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TRANSPORTATION RESEARCH BOARD
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TR NEWS

Logistics of Disaster Response

- Key Lessons for Postdisaster Humanitarian Logistics
- Building Adaptive Supply Chains
- Assembling a Model for Community Recovery
- Planning for the Worst, Teaming with the Best
- Securing the Fuel Supply
- Timely Interventions: Social Media, Ferries
- Commercial Aviation and Business Continuity

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Communicating the Urgency for Action on Climate Change

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TR NEWS

NUMBER 287 JULY–AUGUST 2013

LOGISTICS OF DISASTER RESPONSE AND BUSINESS CONTINUITY

4

18

32

COVER: A U.S. Coast Guard crew loads medical supplies for first responders in Port-au-Prince, Haiti, after the 2010 earthquake. Recent natural and human-caused disasters have highlighted gaps in international aid and disaster relief logistics. (Photo: Stephen Lehmann, U.S. Coast Guard)

TR NEWS

features articles on innovative and timely research and development activities in all modes of transportation. Brief news items of interest to the transportation community are also included, along with profiles of transportation professionals, meeting announcements, summaries of new publications, and news of Transportation Research Board activities.

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ALSO IN THIS ISSUE:

COMING NEXT ISSUE

PHOTO COURTESY OF KEN POLCAK

Noise barriers—the traditional approach to traffic noise abatement in the suburban setting—target the primary noise source and provide a means of restoring or improving the soundscape.

The September–October issue of *TR News* focuses on environmental sustainability in transportation and how it can improve the quality of life for individuals and communities. Articles highlight practice-ready research and cover such topics as integrating vegetation and green infrastructure into sustainable transportation planning; implementing the Eco-Logical approach in Nevada, Colorado, Utah, Montana, Washington, and Oregon; Virginia's improved construction specifications for stormwater pipe-lining materials; creating a multiagency sustainability framework in Colorado; effective noise barriers in North Carolina; Delaware's use of recycling materials and techniques; sustainability in airspace system planning; and more.

INTRODUCTION

Transportation's Roles in DISASTER RESPONSE

The Transportation Research Board established the Task Force on Logistics of Disaster Response and Business Continuity in 2012. The mission of the task force is to provide a forum to initiate and facilitate discussion, feedback, and exchange between the different parties involved in the various aspects of disaster relief and humanitarian aid logistics—from academia, industry, all levels of government, the military, research, nongovernmental organizations, and U.S. and international relief agencies.

The need for this dialogue is readily apparent in the response to the many natural disasters that have occurred in the past few years—for example, the 2011 earthquake and tsunami in Japan and Superstorm Sandy, the deadliest and most destructive hurricane of the 2012 Atlantic season and the second-costliest in U.S. history. The feature articles, minifeatures, and sidebars in this issue of *TR News* provide snapshots of the many parties involved in transportation's role in disaster relief and business continuity—their well-researched initiatives, improvements, collaborations, insights, and the steps ahead—to stimulate interest in this topic, as well as participation in the ongoing efforts of the task force.

—Jon S. Meyer, Chair
Task Force on Logistics of Disaster Relief and Business Continuity

Appreciation is expressed to TRB Senior Program Officers Joedy W. Cambridge, who retired in May, and Scott Brotemarkle for their work in developing this issue of *TR News*. The magazine's editorial board salutes Cambridge for her work in coordinating a variety of theme issues on marine, freight, and transportation security topics and in recruiting many additional feature articles during her TRB career.

Improving Postdisaster Humanitarian Logistics

Three Key Lessons from Catastrophic Events

JOSÉ HOLGUÍN-VERAS, MIGUEL JALLER, AND TRICIA WACHTENDORF

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Publisher's Note: *Holguín-Veras is a 2013 recipient of a U.S. White House Champion of Change Award for "exemplary leadership in developing or implementing transportation technology solutions to enhance performance, reduce congestion, improve safety, and facilitate communication across the transportation industry…."*

Catastrophic events such as the 2004 Indian Ocean tsunami, Hurricane Katrina in 2005, the 2010 Port-au-Prince earthquake, and the Tohoku tsunami in 2011 reinforce the critical importance of postdisaster humanitarian logistics (PD-HL), not only in transporting and distributing supplies to the affected populations but in the larger response effort. Conducting efficient and effective PD-HL operations in the aftermath of such events is a huge challenge.

The world today is embedded in complex sociotechnical systems—networks of individuals conducting technical activities through a set of supporting systems, such as transportation, communications, and finance. The impacts of a catastrophe on these components and systems are severe, as individual members of the social networks may be killed, injured, or displaced; the equipment and materials needed to conduct the technical activities may be destroyed or may lack the necessary inputs to run; and all of the supporting systems are likely to be inoperable or to function at a fraction of their normal capacity.

Catastrophic events present other unique and notable challenges. In the aftermath, large and dynamically changing volumes of critical supplies must be transported in a short time; great uncertainty prevails about the needs for critical supplies; the ability of the local civic society to organize a response is compromised; large portions of critical local assets are destroyed; and huge flows of nonpriority donations arrive at the site, distracting resources from more critical tasks (*1–3*).

Moreover, a poor understanding of catastrophes affects the nature and efficiency of a response. Because catastrophic events are rare, only a minuscule percentage of responders have experience in postcatastrophe logistics and operations. In addition, the events are extremely dynamic and can quickly transition from stage to stage. Lastly, catastrophes are extremely difficult to study—travel to the area is required soon after to observe the unfolding response.

Fieldwork that has spanned such catastrophic events as the September 11, 2001, terrorist attacks on the World Trade Center, Hurricane Katrina, the Port-au-Prince earthquake, the Tohoku tsunami, the Joplin tornados, and Superstorm Sandy has yielded definite lessons. The focus here, however, is on the top three lessons learned from the Port-au-Prince

Photo: Samuel Morse, U.S. Air Force

Flooding at the Sendai Airport near the site of the March 2011 Tohoku tsunami.

and the Tohoku responses. These two events provide complementary lessons leading to a unified and comprehensive set of suggestions for improvement (*4–6*).

Lesson 1. Disasters and catastrophes are not the same; be ready for both.

Disasters of all sizes leave trails of destruction and human suffering that defy easy description or categorization. Individuals and families can experience impacts that are disastrous or catastrophic on a personal level; nevertheless, disasters are defined from a sociological and not from a personal perspective—the focus is on how communities and societies can best prepare for and respond to extreme events.

PHOTO: OXFAM

Pallets of water treatment gear are loaded onto an Oxfam aid flight to Haiti after the 2010 earthquake in Port-au-Prince.

Defining Terms

Although the appropriate definition is a subject of debate (*7*), a disaster can be understood as "a nonroutine event that exceeds the capacity of the affected area to respond in a way that saves lives, preserves property, and maintains the social, ecological, economic, and political stability of the affected region" (*8*). In contrast, a catastrophe is "a high-consequence event that generates widespread and crippling impacts, [so that] the ability of the impacted society to respond is severely compromised" (*2, 9*).

The typical impacts of disasters and catastrophes are summarized in Table 1 (below). In disasters, the local capacity to respond is viable and depends on the state of the civic leadership, the availability of critical supplies, and the capacity to mobilize and distribute critical supplies. The response effort has access to multiple entry points in the disaster area, and the local distribution effort is simpler than in a comparable catastrophe.

In short, the local civic society is able to provide a meaningful first wave of resources in response to a disaster. Outside help complements the local effort beyond the initial 24 to 48 hours, as outlined in the National Response Framework (*10*).

