

A case for evidence-based road-safety delivery

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Overview

A change from a system of road-safety delivery rooted in opinion, intuition, and folklore to one that is founded in science and based on factual knowledge is underway. Change, as always, faces obstacles. The main obstacle is the near absence of professionals who can be the carriers and providers of factual road-safety knowledge. The second important obstacle is the weakness of the knowledge in which these professionals would have to be trained. Both obstacles stem from the same source; in a society in which it is acceptable to deliver road safety on the basis of opinion, intuition, and folklore, there is little demand for factual knowledge and for carriers thereof. Therefore, the most urgently needed change of road-safety culture is to make intuition-based road-safety delivery socially unacceptable. Much of the present content is based on an earlier paper (Hauer 2005).

The uncertain trumpet

The *Safety Culture Backgrounder* (March 30, 2006) placed on the web by the Foundation puts it bluntly: First, that it is not acceptable for 40,000 Americans to die on the road year-after-year. Second, that the customary lip-service response to bad publicity will not get us very far. Third, that a change in safety culture is needed. The culture to be changed is of the “collective acceptance of and/or complacency over the toll of crashes”; the change is “to elevate the place of traffic safety on the national agenda ... and motivate U.S. decision makers and motorists to acknowledge traffic safety as a legitimate priority.”

Suppose for a dreamy moment that the motorists made their desire for change forcefully known, and that, as a result, top decision-makers made road-safety a much higher priority. In this dream, there is now more money for road-safety. What would we do with the money to reduce the present toll of crashes? Should we put more police on the road? Add lanes to reduce congestion? Reduce speed limits? Convert signals to roundabouts? Educate children on safety? Test the road skills of seniors? Put high-tech stuff into cars? Subsidize rail to reduce trucking and buses to reduce car use? Provide bicycle lanes? Build subways to diminish exposure? Do more research?

One can always find ways to spend public money. The two questions are: whether the money can be spent effectively, and whether spending it will bring about a substantial reduction in fatalities. Experts are likely to differ in their opinions about the efficacy and relative merit of the aforementioned countermeasures as well as of many others. They will find it very difficult to estimate what accident savings will ensue if the money were spent on what they might suggest. This is a reflection of the poverty of knowledge in the road-safety delivery field, not of a peculiar fractiousness of road-safety experts. Surely, this is a problem. I cannot imagine the medical profession arguing for the introduction of a treatment of unknown efficacy or a pharmaceutical

company asking for the approval for a drug of unspecified effectiveness. Unfortunately, in the delivery of road safety, we sound a very uncertain trumpet and “...if the trumpet give an uncertain sound, who shall prepare himself to the battle?” (1 Corinthians 14:8).

This brings me to crux of the argument. It is true that to bring about a substantial reduction in the toll of crashes requires money. It is also true that to secure such money requires the raising of the road-safety profile amongst road users and amongst those who hold the purse strings. These are the two strands of safety culture on which the *Safety Culture Background* seems to focus. Yet, remember, to build a decent bench takes both lumber and a skilled carpenter. Similarly, to reduce the toll of crashes takes both money and also persons who know how to reduce crashes effectively. At present, we have little substantive knowledge, and very few people are trained in fact-based road-safety knowledge. The prevailing culture is to think that while one must apprentice in carpentry, road-safety can be delivered on the basis of opinion, folklore, tradition, intuition, and personal experience. This, I believe, is the strand of culture in urgent need of change. Without such a change in the prevailing safety culture, much money goes to waste. The shift from a system of road-safety delivery rooted in opinion, intuition, and folklore to one that is founded in science and based on evidence requires a profound cultural change. Such a change, as will become clear, will take not only a substantial amount of money but, primarily, much top-level resolve.

The road-safety delivery system

It will help to be clear about what is meant by “Road-Safety Delivery System.” If one tries to describe the health-delivery system, what comes to mind are the physicians, nurses, lab technicians, and pharmacists; the textbooks, libraries, and schools where they all are trained and certified; the clinics, hospitals, and medical centers where they work; the industries that develop pharmaceuticals or build the instruments and machines used by health-care professionals, etc. Were one similarly trying to describe the road-safety delivery system, the evident elements would be few. One might list the police officers on traffic duty, the driving instructors and those who test and license drivers or vehicles, perhaps, organizations such as the NHTSA or the MCSA, and a few safety research centers. Beyond these, the system becomes diffuse. Large parts of it overlap with other systems and are difficult to demarcate. There are the highway designers, traffic engineers, urban planners, the municipal planning departments, the state DOTs, the motor vehicle manufacturers, the transport regulators, etc. All these actors affect road-safety “by the way”, as a side product of their main mission. Because it is so diffuse, it is useful to think of the Road-Safety Delivery System as consisting of *all those actors and actions that significantly shape the future number and severity of crashes*. This, in turn, makes it necessary to declare who determines the future number and severity of crashes and how.

