trope with his comment, which, unfortunately echoes the contemporary accident patterns for San Francisco:

*Yesterday we heard in this same conference the pedestrian referred to as 'a young woman, blonde, etc.'; but in checking before I came up here I found that the composite pedestrian injured was not a young woman – she is an old lady between 60 and 80; she habitually wears dark clothes; is a non-driver, and is frequently found crossing the street between the hours of 6:00 p.m. and 8:00 p.m., at which time the accident usually occurs.* (Governor's Traffic Safety Conference, 1950: 52)

Thus, there was a struggle over identities and rights within the pedestrian safety problem, and the solution to the pedestrian safety problem needed to balance these rights and be "just." (Governor's Traffic Safety Conference, 1950: 3-6) Proposed infrastructure solutions included simplifying intersections, creating spaces for pedestrians to cross wide undivided streets and long blocks, and separating pedestrians from heavy traffic flows. On the other hand, "high pedestrian volumes often [give] pedestrians a false sense of superiority," making a just solution difficult to devise. (Governor's Traffic Safety Conference, 1950: 3-6)

The kinds of safety interventions undertaken in California in 1951-1952 included such things as installing traffic signals, STOP signs and other traffic control signs; applying pavement markings; installing lighting; creating "thru" streets, "one way" streets, and channelizing traffic with "traffic islands"; removing objects that obstructed views; and establishing parking restrictions. (Governor's Traffic Safety Conference, 1952: n.p.) Though these may have been necessary safety interventions, certainly they were consistent with the goal of increasing traffic capacity in congested cities. In general, the approach to creating safety interventions was to use traffic safety data to inform the selection of sites for traffic engineering treatments. (Governor's Traffic Safety Conference, 1952: n.p.) This suggests that road safety was framed as an element of traffic engineering and street design, rather than engineering and design being one method of addressing the safety problem. The prevailing wisdom was that "a better road is a safer one", and that "when [an engineer] design[s] a channelization or signal system that facilitates traffic and makes for safer movement of more vehicles...consider that [a job well done]." (Governor's Traffic Safety Conference, 1955)

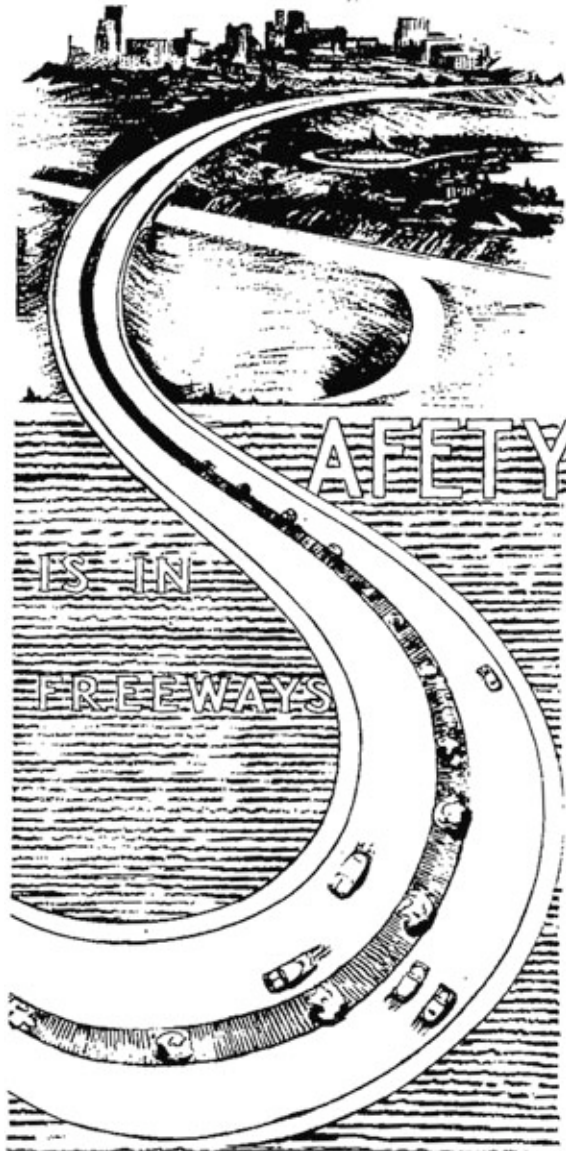


FIGURE 3.1 “Safety is in Freeways” detail from the cover illustration for the 1950 California Governor’s Traffic Safety Conference —Engineering Division. The image shows a relationship between highways and urban growth, and expresses the idea that high design standards prevent traffic accidents. *Source: Governor’s Traffic Safety Conference, 1950.*

## *Regulating Vehicles for Safety*

In general, from the period of early motorization until the 1960s, the automakers were not publicly responsible for traffic safety. Their role was to sell cars, not to become experts on driver behavior, infrastructure, crashes, and injuries. (Blanke, 2007: 123) For example, when it came to regulation, automakers preferred a system of vehicle inspections, which gave car owners responsibility for the quality of the vehicle. (Irwin, 1985: 58) The public role of the automakers changed in the 1960s with federal regulation of auto safety, foretold with a period of professional interest beginning in the 1940s when traffic safety expertise began to focus on reducing the severity of injuries resulting from crashes. (Albert, 1997: 17; Irwin, 1985: 48)

In the US as well as in Sweden, the role of the vehicle emerged as an opportunity for experts with backgrounds in mechanical and biomechanical engineering to design cars to protect their occupants. (Irwin, 1985: 47) In the US in particular, this was also a time where road safety was framed as an issue of consumer protection under the law. This framing of the issue of road safety was the basis for Ralph Nader's book, *Unsafe at Any Speed*, and subsequent federal regulation of vehicle safety standards authorized by the National Traffic and Motor Vehicle Safety Act in 1966. William Haddon, a physician with an interest in public health and injury control, was the first director of the National Highway Safety Bureau (now the National Highway and Transportation Safety Administration (NHTSA)), created by the Safety Act, and was an important figure in this era of road safety, and a major influence on road safety professionals. The key to understanding this way of framing traffic safety is "energy management", or a "dose-response" approach. (Irwin, 1985: 49) Both ideas reflect the contributions of health professionals to improving road safety outcomes. Energy management refers to the hazardous kinetic energy that victims experience in a crash, and the dose-response approach says that vehicles (and by extension, crashes) should be designed such that victims do not incur more hazardous kinetic energy than their bodies can tolerate. Thus, while crashes should be prevented, they cannot be avoided, and safety experts can help determine the outcome of the crash through design.

This regulatory approach focusing on vehicles created a focus on occupant restraint and protracted debates about requiring seatbelts or air bags in cars. This debate around passive safety versus active safety was one of the most prominent issues in the field of traffic safety for nearly thirty years, arguably thirty lost years.

## **4. Discussion and Conclusions**

This study sought to understand road safety thinking at the metropolitan level, and this overview of the development of the organizational field shows that national and state governments have also been key participants. Thus, road safety in Stockholm Region and the San Francisco Bay Area is actually an intergovernmental program based on a combination of expertise and the authority to implement programs and regulate populations. This is true for both Sweden and California. In each case, national and state level public and private organizations supported the development of professional capacity related to building a motorized society. Most of the intellectual capacity in road safety centered on driver behavior (both training and police enforcement), the design of the built environment and the control of traffic, and the development of vehicle technologies for occupant protection. In both cases, traffic safety is an

expert, engineering driven field. Professionals collaborate, but their fields compete for turf and use safety as a means to do this.

The main ideas defining traffic safety had been established by 1970, and the vehicle-road-driver triad is a stable construct. The innovations that have happened since then have been neo-traditional urban design ideas and the Zero Vision policy. These innovations cross national borders, and the flows of information and relationships are international and they go in both directions.

Professional groups that have not had a significant influence on traffic safety include the public transit experts and the economists, which may be because few public transit passengers are killed, and when a transit vehicle injures or kills a pedestrian, the pedestrian is often deemed to be at fault. The non-motorized transportation groups have been increasingly significant in road safety advocacy, as well as innovations in the design of interventions, which, at least in California. Leads to competition between the traditional engineering approaches to road safety and newer approaches based on a more integrated understanding of city streets and travel.

Finally, one of the key similarities between the Sweden and California cases is that legitimate, mainstream road safety knowledge and interventions do not challenge the established auto-centric transportation and land use system. When ideas and interventions do challenge these norms, the path to implementation is difficult. This finding is consistent with prior work on road safety, and what has been called a road safety “orthodoxy”. (Freund and Martin, 1997) Acceptable interventions include treatments affecting individuals, vehicles, and infrastructure. In general, safety interventions in the US have not sought to reduce the use of automobiles. In Sweden, however, there is evidence that legitimate interventions there sought to reduce the use of automobiles in certain places within cities. This is one of the main differences between the cases. Instead of creating a police-based enforcement system, Swedish transportation planners have more often used street design and land use planning to restrict car traffic such that it would be slower and safer. This approach was consistent with a Swedish orthodoxy: architecture and urban planning. These design interventions are the subject of the next chapter.

## Chapter Four—Safety Ideas in Land Use Planning and Street Design

### 1. Introduction

The Swedish government published its first road safety design guidelines in 1968, and revised them over time, publishing new versions every decade or so. In 1967 in the US, the Institute of Transportation Engineers, one of the primary associations of transportation professionals, published its official street design guidelines for subdivision streets, also updating it periodically over time.

In this chapter I explore how the authors of these texts have framed the issue of safety over time, what specific approaches they have recommended to improve safety, and what models of accident causation they have used, implicitly or explicitly, to justify their approaches. Have Swedish and American designers, planners, and engineers innovated with respect to their safety logic and how they understand the relationship between the built environment and accident causation? Has the style or focus of safety interventions in the built environment changed, and if so, have these changes been meaningful? What other issues, in addition to a strict crash and injury conceptualization of safety, do the texts reference in their expression of a safe transportation environment? The answers to these questions may offer a window into the practical art of transportation planning that has influenced the form of the built environment and the safety of the transportation system in Sweden and California.

The research in this chapter uses both primary source materials such as Swedish and American design documents and transportation policies, as well as secondary sources. I translated texts in Swedish with the aid of electronic translation applications. The main sources of information for the analysis of specific design interventions in Sweden were four official transportation planning and urban design guides published in Sweden between 1968 and 2007: *SCAFT* (1968), *TRÅD* (1982), *Calm Street!* (1998), and *Traffic for an Attractive City* (2007). I selected these guides because they were widely used, and they represent official road safety planning approaches from different periods of urban development and planning. For similar reasons, the main sources of information for California include major national design guidelines by groups such as the Institute for Transportation Engineers and the Urban Land Institute, as well as subdivision ordinances and other guidelines from counties and cities in the San Francisco Bay Area. These include *Recommended Practices for Subdivision Streets* (1967, 1984, 2003) and *Residential Streets* (1974, 1990, 2001). Though these are not official documents (in the sense that the *Manual on Uniform Traffic Control Devices*), they are the most comparable to the Swedish documents because they aimed to address road safety through a variety of means, not only through signage or lane striping.

Official Swedish design guidelines for road safety first appeared in the late 1960s, during the peak of urban infrastructure building in Sweden (e.g., suburban housing, public transit, roads). At this time, experts in the fields of planning, architecture, and engineering asserted that the built environment and the surrounding land uses played a part in creating road safety hazards, and that their design should have a role in preventing accidents. The participation of these experts introduced the city, urban planning, and urban policy into the mix of factors associated with road safety. The situation was similar in the US. Guidelines about creating safe neighborhoods began to appear in the middle 1950s during a period of rapid growth in the production of suburban residential housing. In the US as in Sweden, the contribution of these

engineers and planners also highlighted the role of the built environment—not just traffic and road users—in creating a safe transportation.

In Sweden, the creation and use of official guidelines to help design safe streets reflects an evolution in road safety thinking because, before the 1960s, both popular and expert opinion held that poor driving behavior was the main cause of road accidents. Following a driver-centered expression of road safety, the best way to prevent accidents was to train and test drivers to weed out the bad ones. Swedish national and local governments had made road improvements such as straightening, widening, and paving roads prior to the 1960s, but these were mainly improvements for car mobility, and were less motivated by concerns about safety. Again, the story is similar in the US where behavioral models of accident causation were dominant, and where prior safety improvements based on traffic and infrastructure engineering were designed to increase capacity for automobile traffic.

Although there are many similarities between the development of safety thinking in California and Sweden, which were discussed in a prior chapter, there were also significant differences in this thinking in the context of the design of the built environment and in the relationship between traffic and land use planning.

## **2. Swedish Guidelines for Designing Safe Roads**

In Sweden, official guidelines to aid the design of safe road environments emerged from a period in the 1950s and 1960s when Swedish planners, architects, and engineers were working to modernize cities and increase motorization. Between the 1920s and the 1970s, a variety of social and economic policies, including road safety, became integrated with the dominant political agenda of regularizing (and preventing) informal settlements and creating decent middle class housing. This agenda is key to understanding how standards for road safety, and, more generally, how planning as the primary mode for implementing road safety interventions came to be so widely accepted. While housing was at the center of the agenda, transportation was important too. Massive infrastructure projects, including building transit-oriented “new towns” and creating roads and parking for private automobiles were part of the larger project of modernizing Sweden. The transportation and land development nexus provided the foundation for a new urbanized middle class.

### ***The Context of Urban Planning and Design***

Landed elites governed Sweden until 1909; only male landowners, roughly 20 percent of the Swedish population, could vote. Then, in 1909 and 1921, respectively, all men and women received the right to vote. (Sveriges Riksdag, 2009) It was around this time that liberal parties such as the Social Democrats (associated with peasants and workers) gained seats in, and eventually control of Parliament.

During this period of political change in the 1920s and 1930s, Sweden’s economy grew, particularly because of exports of its natural resources, and manufactured and engineered goods. People living on farms in the countryside began to move to towns and cities, wages increased, and there were more jobs in industry. With rising incomes came increasing motorization, and cars began to change the urban landscape.

In 1931, *avant-garde* Swedish architects and urbanists—part of a movement called functionalism—described how Swedish cities were changing because of industrialization,

motorization, and population growth. Uno Åhren, Gunnar Asplund, Wolter Gahn, Sven Markelius, Gregor Paulsson, and Eskil Sundhal, the authors of *Acceptera*, the 1931 Swedish functionalist manifesto, described how “the living milieu [had] completely changed.” They cited urban growth as the cause of this, and described how the old urban centers were different: “Streets need widening and new roads must be constructed as traffic increases; buildings also become higher. ....The street is dominated by the hustle and bustle that always accompanies commerce.” (Åhren, et al., 1931 [2008]: 327-328) The “old fashioned” city had main streets where children played and people shopped, these places were “small scale”, based on a “small-town idyll”, and they were changing. (Åhren, et al., 1931 [2008]: 327-328) From the perspective of an architect, this meant that “...[one could] no longer stand in the middle of traffic to gaze at details of the facades...the living milieu in our modern streets has changed completely...the modern clothes people wear, the smooth shiny surfaces of automobiles, buses, and streetcars, asphalt, large displays of window glass, shimmering neon lights...the features of the new environment.” (Åhren, et al., 1931 [2008]: 328)

A functionalist approach to design coalesced in the early 1930s around the idea that architects, artists, and designers should recognize the new realities of the modern, industrial era in their work. In 1931, the Swedish functionalists characterized the new era with the phrases, “A-Europe” and “B-Europe”, where “A-Europe is industrialized, even down to its agriculture....B-Europe is what A-Europe was a hundred and fifty years ago.” (Åhrén, et al., 1931 [2008]: 157) A-Europe was further defined by its resources (coal), its “specialized, centralized, and...uniform functions”, and its organization around “major veins”: railroads and highways. (Åhrén, et al., 1931 [2008]: 155-156, 157) The new era centered on networked urban centers, communication systems, and integrated global economics.

In this new era, design did not need to maintain its traditional relationships and forms. Designers no longer needed to serve singular, wealthy patrons, for example, and instead could pay attention to the physical and spatial demands of growing popular consumption. Designers would be released from traditional aesthetic and relational constraints, and once released they could use a new rationale to create forms based the needs of the “new” society and its routines of daily life. This conceptualization of the role of design arose in the 1930s contemporaneous with the social and economic policies of the Social Democrats. Social values joined with a rationalist approach to design were core concepts deployed in the emerging Swedish “social welfare” state. (Agren, 1975: 128)

But Sweden was not yet the “A-Europe.” Many of the rural migrants lived in informal settlements at the edges of cities, and there were severe shortages of decent housing for the growing middle class. (Hall, 1991: 178, 183, 193) The Social Democratic government included housing at the center of its agenda in the 1930s, and housing would remain a central political issue through the 1970s, but progress on the agenda was interrupted by World War II. (Andersson, 1998: 123)

Sweden did not fight in World War II, and it did not experience the physical destruction of the war they way other European countries had, but it did share the post-war economic, demographic, and social shifts that had spatial implications: a baby boom, more urbanization, and rising incomes. (Judt, 2005: 327)

The Swedish Social Democratic party, powerful in Sweden even before the War, had broad support for its social agenda, which centered on urbanization and the production of housing. This is not surprising, considering that more than a decade after the end of the War, in 1960, 34 percent of Swedish households still lived “very densely” and 45 percent lived in



dwellings without bathrooms (Hall and Vidén, 306) These circumstances helped create a powerful role for architects and city planners in the middle of the century, and the Swedish housing, building, and planning bureaucracy was strong. (Hall, 1991: 203)

This planning context—the Social Democrat’s social and housing agendas, and economic and industrial development centered on urban labor markets—framed motorization. Elected officials, planners, engineers, designers, and architects created spaces for people and cars through several strategies. They developed new laws to broaden the powers and comprehensiveness of city planning (the Building Act of 1947), created urban renewal programs for the older central business districts, and planned new satellite developments served by public transport and designed with standards and guidelines for streets and parking. (Lundin, 2008) Planners based the standards for these new developments on optimistic forecasts of high levels of car ownership in Sweden, as well as the experiences in the other European countries and the US.