By contrast, a catastrophe is likely to have had an impact on the local leadership, which may be unable

TABLE 1 Comparison of Impacts: Disasters Versus Catastrophes

Characteristic	Disaster	Catastrophe
Leadership of civic society	Typically survives the disaster and is able to lead the response	In most cases, severely affected and unable to lead an effective response
Local stocks of supplies in businesses and households	Only partly destroyed; the surviving supplies may become part of the response	Mostly destroyed; the role of local supplies in the response is minimal
Demand for supplies	Increases with the needs of businesses, people, and the response; precautionary or opportunistic buying could be a problem	Huge increases because of the magnitude of the impacts; precautionary or opportunistic buying could be a problem in nearby areas
Private-sector supply chains	Partly impacted but functional, could help in response	Severed, destroyed, cannot help in response
Number of points of entry to the disaster area	Multiple points of entry provide responders with alternatives to enter the area	Only a few points of entry, complicating distribution efforts
Complexity of the local distribution effort	Challenging but manageable	Exceedingly complex, because of the size of the impacted area and the personnel required
Material convergence of nonpriority supplies	A nuisance that can be controlled	A major problem that distracts significant amounts of resources from critical tasks
Net result	Local help is key in initial days; outside help brings additional supplies	Outside help is the primary source of supplies

Collaborative aid networks such as Caritas—here providing assistance to Congolese residents displaced by war—are well-suited to respond to emergency events.

Photo: Taylor Torka/Caritas Goma

to lead the civic society and to organize aid efforts. The material capacity to respond is likely to be severely compromised—local inventories of critical supplies are usually destroyed or out of reach, and the companies that manage local supply chains for critical supplies are unable to function. Moreover, the demands for the impacted population and for the response itself are much more intense than after a disaster; as a result, the local civic society cannot provide the first wave of resources.

Manning the Distribution

The most challenging component in the response to a catastrophic event is the local distribution of critical supplies at the points of distribution (PODs). This activity is relatively simple in disasters but in catastrophes is hugely complex, because of the large geographic areas to be served; the large number of PODs to be established, manned, and supplied; and the severe impacts on the transportation and distribution networks (*11*).

In the immediate aftermath of the Port-au-Prince earthquake, for example, manning and supplying the 150 to 200 PODs required 20,000 to 25,000 volunteers—approximately the size of an average U.S. Army division, which needs three to four weeks to deploy. In catastrophes that have an impact on large urban areas, therefore, the resources to man and supply the PODs cannot be provided by outside sources; only the local social networks can address the monumental challenge.

Lesson 2. Control material convergence and precautionary or opportunistic buying.

Material convergence—the spontaneous flow of supplies, donations, and equipment to the disaster area—is a unique, overlooked, and poorly understood phenomenon (*3, 11, 12*). The convergence contributes much-needed supplies, along with an astronomical amount of useless and inappropriate items, such as wedding gowns, used clothing, expired medications, and a range of products that have failed in the marketplace.

Material convergence comprises three groupings (*2, 13*):

1. High-priority supplies for immediate distribution and consumption,
2. Low-priority supplies that are not immediately needed but could be useful later, and
3. Nonpriority supplies that are not of any practical use.

Nonpriority items often are termed "in kind" and "unsolicited" donations, but in-kind and unsolicited donations can be useful; a large portion of the international aid that arrived at Haiti was both in-kind and unsolicited, as international donors sent critical supplies without being asked by the Haitian government.

The impacts and problems associated with material convergence were first identified almost a century ago (*3, 11, 12*). Recent rough estimates indicate that

about 5 to 15 percent of the cargo arriving at the site consists of high-priority supplies, about 25 to 35 percent are low-priority supplies, and nonpriority supplies make up a staggering 50 to 70 percent.

Controlling Nonpriority Supplies

The flow of nonpriority supplies is the most problematic component of material convergence. Nonpriority supplies consume resources that could be applied to more important tasks, create major complications to the response, and offer little to help the survivors or the response. Disaster responders refer to the flow of useless, nonpriority goods as "a second-tier disaster" (*14*). These supplies "often complicate unnecessarily the logistics of relief operations," "frequently… have not been asked for," "do not respond to the needs of the affected population," "lead to a waste of time and resources," "are useless or irrelevant," and "should be discarded as soon as possible…to make room for useful supplies" (*3, 11, 13*).

Research suggests that the media's portrayal of needs—mostly subjective and based on what is considered newsworthy—can generate nonpriority supplies (*3*). Moreover, vehicles carrying nonpriority supplies can clog the entry points to the area and usually require longer inspection times because of poor documentation. These vehicles often do not have a consignee and circulate until locating someone willing to receive the cargo; failing that, some drivers may dump the loads, creating health hazards.

Proactive Steps

Proactive steps are needed to increase the net benefits from material convergence by maximizing high- and low-priority flows and minimizing the negative impacts of nonpriority supplies. Disaster plans should explicitly consider material convergence—this is a critical first step. Second, strategies must be developed to reduce nonpriority flows. This may require education efforts aimed at potential donors, the media, and local leaders (*15*). Access controls should expedite the traffic of high-priority supplies, reroute low-priority supplies to storage locations, and prevent nonpriority supplies from reaching the affected area (*2, 3, 11*).

Precautionary or opportunistic buying is another behavior that affects disaster response, particularly in surrounding areas. Anticipating shortages, individuals and businesses rush to purchase critical supplies of food, water, fuel, and electricity generators. This removes from the market critical supplies that are best positioned—in terms of proximity—to help the survivors and the response itself. Rationing of critical supplies or other forms of demand management would be beneficial to the response. Before a disaster, the private sector should be engaged to facilitate these procedures.

Lesson 3. Integrate the civic society in disaster preparation and response efforts.

Effectively integrating the civic society into all facets of the disaster cycle, particularly in the preparation and response, is probably the most important lesson. Examples from Haiti and Japan illustrate this critical point (*4–6*).

Tapping into Networks

After the Port-au-Prince earthquake, large and experienced international organizations had problems distributing critical supplies to survivors. The massive amount of aid that arrived in Haiti piled up at the port and airport and did not reach the population in need with the speediness required by the circumstances. Even the United Nations was unable to find trucks to transport supplies (*4*).

This crisis of connectivity started when the earthquake effectively decapitated the local leadership. When the massive flow of aid arrived in Haiti, the international relief groups could not connect with local leaders. Without the leaders' connections to local truckers and social networks, the relief groups attempted to distribute the supplies themselves, but because of personnel constraints, the agencies could open far fewer PODs than were needed to serve nearly

United Nations Photo by Sophia Paris

Young residents of a temporary camp in Léogâne, Haiti, distribute water from a truck. The United Nations created a registry of local truckers in Haiti to implement the efficient flow of aid and supplies.

2 million beneficiaries. The crisis subsided two weeks later, when the United Nations created a registry of local truckers, opening access to local equipment, personnel, and know-how.

Collaborative aid networks (CANs) were able to put in place efficient and effective PD-HL operations. CANs are large social networks established for other purposes; two notable CANs in the Haiti relief efforts were the Servicio Social de Iglesias and CARE–Caritas RD, the social arms of the evangelical and the Catholic churches, respectively.

The CANs were able to undertake PD-HL with efficiency and ease, through large networks of committed volunteers already on the ground. Haiti and the Dominican Republic have an estimated 30,000 Catholic and evangelical churches; each church, a node in the larger network, has a leader and followers with strong connections to the rest of the CAN, increasing resiliency.

Moreover, because the CANs are spread out in the disaster area, they are ideally positioned to become the backbone of the local distribution effort. Intuitively, the leaders understood this, mobilized their networks, and used many of the churches as PODs, organizing the local population and the PD-HL effort effectively.