The traditional view is to think of road-safety as the problem of bad behavior (drinking, speeding, reckless driving, etc.), bad roads (poor pavement friction, short sight-distances, illegible signs, accident blackspots, etc.) ,or, perhaps, of bad vehicles (unstable trucks, high center-of-gravity SUVs, worn or exploding tires, etc.). This view logically leads to the opinion that the Road-Safety Delivery System consists of those actions and actors the aim of which is to reduce bad behavior, to rectify bad roads, and to improve bad vehicles. I think that this view is too narrow as it encompasses only a very small portion of actors and actions that significantly

shape our safety future. From a broader perspective, the number and severity of future crashes is determined by:

- The future amount of trip making (how many trips, how long).
- The future mode of travel used (on foot, by bicycle, as a rider in public transport, in a private car) and by the mode of goods transport used (car, air, truck, rail).
- The kinds of infrastructure on which this travel and transport will take place (e.g., road class, access control, intersection density, road design and traffic control, subway, etc.).
- The future vehicles and technology in use.
- The demography and norms of behavior of the future, as well as the usual human abilities and frailties.

From this perspective, it follows that those who by their plans, designs, and decisions influence the future amount of trip making and its mode, those who shape the details of the infrastructure, the vehicles, and technology in use, and those who mold the norms of behavior also determine the road-safety future of a society. The corresponding list of professionals and decision-makers should include not only the law enforcement officers, driver educators, highway designers, and traffic engineers whose role in safety is clear. Because the amount of travel and its mode depend on land use, policy, budgets, taxation, regulation, and similar factors, the list should also include town planners, architects, municipal engineers, transportation planners, economists, officials on planning boards, officials who approve planning and design documents, etc. The actions and decisions of all these jointly determine how many would be killed or injured in crashes and how much property would be destroyed. It follows that progress in road-safety delivery depends on the job done by those whose actions and decisions shape the road-safety future.

About progress

To convey an impression of where the road-safety delivery system now is and a sense of the direction in which it is moving, Figure 1. describes two prototype styles of road-safety delivery to demarcate two ends of a scale.

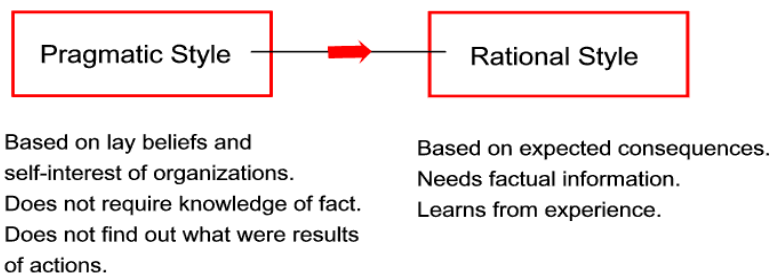


Figure 1. Two styles road-safety delivery systems

The *pragmatic style* rests on beliefs about road-safety and on the nature of organizations. These beliefs may pertain to the efficacy of police enforcement, the importance of stricter laws and firmer punishment, the need for better driver education and more stringent driving tests, etc. The

nature of organizations pertains to their need to cater to what is popular, to demonstrate concern, to show initiative, or to maintain budget, influence, manpower, income, etc. There is no intent to claim that any real organization practices the pragmatic style. However, if one did, then those in its employ would not really need to know facts about road-safety, other than facts about what the widely held beliefs are and what is popular. The organization would have no use for research other than the research of public opinion. There would be no real reason to ascertain what the safety consequences of any initiative were, except if they were useful for public relations.

The *rational style*, in contrast, is rooted in the desire to reduce the harm of crashes efficiently. Here the essence is the ability to foresee the road-safety consequences of decisions and actions, to ascertain their costs, and to balance costs and gains. Again, perhaps no real organization behaves in this manner. However, if one did, people in its employ would need to possess and use existing factual knowledge, and the organization would make sure that the results of important interventions are evaluated so as to learn from experience.

Where on this scale is the operation of a real actor or organization can be ascertained by asking a few questions: (1) Do the actor or the organization require that extant factual knowledge about the safety consequences of decisions be ascertained? (2) Do the actor or organization employ or buy advice from people who have been trained in and have acquired factual knowledge about road-safety? (3) Do the actor or organization engage in evaluative research to learn about the success or failure of its actions? If the answer to these questions is **NO**, the style of the actor or organization is close to being pragmatic.

In these questions, the phrase *factual knowledge* was used. A brief clarification of its importance and meaning is in order. Intuition and experience are fallible guides to road-safety delivery. Just as one cannot tell by intuition or experience whether aspirin reduces the chance of a heart attack, so neither intuition nor personal experience can tell one by how much widening lanes, more speed enforcement, or a new instrument on the dashboard will affect crashes. Only scientific research can do so. This is well accepted in medicine, education, and most similar fields. Thus, the phrase factual knowledge means:

Information accumulated by research that is based on data, measurement, and experiments and is extracted from these by defensible means.