In general, Swedes had a positive attitude toward the car, associating it with modernity, peace, and freedom, despite the fact that the car required so much space and adjustment in the urban environment. (Blomkvist, 2004: 282) In the early 1950s, Sweden was becoming the most motorized country in Europe.

Swedish designers responded to the mass motorization of the country after World War II by creating separate realms for travel and social activities, simplifying the road environment, making it more legible for drivers, and separating cars from other travel modes and activities as much as possible. They accomplished this by integrating transportation and land use in master planning, and by fostering this common approach among designers with tools such as design guidelines. This approach created a multi-modal transportation system by supporting non-motorized travel modes, public transit, and cars with design and land use planning.

In a decision that linked suburban land development and transportation, in 1941, Stockholm’s city council approved the new subway system, which was planned to support “islands” of housing, commercial centers, and workplaces. (Lundin, 2008) Yngve Larsson, who was in charge of city planning in Stockholm at the time said that, “The possibility of being able to transport sufficiently many Stockholmers between their homes and their places of work is in fact...the basic precondition for the solution of the housing question.” (Andersson, 1998: 153)

Swedish transportation planners’ main strategy was to separate facilities intended strictly for movement (i.e., utilitarian travel) from multiuse streets and paths allowing access to social activities and services such as parks and open spaces, shopping, health care, sports and recreational facilities, libraries, churches, schools, and child care. It was key in the design of neighborhoods to locate these services and activities close to residences so that they would be accessible. (Agren, 1975) Architects and planners designed complete neighborhood units around the idea of accessibility, such that the entrance to the subway was located in the center of a neighborhood and was surrounded by dense housing, commercial activities, and services within walking distance of housing. These spaces comprised areas for “society.” The subdivisions also provided space for cars, and the designers used forecasts of future automobile ownership to allocate road space for them and plan parking. (Lundin, 2008) According to the design principles of the time, neighborhoods needed a hierarchical street network with different roads for through traffic, local traffic, building access, pedestrians, and bicycles. Plans such as these were not unique to the Swedish functionalists. They were part of a larger “garden city” movement that built on late-nineteenth century plans to decentralize cities, cluster activities in space, and link the new developments to other urban centers with railways. (See for example

Garden City movement: Hall, 2002: 87-141; Neighborhood unit: Perry, 1929; Radburn: Birch, 1980)

As motorization changed urban environments, creating traffic in urban areas, crowding streets and even sidewalks with cars, residents of Stockholm experienced the consequences of motorization, including traffic accidents, which had become a public issue. (Lundin, 2008) Swedish media began covering traffic safety, calling it “the new plague.”

For reasons other than safety, Sweden shifted from driving on the left to the right side of the road in 1967, but this change provides important context to the development of design guidelines for safety because the switch strengthened public interest—and professional capacity—in road safety. (Lundin, 2008) Several of the road safety professionals whom I interviewed told this story of switching to right-hand driving, describing it as if Sweden had been “preparing for war.” This major change in operations and consciousness, combined with attention to safety, certainly contributed to the salience of design approaches to road safety in the 1960s.

### *Development of Guidelines for Safe Streets and Neighborhoods*

This combined interest in road safety and urban planning resulted in a new set of transportation planning guidelines focusing on road safety. *SCAFT: Principles for Urban Planning With Respect to Road Safety*, a slim and influential transportation planning handbook published in 1968. It represented the road safety thinking among design and infrastructure professionals in Sweden and was written by a group that included prominent city planners, architects, and civil engineers. In fact, in contemporary Swedish planning literature, *SCAFT* is known primarily as a transportation planning guide, not only as a safety guide. (Hall and Vidén, 2004: 305, 327) Its influences included Swedish functionalism, American highway engineering, and British transportation planning.

The guide was the work product of the group after which the document was named: *Stadsbyggnad, Chalmers, Arbetsgruppenen för Forskning om Trafiksäkerhet* (SCAFT), or Institute for Urban Planning, Chalmers University Workgroup for Traffic Safety Research. In the spirit of this collaborative group, the National Board of Urban Planning and the National Road Administration published *SCAFT* jointly as an official national statement on road safety and urban development. These agencies sent *SCAFT* to members of the civil service, architecture firms, and consultants throughout Sweden. Its authors toured Sweden to promote it, giving talks and meeting with others in the design and transportation planning profession. (Lundin, 2008)

Designers implemented the *SCAFT* guidelines in developments built during the 1960s and 1970s, in part because of this wide distribution and promotion, but perhaps more importantly because of the dramatic urban development happening at that time. *SCAFT* was published during a massive effort to increase the supply of housing—the Million Program. It is very important to note that the national government did not have any authority over municipal streets or housing developments; local governments in Sweden have a long history of complete authority over local land use decisions. Yet, the city planners and architects working on municipal projects viewed *SCAFT* as a set of standards that needed to be implemented, and perhaps as a helpful reference during the period of booming development, even though the guidelines were not standards, but only guidance. Thus, *SCAFT* continues to influence road

safety in Sweden intellectually, and through its ongoing physical manifestation in the built environment. (Lundin, 2008; Hagson, 2004)

### ***Safety Principles in Design Guidelines***

In 1961, the SCAFT workgroup started a research program to investigate the link between road users and the road environment, focusing on the psychology of the driving task. One of its research methods was to recode the existing police records of traffic accidents to analyze the role of the built environment. Its primary finding was that improvements in road safety depended on diminishing the need for excessive concentration; the way to do this was to make roadways more legible for drivers and reduce the opportunity for conflicts, particularly in urban settings. (SCAFT Group, 1968: 22) The “general”, if banal, principle in *SCAFT* is that “Road safety is promoted by reducing the possibilities of conflict and confusion in the interaction between road user, vehicle, and road.” (SCAFT Group, 1968: 9) The key point is that, for the first time in Sweden, an officially recognized body theorized that the interactions between the vehicle, driver, and road environment were what determined the safety of the road environment, not solely bad behavior.

The advice in *SCAFT* centered on the contemporary problem of designing new transit-oriented subdivisions, where architects and urban planners needed to plan road networks, grade-separated intersections for different classes of traffic, parking, and the origins and destinations of different activities to minimize conflicts. Within this context, *SCAFT* made four propositions about safety and transportation planning. The first proposition was that activities and land uses should be located to minimize conflicts among cars and other modes of travel, and to minimize the number of trips made by car. An example of this is to site nurseries, playgrounds, and schools away from driveways, parking lots, and roads that carry motorized traffic. Second, road space should be organized into a hierarchical network, where the main network provides mobility for cars, and the local network gives access to access to activities, with priority on the local network given to pedestrians and bicycles. (*SCAFT* also discussed mopeds, but this mode had a vulnerable position between cars and non-motorized modes of access, and did not really fit with either one.) Third, roads and their surrounding environment should be clear and legible for drivers to prevent confusion and distraction. Finally, safety should be a factor in the design of a development early in the planning process, and pedestrian infrastructure—the network that provides access to activities—should be planned before roads for cars. (SCAFT Group, 1968: 9, 22-23) Thus, pedestrian mobility, access, and safety played a leading role in *SCAFT*’s strategy for improving road safety through urban design.

The separation of modes through separate networks and the allocation of road space—ideally using grade separation—was also a prominent idea in the document. Figure 4.1 presents a line drawing from *SCAFT* that illustrates its vision of a safe urban environment. A housing development has two grade separated networks: the pedestrian network connects housing and commercial activities, and the service road network for cars and parking lies below. (SCAFT Group, 1968: 8) Figure 4.2 presents plans from *SCAFT* representing the road pattern for approach roads to blocks of flats. The approach roads link directly to parking lots, which are separate from the housing areas. Developments with single-family homes also used this same strategy of locating shared parking and storage areas away from the housing. While it may be convenient to drive one’s groceries right up to the house, according to the road safety guidelines, it is safer to create completely separate realms for cars and households.

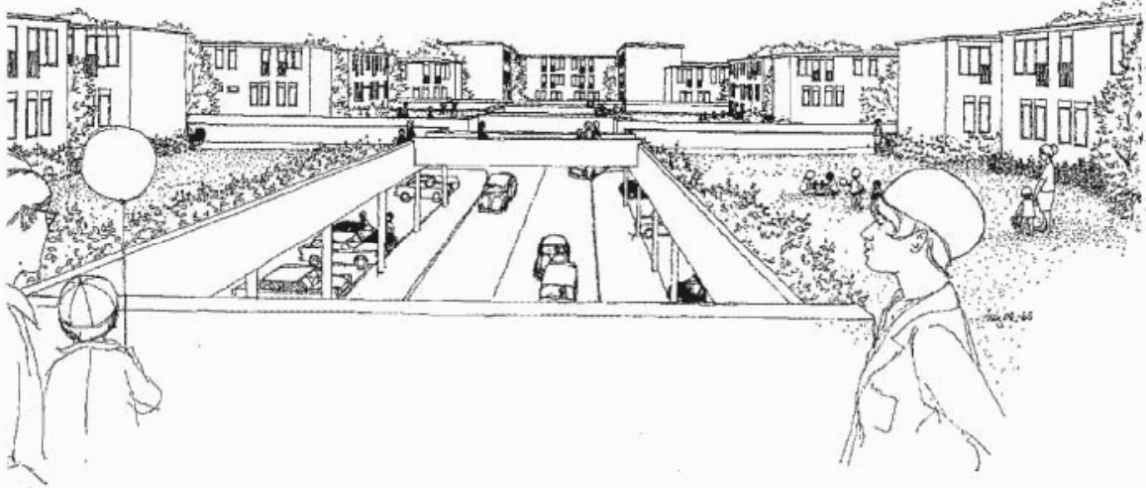


Figure 4.1 Line Drawing of a Safe Road Environment for a Residential Development, 1968  
 Source: SCAFT Group, 1968: 8

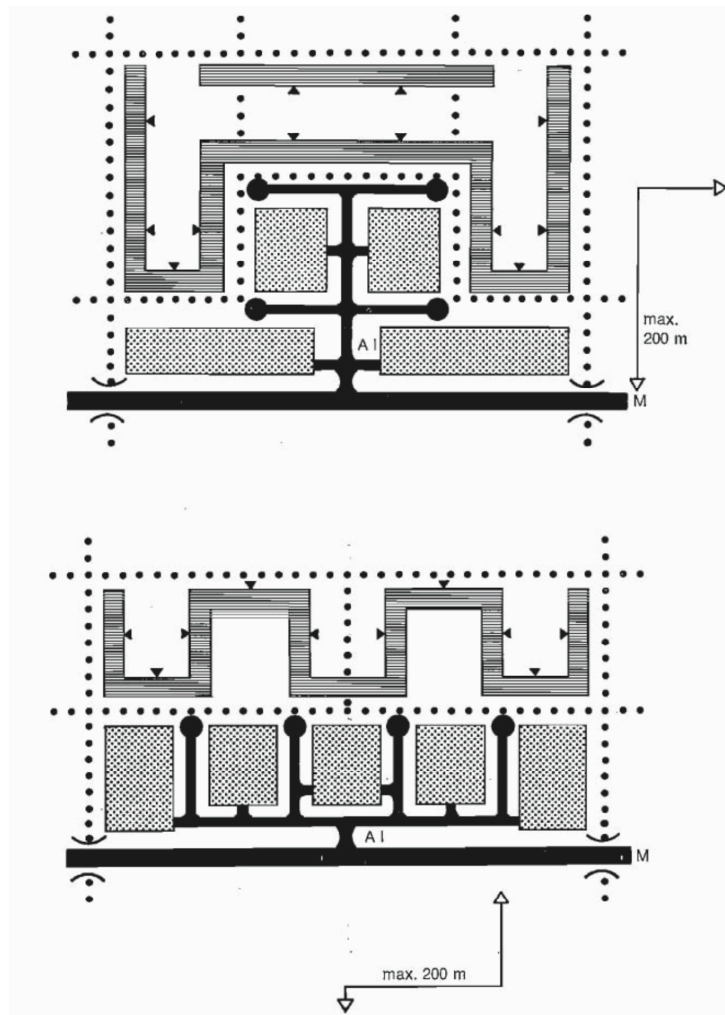


Figure 4.2 Plans for a Safe Road Environment in a Residential Development, 1968  
 Source: SCAFT Group, 1968: 16

In a fold-out page at the end of the book, *SCAFT* set forth its guidelines in a matrix based on a hierarchy of road types ranging from national distributors to access ways. The columns in the matrix specified the appropriate values for safe speed limits, minimum distances between intersections, the maximum number of junctions for roadways, and the number of lanes. It also provided guidance on parking availability, access to property, transportation modes allowed, and preferred types of intersections. For example, an approach road to blocks of flats should have a 30 km/hr speed limit, junctions should be at grade level, no parking should be allowed, the road should give access to property and parking, and it may allow moped traffic but not bicycles or pedestrians, which are allowed only on access ways.

### ***Mid-Century Safety Planning: Precedents and Influences***

Several of the main components of *SCAFT*'s design strategy—the hierarchical street networks, planning at the neighborhood scale, and the attention to the kinds of streets that cars needed—were not original to *SCAFT*, but were topics already in the broader conversation about cities and planning in Europe, and in the US, both before and after World War II.

Comprehensive planning for entire neighborhoods and street networks emerged in the 1940s in Sweden, and the techniques were inspired by the physical planning aspects of Ebenezer Howard's Garden City, the American and British garden suburbs, such as Radburn, and Clarence Perry's concept of the neighborhood unit. (Hall, 2009: 93-98; Cervero, 1995: 41, 43; Andersson, 1998: 153; Hagson, 2004) The new developments of the 1940s included modest-scale central plazas surrounded by stores and multi-family housing of a similar scale. Greenbelts and parks, main streets, and pedestrian paths linked all of these spaces, and cars used streets built to a higher standard and special areas for parking.

Then, there was a new wave of neighborhood planning for the subway system, which increased this focus on planning for “new towns”. Swedish planners continued to study examples in British planning in preparation for the new developments. The Swedish planning scholar, Thomas Hall explained this relationship, writing that after the War, Swedish planners thought “England...stood for modernity, democracy, and optimism about the future.” (Hall, 2009: 100-101) These preparations supported the 1952 General Plan for Stockholm, and subsequent planning ideas from England, notably *Traffic in Towns*, the report from 1963 in which Colin Buchanan presented British ideas about cars and their consequences in cities, were probably also among the influences on *SCAFT*. For example, the English translation of *SCAFT* uses the phrase “environmental area”—the term describing the car-free areas around housing and shopping areas—in the same way it is used in *Traffic in Towns*. (Great Britain Ministry of Transport, 1963) *SCAFT*'s breakthrough was expressing how these designs and plans for urban development contributed, or could better contribute, to creating safer road environments. *SCAFT* also offered a critique of housing developments constructed in the 1950s: they only partially separated traffic, had too many four-way intersections, allowed through traffic on residential roads, and lacked sufficient parking, and its recommendations sought to prevent the propagation of such designs. (*SCAFT* Group, 1968: 22) Though *SCAFT* offered a critique of these neighborhoods, the *SCAFT* guidelines were for new town development, not retrofit or redevelopment projects. The issues of retrofit would become part of road safety design guidelines later in the 1970s and 1980s.

*SCAFT* has a dual significance for road safety in Sweden. The guidelines were implemented in new developments from the 1960s and 1970s, which is significant because “A

large proportion of the Swedish population lives, works, or is being cared for in buildings dating from the 1960s and 1970s.” (Hall, 1991: 194) Second, the safety guidelines were the official national statement on road safety, supported by both the housing and planning agency as well as the highway agency. Subsequent official safety guidelines cited them not just as an official reference on road safety, but also as a reference for transportation planning. *SCAFT* was not a source of standards *per se*, but the guidance was implemented as if they were.

### **3. Swedish Road Safety Thought and Urban Design after SCAFT**

Just as the economic, political, planning, and social contexts of the 1960s—the peak of planning optimism in Sweden—were important for understanding the safety recommendations in *SCAFT*, the changes that occurred in late 1970s and 1980s are important too. First, *SCAFT* was revised in the early 1970s (soon after its first publication in 1968) to include more information for urban renewal conditions where planners could not design an entirely new town and road network. Then, new guidelines replaced old ones every five to 10 years, often in response to some change in the institutional landscape. The advice about privileging pedestrian and bicycle access, and ensuring that traffic is appropriate for the surrounding activities—the core of the safety recommendations—did not change, but other substantive advice did change over time.