Private-Sector Resources

The response to the Tohoku tsunami provides important lessons in integration with the private sector. The PD-HL operations after the tsunami did not go well. The nuclear crisis consumed almost all of the government's attention while the humanitarian crisis gathered momentum.

The PD-HL operation started almost a week late, after members of parliament angrily complained; the government asked the Self-Defense Forces (SDF) to distribute critical supplies to survivors. The government refused offers of assistance from several private-sector companies, however, citing a lack of fuel for the return trips—although the SDF could have brought in fuel for this purpose.

Meanwhile, the commercial supply chains that routinely transported supplies to the impacted and surrounding areas followed usual procedures after a disaster and stopped deliveries until conditions could be assessed; this deprived both areas of much-needed supplies and aggravated the humanitarian crisis. At this critical juncture, a few food and retail companies ignored the warnings and took the initiative to deploy hundreds of trucks loaded with food, water, and other supplies to avert the humanitarian crisis.

This example provides a potent argument for effectively integrating private-sector input and resources in PD-HL preparations and response procedures. Private-sector companies produce and transport supplies, own transportation assets, and have the local knowhow that can make a difference in the aftermath of a large disaster or catastrophe.

Photo: Matthew Bradley, U.S. Navy

A Japan Maritime Self-Defense Force (SDF) sailor participates in cleanup efforts after the Tohoku tsunami. Exclusive SDF efforts faltered until supplemented by private-sector initiatives.

TABLE 2 Key Findings and Policy Implications (*17*)

Goal	Findings	Policy Implications
Integration with civic society	• Lack of pre-established links prevents the advantageous involvement of private sector, CANs, and the rest of civic society • Lack of designated leaders of PD-HL produces confusion and inefficiencies • Difficulties integrating outside help lead to major coordination problems, duplicated efforts, and unmet needs • Lack of training and of realistic exercises fails to involve the civic society	• Integrate private-sector groups, reputable CANs, and other key groups that could contribute to a logistics committee • Designate a point of contact for PD-HL with good relations within the civic society • Facilitate the integration of outside help—for example, divide the area into small districts to be assigned to outside groups • Develop exercises to train potential participants in PD-HL
Response plans	• Usually not suitable for large disasters • Do not consider catastrophes • Operations listed in plans are not scalable • Do not explicitly consider PD-HL	• Consider multiple scenarios for catastrophic events covering multiple jurisdictions • Design scalable response functions • Plan PD-HL operations in detail
Relief distribution and donations management	• In catastrophes, the bulk of supplies must be brought from outside the disaster area • Local distribution is a major challenge • Critical resources, such as fuel, are lacking • Excessive donations of low- and nonpriority supplies create problems • Precautionary or opportunistic buying is a major challenge	• Preposition supplies in lower-risk but nearby areas • Plan for local distribution • Ensure resources are available • Proactively engage the media to advise the public on how to help; make plans to control access to the disaster area • Proactively manage donations • Control precautionary or opportunistic buying via rationing or educational campaigns and agreements with private sector
Assessment and communication	• Lack of technologies to assess damage to infrastructure and impacts on population • Lack of communication and other supporting systems that operate in disaster environments	• Use satellite imagery, remote sensing, and geographic information systems for infrastructure assessment • Preposition communication equipment, such as satellite phones and generators

Integrating Key Segments

The experiences of Haiti and Japan underscore the benefits of integrating key segments of the civic society into disaster preparations and response procedures. In both cases, elements of the civic society stepped up to fulfill a need without any instructions or clear idea about how to proceed, without coordination with the public sector, and without practice or training.

The efficiency of PD-HL operations after catastrophic events could increase greatly with a structure that incorporates participation by various components of the civic society. Such simple steps as designating local nodes from the CANs to serve as PODs, training local leaders and members in first aid and disaster response procedures, and the like, could lead to a better prepared citizenry, enhanced community resiliency, and a more efficient PD-HL process.

Similarly, private-sector representatives could be engaged as part of a PD-HL committee, which would be activated as needed. Their know-how, contacts, and resources could make a critical difference to the populations affected by a large disaster. Companies involved in the trade of critical supplies with both a regional and a local presence are best positioned to help, as they have access to regional resources and know local conditions.

In the aftermath of Hurricane Sandy, the New York–New Jersey region received far more donated clothing than was needed; many months after the storm, piles of clothes still waited to be sorted.

Photo: Liz Roll, Federal Emergency Management Agency

Enhancing Readiness

Jurisdictions at risk of catastrophic events must take appropriate actions to implement the guidelines in the National Response Framework and to enhance readiness. FEMA's grants to foster planning for catastrophic events are a worthy first step (*16*). Table 2 (page 9) summarizes the chief findings of the authors' research encompassing several disasters, along with the key policy implications.

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Humanitarian Relief and Broken Supply Chains

Advancing Logistics Performance

JOHN T. (JOCK) MENZIES III* AND OMAR (KEITH) HELFERICH

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***Publisher's Note:** John (Jock) Menzies III died August 17, 2013, after sustaining critical injuries in a cable car accident near Arnold, Maryland. An article in the online* DC Velocity *noted that Menzies had "transformed the way the logistics community, relief organizations, and individuals respond to natural disasters around the world."*

Natural and human-made disasters inflict terrible casualties, destroy property, and disrupt the normal flow of life and commerce. The Haiti earthquake of 2010, for example, took the lives of an estimated 220,000 people. In 2005, Hurricane Katrina resulted in 1,836 deaths and damage in excess of $100 billion in the United States. Superstorm Sandy this past October again made clear that extreme events are likely to cause supply chain failures such as shortages of transport, facilities, and supplies.

On December 14, 2012, the Supply Chain Resilience Project of the Regional Catastrophic Preparedness Grant Program conducted a strategic capacity exercise in Washington D.C. The tabletop evaluation confirmed the potential for supply chain failures as a result of a major disaster event and highlighted the probable failure of the water and wastewater network; noted that the damage to transport capability, coupled with hoarding, would suppress food resupply; and indicated that hoarding and unanticipated demand would severely affect the supply of pharmaceuticals.

According to the United Nations, the global demand for humanitarian assistance will continue to rise because of conflicts and a dramatic increase in vulnerabilities caused by financial crises, food scarcity and pricing, insufficient energy and water, and the increased severity of disasters—in part the result of population growth and urbanization.

Emergency relief comprises a spectrum of interventions. The services provided during relief operations recognize the basic hierarchy of needs for survival, including medicines, food, water, shelter, clothing, and—in many situations—mental health assistance.

Emergency relief practices also can be examined from the viewpoint of continuity management. Table 1 (next page) reviews the process for continuity management, described in a white paper produced for the Council of Supply Chain Management Professionals after the September 11, 2001 (9/11), terrorist attacks.

Critical Challenges

The timely delivery of goods and services is crucial to effective disaster response. In addition to Hurricane Katrina and Superstorm Sandy, recent examples include the 2004 Asian tsunami; the 2009 earth-

UN Photo by Tim McKulka

Sudanese war refugees receive emergency food aid distributed by the World Food Programme. According to the United Nations, the global need for humanitarian assistance will continue to rise.

TABLE 1 First Four Steps in Each Phase of Humanitarian Logistics Relief

Planning	Mitigation	Detection	Response	Recovery
1. Establish planning team. 2. Analyze capabilities and risks. 3. Develop charter and relief plan. 4. Implement relief plan.	1. Define mitigation opportunities. 2. Develop mitigation plans. 3. Initiate development of mitigation programs. 4. Establish a continuous improvement process.	1. Develop a detection plan. 2. Acknowledge major risks and warnings. 3. Evaluate and act on information and observations. 4. Determine corrective actions and improvements.	1. Review and implement a response plan. 2. Evaluate direction and control. 3. Evaluate communications. 4. Evaluate safety, security and function of processes, property, and people.	1. Review and implement recovery plans and controls. 2. Ensure continuity of management. 3. Maintain worker and community support. 4. Resume sustainable operations.

quakes in Padang, Indonesia; the 2011 earthquake, tsunami, and nuclear power plant event in Japan; and the 2011 flooding in Thailand.