Instead of “factual” I could have used the now popular term “evidence-based.” The [Wikipedia](#) (2006) states that: “*Using techniques from science, engineering and statistics, such as meta-analysis of scientific literature, risk-benefit analysis, and randomized controlled trials, it (evidence-based medicine) aims for the ideal that healthcare professionals should make ‘conscientious, explicit, and judicious use of current best evidence’ in their everyday practice.*” Evidence-based medicine categorizes different types of empirical evidence and ranks them according to their strengths and freedom from bias. The best type of evidence is that obtained from properly designed randomized controlled trials, whereas the worst type is “opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees.” Googling the internet for “evidence-based” shows more than 300 million hits, including “evidence-based toilet training,” “evidence-based marketing,” and “evidence-based hair removal.” While the evidence-based phrase has obvious attraction, its currency has been somewhat devalued since the evidence-based bandwagon is already crowded and has some suspicious looking characters on it. On the other hand, the entirely respectable use of the phrase

in medicine sets a high standard by insisting on learning mainly from randomized controlled trials, a standard that is not really attainable in road-safety research. For these reasons, I elected not to use the “evidence-based” rallying cry (except in the title) and to stick into the text the equivalent word *factual*.

The factual knowledge I speak of is mainly about the link between action and its safety consequences. At present, such factual knowledge is weak. Here are a few examples: Highway engineers believe that safety is the foremost aim of their design procedures. Yet, the highway designer cannot say how many more crashes would occur if a curve were built to a shorter radius. For traffic engineers, the motto is “safe and efficient.” Yet, the traffic engineer does not know how the choice of the signal cycle time affects crash frequency. Similarly, the urban planner has no knowledge about the relative safety of crescents and cul-de-sacs or about the relationship between arterial spacing and safety; the transportation planner does not know how to predict the safety effect of alternative plans or investment; safety is not quantitatively considered in municipal rezoning decisions or exit location; the state does not know what is the safety benefit of its demerit point system; the federal government does not know how truck size is related to safety; motor vehicle manufactures have difficulty predicting the safety effect of some new device, etc. At the personal level, the professional’s concern for road-user safety is genuine. However, a fact-based link between proposed action and its safety consequences is not part of the professional’s toolkit.

I taught traffic engineering, highway design, and transportation planning to civil engineers for twenty-seven years. Therefore, I can attest to the fact that civil engineers graduate from a four-year program and enter practice without being taught about the link between the design decisions they will make and the crash frequency and severity that will follow. Some will protest and claim that concern for safety is implicit in matters such as signal-timing procedures or geometric design standards; that adherence to the MUTCD (FHWA 2000) and the Policy (AASHTO 2001) will automatically ensure that a proper amount of safety is built into roads. Such a belief, while honestly and passionately held, is without foundation. The standards and warrants in the aforementioned documents are, by and large, the embodiment of opinion and personal experience—not of scientifically supportable fact. Having dealt with this issue at length elsewhere (Hauer 2000 a, b), this is not the place to repeat chapter and verse. But the reader can put the matter to a test. Does the Policy (AASHTO 2001) tell how many crashes would be saved if a larger radius were chosen? It does not. And yet, research (on two-lane rural roads) consistently indicates that the larger the curve radius, the fewer the crashes. In spite of overwhelming empirical evidence to the contrary, it is tacitly assumed that if a curve of a given radius is banked (super-elevated) in accordance with the Policy, the curve is appropriately safe. After testing the Policy in a similar manner on many issues, one will conclude that the Policy is the embodiment of tradition, judgment, intuition, and experience—not of empirical fact—and that the safety of roads designed by following the Policy is simply unpremeditated. As such, the Policy is a part of the pragmatic, not of the rational, style of road-safety management.

These views are confirmed in a recent scan of U.S.-based university courses in safety (NCHRP, 2006). The scan identified relatively few current offerings within engineering programs (29 of 117) and a comparable lack of coverage within public health programs (7 of 34). There is a prevalent view, even among university educators, that “good” design and operations, as described in professional guidebooks (such as the Policy and the MUTCD) will lead to quantifiable safety improvements. The relative lack of existing safety research material to

provide a more fundamental and rigorous safety educational experience is a particular concern. This is not intended to criticize individual courses or universities, but rather to identify and shed light on an important educational deficiency that exists throughout the United States. While progress continues to be made in the development of better tools and analysis techniques for safety management, these techniques are absent in most university-based education programs. Perhaps more importantly, there are only a handful of universities that treat safety as a discipline in its own right, with principles and a scientific perspective underlying its practice and future development. It is unrealistic to assume that new, more effective strategies will be developed and implemented by professionals trained using old materials.