#### ***Changing Infrastructure and Urban Policy Contexts***

In the 1970s and 1980s, Swedish urban policy was shifting “...as the long-held Social Democratic consensus unraveled.” (Hall, 1999: 878) The rapid growth and demand for housing of the 1960s crashed in the 1970s, contemporaneous with the energy crisis and environmental movement. The economic boom was slowing, the cost of energy and labor was high, the national debt was high, and Sweden faced strong competition in global markets. These changes resulted in revised assessments of modernism, growth, and social policy, and a “break” with the trends of the 1950s and 1960s. (Hall, 1991: 194-195) In 1976, the Social Democrats lost their majority in Parliament after more than 40 years of leading the country. (Hall, 1991: 195) In the late 1970s, “...there was widespread belief that the age of the [modernist] planner and developer was over...” (Hall, 1991: 238)

Three consequences of these changes are important for understanding the development of road safety planning in the last decades of the 20th century. First, the focus changed from master planning new suburban developments to rehabilitating existing developments and seeking out locations for infill. (Andersson, 1998: 205-206, 217) This meant that *SCAFT*'s specific advice for master planning was less relevant to the urban situations that planners faced. Second, the energy crisis and environmental movements in the 1970s repositioned the car as a source of environmental degradation. Transportation planners in the 1970s and 1980s began to focus on the consequences of automobility rather than its promotion, and investment in large-scale transport infrastructure declined. (Ingo, 1991: 166) Third, people criticized modern, comprehensive city planning as well as the sustainability of the “social welfare” state, which led to a greater interest in and reliance on the private sector in the provision and management of municipal infrastructure and services. (Nyström, 1996: 55; Andersson, 1998: 208; Hall, 1991: 240-241) The result was an even greater decentralization of responsibility to municipalities, which maintained the salience of urban policy. (Pettersson, 1991: 13)

In the 1990s, words such as “tradition” and “livability” began to describe the vision of urban life. (Nyström, 1996: 92; Andersson, 1998: 238) The spatial demands of a fully, functionally separated transportation system no longer appeared sustainable to policy makers, planners, and critics of the mid-century style of development. (Nyström, 1996: 56-58) Furthermore, residents wanted to have more livable, traditional streets that contributed to the urban character. The safety design guidelines reflect these discourses, indicating that the idea of safety in these texts is not just a function of accidents or accident prevention, but of a larger situation.

### ***Urban Infill, Interventions, and Balancing Safety with Other Goals***

National agencies replaced *SCAFT* in 1982 with a new urban design and transportation planning guide, *General Guidelines for Planning Urban Traffic Networks (TRÅD)*, (*TRÅD 1982 – Allmänna Råd för Planering av Stadens Trafiknät*). The Swedish Road Administration, the National Board of Physical Planning and Building, the National Road Safety Office, as well as the National Environmental Protection Board coauthored *TRÅD*. (National Board of Physical Planning and Building, 1982) As with *SCAFT*, *TRÅD* was also published in English. (The acronym, *TRÅD*, rhymes with “road”; tråd is also a noun that means “thread” or “wire”, and it can be used metaphorically to mean the theme, or line of thought.)

The preface to *TRÅD* explained that the text presented a “refinement of the principles contained in *SCAFT*...” based on increased knowledge of road safety. According to the preface, *TRÅD* relaxed some of the “demands” for the separation and differentiation of traffic, gave more attention to the needs of public transport, local, and the disabled, further developed ideas about the integration of roads with the surrounding land uses, and refined ideas for road safety planning in built-up areas. (National Board of Physical Planning and Building, 1982: 4) Thus, *TRÅD* elaborated on ideas in *SCAFT*, shifted emphasis in some areas, and introduced some new ideas.

On the issue of separation, both *SCAFT* and *TRÅD* stated that the road network should be organized into two separate networks (one for cars and another for pedestrians and bicycles), and that access to activities should be organized around pedestrian and bicycle travel. But *TRÅD* elaborates on *SCAFT*'s ideas, too, stating that the main road network should be designed such that a 10-year old could travel alone (presumably not as a driver!), and the bicycle and pedestrian networks should be safe for the youngest school children. On the local network, the main concern is not the accident, per se, but “safety and security.” According to *TRÅD*, security depends on the incidence of conflicts, their seriousness, and their affect on how people perceive places. These representations of safety in *TRÅD* (*Could a child travel here? Do I feel secure here?*) augment the accident-analysis approach to evaluating safety and hazards that was used in both *SCAFT* and *TRÅD*.

According to *TRÅD*, safety on the local network should focus on “unprotected users,” and it depends on traffic flow, the type and density of the surrounding development, and the “character and sensitivity” of traffic. (National Board of Physical Planning and Building, 1982: 18) These are all ways in which *TRÅD* restated the main idea in *SCAFT*, that traffic should be appropriate for the surrounding land uses and activities. This proposition is at the core of the advice in both documents.

*TRÅD* presented a typology of neighborhoods based on their traffic, street design, land use, and building setbacks to illustrate what types of traffic, street designs, and safety interventions would be appropriate given the surrounding environment. (See Figure 4.3) The

street-built environment typology in *TRÅD* was intended to support development in built-up areas by assisting planners and designers determine a safe mix of auto traffic, other road users, and activities.

When *TRÅD* was published, the era of large-scale developments was over, urban growth was happening in the city centers and infill areas, and planners turned to retrofitting built-up areas. This is one reason why *TRÅD* did not offer advice on master planning for new subdivisions, as *SCAFT* did. Instead, it recommended using *interventions*, such as central refuges for pedestrians at intersections, on the main, car-oriented network. The use of interventions instead of large-scale infrastructure improvements also coincided with decreased public expenditure on large public works projects. *TRÅD* offered guidance on selecting sites for intervention: one should analyze the five-year crash history for intersections and take into account traffic volumes and the severity of accidents to determine whether to consider or require treatments. (National Board of Physical Planning and Building, 1982: 16)

*TRÅD* also expanded on *SCAFT* with a new, color-coded system of standards indicating whether different situations have a green standard (good, achievable in new development), yellow standard (“for difficult planning conditions”: redevelopment of existing areas), or a red standard (to be avoided). (National Board of Physical Planning and Building, 1982: 5) These color-coded standards targeted situations where planners found themselves making tradeoffs among different goals—safety, environment, mobility for cars, mobility for transit, and access for pedestrians. For example, locating a pedestrian route inside a group of residential buildings is recommended, but only at very low volumes of motorized traffic (under about 100 vehicles per hour) with a speed of 30 km/hr or less. The standards represented both political and technical aspects of transportation, reflecting actual practice and the contemporary interest in balancing the consequences of motorization with mobility. *SCAFT* paid attention to the practical use of the guide, too, but its advice was to include safety early in the master planning process. Both guides were written to be used, and the differences in their advice for practice indicates that the authors responded to their audience’s circumstances.

This example from later in the decade describes the planning context to which transportation safety was adapting. In 1988, a representative of the National Road Administration delivered opening remarks at an international safety conference about analytical techniques for conducting conflict analyses—an alternative to using crash analyses. He explained the National Road Administration’s interest in sponsoring it, stating that they “...must also...pay more attention to the needs and demands of the road users...put more environmental aspects [in their] work...not only in terms of noise and pollution, but also in terms of esthetics, feelings of safety, social relations, attitude and behavior...” (Tykesson, 1988: 2) He also explained, “The lack of money prevents us from building by-passes around towns with heavy [through-traffic] and safety problems.” Rather than build a bypass, the Road Administration created interventions with attention to “safety and environment” that reduced speed through “experimental” measures such as chicanes and narrow sections. (Tykesson, 1988: 2) The National Road Administration evaluated the measured in terms of a reduction in the number of accidents, but also with behavior and attitude studies, surveying road users and the surrounding residents. (Tykesson, 1988: 2) He said, “We realized that it is not enough to be good engineers doing perfect technical solutions, we must also evaluate how people react and behave in regard to the measures...for us this is a rather new way of working. We don’t have much knowledge of this and we need a lot of help from researchers.” These remarks illustrate how and why transportation safety planners integrated other factors into their safety work.



2. Streets in areas with dense development not separated from the street. This group includes:

a. business streets with entrances directly from the street, and with loading, unloading and waiting on the street.



b. residential streets with blocks of flats, where entrances and play areas are not efficiently separated from the street.

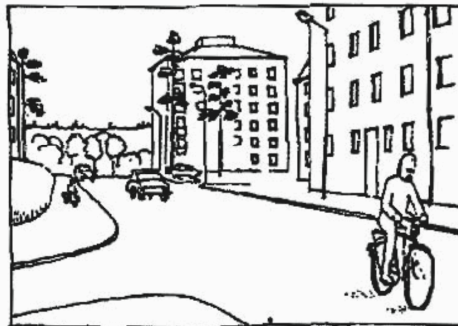


Figure 4.3 Assessing Different Land Uses and Street Environments for Appropriate Traffic, 1982  
Source: National Board of Physical Planning and Building, 1982: 19.

### *Planning and Design after the New National Safety Policy: Zero Vision*

Zero Vision is not a transportation and urban design guide, but over time it has become associated with certain interventions. The primary intervention that has resulted from Zero vision has been speed reduction and associated controls. The theory behind the intervention is that collisions and conflicts cannot be eliminated, but their severity is minimized when speeds are slower. The National Road Administration, and other agencies such as the Swedish Association of Local Authorities and Regions, promote speed reductions in most of their road safety documents. One can find similar arguments, graphics, and language throughout recent publications, including design guidelines, conference presentations, and other communications. This aspect of Zero Vision is essentially a restatement of strategies used in the past—speed control was a fundamental element in *SCAFT* and *TRÅD*.

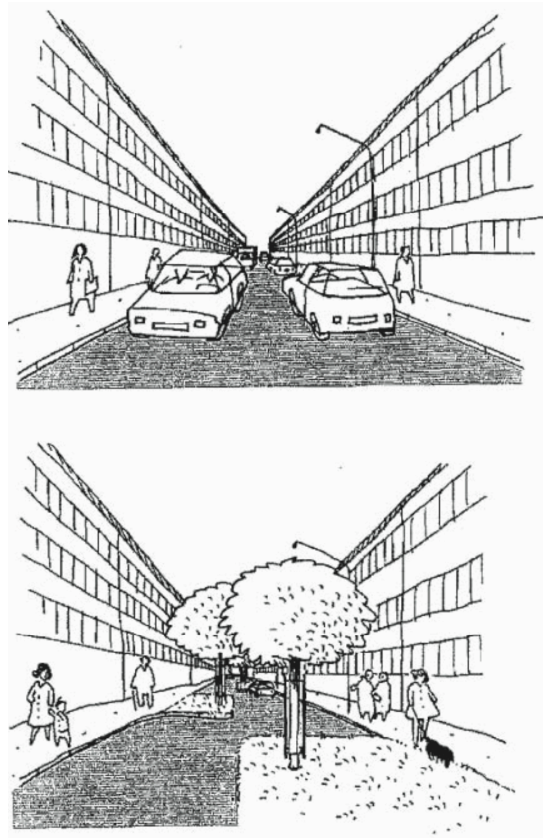
In this way, Zero Vision is consistent with prior safety design principles such as the integration of land use and transportation planning, the differentiation and separation of traffic by mode and type, designing for traffic such that it is appropriate for surrounding activities, and prioritizing pedestrian access. What is new and different about Zero Vision is that it turns a goal or a standard (zero deaths and serious injuries) into a vision, or an ideal—one that is quite difficult to refute with argument or evidence. In this way, it prevents safety from being locked in to technical discussions, and creates a new discursive space for it as a social goal rather than just an outcome of a design or process.

In 1998, *Calm Street! A Planning Process for Safer, Cleaner, More Pleasant, and More Beautiful Urban Streets* (*Lugna Gatan! En Planeringsprocess för Säkare, Miljövänligare, Trivsammare och Vackrare Tätortsgator*) replaced *TRÅD*. The introduction to *Calm Street!*

explained that *TRÅD* needed to be updated after the Swedish Parliament passed the new safety policy, Zero Vision, in 1997, and that this new road safety planning and design guide would address the new policy. (Svenska Kommunförbundet, 1998: 3) This is illustrated in new design guidelines: The road planning processes is represented by pyramid with the Zero Vision at the top of the pyramid as the highest “vision” of the process, followed by other tasks such as goal setting, network analysis and classification, design principles and design details, implementation, etc. (Svenska Kommunförbundet, 1998: 13) Meanwhile, the emphasis of design interventions continued to reflect the new urbanist approach to street design that developed in 1980s and 1990s.

### ***Traffic Calming and an Integrated City***

In several ways, *Calm Street!* repeated the logic of *SCAFT* and *TRÅD*. Building on prior safety guidelines, *Calm Street!* stated that pedestrians and bicyclists should not be disrupted by car traffic, and that access for children, the elderly, and other vulnerable users is the main priority for local networks. Moreover, its main strategy to maintain and improve safety is to prevent conflicts, and therefore personal injury, by separating vulnerable road users from cars, and systematically identifying opportunities for intervention. In a direct extension of *SCAFT* and *TRÅD*, its main conceptual tool was to classify road environments based on the traffic mix, vehicle speeds, and surrounding land uses.



**Figure 4.4 Traffic Calming Interventions, 1998**  
Source: Svenska Kommunförbundet, 1998: 97

*Calm Street!* then moved in a different direction, devoting three appendices to exploring urban design approaches for creating livable transportation environments and traffic calming for various situations. (See Figure 4.4) This renewed attention to design, illustrated with drawings and supported with advice, indicates how urban design thinking about streets changed between the 1950s and 1960s, and the 1990s. (See Figure 4.5) The guidelines discussed and gave examples of how to understand the urban environment with concepts such as strings, nodes, landmarks, edges, and open spaces—quite different from the traditional approach of classifying streets by their speeds and traffic volumes! The appendices discussed different elements of street spaces, including how planting rows of trees can create the effect of a wall, how the design details of a bus shelter, for example, contribute to the street’s character, and that liveliness, livability, street life, meeting places, and other street spaces are important factors in the transportation environment.

This change in safety thinking did not arise from a shift in the conceptualization of hazards, accidents, or risk—although it may affect each of these. Instead, it is another example of how the nexus between transportation and urbanism influenced appropriate street designs, including what design professionals recommended for safety. The wide, straight, legible streets proposed in *SCAFT* were no longer appropriate, even if they might be safe. Other designs for streets can be safe too, while returning to the traditional role as a place for communication rather than a municipal service for mobility. As the representative from Vägverket explained at the conference in 1988, the design changes are evaluated based on police-reported accidents, *and* the opinions of road users and neighbors.

*TRÅD* and *SCAFT* were examples of how changing urban development contexts affected designs for road safety, and *Calm Street!* was an example of how changing ideas and ideals of the city influenced safety thinking. Thus, urban development and livability are two of the discourses through which practitioners socially construct and represent safety. This is important to recognize because safety is often framed as a characteristic of streets, drivers, and vehicles, one that can be defined with crash and injury records. The role of these other discourses in shaping safety thinking illustrates that debates and decisions about safety can be, and in practice are, framed in different ways.

In *SCAFT* and *TRÅD*, livability was important for clusters of housing and plazas for shopping, but not for streets. *Calm Street!* is evidence of changes in how transportation planners understood the street as not just a place for movement, but a place to carry out daily life. That the approaches to safety would reflect changing thinking about urban life indicates that the authors were linking safety interventions with planning and design situations that were relevant at the time. Thus, the guide serves as a way to maintain the main safety principles, and update their delivery to match the needs of practitioners and residents.



Figure 4.5 Integrating Streets and Urban Life, 1998  
Source: Svenska Kommunförbundet, 1998: 75, 83

## *Safety Analysis and New Technology for Self-Regulation and Enforcement*

Traffic calming and livable streets remained important, and are still recommended in safety design guidelines, but the advice changed again in Sweden's most recent official transportation planning guide, *Traffic for an Attractive City (TRAST – Trafik för en Attraktiv Stad)*, published in 2007. *Traffic for an Attractive City* was produced by the National Road Administration and the Swedish Association of Local Authorities and Regions, in cooperation with the National Rail Administration and the National Board of Housing, Building, and Planning. (Sveriges Kommuner och Landsting, 2007) Unlike *SCAFT*, *TRÅD*, and *Calm Street!*, which were short, *Traffic for an Attractive City* is over 300 pages long. It is a comprehensive guide to transportation planning, addressing a range of issues ranging from pedestrian accessibility to parking, and freight traffic in cities.

The chapter about safety has a logic that is slightly different from prior design guidelines. First, it positioned road safety in the context of public health, explaining that health is an essential requisite for quality of life, and that this idea extends to the transport environment. Next, it described Sweden's Zero Vision policy, and asserted that speed is the critical element in creating a safe transport environment. After describing the relative risk for different types of road users, types of roads, and vehicles, *Traffic for an Attractive City* discussed how to use data to evaluate safety and prioritize interventions. Both *SCAFT* and *TRÅD* also discussed the collection and use of data to facilitate planning, but this new guide described the quality of the data in much more detail, and devoted several pages to discussing the interpretation of data and accident patterns, and devoted attention to vulnerable road users in particular. Similarly, *Traffic for an Attractive City* placed even more emphasis on setting goals and measuring performance, framing this technique as the appropriate planning process for road safety.