Field research has estimated that logistics account for 60 percent to 80 percent of expenditures by aid agencies. All of the stakeholders in a relief operation—donors, humanitarian relief organizations, governments, local nongovernmental organizations (NGOs), the military, and the private sector—are connected by a relatively fragile supply chain. The challenge is to create a flexible and adaptive supply chain for humanitarian relief in an increasingly uncertain world.

More complex disasters will require significantly enhanced responses. First, as societies become more interdependent, the supply networks become more complex and vulnerable. Second, the accelerating rate of advances in technology introduces unprecedented and unanticipated opportunities to interfere with human life, as through terrorist acts. Third, global power shifts and conflicts generate new threats.

Members of the U.S. Air Force 353rd Special Operations Group and of the Indonesian Air Force unload relief supplies after a 7.6 magnitude earthquake in Padang, Indonesia, in 2009.

Photo: Aaron Cram, U.S. Air Force

These trends intensify distinctive weaknesses in the humanitarian supply chain, such as decoupled finances, ambiguous objectives, limited resources, high uncertainty, extreme urgency, and political boundaries.

Commercial supply chains are also becoming more vulnerable through changes in business best practices, such as lean initiatives to support just-in-time deliveries, as well as through increased complexity and globalization. Most private-sector companies develop plans to protect against low-impact, recurrent risks but ignore high-impact, low-likelihood risks. Humanitarian organizations, in contrast, must face high-impact, low-likelihood risks somewhere every day; nevertheless, they rely on commercial supply chains to provide much of their support.

Exploring the Vulnerabilities

In the United States, relief agencies have been redesigning their processes continuously to improve performance. The Federal Emergency Management Agency (FEMA) and the American Red Cross (ARC) study and strive to implement appropriate supply network models and system solutions. The complexity and uncertainty of the events, however, challenge these preparations, as do the lack of human and financial resources for the supply chains.

Funding is usually decoupled from the response to an event; this can curtail swift humanitarian response. Funding systems and financial flows play an important role in humanitarian operations and affect the scope, speed, effectiveness, and efficiency of disaster response. Models of humanitarian supply chains often do not consider the constraints imposed by funding systems; when time is of the essence, a relief agency does not expect to be asked, "Who is paying for this?" or to be told, "First send a check."

The complexity of the situation—such as the magnitude of the event, the level of the threat to life, the impact on the infrastructure, the difficulty of

communications, or the stage of the event—may yield ambiguous objectives. Limited resources hamper assessments of the needs, as well as the ability to obtain the appropriate types and amounts of equipment and materials for search and rescue and for survival and recovery. Communications between the first responders are not always effective; this delays coordination among the many organizations on the scene that are ready to provide assistance.

The environment after a major disaster is usually rife with uncertainty about the status of the damage, even after the initial damage assessment. The urgency is acute for major events that require immediate search and rescue, encompassing basic survival needs such as triage and medical treatment, movement out of harm's way, and supply of water and food. Addressing these needs takes priority, with considerations of cost and resource efficiency secondary until the next stage of the relief effort. Reviewing awareness of the situation is critical at each phase of relief, because the priorities shift with the transitions from initial response to recovery.

A major event, by definition, involves multiple political boundaries. The challenges are obvious when a response effort spans countries, but can be complex even across county and parish boundaries—as was the case in the United States following Hurricane Katrina. The response to recent disasters continues to raise questions about the appropriate roles of business, government, and NGOs in supplying resources.

Improving Responsiveness

After the 9/11 World Trade Center attacks, many thought that an industry team could apply best practices and provide more effective and efficient preparation and response to major disasters. A team of representatives from several major corporations held discussions with NGOs and reviewed the challenges after a major disaster; the team concluded that industry alone could not supply the solution for disaster logistics response practices—a collaborative effort was necessary.

Humanitarian supply chains must be capable of launching a variety of services appropriate to the type of incident, with a potentially wide scope. NGOs and federal agencies prepare for disaster response during the year, but when a disaster occurs, the response must be immediate and must allow for large-scale operations in a relatively short time.

Maximum responsiveness—flexibility and agility—includes a capability to respond quickly to a range of needs for human resources, as well as for supplies and equipment. In all major disasters, the quick establishment of communications systems is critical. The responding organizations must maintain internal communications and must link to the incident command center, as well as to all major responding organizations.

For example, ARC's Disaster System for Human Resources can contact thousands of volunteers trained in various skills at differing levels at any time. During hurricane and high-alert periods, ARC's Advanced Logistics Emergency Response Teams or ALERTs are on call and ready to respond to the ARC national center within a few hours.

Comparing Networks

The humanitarian community generally agrees that its logistics lag behind those of the commercial sector. Commercial and humanitarian logistics networks have many similarities; both do the following:

- Operate within complex networks and require risk assessments,
- Manage rapid-response and demand-driven systems,
- Rely on collaboration and information-sharing to enhance agile response,
- Follow established processes for effective solutions,
- Address risk with a redundancy of resources, and
- Improve flexibility through the principle of postponement—meeting needs with a minimum amount of inventory—and through the deployment of multiple skills.

Photo: National Highway Traffic Safety Administration

Communications between first responders can aid coordination between the many groups on the scene of a disaster.

Photo: MTA New York City Transit

City Island in the Bronx, New York, was placed under a mandatory evacuation order during Superstorm Sandy. Agencies must be able to deploy large-scale operations, such as mass evacuations, on short notice.

Photo: Jason Colston, American Red Cross

Red Cross volunteers coordinate logistics of relief efforts in Queens, New York, immediately following Superstorm Sandy.

Research and experience, however, point to critical differences in the two types of networks, as presented in Table 2 (below).

The complexity of humanitarian disaster planning and response inevitably results in inefficient logistics and supply chain management. Nearly 30 percent of delivered materials are reported as wasted during a response to a disaster. Damaged infrastructure and the intermittent availability of electricity complicate local planning and the coordination of aid. As a result, relief efforts predicated on advanced methods and high-tech approaches may be ineffective during the initial hours after a disaster.

Advancing Humanitarian Logistics

Experience and findings from the literature and research indicate several areas of opportunities for the continuous improvement of humanitarian logistics. The similarities between commercial and humanitarian logistics suggest the value of increased collaborative efforts; the differences suggest that advances in humanitarian logistics cannot be achieved by adopting best commercial practices.