The line connecting the two prototype styles in Figure 1 has an arrowhead pointing to the right. My intention was to show that progress is away from the “pragmatic” and towards the “rational style” of road-safety management. That this is indeed the direction of change follows from four lines of reasoning. First, the history of humanity is the story of moving away from action based on intuition and belief and towards action based on fact-based knowledge and science. It would be extraordinary if the management of road safety bucked this universal trend. Second, once the intuitively obvious has been implemented, only reliance on knowledge, science, and technology holds the promise of reducing the toll of crashes effectively. Third, the legislation now requires that transportation plans and decisions at the state and metropolitan levels to take road safety into account more directly. In some states the explicit consideration of safety in major transportation projects is now standard. Fourth, many initiatives in the last decade point in the right direction: the *Canadian Geometric Design Guide* (TAC 1999), the Interactive Highway Safety Design Model software tool, the *Highway Safety Manual* now under development, the *AASHTO Strategic Highway Safety Plan* (AASHTO 1998) in implementation; the SafetyAnalyst (Harwood 2002) tool soon to be released, the specification of core competencies and safety workforce training requirements by a Transportation Research Board Committee (NCHRP, 2006), and a future project (17-40) by the National Cooperative Highway Research Program serving a similar purpose, etc.

Here is a sum of the argument chain presented so far. I think of the Road-Safety Delivery System as consisting of all those actions that significantly shape the future number and severity of crashes. This leads me to reject that parochial view limiting the scope of road-safety delivery to improving bad behavior, bad roads, and bad vehicles. I argued that our safety future is constantly shaped by many actors and mentioned some of their decisions and actions. Here I paused to describe the two prototype styles of road-safety delivery. My view is that the road-safety delivery is moving from the pragmatic style towards the rational style. In contrast to the pragmatic style which requires little factual road-safety know-how, the *kingpin of the rational style are persons in possession of factual knowledge enabling them to anticipate the road-safety consequences of decisions*. At present this kingpin is weak. This is the main obstacle to progress towards a rational Road-Safety Delivery System. The recognition that this is the main obstacle is principal cultural change needed.

The strap of the boot

The question is how to bring into existence a healthy layer of professionals to be the carriers and suppliers of factual road-safety knowledge. Three conditions must exist:

- There has to be sufficient factual knowledge.
- There have to be the textbooks, teachers, and courses of study by which the factual knowledge is imparted onto trainees.
- There have to be jobs in which the graduates make use of the knowledge they mastered.

All three conditions are necessary, and none now exist to a nearly sufficient extent. Therefore, as noted early in Section 1, substantial resources and much top-level resolve will be needed. Where to begin? The current weakness in all three conditions may suggest a bootstrapping approach. However, I believe that factual knowledge is sparse and training for professionals is sporadic because there is virtually no demand for the services of persons trained in road-safety. This is why the third bullet is the strap to be pulled on first and strongest.

On various occasions, mention was made of the health delivery system. While it's parallel with the road-safety delivery system is appropriate in a limited sense (both deal with injury and its prevention), there is one overriding difference between the two: there is a natural (some say unlimited) demand for health delivery services at the individual level while there is nothing of that sort for road-safety. Without demand there is no supply. Ergo, no jobs for persons trained in safety; ergo, no need for courses, teachers, or textbooks; ergo, little use for knowledge created by research. In this respect the contrast between the delivery of road safety and the delivery of health is clear and stark; the difference is in demand!

The telling of a historical anecdote at this point is instructive.—From early on, traffic engineers learned to conduct travel surveys and think in terms of “origin-destination” tables and “trip desire lines.” However, till the early 1950s there was little of what could be called a “transportation-planning process” or a profession called “transportation planning.” Change came in the fifties. As told by Weiner (1997), “an important cornerstone of the federal policy concerning urban planning was Section 701 of the Housing Act of 1954. The act demonstrated congressional concern with urban problems and recognition of the urban planning process as an appropriate approach to dealing with such problems. Section 701 authorized the provision of federal planning assistance to state planning agencies, cities, and other municipalities ... and ... to metropolitan and regional planning agencies.” The source of congressional concern was with the efficiency by which federal money was being spent on transportation. Federal money was the carrot used to induce municipal governments to prepare transportation plans. But who knew how to do so?

Again according to Weiner (1997), “Prior to the early 1950s, the results of early origin-destination studies were used primarily for describing existing travel patterns, usually in the form of trip origins and destinations and by desire lines,’ indicating schematically the major spatial distribution of trips. Future urban travel volumes were developed by extending the past traffic growth rate into the future, merely an extrapolation technique. ... Beginning in the early 1950s, new ideas and techniques were being rapidly generated for application in urban transportation planning.” The need to prepare transportation plans quickly generated a supply of professionals who knew how to do so. It gave rise to respectable methods which they used and created the courses of study where the transportation planning was taught. This is how the now vibrant transportation planning profession came into being.