With respect to physical interventions, *Traffic for an Attractive City* maintained the core strategy presented in other documents: transportation and land use are united and that both safety and traffic emerge from activity patterns. It also maintained the idea, originally set forth in *SCAFT*, that reducing traffic in general reduces accidents. The physical interventions that the guidelines recommended are not new; they include traffic calming, roundabouts, and other interventions, but they were discussed only briefly. Instead of devoting attention to physical measures, which *Traffic for an Attractive City* stated have already been "developed and established," the guide introduces the use of electronic devices to help control speeds. Cameras are one example of such a tool already in use, and in-vehicle ITS to support drivers are another option this guide recommends. In another twist, the chapter on safety highlights the role of road user behavior, and recommends safety campaigns for such things as seat belts, bicycle helmets, drinking and driving, as well as speeding, as cost-effective ways to improve safety. Interventions targeting education and driver behavior have been the norm for road safety programs and research since the 1950s, but this was the first time they were included in a manual for transportation planning, a field that is usually associated with design and engineering rather than medicine, education, and behavioral science, the disciplines that were traditionally responsible for these approaches to road safety.

In an elaboration of both *TRÅD* and *Calm Street!*, *Traffic for an Attractive City* included both safety and security as aspects of road safety (and transport safety more generally, including the safety and security associated with riding public transit), although it presented them in separate chapters. The chapter about security detailed the relevance of road users' perceptions of crime and safety in the transportation environment, explaining that a lack of security can

constrain one's freedom of movement and become a barrier that prevents participation in city life. (Sveriges Kommuner och Landsting, 2007: 80-81) It also stated that the perception of safety and feeling of security are necessary for a safe transportation system. The manual contrasted personal feelings of fear, insecurity, and lack of power in relation to the surrounding environment with objective measures of risk, noting that the two do not necessarily coincide. Nevertheless, regardless of the objective risk, the perceived risk also influences behavior.

The recommended interventions to improve security should address the insecurity that parents feel about children's travel, the insecurity in the transport system that women are believed to experience, and the insecurity that vulnerable groups, such as immigrants, feel. According to the manual, the urban design approach should create public spaces that prevent crime by mixing land uses to avoid creating empty places where one may feel isolated. Along these lines, the manual recommends creating human-scale spaces with an overall transparency in the built environment. With respect to traffic, the main problems that create feelings of insecurity include such things as fast and heavy traffic, pedestrian signal phases that are too short, difficult street crossings, uneven pavements, fear of falling, bicycles and mopeds on the sidewalk, and inadequate snow removal. (Sveriges Kommuner och Landsting, 2007: 83)

Photographs illustrating the chapter repeatedly call attention to grade separated walkways and bicycle paths, the underpasses in particular, as places in which people feel insecure and are, therefore, unsafe. Yet, these are the same facilities that safety guidelines have recommended over the decades to protect pedestrians and bicyclists at intersections with major roadways. Separating networks for access and through traffic has several benefits, but eventually these networks intersect, and how to accommodate pedestrians and bicyclists on main thoroughfares has been a perennial problem.

Including discussions of crime, the transportation environment, the urban spaces, and safety—collectively labeled “security”—is another change in the way manuals framed road safety. Using the lens of planning and design did not change, however. Instead, the emphasis was augmented to include not only a legible environment for car drivers, but also a legible environment for pedestrians. Such legibility may include slow speeds that allow pedestrians and drivers to make eye contact, but more generally it is a quality of the urban design that facilitates wayfinding and navigation, interest and rhythm in the physical environment, and social engagement with the surroundings, through activity in the area and connection with other people. In the context of crime, the transparency of the built environment as well as the degree of social engagement are factors that contribute to the enforcement of social norms in these public spaces. (Felson, 2002)

#### **4. California Guidelines for Designing Safe Roads**

##### ***The Context of Urban Planning and Design***

Historians of motorization have argued that redefining streets as legitimate places for automobile traffic was a requisite part of creating car-oriented cities in the US. (Norton, 2008; McShane 1994) City administrations in the nineteenth century viewed wheeled travel as inappropriate for most streets, and most streets served local pedestrian and horse traffic, not through traffic. Methods for street maintenance reflected these preferences. Most cities and their residents had a system of street maintenance where abutting land owners “decided when, how, and by whom their streets should be paved.” (McShane, 1994: 63) Abutters often deferred

maintenance and did not pave the streets because they did not want to attract more traffic, which was usually dirty and polluting. In the later 19<sup>th</sup> century, the system of street maintenance changed as cities and suburbs grew and as cities took on more municipal improvements, justified by public health.

From the 1870s through 1900, the US experienced major population growth and increasing urbanization. People in cities experienced these changes in many cases as overcrowding and poor living conditions. This general pattern for cities in the US included San Francisco, which grew by 96 percent during that period. Growing demand for suburban housing arose from this situation, and resulted in pressure to decentralize housing, though many activities were still concentrated in urban centers. (McShane, 1994: 21-22) The growth of public transit systems such as streetcar lines and ferries facilitated the deconcentration of cities, and the private automobile enhanced this process. (Blanke, 2007: 17; McShane, 1994: 14-15)

As suburbanization increased and people lived further from major activity centers, people began to have different expectations of streets. Mobility became valued as the composition of street traffic became more diverse (including new forms of public transit, for example), and as traffic flows and congestion increased. (McShane, 1994: 22-23, 65) The nature of streets had already started to change before the growth in motorization, but by the 1920s, once auto manufacturers targeted urban markets for their vehicles, the nature of traffic and streets changed even more because of car traffic. Instead of being places for a variety of kinds of communication and public life, streets became places designated for travel. (Hayden, 2004: 165) The growth of cities created both the traffic and safety problems of car-oriented traffic, as well as the opportunity to reconfigure space to match these new demands for street capacity and safety. Just as the Swedish functionalist architects described the changing streets in Stockholm, the same story could be told of streets in San Francisco and other cities in the Bay Area. This new development required municipal services, including new road infrastructure.

A critical element in this story of urban growth, motorization, and road building in the US was an increasing federal role in housing markets, which cultivated both the supply and demand for suburban housing. By the 1920s, American real estate interests had become an increasingly important political lobby. By 1930, these real estate groups had convinced the federal government to take on a larger role in the development of building codes and development controls, financial markets and financial instruments for housing, as well as tax strategies such as allowing homeowners to deduct mortgage interest from their income taxes. (Hayden, 2004: 4) In 1932, the Federal Home Loan Bank Act increased the supply of credit for home loans. In 1933, the US created the Homeowners Loan Corporation for home finance, as well as “risk management” measures, such as redlining, that institutionalized racial and ethnic discrimination in the supply of housing. In 1934, the US passed the first Housing Act that created the Federal Housing Administration (FHA), in 1935 the US created the Resettlement Administration, and in 1937 a revised Housing Act strengthened the federal role in the supply of public housing by providing housing funds to local governments. Though new construction during this time did not meet demand for new housing, this marked a critical point in the development of housing in the US. These new laws supporting the development of housing favored the single family home built on greenfield suburban lands. During the 1940s, the federal government expanded its role with additional housing acts and the Veterans Administration supported loans for returning war veterans. (Hayden, 2004; Jackson, 1985)

The implications of these housing policies on transportation and transportation safety are important here just as they were in Sweden. Though increasing motorization created the acute

need to intervene in streets through design and regulation, the growth of suburban development, and the institutions that supported the development, gave experts, such as municipal engineers and traffic engineers, access to newly developed streets and the opportunity to change them. (McShane, 1994: 57) Because the street was considered a public good, it was therefore eligible to be regulated by experts in the name of the public interest to deal with problems such as congestion and safety. (Norton, 2008: 16) In fact, Norton argued that creating safer streets and traffic was central to enabling mass motorization of American society because had the safety problem not been addressed the public would not have accepted the changes. (Norton, 2008) This concept was also central in Per Lundin's analysis of motorization in Sweden. (Lundin, 2008) In both cases, the role of the street and its design, including designs to prevent accidents, were central to creating modern, car-oriented cities. (Norton, 2008: 16)

With the development of an organized real estate lobby in 1930s, there was increasing advocacy among planners and urbanists for community planning to influence the design of new housing developments. The Regional Planning Association of America, whose members included Catherine Bauer, Edith Elmer Wood, Lewis Mumford, Clarence Stein, and Henry Wright, advocated for, and designed housing subdivisions that considered access to housing and schools, jobs and transit, as well as the car. (Hayden, 2004: 125-126) The design of suburbs that these planners envisioned are expressed by Clarence Perry's concept of the "neighborhood unit" (a geographic unit with an elementary school, small stores, safe pedestrian access to public facilities, and open space), and the design of Clarence Stein and Henry Wright's housing development in Radburn, New Jersey. (Broadbent, 1990: 126-128) In the urban spaces envisioned by these designers, car traffic would be separate from places where, for example, children would go to school. There should be a separation between motorized circulation and social circulation. (Appleyard, 1981: 148-149) These were many of the same principles that influenced housing and planning in Sweden, as well as Swedish road safety thinking. One of the differences between the countries is that planners in the US faced resistance from Republicans at the time, as well as the real estate development lobby. Both of these groups rejected these planning approaches, and the Democrats that supported a community planning approach to housing development did not win the battle. (Hayden, 2004: 126) Although residential subdivisions in the suburbs designed around single family homes and automobile access represented idealized family values and a moral environment, the planners' ideal community with social centers did not materialize in American suburbs the way they did in Sweden. (Hayden, 2004: 6-7, 9; Fishman, 1987: 4)

### ***Development of Design Guidelines in California***

Despite the differences with respect to community planning, there were ways in which Swedish and American approaches to suburban development were similar. Both styles depended on large organizations and modern planning institutions to carry out the coordination and building. Before WWII, the individual owners built most housing, but by 1950, two thirds of all housing was built by large developers. Weiss (1987) explained the central issue with a quote from Clarence Stein regarding Radburn in which Stein explained that one cannot do community planning house-by-house. It is the relationship of each house to the whole community that makes the subdivision work. Second, quality housing is not economically feasible without the context of large subdivision planning because housing units need to be developed at a larger scale. (Weiss, 1987: 2-3)



To support the development of these complicated, larger developments developers and planners created new tools to support the coordination of the planning process. Subdivision developers worked with engineers, landscape architects, urban designers, banks, and other developers to subdivide the land. Subdivision regulations, development agreements, specialized area plans, and redevelopment areas are some of the mechanisms these groups have created over time to facilitate this form of development.

Subdivision regulations are one of the primary means through which safety designs and policies in both Sweden and California were implemented. California has recognized and required subdivision ordinances since 1893. Originally, subdivision regulations were used to regulate the development of property by requiring clearly indicated property boundaries to minimize disputes over land ownership. Later, subdivision requirements were used to establish minimum standards for utilities and other aspects of the functionality of the property (e.g., roads that would be alignment with past and future developments). In addition to zoning ordinances and the policies set forth in general plans, subdivision regulations have been one of the main forms of guiding the design of the built environment. (Fulton and Shigley, 2005)

Subdivision ordinances set minimum standards for streets and street environments with the goal of protecting the health, safety, and well being of the public. Despite this broadly defined objective, practically speaking, the ordinances developed out of cities concerned about embarking on large public works projects, such as paving municipal streets. The design guidelines developed to assist cities built on existing capacity in highway design, and the standards were based on highway standards. (ULI, et al., 1974: 7-8) Cities implemented these local street standards without too much adaptation to local contexts. (ULI, et al., 1974: 7)

A street standards guide published by the League of California Cities in 1966 provided advice for the design of expressways, arterial streets, industrial streets, collector streets, and minor streets. Each section gave a definition of the type of street (e.g., a collector street “serves abutting property and carries traffic to the arterials and expressways”), the permissible width of the right-of-way, the number of moving lanes for motorized traffic, and access, traffic, and planning features. (League of California Cities, 1966: 5-13) For subdivisions, the guide provided guidance on curbs and gutters, the thickness and width of sidewalks, the width of driveways, as well as sewers, water mains, fire hydrants, street lights, street name signs, street trees, utilities, and street alignment. (League of California Cities, 1966: 15) The manual expressed cities’ concern that subdivision developers provide sufficiently high quality infrastructure and services so that the city would not be left maintaining shoddy work.

The subdivision ordinances for cities and counties in the Bay Area express similar concerns, and have been similar over time. In general, they are concerned with street grading, curb radii, the installation of curbs and gutters, drainage, paving streets, paths, and alleys, and the installation of sidewalks. (Sidewalks were not always required.) The 1956 subdivision ordinance for the City of Richmond required residential subdivision to have curb radii of 20 feet. (Richmond, 1956) The ordinance sets forth standards for Class A and Class B streets, both of which allowed on-street parking. Class A streets are for areas where most of the lots were about 20,000 square feet in size, and B streets are for areas where most of the lots are larger than that. Class A streets needed sidewalks on both minor and collector roads, but Class B streets did not require this. Class A minor streets were required to have a 50-foot right of way, with a minimum pavement width of 34 feet, whereas class A collector streets needed a larger right of way, 60 feet with a pavement width of 40 feet. Class B streets could be much narrower, with the same requirements for rights of way, but with required pavements widths of only 22 and 24 feet for

minor and collector streets, respectively. (Richmond, 1956) In the Bay Area, contemporary street standards set forth in subdivision ordinances are not very different from those of Richmond of the 1950s.

As discussed in a previous chapter, a significant proportion of cities in California relied on public works departments to carry out street and traffic planning. The subdivision guidelines I reviewed for counties in cities in the Bay Area reflected the main concerns of a municipal engineer involved in maintaining utilities and services. As the traffic and highway engineers lamented in their conference proceedings, municipal engineers did not always have a traffic engineer's perspective. For this reason, the Institute of Transportation Engineers (ITE) produced recommended guidelines for designing residential and arterials streets.

In the 1940s, transportation engineers advised on lane widths, intersection design, driver comfort, safety, and efficiency of roads. In the 1950s, these guidelines addressed safety in neighborhoods by recommending a hierarchical street network to keep through traffic off of residential streets. ITE published its Recommended Practices for Subdivision Streets in 1960s, and it has been widely used by local governments ever since. (Ben Joseph, 2005: 40-43)

To the extent that traffic safety concerns specifically regarding streets and the built environment became codified in county and city ordinances, they reflected the perspective of traffic engineers and public works officials. To a large extent, these groups emphasized mobility for cars over other neighborhood goals, and "often exclude a social perspective." (Ben Joseph, 2005: 43) Moreover, according to Appleyard (1981) "the long wide collectors and arterial encourage high-speed travel, and as many as half the houses in many subdivision are to be found on these high-speed streets. Their residents are becoming as vociferous in their complaints about traffic as those in the inner city." (Appleyard, 1981: 150)

### ***Safety Principles in Street Design Guidelines in California***

As in Sweden, the main recommendation for preventing accidents in neighborhoods was to use a hierarchical street network design to keep through traffic off residential streets. (ITE, 1967: 2) The guidelines were also concerned with street cross-section design criteria. The illustration from the document that captures the key safety ideas is a cross section diagram of a street. (See Figure 4.6) The main safety message in the design criteria is consistent with the dominant approach to subdivision regulation, despite the fact that the recommendations called for a greater consideration of traffic. If the infrastructure is designed to a high standard, then streets will be safe.

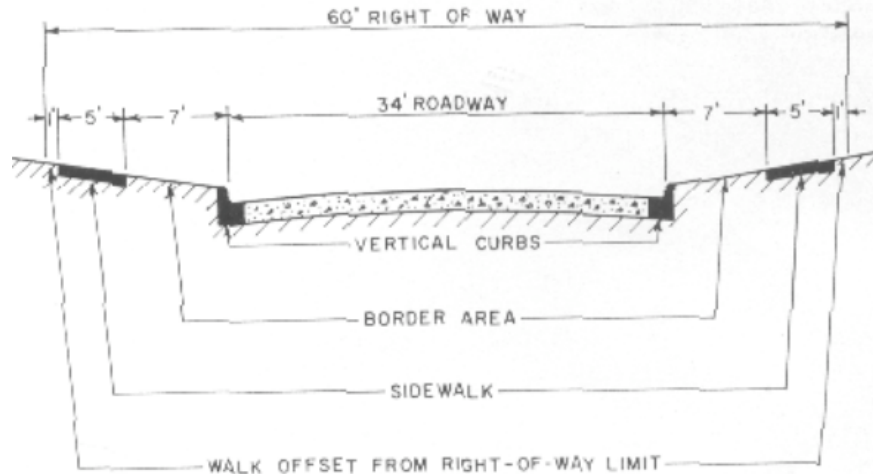


Figure 4.6 Representation of a Street Designed to Be Safe  
Source: ITE, 1967

The recommendations went beyond the infrastructure approach, and recommended considering traffic by accounting for “the actual layout of the street and pedestrian system as related to land use” as well as “the engineering standards for vehicular and pedestrian facilities.” According to ITE, these aspects of streets and neighborhoods should be integrated through design to create a “safe and efficient access and circulation system.” (ITE, 1967: 1)

The ITE recommendations include consideration of land use, but the emphasis is on traffic generation and the potential for congestion due to the location of schools, shopping centers, churches, and so forth. (ITE, 1967: 3) Nevertheless, the *Recommended Practices* maintain that local, residential streets should maintain a residential character and should have low volumes of traffic and be planned accordingly. For example, residential streets should have slow speeds, around 25-30 miles per hour. (ITE, 1967: 3) Also consistent with the Swedish recommendations, planners and engineers should consider the location of schools and pedestrian routes, and should create a network such that pedestrians can avoid major arterials as they travel. (ITE, 1967: 3)

The *Recommended Practices* warned that an analysis of the relationship between traffic and land use may be complicated by the “variety of housing types” present in a subdivision, which may create “special problems in street design”. This special problem is that the “nature of street use” is more difficult to “predict”. In these difficult cases, the design guidelines recommended designing the streets with a “high standard”, which means to design them for a maximum possible capacity. The document stated, “..all segments should be capable of meeting any of the possible [traffic] demands” (ITE, 1967: 14) Thus, the traffic engineering response to varying housing types is to design streets for maximum possible capacity, which contradicts the goals of maintaining low volumes of traffic to sure streets keep their residential character.