Moreover, disaster relief and development require greater coordination with supply chain risk management and risk reduction planning and prepared-

TABLE 2 Commercial and Humanitarian Logistics: A Comparison

Attribute	Commercial Networks	Humanitarian Networks
Business motive	Profit for stakeholders	Provide essential services to affected recipients
Operating mode	Uninterrupted	Interrupted
Metrics	Economic value added and balanced scorecard: cost, speed, quality, customer service, flexibility, sustainability	• Not well recognized; focus mostly on outputs instead of on outcomes from recipients' perspective • Shift with phases of event: during initial response, life-saving and support services are key, cost is secondary; during recovery operations, cost-efficiency gains importance
Operating environment	• Generally defined processes to achieve efficiency and effectiveness • Operate on continuum from initial decision, development, implementation, and operation of network; lean practices	• Less certainty and less definition of processes • Focus on humanitarian aid recipients—life saving and life support are initial priorities; costs become more of a concern in recovery phase • Space for humanitarian efforts is often less available, because of the number of areas of need
Supply chain segments	Direct link between financial and material flows	Financial and material flows are decoupled; identity of true customers is ambiguous
Risk	Assess risk through continuity planning; highest risk usually is the disruption of the global supply chain	Frequently the greatest risk is the "last mile," serving the recipient most affected by the disruption; failure can result in loss of life and prolonged human suffering
Uncertainty	Decisions under risk are likely, but usually with range of estimated certainty	• All segments of supply chain operate under uncertainty in disaster situations, demand frequently exceeds supply and capability—for example for food, water, transport, warehouse space, and communications • Demand and supply can change quickly—as with Hurricane Katrina, Superstorm Sandy, and Japan tsunami
Asset availability	Initiatives include planning for logistics assets	Finding assets in and near the impact area is frequently difficult; nonprofit American Logistics Aid Network (ALAN) assists nongovernmental organizations to locate assets
Alert for logistics services	Initiatives base need on an approved plan	• Some disaster events such as hurricanes allow a few days for planning, but sometimes only hours or, in the case of tornadoes, a few minutes; often no alerts for intentional acts of destruction • Disaster logistics must be able to respond in "organized chaos" with little or no advance warning

ness during nondisaster periods. Table 3 (below) summarizes areas for research and initiatives to advance the state of humanitarian logistics.

Continuous Improvement

Research is needed for the distribution planning and the control of humanitarian logistics processes. In particular, accessible planning techniques are needed for relief workers confronting a disaster.

Disaster planning and response take place in a limited environment. An initial response may demand a basic, low-tech approach with planning techniques that complement other high- and low-tech tactics and that are relatively easy for inexperienced individuals to employ until additional resources become available. Research suggests that tools that are less resource-dependent are available to facilitate on-site planning and response.

For example, a managerial approach known as Lean Six Sigma (LSS), developed in 2002, includes planning and response tools that could be applied to disaster relief. LSS tools can assist organizations in becoming effective and resilient in supply chain management and therefore could assist in resolving the challenges of humanitarian logistics.

Applying LSS system tools appears to be practical and useful in disaster response, with proper planning and preparedness. LSS offers two major methodologies:

1. Define, measure, analyze, improve, and control (DMAIC), which parallels the Deming cycle of plan, do, check, and act and is used for improving processes already in place; and
2. Define, measure, analyze, design, and validate, a method for designing new processes.

Interest in using these methods to design and plan critical services such as logistics is increasing. Few studies, however, have connected LSS methods with humanitarian logistics. The sidebar on page 17 provides the results of an application of LSS contin-

TABLE 3 Potential Improvements to Disaster Logistics Management

Potential Area	Description of Improvement
Disaster performance metrics	• Develop metrics focused on outcomes; for example, percentage of items reaching beneficiaries, donation-to-delivery cycle time, and financial efficiency and cost of providing goods to beneficiaries. • Develop longitudinal metrics for sustainable solutions; for example, metrics addressing quality of life, such as longitudinal profiles of family health; social and economic metrics from the medical and social sciences. • Apply balanced scorecard approach for outputs and outcomes.
Disaster information management and process standardization	• Adopt end-to-end and real-time information management systems. • Address the difficulty field workers have in gathering accurate information while working under time pressures and in extreme circumstances. • Implement process standardization and pipeline visibility; American Red Cross has a system for all human resources and a system for procurement. • Develop standard process mapping across the supply chain to eliminate delays and errors in the order cycle. • Establish corporate social responsibility programs to involve the private sector. • Explore crowd sourcing as an emerging opportunity. • Integrate geographic information systems tools with crowd sourcing to increase visibility and situational awareness.
Disaster continuous process improvement (CPI) using Lean Six Sigma (LSS) methods	• Apply CPI to improve project efficiency and effectiveness; promising applications include chapter logistics planning, collaboration among Voluntary Organizations Active in Disaster, and balanced scorecard metrics. • Use LSS tools in generating plans, implementing process improvements, setting priorities, and assessing risks. • Apply CPI to ensure the flow of funding and voluntary efforts to sustain humanitarian initiatives.
Disaster management systems	• Develop information technology and systems for in-field transactions and tracking across a complex, humanitarian supply network; investigate use of a private-sector system, with costs shared by the response community. • Maintain a knowledge base for disaster response, to be shared among responding agencies and organizations.
Disaster management resources	• Address problem of limited resources—for transport, handling, and storage—by coordinating through organizations like ALAN, as appropriate. • Consider working with faith-based and other organizations that have facilities for feeding and sheltering, as well as trained staff and volunteers, and formal members of the primary disaster NGOs' response and recovery team. • Collaborate with FEMA and commercial organizations such as logistics companies for special transport and handling equipment.

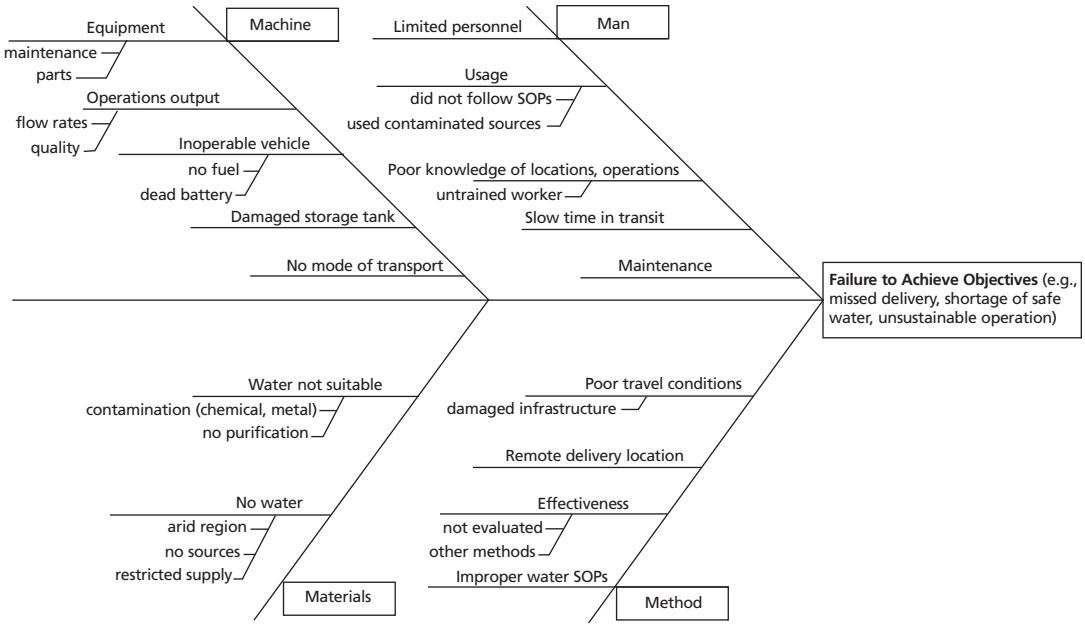

FIGURE 1 Humanitarian relief: example cause-and-effect diagram. (SOPs = standard operating procedures.)

uous improvement models to a humanitarian initiative providing clean water to poverty-level families in the Dominican Republic. The pilot used several LSS tools, including DMAIC, cause-and-effect diagrams, checklists, process flow charts, control plans, activity networks, and audit guides. Figure 1 (above) and Table 4 (below) present examples of Six Sigma methods applied to a humanitarian initiative.

Achieving Best Practices

As noted earlier, humanitarian supply chains lag behind the private sector in technology implementation, best practices, and operating efficiency. Inherent differences account for some of this lag, but humanitarian logistics decision makers either have not yet recognized the importance of newly introduced tools and approaches or—more likely—lack the staff and financial resources for implementation.