The moral of the story is this: where there is demand, supply follows. Unlike in health delivery, neither the demand for transportation planning nor the demand for road-safety comes directly

from the individual user. It is the government's responsibility (federal, state, or local) to plan for orderly investment in transportation infrastructure and services. Naturally, it is the government's responsibility to deliver appropriate road safety on the infrastructure it plans and builds. If there is to be progress towards rational road-safety delivery, the demand for it must be created by government. This could be done in several ways. For example, one could insist that some decisions must be accompanied by a **“road-safety impact statement.”** The need to write such a statement in terms of accident frequency and severity impacts would create an immediate need for knowledge and training. Similarly, one could insist that only professionals trained and certified in the road-safety aspects of their profession may sign plans, designs, and other documents with significant road-safety impact. Another demand-generating direction is the establishment of safety-conscious and knowledge-based procedures in major action centers — the department or ministry responsible for physical planning, the ministry or department of transport, the department or registrar of motor vehicles, the police, the major municipalities, and so on.

Actions of this kind may seem revolutionary against the impoverished landscape of present practice. However, I suspect that the travelling public does not know that the infrastructure on which they get injured with statistical regularity is planned, designed, and operated without knowledge and premeditation of its safety. If they knew then, what now is considered revolutionary, may seem to make common sense and become commonplace. After all, there are no other products known to be similarly injurious to human health that are put into use with the same blissful ignorance of its injury-producing potential as are roads and traffic control on them.

At this point, the main strands of my argument converge. Our road-safety future is determined by the many actors who shape the future transportation system and its use. These actors, by and large, work directly or indirectly for governments or are subject to government regulation. It is therefore manifest that the principal responsibility for the road-safety delivery system is of the government, and, therefore, only action by the government can bring into existence demand for a healthy layer of professionals to be the carriers and suppliers of factual road-safety knowledge.

Training of professionals

Suppose then that the prevailing safety culture has changed, that the government acknowledged its responsibility for our road-safety future, and that demand for trained professionals was created by mandating and funding the use of factual information. Now, there is work to do, and training has to be provided. This raises the question of whether the requisite information exists. Can one write text books and course material? If not, how could one devise adequate training programs? To give an impression about the state of affairs prevailing in transportation engineering, I will describe my experiences in working on the Interactive Highway Safety Design Model (IHSDM) project and in following the first halting steps of the budding *Highway Safety Manual* (HSM).

The goal of the IHSDM project was to create software, enabling designers to predict the safety consequences of design alternatives for rural two-lane roads. Design alternatives may differ in horizontal alignment, vertical alignment, lane and shoulder widths, number of driveways, provision of left-turn lanes at intersections, etc. To assess the safety impact of such design decisions, the project group assembled the relevant published research reports. Some topics were

found to have been researched in depth, while very little about others was published. Also, as is usual, the research studies varied in quality and in their conclusions. Once the literature was assembled and reviewed, a group of experts met to hammer out what seemed to be the best conclusions that could be reached at that time. The results of their work are now published (Harwood et al, 2000). There is no doubt that when new research results will be published, much of what has been stated will need to be modified. Nevertheless, there is now an authoritative document that is based on the accumulated empirical research, and that, for a fairly large set of design choices, can guide the designer of two-lane rural roads on the question—What can I expect to be the annual number of crashes on this road if I decide to use design option X? That, heretofore, such a question was not asked by highway designers, and if asked could not be answered, may be puzzling to those who are not familiar with the practice of highway design. In this sense, the IHSDM work is indeed is a quantum leap in present practice. At least in this case, so it turned out, the seven decades of accumulated research provided a sufficient basis for building a rational procedure. It follows that the accumulated knowledge on the safety consequences of design decisions for two-lane rural roads is also sufficient for training.

Experience with the IHSDM emboldened some visionaries in 1999 to think that enough factual knowledge exists to write a modest first edition of a *Highway Safety Manual*—a book containing the best factual information available for transportation engineers. Its first edition is expected in 2008. Work on the HSM, i.e., the process of transforming the vision into a book proved to be tortuous. From my perspective, the obstacles are mainly three.

First, almost a century of research and study resulted in many publications of variable quality and diverse in conclusions. Very few of those studies approach the quality aspired to by evidence-based medicine. Squeezing of what should pass for “factual knowledge” out of these diverse publications is often controversial.

Second, there is a tug-of-war between those who want to include in the HSM statements that are in accord with common beliefs and practice even if not supported by data-based studies and those who hope for the Manual to be a clear break with and a departure from the pragmatic style of road-safety delivery.