According to the recommendations, sidewalks should be provided for residential streets and collector streets, especially for the safety of children who may play in the street and who walk to school. Sidewalks should be installed also for the safety of adults who may walk to local shopping and transit “if any” were to exist. In very low density developments, the ITE did not see a need to require sidewalks because “walking distance to regular elementary schools is often excessive...[and] all such travel is by way of school buses.” (ITE, 1967: 5-6, 10)

Despite the recommendation to integrate land use and traffic planning to create safe neighborhoods, this message was not implemented in practice, and local subdivision requirements did not reflect these ideas, nor did local governments create integrated staff to design roads and housing developments together. For all practical purposes, transportation planning (i.e., streets and traffic) was separate from land use planning (i.e., housing and the location of activities).

In 1984, ITE published a design guide focusing on major urban streets such as arterials. This design guideline does not discuss the relationship between surrounding land uses, traffic, and safety. It does discuss speed control and safety, arguing that the underlying issue is *differences* in speeds, not that speeds are too high. Thus, maintaining uniform speeds should be a primary consideration. Furthermore, it stated that lane widths should not be standardized because of differences in traffic conditions, zoning, presence of schools and so forth—but using “excessively narrow” lanes may cause more accidents. (ITE, 1984: 73) Otherwise, this document does not depart from the dominant ideas about road safety.

In 1974, a group of national professional organizations—the Urban Land Institute (ULI), the American Society of Civil Engineers (ASCE), and the National Association of Homebuilders (NAHB)—published a separate street design manual, *Residential Streets: Objectives, Principles, and Design Considerations*, to deal with street development practices. (ULI, et al., 1974) To highlight the significance of the collaboration between these different groups, the foreword of the guidelines states that it “...represents the combination of three entirely different perspectives..” (ULI, et al., 1974: 6) The motivation for creating the separate standards was not a concern for safety, but a concern for the cost of providing streets designed to highway standards. According to the guide, “To the degree that conservation is consistent with utility, safety, and reasonable user convenience, it is intended herein to reflect a conservation bias. A conservation bias may seem to favor minimum builder/developer investments, but it also benefits property owners who much ultimately pay for that investment and the community which must bear operation and maintenance costs.” (ULI, et al., 1974: 11)

The document’s section on safety principles focuses on having the appropriate lighting, signage, break-away street furniture, sight distances, separation of modes, and limited traffic flows through neighborhoods. (ULI, et al., 1974: 15) In addition, the guide states that “Children will use streets to play if no alternative plan is provided for them.” This advice seems to say that streets should not be made safe for children. Instead, children should be allowed only in playgrounds. With a similar logic, the guidelines also state that “The surest way to improve pedestrian safety is to remove pedestrian traffic from areas of potential conflict with automobiles.”

With a nod to land use planning, the guidelines recommend that “Street planning and dwelling unit siting should be coordinated to reduce the incidence of housing on through-streets.” This is nearly like saying traffic should be appropriate for the surrounding context, but not as strong because it does not seek to control traffic, only housing. (ULI, et al., 1974: 15) Regarding pedestrians and bicycles, it states that “Pedestrian and bicycle-way alignments should have a reasonable relationship to foreseeable movement desires, parking, and community facilities, and should be safe, secure, and attractive.” (ULI, et al, 1974: 21) This is similar to SCAFT, but again, not as strong. SCAFT recommended setting out the pedestrian circulation system before designing any other circulation system.

## 5. Road Safety in the Changing Contexts of Infrastructure and Urban Planning in California

In both Sweden and the US in the late 1960s and 1970s, attitudes changed toward the city and the car. Instead of being a symbol of modernity, people associated the car with environmental degradation and health problems. For example, Donald Appleyard, an urban designer and planner dedicated his book, *Livable Streets* to “children whose lives are threatened by traffic and to all those who suffer noise, vibration, fumes, dirt, ugliness, loneliness, alienation or other impoverishments due to its presence.” (Appleyard, 1981)

Very much in response to the effect that urban highways had on local communities, people in cities across the US reacted with highway revolts and neighborhood conservation movements. These movements were first active in west-coast cities such as San Francisco and Berkeley in about 1970, and the movements spread to other cities across North America during the 1970s. (Appleyard, 1981: 151) One of the key strategies was to diminish traffic volumes in neighborhoods by installing diverters on some of the through-streets. A second strategy was to plant more street trees to make neighborhood streets more attractive. Richmond, California was the first city in California to install such a traffic diverter, and Oakland, San Francisco, and Berkeley used these and other traffic calming techniques as early as 1955, but they were more common beginning in the 1970s. Roundabouts to slow traffic in neighborhoods were widely used in Berkeley, Portland, Seattle, and many other cities. In general, these interventions were driven by residents’ interests, and were carried out by local governments working with a committee of residents. In some cases, residents opposed plans for installing diverters because they viewed them as a second-best option to making larger improvements in public transit service and other alternatives to private automobiles. (Appleyard, 1981: 220)

In a “Statement of Principles”, Appleyard asserted that “Through nominally public, [streets] are actually controlled by agencies and ordinances that are remote from the residents of each street, a fact which severely restricts efforts at improvement by the residents.” (Appleyard, 1981: 243) He argued that streets should not be “remote” from neighbors of streets, and proposed that streets should be a “safe sanctuary”, “livable, healthy environment”, a “community”, “neighborly territory”, “place for play and learning”, “green and pleasant land”, and a “unique historic place”. (Appleyard, 1981: 243-244) To protect neighborhoods, he proposed that streets should not have 25 mile-per-hour speed limits because they are too high. A better limit would be 15 miles per hour. In addition, traffic volumes should be below 2,000 vehicles per day, and pedestrians should have the right of way on the streets. (Appleyard, 1981: 251-252)

People have also reacted to the functional separation of travel modes and street infrastructure and wanted to reintegrate streets with social life. Urban design guidelines for transportation environments in the 1990s framed streets as places for social activity, not utilitarian travel only. Revised approaches to safety interventions emphasized the multi-functional aspects of streets, while using the basic principles of minimizing conflict, separating people and cars, and slowing speeds where fast traffic would be inappropriate. For example, in 1990, the Urban Land Institute, the National Association of Home Builders, the American Society of Civil Engineers, and the Institute for Transportation Engineers published a revised edition of *Residential Streets*. (ULI, et al., 1990) Again, this manual opens with costs, not safety, as the motivating factor for its creation. (ULI, et al., 1990: 15) In the cost-savings framework, the authors appeal to the idea that “movement of vehicles is only one of a residential

street's many functions.” (ULI, et al., 1990: 19) Here, they are only talking about residential streets. The idea of integrating streets and surrounding land uses can be taken further by asserting the integration can and should occur on major roads such as transit corridors. Still, the message in this guideline is that “the design of a residential street should be appropriate to its functions.” (ULI, et al., 1990: 20) The main approach is to not overdesign the streets. In a departure from other design guidelines, this one recommends design speeds of 20 miles per hour for access and subcollector streets, with a 35 mile per hour design speed for collector streets. While higher than design speeds in Sweden, these are lower than other guidelines have advised. The authors have targeted these design guidelines to new planned developments, not to infill developments. (ULI, et al., 1990: 23) In its third edition, published in 2001, the authors included the Institute for Transportation Engineering, and the concerns were the same as in previous years. In 2001, there is direct acknowledgement of neotraditional or New Urbanism as a design strategy. Its advice for bicycles and pedestrians has become stronger. For example, “Bicycle travel has taken its place along with pedestrian travel as an important consideration in residential street planning, warranting the same level of design attention as motor vehicle travel.” (ULI, et al., 2001: 42) This edition of the manual also included a section on traffic calming. (ULI, et al., 2001: 49-50) It said that “since the 1990s, traffic-calming actions have become an important part of residential street design.” (ULI, et al., 2001: 49) It also advocated for “pavement sharing” as a strategy—a departure from the idea of strict separation. (ULI, et al., 2001: 49)

Another example of this thinking that has been implemented is the redesign of Octavia Boulevard in San Francisco. The history of the Octavia Boulevard project begins with the federal interstate highways in San Francisco. In the late 1950s and early 1960s, residents protested the building of some segments of the freeway, such as the segment along the Embarcadero on the east side of the city. In response, local elected officials stopped the interstate program, and while many segments were constructed, others were not. (Hastrup, 2006) Allan Jacobs, former director of city planning for San Francisco said that the 1967 General Plan included recommendations and plans for removing the elevated interstate highways from the city. (Jacobs, 2006: 62) Finally, in response to damage caused by the Loma Prieta earthquake in 1989, the city removed the Embarcadero freeway. Removing sections of the Central Freeway took longer, and without leadership from elected officials, required neighborhood activists to push for demolition. As Hastrup explained, a ballot measure supported by a different group of community activists won support for *rebuilding* the freeway. Finally, groups opposing the freeway united on a boulevard design for Octavia Street created by Elizabeth Macdonald and Allan Jacobs. The supporters of the Boulevard design proposed their own ballot measure, which linked the transportation improvements to creating new housing units in the area, and won. (Hastrup, 2006: 68-70) The proponents of the boulevard design for Octavia boulevard faced opposition from traffic engineers and officials with the California Department of Transportation (Caltrans) because the boulevard imposed restrictions on automobiles—not through regulations, but through the design of the built environment. Reconfiguring streets back into pedestrian-oriented places required the legitimacy provided by elections and community organizing and it took three ballot measures and more than 15 years to complete the process. Redesigning streets such that non-motorized traffic receives priority equivalent to that of cars did not come easily to professionals from engineering disciplines. This illustrates the separation between transportation and the physical planning and design disciplines.

In 2003, the ITE published a more recent iteration of the street design guidelines. At this time, the ITE stated that “neighborhood streets that serve predominantly residential uses or urban business/commercial uses should be designed to a pedestrian scale...” (ITE, 2003: 5) In addition to pedestrian-oriented infrastructure and amenities such as sidewalks, lighting, and minimized crossing distances, “traffic volumes and speeds should be kept low...” (ITE, 2003: 5) These guidelines are consistent with the main idea of those in Sweden: traffic should be appropriate for surrounding land uses. (ITE, 2003: 6)

Target speeds are between 20 and 35 miles per hour. (ITE, 2003: 13) The 20 mile per hour speed limit is comparable to Sweden’s 30 km per hour limit, while 35 miles per hour is about 55 km per hour. The target speeds are higher in the US than in Sweden.

Still, many parts of these design guidelines are not materially different from those created in 1967. The emphasis on the design of street cross sections, intersections, grades, and curves. The recommendations do not give much consideration to the behavior of road users, for instance, or guidance on how transportation planners should evaluate and analyze land use concerns.

## **6. Discussion and Conclusions**

In the beginning of this chapter, I set forth four questions: How do Swedish and American road design guidelines frame road safety? What interventions do they propose? What model of accident causation do they use? How do they change over time? Based on this analysis of the documents, Swedish approaches to road safety have changed over time, and the changes reflect adaptation to the larger institutional contexts. Members of road safety policy communities adjusted the key concepts in road safety thinking—separation, traffic appropriate for surrounding conditions—to the opposition to modernist planning and design, to changes in the welfare state. Table 4.1 describes the characteristics of these changes over time

In terms of physical interventions, Swedish approaches to safe road environments have been rooted in separating the road transportation system into two different environments: the main network for motorized traffic, and the local network that provides access to activities, prioritizing pedestrians, bicyclists, and vulnerable (or “unprotected”) road users. The main approach to minimizing conflicts has been to ensure that traffic is appropriate for the surrounding activities and land uses, to separate car traffic from bicycles and pedestrians as much as possible, and to keep car speeds slow when traffic is mixed. Thus, the nexus between transportation and land use has continuously been a key organizing principle of the transportation system and its safety performance.

The design of physical interventions to improve the safety of road environments has also adapted to new conditions and demands. Instead of changing as a function of accident causation, physical design interventions to improve road safety have evolved as a function of changing urbanization, policy contexts, and attitudes toward the city, thus keeping safety relevant in changing times. In the 1960s, during a period of rapid growth and urbanization, designers and planners sought to create separate realms for transport and “society”. Transportation linked the nodes of workplaces and homes, factories and ports through the movement of goods and labor. Elements of social life such as child rearing, recreation, and material well-being existed within a separate, protected, and planned area. Creating such a transport system was possible because new suburbs, particularly around Stockholm, used comprehensive, rational planning.

The story is similar in the US, and particularly in California, where reactions to the modernist design paradigm ranged from reconfiguring neighborhood streets to slow speeding

traffic to removing urban sections of the Interstate highway system. Table 4.2 describes the experience in the US. In both Sweden and California, new urbanist thinking replaced the old paradigm, but to different extents. Because Sweden had already created a multi-modal transportation system, these new urbanist ideas such as traffic calming did not challenge the car-oriented precedent uniformly throughout the city. Instead, these ideas could be adopted in areas where the conditions make sense. In California where these distinctions are rare, and where public transit alternatives to driving are not options in many suburban cities, new urbanist responses to streets challenged the established norms. This has made safety interventions—interventions such as separated bike lanes, street trees, landscaped medians, curb bulb outs, and pedestrian-oriented signal timing—difficult to implement.

What do these differences signify? I think they point to what is underlying the different ideas of professionals and the different compositions of professionals. In Sweden, architects, community and land use planners, and urban designers have had a more significant role in transportation planning over time. It was legitimate for land use planners and designers to make decisions about streets and transport and it still is. According to interviews with local planners, transportation planning offices are staffed with people with different planning backgrounds who are supported by people who specialize in different aspects of transportation planning and engineering. A community planner consults with a traffic engineer about signal timing for a neighborhood plan. The traffic engineer does not need to sign off on the plan. The local planner has the power to do that.

The legitimacy for integrating transportation and land use planning comes from the different legitimate roles of the state in urban development in each case. In Sweden, creating sufficient quality housing was framed not just as a real estate problem but a fundamental part of national economic development after World War II. In that environment, the housing bureaucracy had tremendous clout because it was at the center of the political agenda (as was urbanization). Transportation was important, too, for example, as a key element in transit oriented new towns. But transportation ideas needed to be integrated functionally and symbolically with housing and community planning in order to be expressed in a way that was relevant. This created an organizational environment where it was necessary to integrate transportation and land use planning. The creation of *SCAFT* is an example of this. An engineer, a planner, and an architect created a method for creating safe streets based on the idea that traffic should be appropriate for surrounding conditions. The specific designs relied on the popular modernist concepts of separation and homogenous flows of traffic in a Corbusier vision, just as they did in the US. But the underlying logic was different.

In California, transportation and land use planning were separate activities in practice. The role for the transportation engineer was to ensure mobility on the arterial streets linking the residential subdivisions in order to allow for the growth of the region. Restricting car traffic was anathema to their mission, and they considered land use only to the extent that it affected traffic patterns. Land use planners were responsible for giving consideration to the extent that traffic affected activities. Thus, policy communities working on safety policies and physical interventions expressed their ideas such that they were consistent with the dominant norms of urban development—the ideal city. In both Sweden and California, these ideal cities were the product of techno-rational planning and state support for economic development through urban growth. The difference is that community planning in Sweden was a legitimate means for supporting economic development, and this community planning included the integration of transportation and land use planning, as well as a multi-modal transportation system. In the US,



the legitimate roles for planning was predicated on the belief that the public interest is the sum of all private interests, and that planning should enable as much private development as possible, subject to certain regulatory constraints. (See Figure 4.7 and Figure 4.8)

This different logic enabled Swedish designers, planners, and engineers to create differentiated urban environments. Some environments were protected from automobile traffic, and in other places fast traffic was permitted (even encouraged). In the US, the subdivision standards created environments where automobile traffic was permitted everywhere. In fact, if one considers the attached garage, traffic was even allowed inside houses. In Sweden, where much of the housing was multi-family housing, units did not have attached garages. Residents and guests parked cars in parking lots separated from the developments. The designers of the *SCAFT* guidelines took care to note that these parking areas should also be kept separate from pathways that children and other pedestrians may use to travel around their neighborhood, and from play areas. In Swedish design, there was a real sense of separating the car from society.

Later, after residents reacted to the modernist approaches to planning and design and called for more livable cities where streets could be integrated with the surrounding environments, many places already existed where traffic was calm. These places already existed because they were created on the prior logic of separating cars from society. Extending this idea to new spaces did impose a new constraint on automobiles. It was already acceptable to impose constraints on automobiles under certain conditions. (Not under all conditions—transportation planners and politicians in Sweden do argue over traffic capacities and speeds on major regional roads that they view as being critical to economic productivity.) In the US, controlling the car in neighborhood settings was not a legitimate practice based on the professionals' understanding of their roles. It has been made acceptable only in cases where residents and other citizens support its legitimacy and demand professionals to respond.