The lack of standardized or universally accepted metrics also hurts humanitarian organizations, as they have difficulty knowing their finances to the degree of granularity that their commercial counterparts have achieved. This limitation affects the entire humanitarian supply chain—how the operations are managed, controlled, and continuously improved. Humanitarian logistics is a fertile area for process improvement with LSS and related tools.

TABLE 4 Example Failure Modes and Effects Analysis for Humanitarian Relief

Process Function Requirement	Potential Failure Mode	Potential Effect of Failure	Potential Causes and Mechanisms of Failure	Process Control	Recommended Action
Provide safe drinking water	Unsafe water	Smell, sickness, and disease	Contamination; poor water treatment	None	• Filter the water; improve quality control of water supply • Invest in treatment facility or filter devices
Store water for safe drinking	No storage or limited storage	• Supply of water but no space • Scarcity, loss, or leakage • Contamination • Sickness, disease	• Damaged or destroyed storage structures or containers • Leaks, theft • No cover or protection	• Use an open well and temporary storage • Guard or monitor the storage	• Build or acquire water storage tank for the community or for individuals • Use inexpensive filter and storage device
Distribute safe drinking water on time	Missed delivery	Water shortage	• Impassable routes • Transport unavailable	Delivery by truck	Change delivery mode (e.g., to cart and horse, pipeline, air drop)

Humanitarian Clean Water Initiative in the Dominican Republic

Summary of a Sustainability Pilot

JOHN T. (JOCK) MENZIES III AND OMAR (KEITH) HELFERICH

Humanitarian relief has broadened its focus from particular response situations to the strategic—that is, how best to operate a sustainable network. Many corporations build a culture of sustainability by establishing standards of performance and implementing continuous process improvement (CPI). CPI was applied in the support of a humanitarian initiative to provide safe water in the bateys—the sugar mill company towns—of the Dominican Republic. The goals were to improve project efficiency and effectiveness, ensure funding flow, and stimulate voluntary efforts to sustain the project throughout its expected span.

CPI provided the following benefits:

◆ Long-term, in-field availability of products and services through proper installation and maintenance training;

◆ Measurable medical, educational, economic, and social improvements in recipient households; and

◆ Stakeholder collaboration to improve products and services.

The project provided a biosand filter for safe water to households in the region of La Romana in the Dominican Republic. The CPI method followed the typical Six Sigma or Deming cycle process.

Define and plan. Deliverables at the first stage included the project charter, the project plan, a process chart for the initiatives, and a template for achieving continuous improvement for clean water initiatives.

Measure and do. Deliverables included the following:

◆ Write protocols for the clean water procedures.

◆ Develop, test, redesign, and translate into Spanish the surveys and guidelines for installation, baseline household health, education, economic and community activity, and a six-month follow-up.

◆ Collect and analyze data with Survey Monkey and Microsoft Excel to demonstrate sustainability.

◆ Install filters in households, conduct surveys, and enter the data into Survey Monkey.

◆ Conduct surveys of filter locations after six months of operation to determine the impact on family profiles—health, education, economics, and community activity.

Analyze and check. The tools were used to guide activities and collect information about performance:

◆ Evaluation of electronic versus paper surveys for primary data collection;

PHOTO: LIVING WATER INTERNATIONAL, WWW.WATER.CC

Initiatives to provide safe water to developing countries can benefit from continuous process improvement.

◆ Review of the filter performance after six months;

◆ Review of the impact of clean water on family profiles: health, education, economics, and community; and

◆ Identifying issues for further development, using a cause-and-effect diagram.

Results indicated that more than 90 percent of the filters maintained flow rates in the target range of 500 milliliters (ml) to 800 ml per minute. Medical incidents declined during the six months after the use of the clean water, and the number of school days missed also declined. Some discontinued the program because the water tasted salty, or they did not trust the technology, or they believed the water was not suitable for very young children.

Improve, act, and control to achieve sustainable process improvement:

◆ Guidelines for installation and performance audits need to be simplified further and completed in Spanish.

◆ A checklist for the ongoing use of CPI methods for clean water iniatives will be provided to the primary stakeholders.

The methods met the steps and objectives of the World Health Organization–UNICEF Report for Monitoring and Evaluating Household Water Treatment 2012. The most successful results were in areas with a resident paid to check on households, answer questions, resolve minor maintenance issues, and report to the primary stakeholder each month.

Acknowledgment

The authors thank key stakeholders for their support of the pilot sustainability initiative, including Good Samaritan Hospital, the Safe Water Team, Wolverine Worldwide, Cascade Engineering, Universidad Central del Este, and Supply Chain Sustainability.

Building Resilience in Community Recovery

Overcoming Supply Chain Performance Challenges in a Crisis

CHARLOTTE FRANKLIN

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At the local level, the traditional approach to resource management for recovery from a disaster has addressed private businesses in a conversation that begins "Here's what you can do for us." But this government-centered approach to emergency planning has an inherent weakness—it focuses on resource management as an inventory issue.

In contrast, approaching disaster recovery resource management as a supply chain issue focuses on the delivery of critical supplies to citizens more quickly and more efficiently. With this approach, local government initiates the conversation with private businesses by asking, "How can we clear the way for the delivery of emergency resources?"

Businesses already have the expertise and processes in place to move supplies into the community; they are the experts in recovery and continuity. The types of supplies that are needed may change depending on the effects of the disaster, but the delivery and distribution challenges remain consistent. The goal is to enable a fast, smooth transition from the supply chain's normal, cost-efficient function to the life-saving focus needed in a crisis.

Timing is the most important component of any local government's approach to disaster planning. Plans for supply chain involvement must be in place well before an emergency occurs. Government must stand ready to clear the way for private businesses to deliver disaster recovery resources quickly and efficiently, so that lives and businesses can return to normal.

Resource Management Lessons

The middle of an emergency is too late to start planning—the need is for doing. The current approach to recovery resource management therefore is not working. In this context, the following observations apply:

◆ During the period when response is the priority, the delivery of short-term recovery resources into the community will experience delay at some point. If short-term recovery could start immediately, the right supplies could already be on the way during the response phase.

◆ The private sector and the nonprofit sector are participants, whether invited or not. Local emer-

PHOTO: ANDREA BOOHER, FEMA

North Dakota residents prepare for flooding of the Souris River. A plan for implementing a supply chain approach is necessary before an emergency occurs—although businesses have experience and inventory, delivery and distribution are challenges.

Photo: Jocelyn Augustino, FEMA

Federal, state, local, and nongovernmental agencies at the City of San Antonio and Bexar County Emergency Operations Center in Texas coordinate activities in preparation for Hurricane Ike in 2008.

gency managers therefore could work with both sectors before an event to prepare for and address regulatory and policy obstacles that may impede full and successful participation. Emergency managers are less available during the chaotic phase immediately after a major event; therefore on-the-ground situational awareness could be established before an event to allow the private and nonprofit sectors to operate independently, efficiently, and effectively.

◆ When an incident disrupts normal operations, the supply chain abruptly shifts into an emergency mode, in which everything changes, including objectives, commodity flow, the balance of demand, decision-making procedures, the repetition of established cycles, and the choices of supporting infrastructure. The mechanics of these shifts can be examined in developing new approaches (*1*).

◆ Community resiliency can be measured only after an incident by the length and efficiency of the recovery time. A resilient community will recover faster and will return to the new normal more effectively than one that is not. Local emergency management therefore needs to make supply chain resiliency a priority, not an after-the-fact solution.