Third, no matter how many disclaimers will be written into the preface to the HSM, the factual information in it is bound to raise questions about the appropriateness of present practices that are often based only on common sense and sanctified by a tradition of long use. The inevitable differences between decisions made in accord with the pragmatic style and the rational style bring to the fore concerns about lawsuits, fear of change and its institutional and personal consequences, loss of face or budget or influence, etc. These concerns and tensions are reflected in behind-the-scenes struggles for control, for rights of review, fear of censorship, etc.

Nevertheless, whatever its content will be and however the conflicts will be resolved, the HSM will be published in a few years. This act in itself will be an important step towards rational safety delivery, at least for engineers. It is the act of placing factual information where it belongs—in the hands and minds of those who create a part of our safety future.

The lesson of these experiences is that much factual knowledge already exists and that in some instances, with effort, it can be made into material that can be taught and used. At the same time, it is possible that on several key topics (e.g., transportation planning, subdivision design, traffic calming, and traffic signal coordination) not enough is known to give fact-based guidance. This

is not unusual. There are diseases about which medicine knows little and phenomena that scientists do not understand. In medicine, in science, and also in road-safety, research ensures that the domain of what is known continues to expand. In sum, imperfect as the present state of knowledge is, one could put together a respectable curriculum to cater to many training needs.

It is at this point that faith in microeconomics and bootstrapping must kick in. The situation is reminiscent of where transportation planners were in 1954—work needs to be done while tools are few and trained manpower scarce. The faith is that the supply of knowledge and training will grow to meet the demand.

Creation of knowledge

I conceded in “The strap of the boot” that on some issues the knowledge needed for rational road-safety delivery and, in particular, for workforce training does not exist. It is research that generates knowledge, and knowledge is the engine of progress. In road-safety, the generation of knowledge has been slow. True, the problems are not easy to tackle, the data are insufficient, and conducting controlled experiments is seldom possible. Still, given the extent of experience with road building and road use and the large amounts of money already spent on road-safety research, much more knowledge could have been expected. There are two important impediments to knowledge-creation in road-safety. One is the backwardness and dilettantism that characterizes much of the road safety research community; the other is the Soviet style management of research by those who make decisions about how research should be done and what product is acceptable. Both impediments are discussed at length in Hauer (2005). Only a brief summary will be given here.

Several conditions combine to produce reliable research results. Paramount among those is that the researcher be well trained both in road-safety knowledge and in methods of road-safety research. Gone are the days when teeth were extracted by blacksmiths because they had the tongs and blood was let by barbers because they owned razors. Today, we expect dentists and physicians to be trained and licensed, to acquire experience, and to practice for a long time. Research too is a skill that is acquired by specialized training and by long experience. And yet, for some unfathomable reason, there is a widespread notion that common sense and an undergraduate degree are sufficient to do road-safety research. The upshot is a road-safety literature that is produced in large part by dilettantes and is replete with dubious conclusions.

Dilettantes would not do much harm if their products were kept out of the pages of the professional literature. Unfortunately, the barriers to publication are low. Poor quality research and its unreliable conclusions will find its way into the Transportation Research Record and the ITE Journal because the concept of peer review has been largely corrupted by the same prejudice: namely, that to be a referee of a research paper on road-safety, all that is needed is common sense; that training in road-safety and in research methods and that experience in road-safety research are not necessary to be a peer.

The problem is compounded by the managers and administrators, by those who decide on research needs, on priorities, on who ends up researching what and in what way, and on the acceptability of the product. Their judgment is good regarding the questions to which their organizations *currently* seeks answers. However, they know little about what is already known,

what research can and cannot produce, and about methods that are likely to produce defensible results. This seriously impairs the quality of the decisions they make. Furthermore, the manager-administrators have no understanding of, and no sympathy for, the need of theory to guide productive research or the need for research on methodology to produce more trustworthy results. As a result, research is done about what is of immediate concern and what is pressing; very little research is done about what is fundamental and essential for reaching sound conclusions. And yet, it is this administrative layer who decides what researchers will work on. The compulsion of the administrator-manager to closely control the research process stems not only from the psychology of mistrust and prejudice against the research class; at times it reflects the self-interest of the organizations to which the administrator-manager owes loyalty. What if research showed that a practice or standard now in use is not in the interest of safety or if a program which an organization promoted or in which a politician took active interest is ineffective? Thus, for the administrative mindset, some stones are better left unturned, and some research questions are better not asked. For this, control over aims, process, and product is essential.

A good example is the RFP (Request for Proposals) calling for research to evaluate “Safety Strategies at Signalized Intersections” issued in March 2006 by the National Cooperative Highway Research Program, a body financed by the American Association of State Highway and Transportation Professionals (AASHTO). The text of such RFPs is forged from the views of a “panel” of perhaps a dozen administrator-managers that is drawn almost entirely from state highway departments. The downfall of this RFP and of the panel that inspired it is twofold.