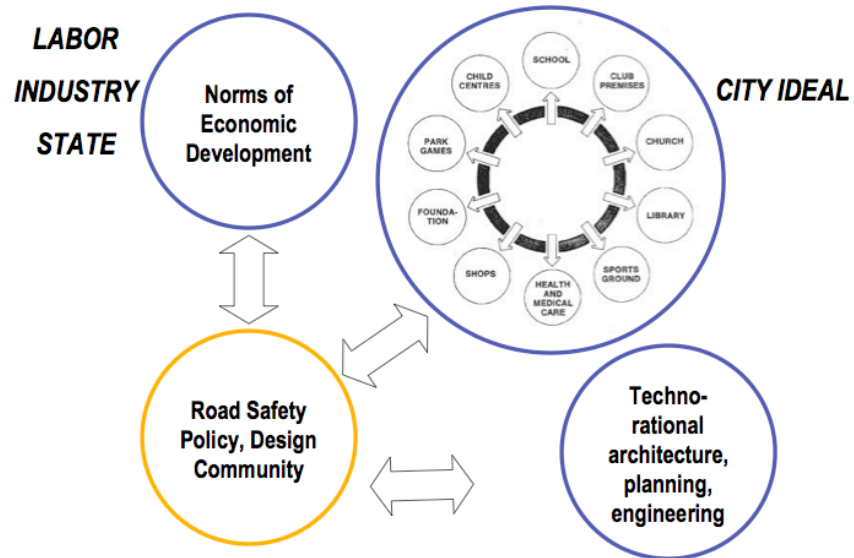


Figure 4.7 Legitimate Safety Planning in Sweden: Community Planning for the Ideal City

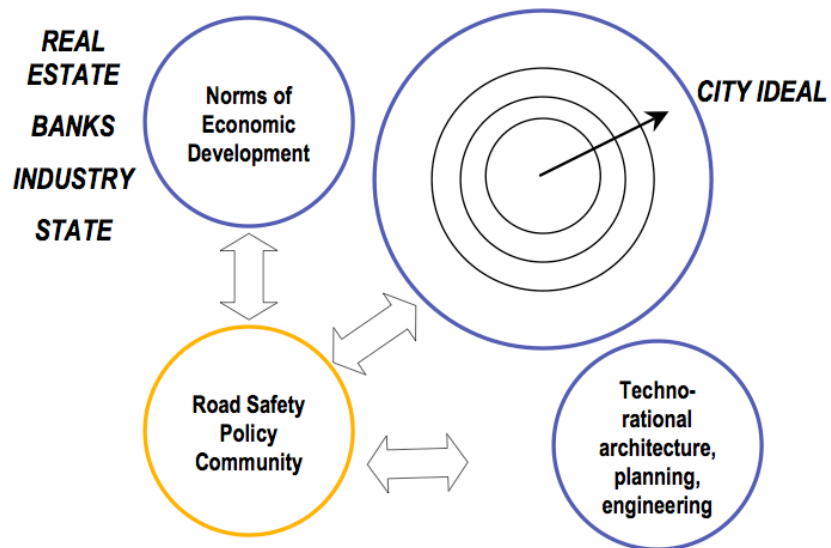


Figure 4.8 Legitimate Safety Planning in California: Growing the Region Creates the Ideal City

Table 4.1 Safety in Swedish Street Design, Dimensions of Change

	Early motorization	Modernism, 1960s – 1970s	Reaction to Modernism, 1970s – 1990s	System design, 1997 - present
<b>Accident causation</b>	Road users' behavior	Cars and road users in conflict with the built environment	Cars and road users in conflict with the built environment	Conflicts by design
<b>Intervention</b>	Road user education, rule making and enforcement	Physical planning, separation of modes	Physical planning, separation of modes	Road users, vehicles, built environment together with high-technology
<b>Mode of intervention</b>	Laws and enforcement	Master planning	Redevelopment, infill, spot interventions, traffic calming	System management and data analysis
<b>Professions</b>	Medicine, psychology, law, statistics	Architecture, planning, engineering	Architecture, planning, engineering	Planning, engineering, health, psychology

Table 4.2 Safety in California Street Design, Dimensions of Change

	Early motorization	Modernism, 1960s – 1970s	Reaction to Modernism, 1970s – 1990s	System design, 1997 - present
<b>Accident causation</b>	Road users' behavior and chaotic traffic	Road users' behavior, poor infrastructure, unsafe cars	Road users' behavior, poor infrastructure, unsafe cars	Cars and road users in conflict, road user behavior, vehicles, chaotic traffic
<b>Intervention</b>	Road user education, rule making and enforcement	3E's: education, enforcement, engineering (separation)	3E's: education, enforcement, engineering (separation)	3E's: education, enforcement, engineering (separation and calming)
<b>Mode of intervention</b>	Laws and enforcement	Infrastructure, laws, and enforcement	Laws, enforcement, and vehicles	Laws, enforcement, vehicles, and infrastructure
<b>Professions</b>	Law enforcement, industrial safety	Traffic and highway engineering, police, health	Traffic and highway engineering, police, health, urban design (not mainstream)	Traffic and highway engineering, police, health, urban design

## **Chapter Five—The Work of the System Designers**

### **1. Introduction**

The previous chapters have focused on the historical development of the field of road safety in Sweden and California. This chapter focuses on contemporary work on road safety: who are the policy communities who are concerned with road safety, how do they understand their roles, and what interventions do they use to improve road safety outcomes? It explains that contemporary road safety work in both Sweden and California is generally an extension of how the professional field of road safety has developed over time in both of these cases, generally following the partitions between experts who focus on road users, road environments and infrastructure, and vehicle safety. There are differences between the two cases in terms of the composition of professionals making decisions. In Sweden, planners and designers working in the larger context of a “livable cities” approach to urban development have a significant role in mainstream road safety planning, whereas the mainstream approach to road safety in California is still tied to its highway engineering roots. Comparable groups of planners and designers working on road safety in California do not have the mainstream, institutional role, but they are important advocates for the safety of non-motorized modes. There are also differences in how these professionals view their roles and their strategies for addressing safety. A safety advocacy style was more prevalent in Sweden than it was in California (though advocacy is important for experts in California who work on active transportation modes). Finally, though professionals from the two cases have similar ways of framing the issue of safety, as described in prior chapters, they use different ways of collecting information and creating arguments to demonstrate when the transportation system is safe and when it is not, and how to improve safety through interventions.

### **2. Methods**

The focus of this chapter is on information that I collected through interviews with planners, engineers, health professionals and other participants in the road safety field in Sweden. I interviewed these participants in April and May 2009 in Sweden and between December 2008 and June 2009 in California. In Sweden, I conducted 16 semi-structured interviews with 19 people. In the US, I conducted 14 interviews with 14 people. Most of my interviews were with people in technical positions working with transportation and road safety, including researchers working at various universities and institutes whose work relates to road safety. I interviewed others who could offer perspective on the role of road safety within the larger field. I spoke with men and women, and people in different stages for their careers. About half of the interviews were with safety experts, and the other half were with people who know the transportation, city planning, and public health fields more broadly and who could place road safety expertise in a larger context. (See Table 5.1.)

I identified potential interviewees through two main methods. First, I used the snowball methods beginning by identifying a few people who have a broad, general knowledge of the transportation field. This handful of people provided information about road safety, city planning, and government in Sweden, as well as contacts with additional people. I followed up with these contacts, arranging new interviews, and following new leads. My second approach to selecting participants was to identify specific individuals in key positions in road safety or who

had authored or otherwise been affiliated with documents that I thought were important in Swedish and Californian road safety.

The interviews were designed to collect information about the main road safety issues that people deal with in their work, why these issues were relevant, and what role they have in them. I also asked questions about the process for identifying safety problems, gathering intelligence about them, and designing and implementing interventions. How was each interviewee involved and how did they work with others on these issues. I asked probes, follow up questions, and new questions to follow the conversation and to get deeper explanations and fuller stories. Some interviewees had special knowledge and I sometimes asked specific questions about these topics. Other times, I snowballed topics from one interview to the next to get a sense of the prevalence of a practice or attitude, and to seek out different opinions.

**Table 5.1 Interview Participants**

	Road safety experts (research & practice)			Transport/Planning/Health experts	
	Behavior / enforcement	Vehicles	Infrastructure	Academia / research	Industry / practice
Sweden	2	3	4	5	5
U.S.	2	1	5	3	3

In addition to interviews with individuals, I have been attending meetings and conference sessions about road safety, transportation, planning, and health since 2004. Through these professional meetings I have become familiar with the field, its members, and its debates. This information has also shaped my interpretation of the interviews and policy and planning documents.

### **3. Participants in Road Safety Work and Their Roles**

Previous chapters in this dissertation presented findings about the development of road safety thinking and the professional fields that have supported it over time. California and Sweden had similar road safety ideas and similar professional groups responsible for creating a safe transportation system. In both cases, road safety experts began by emphasizing poor driver behavior and the need to correct it. Road infrastructure, subdivision designs, and vehicles were also areas for intervention.

Today, in Sweden and California, the professionals working in road safety reflect these historical roots. The organization of the field of road safety is roughly similar across the cases, with a combination of local and state governments, researchers, non-governmental organizations, and consulting firms participating in the work. In both cases, professionals do come from different disciplines, primarily city planning, transportation engineering, public health, psychology, and law enforcement.

There are three main differences in the contemporary work in road safety across the cases. First, Swedish road safety policy communities use an advocacy style to promote road safety within Sweden and among international agencies and experts. The style in the US and California is more technical, except for the work of non-motorized transport advocates. Second, Swedish policy communities are more likely to use the built environment as a method for shaping road user behavior, and the policy communities in the US and California are more likely to use a combination of education and law enforcement to shape behavior, as well as traffic

control interventions. For example, instead of using speed limits to slow traffic, Swedish road safety interventions use traffic calming on both major high-speed roads (e.g., roundabouts) and on local roads (e.g., chicanes). Third, while experts in both cases justify their safety interventions with their knowledge of the interventions' effectiveness, the different groups appeal to different kinds of knowledge. Swedish road safety policy communities were more likely to discuss the "engineering effect" of an intervention—the theory behind the treatment is the key to its success. Roundabouts on major high-speed roads are effective because they are *designed* to improve safety. The new design for Swedish two-lane undivided highways—the 2+1 roads—are safe because they are *designed* to be safe. In contrast, the safety policy communities in the US and California were more likely to appeal to an intervention's effects on injury and fatality rates, and be skeptical of interventions that they believed were untested. This focus on the empirical rather than the rational-theoretical leads to a great effort in the US and California to collect exposure data (e.g., pedestrian counts) to demonstrate the relative safety of different environments or treatments.

### ***Municipal Governments: Capacity and Advocacy***

In both Sweden and California, a significant proportion of the road network comprises local roads for which the municipal governments are responsible. Also, in both cases, local entities have control over land use decisions. Thus, local governments have a primary role in shaping road safety through interventions in built environment and the distribution of activities in space.

In a hard-cover report filled with photographs and illustrations created to inform local elected officials of the importance of road safety in Sweden, the Swedish League of Cities, now the Swedish Association of Local Authorities and Regions (SKL), outlined the areas in which municipalities play a direct role in road safety. Municipalities are responsible for the planning and design of the local built environment and the planning and procurement for transportation. They are also responsible for the education, health, and welfare of its population, and its employees such that they are not injured or harmed while working (e.g., on the streets). Municipalities also influence mobility in their jurisdiction, and thereby influence safety. (Svenska Kommunförbundet, 2003: 38-39) Although this list was created for Swedish municipalities, the principles are the same for California cities.

Much of the road safety work in municipalities in both Sweden and California is targeted at improving safety for bicyclists, pedestrians, children, and other vulnerable road users. (Roos and Nyberg, 2005: 31) I reviewed general plans for selected cities (and some counties) in the Stockholm Region and the San Francisco Bay Area (12 in the Stockholm Region and 15 in the San Francisco Bay Area) and found that contemporary local governments frame road safety as a matter of safe mobility for pedestrians and bicyclists, and general quality of life in cities. In some cases, cities also linked pedestrian safety with feelings of security. In a few cases in California, cities' general plans included an engineering approach to road safety, such as discussing the safety benefits of installing new protected left turn lanes at some intersections, but these approaches were in the minority.

Although California general plans promote road safety for non-motorized modes of travel, just as the Swedish plans did, most interviewees said that the actual practice of creating safer streets is an uphill battle because of the long-established focus on creating street capacity for automobiles. In one case, an interviewee in California who specializes in non-motorized

transportation safety said that when designers, planners, and engineers work on plans for street, they fight over pedestrian and bicycle safety *at every intersection* because there is no existing way to systemically change the transportation priorities throughout a city or neighborhood. This interviewee said that these adversarial interactions are a necessary part of creating change in the local transportation system.

Cities aspire to protect their citizens, as their general plans illustrate, but cities have limits on how they carry out this protection. For example, the role of local governments is incomplete because they do not control all roads in their jurisdictions, nor do they affect the design of automobiles. In addition, though all cities have a critical role in creating safe transportation environments, cities have different capacities with respect to their ability to collect and analyze information, and design and implement road safety interventions. Both the Stockholm Region and the San Francisco Bay area comprise large and small municipalities with varying capacities. Several interviewees in both Sweden and California distinguished between large and small municipalities with respect to their road planning capacity. In a study of local elected officials' perspectives on road safety, researchers from VTI found that smaller municipalities carried out relatively smaller scale safety interventions with a faster implementation schedule, whereas the larger municipalities undertook larger safety projects, sometimes in cooperation with several groups, including sometimes the EU. (Roos and Nyberg, 2005) Despite the differences across municipalities, according to research by VTI, the availability of funding for road safety projects was a problem for all municipalities in Sweden. (Roos and Nyberg, 2005: 12) This issue of funding for road safety came up in interviews in Sweden and California. In both cases, much of the road safety funding comes from transportation infrastructure budgets, with some allocated to enforcement and educational activities.

While funding for safety interventions is sometimes difficult to find, technical assistance for road safety is relatively common in Sweden. SKL, the Swedish League of Cities, the author of the glossy road safety advocacy book, in cooperation with the National Road Administration and other organizations, actively promotes the consideration of road safety among its members. For example, SKL hosts conferences on road safety topics and these are well attended by different members of municipalities, staff and sometimes politicians. They also create other road safety publications, such as *Calm Streets!*, the design guide discussed in the previous chapter. SKL provides these technical seminars because it wants to offset the different capacities of the municipalities. SKL also uses this advocacy strategy to influence decision makers, including municipal staff and elected officials.

The use of persuasion and advocacy in Swedish road safety work is distinct from the work happening in California. In California, the road safety advocacy is generally a component of the larger advocacy work of sustainable transportation groups, including groups promoting increased attention to walking, bicycling, and public transit, and decreasing the emphasis on the private automobile. In these cases, road safety is part of the non-motorized transportation message. In interviews with practitioners and safety experts in California, people expressed frustration that the established norms of road safety are dominated by traffic engineering institutions such as the traffic signal, warrants to install traffic signals, and the level-of-service (LOS) indicator for the quality of the road transportation system. The problem that frustrates these practitioners and experts is that conservative members of the road safety establishment in cities believe that safety options that support a multi-modal environment conflict with reducing car traffic congestion, and create operational hazards for cars.



In Sweden, the safety message stands alone, and though it is not the dominant message, it does not need to overcome the modal challenges that safety advocates face in California, particularly at the local and metropolitan level. Safety practitioners and experts in Sweden talk about safety in a variety of environments and have different tools and interventions that they use in these environments. The safety interventions are sensitive to the surrounding contexts. This is one of the outcomes of the multi-modal approach to transportation planning that Sweden started in the 1960s.

The advocacy in Swedish road safety is distinct from the road safety advocacy in California in another way. In Sweden, the road safety work focuses on the emotional and moral messages, rather than the empirical data to persuade. Some of the leading experts in Sweden explained that this method—first presenting emotional information to persuade, then supplying the quantitative data—is stronger than using quantitative data alone. In California, much of the work happening in road safety advocacy is focused on demonstrating that road safety is a problem by collecting better measures of exposure, especially for pedestrians and bicyclists, in order to prove the safety problem exists, and to defend the position that road safety improvements require slowing cars, and therefore decreasing the LOS.

### ***Responsibility for Road Safety***

One of the most significant differences between local road safety planning in Sweden and California is the responsibility of local staff members. In California cities, it is common for the lead transportation engineer, or the transportation engineering department, to be assigned responsibility for road safety. In many cities in the Bay Area, plans that would require changes in the transportation system must be approved by the transportation engineer. A minority of cities require committees comprising staff from various departments to make decisions affecting safety. In interviews with people who work closely with local governments, the transportation engineer's power to approve road safety plans was problematic. The problem was not with the engineering approach per se, but with individuals who were conservative in their approach to safety. In these cases, conservative meant not approving pedestrian and bicycle improvements when they would cause delay to motor vehicles. More generally, interviewees working on road safety issues said that adherence to the engineering LOS standards for streets, which prioritize the mobility of cars rather than a multi-modal transport system, is also a widespread problem. The locus of safety responsibility with the local traffic engineers exacerbates the difficulty of working against these norms.