◆ Recovery resource conversations have focused on inventory and warehousing. Yet emergencies are unpredictable; the needs, quantities, and affected populations and locations vary; and the destruction may affect the safe storage of resources, complicating the preplanned deployment of inventory and warehousing. Shifting to a supply chain model introduces adaptability, which allows the delivery of recovery resources to be preplanned and managed, from point A to point B.

◆ The for-profit supply delivery systems actively intersect with the nonprofit services at work in the community, daily delivering food, medical services and supplies, water, and shelter—for example, food chains donate nearly-out-of-date food to food pantries every day. The new approach to recovery resource management could leverage this point of intersection and avoid reinventing a process that already works.

These observations are true wherever a disaster may occur. The concepts can be examined to determine what actions can be taken and what tools can be designed to address the dilemmas of recovery resource planning.

Program Actions

In Fiscal Year 2013, the Arlington County Office of Emergency Management, on behalf of the Northern Virginia Emergency Response System (NVERS), began implementing a supply chain–focused partnership between local government and private businesses:

◆ Locations are being determined for the drop-off and distribution of disaster recovery resources. By

Summit Explores Lessons from Supply Chains

On January 30–31, 2013, the Arlington County Office of Emergency Management successfully completed a two-day Local Supply Chain Capacity in a Crisis Summit Exercise. The summit addressed a new approach to improve disaster planning by working through the supply chain. With speakers and panelists from the public and private sectors, as well as from nonprofits, program discussions centered on the challenges and solutions related to the development of a local supply chain approach to disaster resource planning.

Thad Allen

U.S. Coast Guard Admiral Thad Allen (retired) keynoted the first day's program. Panelists examined issues that confront the transportation, communications, and power infrastructures in the delivery of resources for community recovery. Presentations focused on real-world experiences and defined the critical components for solutions addressing recovery challenges.

Charley Shimanski

The keynote speaker on the second day was Charley Shimanski, Senior Vice President of Disaster Services for the American Red Cross. Panelists examined supply chain issues in the delivery of financial services, medical supplies, and other vital resources. The presentations explored how to create a successful supply chain solution that expedites the delivery and distribution of resources.

Charlotte Franklin, Deputy Coordinator of Arlington County's Office of Emergency Management, noted the importance of understanding what happens in the supply chain when "normal" abruptly shifts to "emergency."

"Supply chain modeling is more flexible and can adapt more readily to supply-and-demand shifts that occur when a disaster strikes," Franklin observed. "The goal is to develop salient, supply chain–focused recommendations and remedies for disaster resource planning."

A report with recommendations for local supply chain capacity has been published,[a] drawing on discussions from the summit, which was funded through the Regional Catastrophic Preparedness Grant Program of the Federal Emergency Management Agency, U.S. Department of Homeland Security.

[a]http://recoverydiva.files.wordpress.com/2013/06/arlingtonsummitreport_finalrev.pdf.

using the distribution paths already in place in every community, resource providers and local governments can rely on food pantries, medical dispensing sites, temporary shelters, and organizations such as Goodwill and the Salvation Army to help receive and distribute critical supplies and to help manage donations.

◆ A Public Recovery Resource Access Portal is in development on the web, and a major project will add map layers and expand usability across jurisdictions. The online resource provides real-time updates to help businesses and the general public know where to donate and receive supplies during a disaster. The portal design is easily adaptable to any jurisdiction. Funding is through an Urban Areas Security Initiative grant from the U.S. Department of Homeland Security Federal Emergency Management Agency (FEMA). Documentation to assist jurisdictions in developing their own public access portals is in process through a grant from the Rockefeller Foundation's 100 Resilient Cities Centennial Challenge.

◆ A Regional Catastrophic Resource Planning Summit Exercise convened January 30–31, 2013, in Arlington, Virginia (see sidebar at left). Participants included grocers, retailers, supply chain experts, representatives from financial institutions and medical suppliers, and stewards of the critical infrastructure that supports their activities. Private-sector representatives, staff from Information Sharing and Analysis Centers[1] (ISACs), and local emergency managers worked together to develop tangible, before-the-event remedies that every community can apply to mitigate the impact of a disaster on the distribution and delivery of goods and services. Recommendations from the summit, which was funded by FEMA's Regional Catastrophic Preparedness Grant Program, are available to all communities as a guide for a supply chain–focused approach to emergency preparedness.[2]

Risk and Flexibility

Almost all decisions incorporate uncertainty about the future. The assessment of uncertainty and the risk inherent in these decisions can be critical, especially in a disaster (2). Providing the real-time, granular information required for sense-and-respond situational readiness can help assess risks when information about future events or the effects of events is incomplete and imprecise.

Risk analysis is the main tool for dealing with uncertainties. Without proper information or the

[1]www.isaccouncil.org.

[2]http://recoverydiva.files.wordpress.com/2013/06/arlingtonsummitreport_finalrev.pdf.

ability to perform real-time monitoring, strategy and risk analysis cannot be fine-tuned and complete for making predictions. Risk is related to a lack of knowledge about the future; the more information available, the more is known and the less the risk.

Businesses achieve the flexibility needed during a crisis by sharing key supply chain data with business partners. Information transparency is critical in providing visibility for product movement and in understanding the impacts on operations. In a weather-related emergency, a retailer is likely to face disruptions in receiving products allocated to, from, or through affected areas. Accurate product tracking and visibility enhances the ability to locate products in the supply chain at any time. The ability of retailers, carriers, and suppliers to access the same real-time tracking information can ensure that a product is rerouted to a nearby facility or a forwarding location.

Photo: George Armstrong, FEMA

The Salvation Army and other voluntary agencies provide critical services in emergency situations and have already established networks within the community.

Intelligent Tools

Also important are intelligent and responsive tools to anticipate and react quickly to changing demand. Retailers and shippers need to sense and respond to immediate increases in demand. With intelligent tools that track product movement, such as radio frequency identification (RFID), retailers can redirect and reallocate products out of harm's way and maintain profits even during an emergency.

These tools also provide visibility into product shipments and cost structures. The visibility of the exact location of products on individual trucks is vital. A rerouted truck will need to arrive at multiple destinations in the right order to facilitate efficient unloading. Responsiveness tools help companies anticipate demand changes and react intelligently in emergencies (3).

Responsiveness entails the accurate anticipation of changes in demand. In a natural disaster, demand can spike and shift unpredictably—the time for reaction is razor-thin. Instead of forecasting from several sources, a single point of demand can be established to increase visibility and avoid wasting time in reconciling information from different divisions. Companies do this to respond quickly, scheduling the necessary labor resources for the expected volume increases and planning for the replenishment of assets back through the supply chain.