First, even though the panelists are not experts on road safety, they directed potential bidders to propose research on topics they thought important and forbade them to propose research on other topics. Thus, e.g., the bidders were asked not to propose research on the safety effect of signal coordination, even though traffic signals are coordinated in all large urban areas, a large proportion of crashes occur at these intersections, and nobody knows how the main coordination decisions (choice of cycle time and of the green-offset between adjacent intersections) affect crashes. The prevailing practice is to co-ordinate signals so as to minimize delay; the safety consequences of this practice are entirely unknown and, again, unpremeditated. And yet, it is entirely reasonable to expect that crash frequency is related to how often the signal aspect is changed (cycle time) and to how many cars are near the “dilemma zone” when the signal aspect changes, as determined by the green-offset. The panel’s failure to recognize the magnitude of the target crashes and their poor knowledge of what is the state of the art in road safety means that a significant opportunity for crash reduction will continue to go unexamined, and the potential safety benefits of signal coordination will be unexploited in all big cities. While such issues of primary importance were explicitly excluded, bidders were asked to consider research on secondary topics such as the effect of providing “public information and education” or of restricting “access to properties using driveway closures.” In this manner, scarce research money will likely be spent in ways that are not cost effective.

The second downfall of this RFP reflects the general poverty of NCHRP panels in persons knowledgeable in research methods. The RFP asserts that: “*In this project, data will be collected and before-after safety effectiveness evaluations will be performed at sites where selected safety strategies have been implemented.*” That is, a panel of administrator-managers not only decided what the questions to be researched are but also dictated what research method must be used. Recall that the subject of this RFP was safety at signalized intersections. It is a setting conducive

to both experimentation (e.g., changing cycle times or offsets) and natural quasi-experiments (e.g., comparing opposite approaches at the same intersections). But no, apparently the panel knows best!

I do not hope to get much sympathy for my argument from the class of administrator-managers nor from their stable of research consultants; both will resist change. The vibrant safety research community whose absence is lamented is not here to cheer. But this much is certain: material improvement in the product of research in road-safety will come from a well-trained body of researchers working as equal partners within a framework of mutual respect with managers-administrators.

Just as the problem is evident, so the remedy is obvious:

- To do good research, the researcher has to be:
 1. trained in road-safety knowledge,
 2. trained in research methods, and
 3. be in research as a long-term career allowing for the accumulation of research experience.
- Only reports that are properly *peer reviewed* should be published. For this purpose *peer reviewers* are persons who are entirely independent of the organizations that sponsored the research and of individuals performing the research. Furthermore, peer reviewers are persons who are on top of the current safety lore and who are experts in research methods.
- The process of formulating a research program must continue to be influenced by agencies that build roads, operate traffic, or set policies, standards, or warrants. However, the process must not be allowed to be dominated by people ignorant of road safety in general and of research methods in particular. Nor must it be influenced by agencies that have an interest in what is researched, what the conclusions are, and in what stones they like to see unturned. The trained and independent researcher must be an influential partner in the process of formulating research programs, the shaping of RFPs, and the selection of researchers to perform the work.
- To get good research products, the sponsoring agencies must recognize that research is not piecemeal and cannot be managed as if it were.

Describing the four elements of the remedy is easy. It is less easy to say how the transition from the present research setup to a sounder future can take place. How can researchers be trained in road safety and in road-safety research methods if no university offers such a program? Why should young people enlist in a program to be trained in road safety and research methods (even were one to exist) if there are no progressive career paths in road-safety research? What would one teach in such a program when present knowledge is fragmented, there are no textbooks, and only few qualified teachers? In addition, there is the thorny question of control. How can one induce the agencies that sit on the money (e.g., AASHTO) to give up their tight control over what is done; how can they be made to yield considerable influence over these matters to independent, trained researchers?

Again, the key to creating a sound safety-research infrastructure is demand. If there were steady work, good remuneration, and progressive, secure career paths in road-safety research, talented

people would gravitate to the field; if talented people sought training in road-safety research, universities would provide the programs; if graduate programs in road safety were offered, training material would be written. In this case too, demand cannot emanate from the road user. The source of demand for better knowledge can only be created by high-level decision makers in public bodies. Were the transportation infrastructure planned, built, and operated by the private sector, the government would be called upon to provide the oversight to ensure that appropriate safety is built into the infrastructure. (Consider, e.g., NHTSA whose role is to make sure that car manufacturers build appropriately safe cars). But, because it is mostly the public sector that plans, builds, and operates the transportation infrastructure and there is no independent overseer, the demand for knowledge-based safety management has no visible patron. The demand must come from within the public sector. However, recognizing the strong organizational self-interest, it is imperative that the demand be guided not by medium-level administrator-managers but by enlightened professional and political leadership. Thus, it is the responsibility of the public sector to create the long-term stable demand for road-safety research, with the promise of progressive employment for a well-trained workforce. If this is not done, future progress will be similar to the past.