The responsibility for road safety in the Stockholm region is diverse. In some cases, local road managers and public works departments are responsible for safety. In the City of Stockholm, the largest city in the region with the largest technical staff, the Municipal Council is responsible for road safety and sets goals for road safety in the city. The Municipal Council has delegated responsibility for road safety to the Traffic and Sanitation Board, which delegated this responsibility to the city's Department of Strategic Transportation Planning (the Traffic and Sanitation Board assumed this responsibility in 2005 from the Street and Real Estate Board, which dissolved at that time). (Vägtrafikinspektionen, 2004: 13; Stockholms Stad, 2009) The Strategic Transportation Planning group creates and carries out a five-year road safety program. (Vägtrafikinspektionen, 2004: 13; Stockholms Stad, 2008: 11) The formal responsibility for road safety is not identical in all municipalities in the Stockholm region; the responsibility may lie with different municipal boards, but it is generally similar.

With respect to approving transportation plans and designs, the decision making in the city of Stockholm is distinct from the larger cities in the Bay Area. In Stockholm, the transportation department staff include people with backgrounds in community planning, urban design, architecture, municipal engineering, as well as transportation engineering. Planners are staffed such that they are responsible for making decisions about plans for specific neighborhoods in the city, even if those plans are for transportation or another special topic outside of their own area of expertise. Essentially, these planners are area specialists whose primary job is to maintain relationships with local elected officials, residents, and businesses, and to develop a deep understanding of a particular neighborhood's issues. Area specialists may come from any planning background. These area specialists can rely on advice from technical specialists working in the department. The specialists include people who are experts in issues such as non-motorized transportation or traffic signal timing. Thus, decisions affecting road safety can be made by any combination of planners with various backgrounds. Moreover, within the planning department, people do not share a single approach to road safety, and there are many opinions in the department about the best way to improve road safety. The staff members debate these issues internally, and the outcomes are shaped by these discussions, as well as the interests of elected officials and local residents.

Differences also appear with respect to the professional composition of the road safety policy communities. In Sweden, professionals who debate road safety and make decisions affecting road safety are more likely to include people with backgrounds in city planning, urban design, and architecture. Transportation engineers working in local or state agencies are involved in these debates, but in contrast to the situation in California, the engineers are not the sole experts responsible for the issue. While some interviewees in Sweden were critical of engineering approaches, saying that the field of road safety relied too much on engineering solutions, in general the traffic, civil, and municipal engineers do not monopolize the field, and engineers work with multiple groups of experts.

This is a significant difference from the road safety work happening in California. In California, decisions affecting road safety must be approved by the lead traffic or public works engineer in each city. Interviewees who work closely with local transportation engineering departments expressed a range of feelings from resentment to ridicule toward the engineers making safety decisions. Some interviewees (from both engineering and other backgrounds) resented the power that the engineers have to make decisions. Others criticized the engineering decisions for being small-minded.

These differences in the professional composition of the field of road safety across the two cases may be because, historically, the housing and transportation agendas in Sweden were linked through the building of transit-oriented new towns. Instead of separating the planning of transportation facilities and housing, the two areas were more integrated. This pattern is still part of the contemporary work on road safety in Sweden. A second characteristic of the Swedish transportation and land use system is that it was designed to be multimodal. Swedish transportation and land use professionals created spaces for cars to travel on special facilities such as arterials and motorways, but limited car travel in other areas where pedestrians were given priority because they needed access transit, residential areas, shopping, schools, and other activities. This difference in the organization of the transportation system has also influenced the work on road safety.

## *State-Level Highway Agencies*

Within each metropolitan area, state departments of transportation are responsible for the major highways and other state-owned roads. This system of ownership means that road safety decisions are influenced by intergovernmental relationships between state and local entities. In each case, larger cities have good capacity in terms of transportation planning and road safety, but for smaller cities, the California Department of Transportation (Caltrans) and the Swedish National Road Administrations are primary sources for expertise and data on safety.

As the national body with expertise in roads, the National Road Administration's main functions are to collect data for the whole country, coordinate interests across regions and different sectors, work with stakeholders to develop the road transport sector, and to oversee all safety and environmental issues related to road transport. (Roos and Nyberg, 2005: 16) The National Road Administration is also responsible for the construction, operation, and maintenance of the network of state-owned roads in Sweden. In the past it has also been responsible for creating the traffic rules, licensing drivers, and registering vehicles, and drivers, but these duties have been moved to the newly-established Swedish Transport Agency (*Transportsyrelsen*). The National Road Administration is viewed as an "important partner" by municipalities, but can also be viewed as "trampling" municipal interests. (Roos and Nyberg, 2005: 11) This message came out in interviews as well. Interviewees who specialize in behavioral aspects of road safety said that the infrastructure focus on the National Road Administration dominates the field and crowds out other approaches to road safety. This is consistent with Lundin's analysis of the development of the road safety profession in Sweden, and the competition between the behavior and infrastructure specialists to define the road safety problem. Other interviewees described the National Road Administration as a large, conservative, male-dominated engineering organization that was slow to change or adopt new ideas about road safety, particularly when those ideas emerged from groups outside of the organization. On the other hand, some interviewees said that they appreciate the National Road Administration's expertise in safety because the organization is a resource that smaller municipalities can use to support their transportation and safety planning.

Caltrans is similar in structure and function to the National Road Administration. It collects data for California, coordinates interests across different counties, and oversees all of the construction, design, and safety and environmental issues related to state and national roads in California, except for the four large metropolitan regions (Los Angeles, San Diego, SF Bay Area, and Sacramento) where Metropolitan Planning Organizations have the lead. Similar to its Swedish counterpart, the agency focuses on state-level transport and infrastructure, and is not as sensitive to local transportation needs and travel behavior issues.

Because both agencies focus on infrastructure, the employees have backgrounds mainly in engineering. The agencies do include employees with different professions, such as landscape architecture.

In the National Road Administration the central policy group for road safety is part of the headquarters, and certain staff in the regional offices hold positions as road safety experts. When a regional road project is staffed, the project manager can (and often does) include a safety expert on the team. This amounts to allocating some of the budget to road safety, even on projects that are not "road safety projects". The more complicated the safety issues, the greater the proportion of the budget gets allocated to a road safety expert.

I talked to one such expert with a background in engineering who said that he is professionally responsible for ensuring that the projects he works on are safe in terms of traffic safety (i.e., accidents, but not security issues). It is up to him to sign off on the safety of a project. In their capacity as experts, these members of the organization do not report directly to the project manager on that issue, and have the authority to stop work on a project when they determine that safety is compromised. This is something that happens rarely, but it does happen.

### ***Police Enforcement and Shaping Behavior***

There is a link between law enforcement and traffic safety in both Sweden and California, but the organization of the police forces is different. Sweden has a national police force, the Swedish National Police Board (Rikspolisstyrelsen) that is subdivided into county-level operations units. California has the state-level highway patrol, which was created to promote traffic safety, and local police forces.

Although behavioral approaches to road safety are significant in both Sweden and California, in California these approaches are led by law enforcement, whereas in Sweden the police have a relatively smaller role. It is an important detail that California's state-level police was created as a *highway* patrol, whereas Sweden's never had the traffic emphasis.

In interviews, discussions of speeds, speeding, and speed enforcement raise the issue of police. Some road safety practitioners in Sweden said that they would like to see the police play a bigger role in road safety, suggesting that most of the preventive activity occurs with other groups. Speeding cameras and other devices are used, but they are effective only temporarily and only in specific locations, that do not necessarily correspond with risk. Interviewees said that these automated techniques are a marginal part of the whole traffic safety system.

It is also interesting to compare Swedish perceptions of the US, and American perceptions of Sweden, especially on the issue of law enforcement. One of the most common assumptions that road safety professionals in the US make about Swedish road safety is that the differences in safety outcomes must be due to stronger laws, stronger police enforcement, and more obedience on the part of the road users. American safety experts know about Sweden's strong drinking-driving rules (Sweden's blood-alcohol limits are a quarter of the limits in California), and its strong penalties for drinking-driving, speeding, and other infractions.

While it is true that Sweden has stronger traffic rules, the assumption that these are the cause of the better safety performance was not supported by my interviews with practitioners in Sweden, or my analysis of Swedish traffic safety literature and thinking. For instance, while penalties for speeding in Sweden can result in one's driver's license being revoked, many people in Sweden speed and interviewees said that this is one of the most serious problems in Swedish road safety. Moreover, interviewees commented on how drivers commonly use technology such as radar detectors to facilitate speeding.

It is an assumption that Swedes are more rule-oriented and obedient than Americans, and I think that this proposition says more about the US approach to traffic safety and American expectations than it does about safety performance. Historically in the US, popular and expert beliefs about road safety have positioned safety as an outcome of regulation, self control, or limits on personal freedom. If a place is safe, then it must be the result of obedient people or policing. In interviews with US safety experts, when I described the research comparing traffic safety in the US and Sweden, the interviewee frequently said something similar to, "How can you compare the US and Sweden when they are so different?" When I probed, asking what these

differences are, some interviewees responded by saying that Sweden is more likely to have a strong government role in road safety. The implication of this statement is that Sweden's national and local governments have a role in road safety that overcomes any resistance, whereas in the US or California people are more likely to resist government intervention. With respect to road safety, this American exceptionalism is a myth. As this dissertation demonstrates, road safety in the US has had strong government support, particularly for interventions based on traffic engineering that facilitate greater traffic flows and organize traffic.

The subject of rules and obedience arose in my conversations with people in Sweden who, and most of the Swedish interviewees did not believe that improvements in behavior have been the cause of the safety improvements. Interviewees were much more likely to discuss changes in the built environment that calm traffic, reduce speeds, and reduce the severity of injury given a crash as reasons for the safety performance there.

With respect to drinking-driving, Swedes have created a social norm in which it is not socially acceptable to drink and drive. This rule is enforced by police, but it is enforced as much, if not more, by friends, neighbors, and relatives. Yet, people in Sweden continue to drink and drive, and drunk driving continues to be a problem (though it is difficult to measure the extent to which alcohol contributes to crashes). It is likely that drinking-driving is a larger problem in the US, but it remains a problem in Sweden too.

### ***Examples from Practice***

#### *Safety Around Schools as a Transportation and Land Use Decision*

Safety around schools is an important issue in both Sweden and California. Safe Routes to School, a federally funded program in the US, is an important component of local safety work. It is also an important issue in Sweden, where Swedish transportation planning documents often frame children's travel as an essential part of their development—for their health and quality of life both as children and adults. (Stockholms Stad Trafikkontoret, 2008: 31; Svenska Kommunförbundet, 2001: 3) The logic is that “in order to develop, children need to explore and move freely in their local community.” (Stockholms Stad Trafikkontoret, 2008: 31)

When planning for road safety around schools, one might want to start from scratch. This was the opinion of one transportation engineer and planner who works on school safety in a municipality in an inner suburb in the Stockholm region. It is easier and more effective to specify the spatial distribution of land uses, activity patterns, and facilities for different transportation modes when working with a blank slate, so to speak. He said that he would build bicycle and pedestrian infrastructure as complete networks separated from the motor vehicle traffic. Also, he would choose to locate schools with compatible land uses, not with industrial neighbors that attract heavy vehicles. Ideally, he would also influence parents' behavior: parents who drive their kids to school because they are concerned about safety are one of the major hazards around schools.

In developed areas, including road safety requirements in land use decisions is, as another safety expert explained, “Complicated.” In most cases, municipal land development decisions occur through a combination of formal and informal political and administrative channels. Planning staff working in a municipality's technical office may not have access to all of the decision making processes, and therefore land owners, elected officials, and, in some cases, senior planning staff are the main groups making land use, and therefore road safety decisions.

In one case, a junior planning staff member would have objected to locating a new private school in his city's industrial neighborhood, but he did not try influence the decision making because he did not know how the process worked. He said that the decisions about private activities, such as this private school, are made at high levels, are political in nature, and are out of technical staff's scope of influence. Several, but not all, of the municipal, regional, and national agency staff with whom I spoke might not have thought at all about influencing political decisions, believing instead that their role as technical staff is to provide information to decision makers. Other planners with whom I spoke took a different position, and work in an explicitly political style, advocating for road safety by lobbying elected officials, as well as technical staff, in municipalities and county councils. Still it is unclear whether and how the safety advocacy planning would influence specific land use decisions such as building a new private school.

Municipalities in Sweden have responsibility for land use planning. Comprehensive municipal plans and more detailed area plans guide land development in Swedish municipalities and are approved and updated by the Municipal Council, the decision-making body of the municipality. (COMMIN, no date: 8, 12) Municipal comprehensive plans (*översiktsplan*) set forth plans for land uses, including areas of renewal, conservation, investigation (changing land uses that must be investigated before being implemented), and development. The comprehensive municipal plan is a visioning document, and is not legally binding, though it is used to make determinations for building permits. (COMMIN, 2009) The detailed development plan (*detaljplan*) is also negotiated and agreed upon, and this document is the legal basis for land development. (COMMIN, 2009)

In California, the sentiment about the complicated link between land use planning and road safety is similar. A planner in the Bay Area explained that cities would get the road safety improvements they need when transportation departments stop co-locating arterial streets and schools. This planner criticized the transportation mentality that prioritizes mobility over safety, and said that until this way of thinking changes, California streets will not be safe.

Planners who work on road safety issues also said that they have limited ability to influence the traffic safety effects of new developments. For example, the main instruments for influencing local development include the city's general plan and the CEQA (California Environmental Quality Act) reviews of new projects. Neither instrument was created to improve road safety per se, and these documents usually do not set for criteria for evaluating safety and justifying interventions. Work on road safety, particularly the link between safety and land use planning, could be strengthened by including road safety in these planning instruments.

### *Converting Intersections to Roundabouts*

Roundabouts (traffic circles) have made a comeback in Swedish road design. In 1980 there were about 150 roundabouts in Sweden, in 2000 there were 1,000, and by 2008 there were 1,500. (Sveriges Kommuner och Landsting, 2008: 6) One explanation for the roundabout's return is that Parliament passed Zero Vision in 1997, and the National Road Administration sought ways to improve road safety with system-wide interventions. (Vägverket, 2000: 3) A complementary explanation is that transportation planners perceive roundabouts as providing mobility for cars while addressing three other important goals: traffic safety, environment, and design.

Roundabouts also receive attention in the Bay Area, where planners have suggested using roundabouts to simplify complicated intersections on major roads. In the Bay Area, it is not

straightforward to implement a new roundabout at a major intersection, and the process can take years of planning, data collection, analysis, and public debate. On the other hand, as discussed in the previous chapter, roundabouts in residential neighborhoods have become an acceptable traffic calming strategy in the Bay Area. These two types of roundabouts, large traffic circles on high-speed, high-volume roads and small traffic circles on low-speed, low-volume residential roads are different.

In theory, large roundabouts reduce vehicle speeds, resulting in less severe accidents at intersections. When roundabouts are designed carefully, they can also be safe for pedestrians and cyclists. (Vägverket, 2000: 11-12) One of Sweden's official urban transportation planning and design manuals, TRAST, discusses roundabouts mainly in the context of traffic safety, and to a lesser extent in context of traffic smoothing and traffic calming. (Sveriges Kommuner och Landsting, 2009) In terms of environment, roundabouts can reduce average delay and emissions at intersections with low-volume approaches. (Hallberg and Nowak, 2003: 5; Hydén and Várhelyi, 2000: 20) Finally, roundabouts can be designed in ways that contribute to the quality of the urban environment, creating spaces for public art, plantings, street furniture, and other things that integrate the streets with the surrounding activities. (Sveriges Kommuner och Landsting, 2008) The Swedish Association of Local Authorities and Regions published a guide to planning and designing traffic circles that emphasizes their aesthetic appeal, illustrating the book with photographs of roundabouts planted with flowers and trees, and accompanied with public art. (Sveriges Kommuner och Landsting, 2008)

Some of the road safety professionals with whom I spoke explained that they cannot always prevent accidents, and the Zero Vision policy accepts that accidents will occur and aims instead to prevent serious injury. Thus the road designers understand that instead of preventing accidents they are in a sense designing them. One example of this is the new 2+1 road. The National Road Administration converted some of the two-lane roads in the countryside into roads with three lanes and a wire center divider that alternates to create a passing lane in each direction every few kilometers. In theory, this design eliminates all head-on collisions because cars no longer need to overtake traffic by crossing over into oncoming traffic. The roundabout is another example of this “accident design” principle.

The roundabout, and in particular the single-lane roundabout, prevents certain kinds of dangerous collisions because of its geometry (e.g., head-on, right-angle) and lowers speeds so that if cars do crash, the occupants are not likely to be seriously injured. (Hydén and Várhelyi, 2000: 16-20) However, roundabouts are not necessarily safer than signalized intersections for bicyclists, pedestrians, and people with disabilities, and the safety and quality of access for bicyclists and pedestrians depends on the details of the roundabout's design, particularly in large roundabouts with relatively high speed approaches. (Hydén and Várhelyi, 2000: 20; Vägverket, 2000: 12)

I asked interviewees to tell me their opinion of the roundabouts, and whether and how their safety impact has been evaluated. Most explained to me the theory behind the roundabout—they reduce vehicle speeds and their geometry prevents the conflicts that cause serious injuries—and most believed that these theoretical safety impacts justified their use. One person noted that roundabouts are not always safe, and that they must be designed carefully to have safe speeds and they should have only one lane for motorized traffic.

When I probed for information from evaluations, some said, vaguely, that roundabouts have been evaluated and studied and that they are an effective safety intervention. I asked whether individual roundabouts have been evaluated; no, single roundabouts have not been

evaluated, instead, their system-wide impact has been studied. No interviewee offered information about specific studies, and the responses I received were somewhat crisp, as if my questions about evaluation suggested that I doubted their effectiveness, and by extension the authority of their expertise. I felt as if there were a group of professionals in Sweden, experts in road safety who had reached agreement about what countermeasures were acceptable, and that my questions were irritating because I was questioning things that had been decided already.

Most of the documentation that I have found about roundabouts in Sweden focuses on their design and implementation; few have been designed as evaluations. The National Road Administration used an accident prediction model calibrated with 1970s data to estimate whether roundabouts in high speed environments (90 to 110 km/hr) were less safe than other roundabouts. The study did not find evidence that roundabouts in high-speed environments were less safe, but also noted that the data and method used to estimate the impact were probably too old to be reliable. (Vägverket, 1997) A literature review/meta-evaluation by Vinnova of speed reducing measures looked at the safety effects of roundabouts and concluded that “building roundabouts can undoubtedly be one of the factors” that explains the safety improvements in cities and towns in Sweden, but that other measures contribute to the safety performance. (Vinnova, 2007: Appendix 3, 7) The National Road Administration’s official guide to roundabout design cites to a Danish evaluation of roundabouts that recommends installing them only on roadways with moderate (up to 50-70 km/hr). (Vägverket, 2000: 11, citing to Vejdirektoratet, 1994)

A small number of interviewees did have a perspective that was different from the mainstream opinions I received on the subject of roundabouts, and they said that roundabouts are not always safe for all road users, and that their effect has not been thoroughly studied. For example, no one knows whether some travelers avoid roundabouts because they feel insecure, choosing another, possibly less safe route instead. When I suggested this to another interviewee, one with more official opinions, he said that such a situation would be “impossible” and that it was not in the designer’s scope to consider these possibilities. The roundabouts are as effective as they are designed to be, and that is why the design must be careful.

#### **4. Different Ways of Knowing Safety**

The road safety experts have a specific position from which they create their knowledge of traffic safety and hazards. In both cases, the road safety experts justify their roles in designing a safe transportation system through their possession of specialized knowledge of risks and hazards and the means of mitigating them. Safety experts in Sweden, California, and throughout the world have said that road users make mistakes, apply faulty logic, and have limits to their rationality, and for these reasons roads, cars, and laws need to be created to protect them from harm. Even in Sweden, where the new Zero Vision approach no longer “blames the victim” with a “moralizing” (i.e., misbehavior) basis for road safety, the “system designers” who are the experts responsible for road safety still define their roles in contrast to the road users. The experts define their roles in contrast to the non-experts, the road users, who require protection. This role definition creates an artificial dualism between the experts and non-experts based on the assumption that expertise in safety cannot be known by regular road users. The converse to this is that the knowledge of regular road users is also obscured by this dualism, and so-called “informal” knowledge of road safety is not included in experts’ knowledge. In interviews with safety experts, a minority of people sought knowledge of safety directly from road users, and



most interviewees spoke of road users as being a source of hazards rather than a source of protection and safety intervention.

The problematic position of experts in modernist policy and planning regimes has received an elaborate critique over the past several decades, particularly in the fields of city planning. (Scott, 1998; Holston, 1989) In the context of road safety, the achievements modernist planning (e.g., complete knowledge, comprehensiveness, efficiency, optimality) are an illusion because experts cannot know and define the boundaries of the transportation system and its hazards such that these hazards can become solvable problems. (Rittel and Webber, 1973) For as long as road safety experts have proposed this solution, they have also lamented the “leaks” in the system. Road users do not perform their roles as defined. As discussed in Chapter Two, a pedestrian will walk on a highway despite the fact the highway was designed to prevent pedestrian access. This is a problem in both California and in Sweden. On a more mundane level, a person will cross a street in the middle of the block if it makes sense to her. Road users, including motorists and non-motorized travelers, use both the formal rules of the road and informal rules to make decisions about travel and to communicate with other travelers.

When I compare the cases of Sweden and California, I find an interesting difference between the experts in both cases. While both groups of experts rely on specialized knowledge to justify their positions and interventions, they have different ways of knowing and justifying the safety of a situation or environment. The use of roundabouts on major high-speed roads is a good example of these differences. In Sweden, the roundabouts came up in conversation with multiple interviewees. When I asked about the history of the roundabouts and the decisions to install them, the interviewees said that cities installed roundabouts because of their safety benefits, and because they don’t compromise street capacity. What are these safety benefits? Roundabouts are safe because cars slow down to navigate through them, and they prevent head-on and right-angle collisions. When I probed, asking how they know that roundabouts have these properties, the safety experts in Sweden explained their confidence in roundabouts: Roundabouts are effective because *they have been designed to be safe*. What this means is that intuitively, theoretically they are safe, and if they are safe in theory, then they are also safe in practice.

Roundabouts are not as popular in California, although safety experts talk about them and are aware of their safety merits for both neighborhood streets and high-speed roads. For instance, an interviewee in California talked about local interest in installing a roundabout in one particularly hairy and complicated intersection. Yet, she doubted that the road safety experts in the relevant organizations would implement such an intervention because, though roundabouts work in theory, there isn’t enough evidence about how the roundabout will perform in practice. Would it limit capacity too much, causing queuing on nearby streets? Would it be hazardous for pedestrians? Would drivers know how to navigate the new facility? In California, much of the work on road safety is concerned with collecting and analyzing crash and injury data, and evaluating the effectiveness of interventions in practice. According to my interviews, safety experts understand the theoretical basis for many of the interventions commonly used in Sweden, but these interventions must be deemed safe according to the local crash record. Instead of installing interventions, safety experts debate the validity of measurements of the interventions’ effectiveness. According to interviews with practitioners in California, this skepticism toward novel safety interventions is deeply troubling, and affects not only safety, but also designs and traffic operations plans that seek to accommodate non-motorized travelers.

The different bases for knowledge that road safety experts use are generally consistent with the differences in the rationalist and empiricist traditions in epistemology. Rationalists assert that valid knowledge can come from intuition and deduction, whereas empiricists assert that knowledge must have an experiential basis. (Markie, 2008) Still, in both cases, experts are conservative and focus on crashes, crash locations, and road user behavior, and few expand the universe of road safety thinking by including issues such as the role of the private automobile in cities and in the transportation system.

## Chapter Six—Conclusions, Implications for Policy, and Future Research

In my interviews with practitioners, one particularly wise person asked a rhetorical question to compare the approaches of Sweden and California, “Is it the traffic, or is it the safety?” This distinction between road safety approaches that focus on traffic, and those that focus on safety appeared very clearly in this analysis of road safety work in both cases. In general, legitimate road safety interventions must be consistent with the overall goals for the transportation system. In the US, and in California specifically, the most important of these goals has been the mobility of motorized traffic, and safety interventions in California have focused on improving mobility, or improving safety without degrading mobility. Examples of mobility-oriented safety interventions include driver education, traffic control devices such as red-light running cameras and protected left-hand turn signals, and the geometric design of highways and arterial streets that focus on wide lanes and clear roadsides. But mobility oriented safety interventions are not the only way to address the problem. It has been done differently in Sweden primarily through interventions that increase mobility for non-motorized modes, and the outcome has been traffic fatality rates that are, overall, as safe as the safest places in the US, much safer than the average suburban landscape, and far safer for pedestrians and bicyclists. Examples of safety interventions that would reduce mobility for cars, but increase mobility for other modes and increase safety for all modes include methods to slow traffic speeds either through traffic calming infrastructure or lower speed limits and allocating separate road space to non-motorized modes.

### *Summary of Chapters*

This dissertation sought to answer the questions: who are the professionals who work on road safety, how do they frame the issue in their work, and what are the organizing principles of this work? The motivation behind these questions was to compare the professional practice of creating a safe road transportation system in two contexts—one with a reputation for safety and the other without such a reputation.

Before proceeding with the research questions, the second chapter investigated the relative safety of Sweden and California, focusing on two major metropolitan areas: the San Francisco Bay Area and the Stockholm region. Using the official crash and injury data for each region, and non-parametric statistical tests, I found that the Stockholm Region is far safer for pedestrians (about ten-times safer) and bicyclists (about twice as safe) than the Bay Area, but not necessarily safer for motorists. For motorists, the safest areas in the Stockholm Region are about as safe as the safest places in the San Francisco Bay Area. The motor vehicle occupant fatality rates in the suburban counties in the Bay Area are about twice as high as those in the more central counties.

Two other things stand out in this analysis. The first is that dense, walkable, transit-oriented neighborhoods are not *per se* safe for pedestrians. Both Stockholm and San Francisco are similar with respect to the experience of being a pedestrian, but pedestrians are killed in San Francisco at a rate five times higher than in Stockholm. Moreover, the travel mode shares in the two cities are comparable. The speed of traffic is one factor to investigate further, as is the design of the pedestrian environment. Specifically, is there a difference in the quality of exposure of pedestrians in the two cities? Swedish subdivision standards recommended separating the automobile from “society”, that is, areas where people live, shop, play, and so

forth. These standards were implemented in the design and construction of suburban developments in Stockholm and throughout the country. Much of the population still lives in these subdivisions. Perhaps the separation is an effective way to reduce exposure, particularly if the separation does not result in a loss of pedestrian access and mobility.

Chapters three and four addressed the main research questions, and presented a case for why these safety differences, particularly the differences in pedestrian safety, appear in these cities. Both cases have similar fields of safety experts and with similar ways of framing the issue of safety in their work. The similarity comes from the relationship between safety thinking and the development of motorization in each country. In both cases, the triad of the vehicle, the road user, and the built environment are the main areas of focus for safety intervention, based on the knowledge that bad drivers, bad roads, and unsafe cars cause traffic accidents. In each case, professionals with backgrounds in psychology and medicine, traffic and highway engineering, city planning, urban design, education, and public health are the main groups of professionals in the field of road safety. Although the cases are similar, they are not the same. The field of professionals in Sweden is more likely to include community planners, architects, and urban designers in decision making positions.

These differences in professional fields reflect the relationship between transportation and land use planning in each case. The relative prominence of architects, urban designers, and community planners in Swedish road safety planning parallels the relative importance of housing in the Social Democrat's political agenda from the 1930s through the 1970s. During this period of significant urban development when Sweden experienced both an internal migration to cities from the countryside and immigration from southern and eastern Europe, as well as rising income and increasing automobile ownership, city planning and architecture were important professions working on building Swedish cities to accommodate, and to some extent to promote, these changes. The major road safety planning document, *SCAFT* (1968), was a collaborative project between an architect, a city planner, and a traffic engineer. This coordination among the professional groups reflected a practical interest in coordinating land use and transportation planning. During this period, Sweden was constructing transit-oriented suburban new towns with rail service, commercial districts, and multi-family housing units. These areas were designed to support multi-modal travel—pedestrian access to shopping, services, and transit, transit service to the city center and employment centers, and automobile access for the growing fleet.

Swedish safety ideas were more adaptable to the changing social and political contexts over time because of the way the transportation system had been organized into a multi-modal system. Cars and fast traffic are acceptable on motorways and high-speed arterials, but in other parts of the city, traffic calming strategies were adopted because they were predicated on the existing organization of the transportation system. While there are still problems and conflicts at the margins of travel modes, this organization of the transportation system has allowed safety advocates to implement a wider range of interventions, and to pursue multiple agendas that were consistent with different political interests.

Housing development was also important in the development of California's cities and transportation systems. In California, as in most other places in the US, transportation and land use planning have been separate activities, linked only by the principle that growth should be as free as possible, and that transportation should provide access (private automobile access) to all of this development. In the 1960s and 1970s, when planners, citizens, and elected officials began to question the growth assumption on the grounds of environmental quality, the

transportation priorities had already been established and institutionalized by state and local highway and traffic engineering departments and development standards. As smart growth and new urbanism have become more common—planning agendas that require more integrated transportation and land use planning—the difficulty has been in implementing policies and plans based on the concepts of livable streets. This has affected safety planning because these livable streets ideas are consistent with multi-modal road safety strategies.

The interesting similarity between California and Sweden’s urban development was the role of land development institutions to coordinate the work of multiple organizations. The majority of the land developed in Sweden during the 1960s and 1970s was on publicly-owned land and carried out by the municipality as the developer and a mix of public and private construction firms. In California, the land, developer, and construction firms were all private. But in both cases, the national government, sometimes acting through more local entities, subsidized loans and set the terms of the loans to promote national policy. Moreover, in both cases, subdivision standards and other forms of land use controls were developed to carry out this development. Finally, comprehensive planning, the general plan, and techno-rational planning styles facilitated this work. These distinct organizational environments used remarkably similar mechanisms to coordinate work among many actors. The work did not require necessarily a nationalized command-and-control or a privatized free market framework, but it did require certain formal and informal arrangements to support the work. These auxiliary institutions were supported by the state, though, revealing the role of the state even in a free market setting. (Chisholm, 1989; Polyani, 2001 [1944])

Swedish road safety thinking has adapted to the decline of the Swedish welfare state and the rise in neoliberal policies by adopting the Zero Vision policy, which created a new framework for governing traffic safety. Instead of the traditional government-driver relationship, Zero Vision introduces the idea of the system designer-road user relationship. Zero Vision established a network governance idea for road safety in the recognition that both private and public policies shape the safety of the transportation system. This policy approach is consistent with the direction of urban policy—toward a network governance structure and away from a centralized ministerial agenda—throughout Europe. (Hajer, 2003) This network governance pattern is consistent with how Zero Vision was created, promoted, and adopted. Swedish road safety experts proposed the Zero Vision concept in Sweden, but could not convince the transportation bureaucracy to adopt it, though they did convince the transportation minister who was an appointed official. Instead of pressing ahead within Sweden, these experts promoted the idea among international organizations specializing in health and safety policy. Once the concept of zero deaths was accepted internationally, it was more difficult for the national staff members to resist (though many did). This is an example of how the governance of road safety is both local and global.

Chapter five presented an argument about the contemporary set of road safety experts and how they view their roles and how they frame the issue of safety. Contemporary work in road safety is an extension of the historical practice. The organizations that carry out the work today are those that created the field roughly one hundred years ago. Municipal governments, state highway agencies, law enforcement organizations, and various non-governmental organizations have been responsible for road safety policy and planning for many years and this has not changed very much. Despite these similarities, road safety professionals in Sweden and California have different policy and planning styles. In Sweden, road safety is a topic of policy advocacy as well as technical specialization, whereas in California, it is generally a technocratic

practice with the exception of non-motorized transportation advocates showing that safety is a requisite for a multi-modal transportation system.

Another important difference is that strategies to influence road user behavior rely on law enforcement approaches in California, but in Sweden they are more likely to include interventions both with law enforcement and in the built environment. These different styles illustrate the influence of the social and political contexts of each case. In California, social policy such as the regulation to protect the health, safety, and welfare of the public, is not easily accepted. Acceptable areas of intervention generally target the accident prone drivers, or they target improving overall mobility with traffic control measures. Changes in the physical design of streets, such as traffic calming interventions that might slow traffic, are more challenging to implement. In contrast, design measures are often implemented in Sweden, including interventions such as roundabouts on major roads and traffic calming in neighborhoods and busy commercial districts.

### ***Implications for Road Safety Policy and Planning and Future Research***

1. In areas where transportation and land use planning are not integrated, getting the necessary traction for including road safety in land use decisions means redefining the problem. Currently, road safety is a transportation problem. For example, cities' general plans in the Bay Area discuss traffic safety in the transportation element, but not in the public safety elements (reserved for large disasters such as earthquakes). Road safety needs to be recognized as a land use and design problem too, and other groups, such as housing and urban design experts need to include road safety among their objectives, and in their policies. For example, one interviewee who works in transportation consulting in California said that if road safety is not included in a city's general plan, and if the city does not have guidance about how to address safety in the environmental review process, then safety advocates (including experts and neighbors) cannot use these policy tools to advance their safety projects, or to critique development that is not safe.
2. Interventions to create a safer road transportation system focus on vehicles, road users, and infrastructure. As with other policy problems in transportation such as energy, health, and environmental sustainability, taking a broader, more critical perspective on the role of the automobile in the transportation system can help create policy that challenges the dominance of this mode. The car-oriented transportation system in California is a root cause of the road safety problem.
3. Along these lines, further research about the health and safety benefits of multi-modal transportation systems can support the development of such systems in regions and cities that are currently reconsidering the role of the automobile in urban mobility.
4. Based on this analysis of the San Francisco Bay Area and the Stockholm Region, not every multi-modal transportation system is equally safe. Transportation policy and planning documents identify dense, transit-oriented, walkable neighborhoods with safety, but the comparison of San Francisco and Stockholm showed that not all core cities are safe. Generally, core cities are safer than suburban environments, but San Francisco, for example,

needs to decrease its pedestrian fatality rate by five- to ten-fold before it is comparable to Stockholm in terms of pedestrian safety.

5. Finally, the deaths of young people due to traffic accidents has been a key ingredient in the road safety movement since the 1910s, but older travelers, especially older pedestrians, also have a high risk of death in traffic. Mobility for older adults is already an important policy issue, but the attention needs to shift from away the risk of accidents due to older drivers and toward developing better protections for active people of every age.

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