The transition towards rational road-safety management is hungry for information produced by competent researchers using good data and methods and working on research programs set up co-operatively by people who know the problems, who know the road-safety field, and who know what research can and cannot do and can distinguish between reliable results and shoddy work. As noted repeatedly, to make progress in this direction will require much political will, considerable resources, and a well thought-out, concerted effort.

In conclusion

There is always more than one course of action, more than one design alternative, more than one decision option. Each action, design, and option has crash-frequency and severity consequences. Is it not obvious that these different safety consequences should be examined before the choice is made? Is it not clear that the future safety of a road should be considered before the ribbon is cut and that the future safety of a new subdivision be examined before it is approved? I think that most road users will be very surprised to learn that this is not done. It borders on the unbelievable that the safety consequences of the actions shaping our safety future are not examined and that many cannot be examined because we do not know enough to predict what they are likely to be. Even more perplexing is the claim that a “cultural change” is needed to convince high-level decision-makers of what must be self-evident—that we should not stumble into our safety future as blind bats. Just like in the delivery of water, education, or health, road safety too can and should be supplied, delivered, and managed in a rational manner.

A distinction was made between two styles of road-safety delivery. The pragmatic style relies on personal belief and intuition—the rational style on factual knowledge. The history of mankind has been to move away from action guided by intuition and towards actions grounded in knowledge of fact. The delivery of safety is at the beginning of the same road, but the road is blocked by a few big boulders. Foremost is the absence of a trained layer of professionals who can be the carriers of factual road-safety knowledge. This layer does not exist mainly because in the pragmatic style there is no demand for it. If there is to be progress toward the rational style, the demand has to be created. It can come only from the public sector: those who build the road-

safety future and must be responsible for it. Another boulder obstructing progress is the inefficient process of knowledge-creation by research. When belief and intuition are deemed sufficient, demand for knowledge is weak. Here too, demand for a vibrant layer of road-safety research professionals free from the Soviet-style interference by administrator-managers has to be created.

How can the public sector be induced to acknowledge the need for rational road-safety delivery and to create the corresponding demand for jobs, training, and knowledge? I can ask the question but am not competent to discuss it, except at the most general and superficial levels. As there is no market in which the individual road user can buy safer roads, it must be done through pressure and representation. In this, the AAA has an obvious role. In some respects, the situation is similar to that in the 1960s when Ralph Nader published *Unsafe at any Speed*. This booklet, more than anything else, caused safety to be more carefully considered in the manufacture of motor vehicles. In the “Preface,” Nader writes—“A transportation specialist, Wilfred Owen, wrote in 1946, ‘There is little question that the public will not tolerate for long an annual traffic toll of forty to fifty thousand fatalities.’ Time has shown Owen to be wrong.” Owen is still wrong; in the 2000–2004 period there were nearly 42,000–43,000 fatalities every year. Perhaps, if the travelling public knew the extent of ignorance about safety with which roads are created and operated, the requisite pressure would materialize. Unfortunately, Nader’s task was easier in one important respect: his target was the private industry which we do not trust to be a sufficiently diligent guardian of public safety. This is why NHTSA was created and made into an overseer. Our future safety is created largely by the public sector, which is traditionally viewed to be on the side of the angels. Quod custodiat ipsos custodiet?

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Biographical statement

Dr. Ezra Hauer is a Professor Emeritus in the Department of Civil Engineering at the University of Toronto where he has earned international renown as an innovator in engineering principles. Dr. Hauer has been active in road safety research and consulting since 1970. He completed his bachelor's and master's degrees in Israel, and later received his doctorate from the University of California, Berkeley.

Dr. Hauer has gained an international reputation for his scientific rigor and practical understanding in the study of the relationships between roadway design and safety. In addition to developing new statistical methods and theories, he has excelled in translating statistical theory into techniques useful for practicing engineers and researchers alike. His book, *Observational Before-After Studies in Road Safety* (Pergamon 1997), provides invaluable guidance to state and federal transportation agencies as well as to the research community. Recent and ongoing projects include work on safety improvements at signalized intersections, safety effects of resurfacing roads, safety analysis of roadway geometry and contributions to the Canadian Geometric Design Guide.

Dr. Hauer has published numerous articles, papers, and reports, and has received many honors. Most notably, he received the Roy W. Crum Award, the highest honor bestowed by the Transportation Research Board, for his outstanding contributions to developing and using statistical and experimental methods in transportation design and safety. He was a director on the Transportation Safety Council of the Institute of Transportation Engineers (ITE) from 1993 to 1995, and he received the ITE Transportation Safety Award in 1993. He has served as vice president and president of the Canadian Association of Road Safety Professionals, and chaired the International Committee of Symposia on Traffic and Transportation Theory.