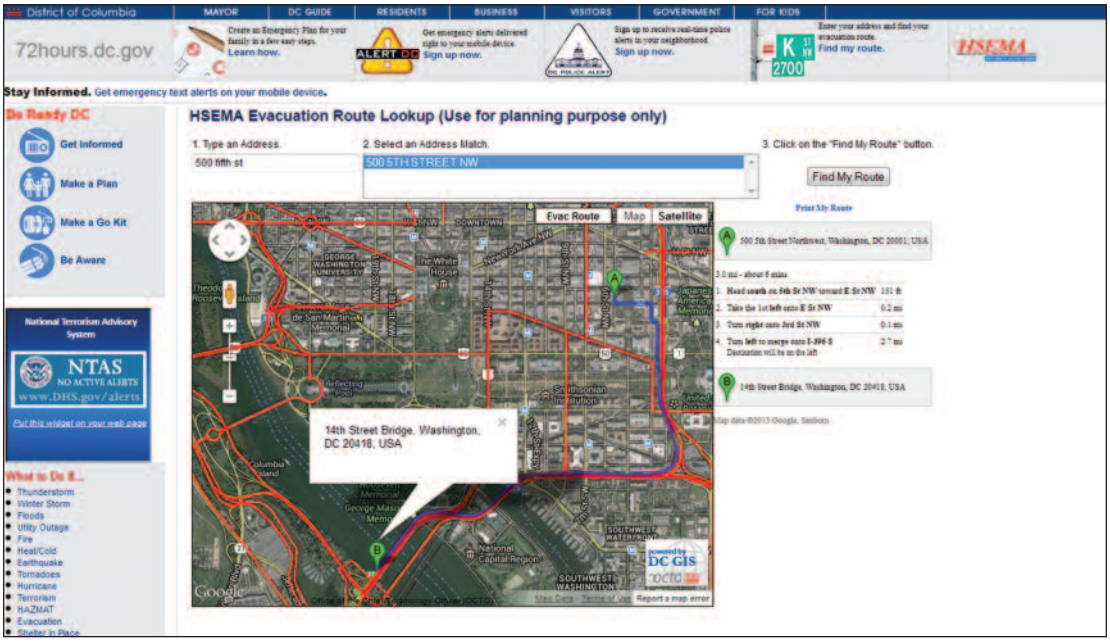
This is how a supply chain responds to sudden disruptions. But immediately after a disaster strikes, what local information can be made available so that inbound recovery resource providers are part of the communication loop and do not make independent decisions or search on their own for information about what is happening? Adept use of sophisticated information tools can help, but only if the most valuable real-time information is provided in a trustworthy and useable format.

Survey Insights

To determine the information that would be most valuable to recovery resource providers immediately following an emergency, a survey was sent to 30 professionals who deal with supply chain matters in either normal or emergency operations. Recipients were asked to identify from a list the real-time information items that would be most valuable for supply chain continuity during a crisis. The survey results showed that 93 percent to 100 percent of the respondents agreed about the value of the following real-time information:

- Transportation—specifically, detours, traffic conditions, and bridge and road closures and access;
- Energy—specifically, power and electrical outages and mobile fuel supplies;
- Telecommunications—specifically, service disruptions and Internet access;
- Resource management—specifically, identification of resource needs, locations for drop-offs and deliveries, and coordination with other providers;
- Infrastructure status, especially water conditions;
- Weather conditions; and
- Real-time situational awareness through the local emergency operations center (EOC) and a mode of interfacing with EOCs via real-time, electronic alert systems.

Of the respondents, 80 percent thought that changes in regulations or policy would be useful. Respondents also indicated that the following addi-



A District of Columbia online planning tool shows alternative evacuation routes in a city emergency. Intelligent tools can anticipate changes in demand and make adjustments.

IMAGE: HTTP://72HOURS.DC.GOV

tional real-time information was important for continuity during a crisis:

◆ Current threat status, criminal activities, and responses;

◆ Central information and availability of data for real-time mapping and information sharing; and

◆ Key points of contact at government agencies.

Addressing Challenges

Probably the most valuable information captured through the survey was the identification of challenges that confront private-sector supply chain managers during a disruption that could be addressed by emergency managers before an event, facilitating the delivery of goods. The most effective way emergency managers can partner with private-sector providers during an emergency is to share information to develop mitigations and remedies to the unique challenges in transitioning supply chains:

◆ The uncertain condition of the transportation infrastructure compounds the challenges of meeting the needs of disaster victims.

◆ With markets evolving toward flexible, lean inventories, capacity is diminished, hampering the market's ability to deliver supplies to victims in a disaster.

◆ Stakeholders have a gap in knowledge and skills; management tools and decision support systems need to be expanded, along with leadership capabilities and situational awareness.

◆ Storage and warehousing dynamics are changing in normal operations, affecting the response to needs that arise in an emergency.

◆ Communications capabilities continue to be strained, but social media and portable communication devices are making significant progress in improving what are termed common operating pictures—a single display of shared information.

◆ Legal and regulatory issues are changing in the new environment of homeland security. Requirements for cross-sector and cross-jurisdiction interfaces are challenging regulatory environments built over decades.

Information Platform

Arlington County has been investigating the requirements for developing the first phase of a comprehensive private-sector resource information platform to make the kinds of data described in this article available for any U.S. zip code. Many organizations have been collecting these data, and much is already available to the public, although often not in open format. Arlington County's Public Recovery Resource Access Portal is a beginning and will provide the public with such vital information as which pharmacy is open and eventually which ATMs are in service.

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Boone Electric Company repairs power lines after a storm in Columbia, Missouri. Recovery depends on close cooperation with service providers.

PHOTO: DHONIQUE RICKS, KOMU NEWS

Disaster Resilience in America

Steps Forward

ELIZABETH A. EIDE AND LAUREN ALEXANDER AUGUSTINE

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Natural disasters pose a mounting threat to the economic and social well-being of the United States. The frequency and cost of disasters triggered by natural hazards have been rising over the past several decades. In the 1980s, the United States experienced approximately 50 natural disasters per year, but in the past decade, the number has tripled to approximately 170 per year.

Costs have risen, too, with disasters in 2011 causing more than $55 billion in damage and the loss of nearly 600 lives. That year, the unusual combination of a rare East Coast earthquake, Hurricane Irene hitting the Mid-Atlantic, deadly tornadoes in Massachusetts, and more than $8 billion in flooding damage brought into sharp focus the need for increased resilience to hazards and disasters.

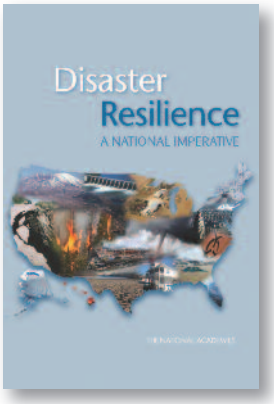
PHOTO: NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

The Bonnet Carré Spillway in New Orleans is a structural flood mitigation measure managed by a partnership between local, state, federal, and other organizations.

Defining Resilience

A 2012 National Research Council (NRC) report, *Disaster Resilience: A National Imperative* (2012), defines resilience as the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events. The report outlines ways in which increased resilience can help to reduce the risks of—and vulnerability to—disasters before they occur, to decrease disaster costs, and to mitigate the consequences.

What does resilience look like? The report describes a future, disaster-resilient America in 2030 in which the citizenry is well-informed about levels of risk, communities have established plans for disasters, community networks provide support when normal services are interrupted, and the need for postdisaster aid and resources has decreased. A disaster-resilient America also would have an upgraded infrastructure designed and built for 21st century disasters and extreme events.



For more information about Disaster Resilience: A National Imperative, *published by National Academies Press, go to www.nap.edu/catalog.php?record_id=13457.*

Key Actions

The challenge for communities and experts is how to move from the recovery-focused, disaster-management mindset of today to a culture of resilience for the future. Four key actions can help the United States to increase resilience to hazards and disasters:

1. Develop access to better and more complete data and information about hazards and disasters—this can improve the prediction of events and the understanding of risk and can provide the means to document injuries, loss of life and property, and impacts on economic activity.
2. Improve ways to understand, communicate, and manage risk—this is critical to building a well-informed citizenry.
3. Identify measures of a community's resilience—this provides a foundation for determining progress toward resilience, documenting returns on investment, and setting priorities for building resilient communities.
4. Support and maintain coalitions and partnerships within and across communities, because community resilience is a shared responsibility—this can facilitate exchanges of information, best practices, and ways to leverage resources.

To advance these four actions, policies can be developed that mitigate risk—for example, through building codes and zoning; that invest in critical infrastructure for energy, public health, and other fundamental capabilities; and that secure arrangements for international cooperation in emergencies. The many units across NRC will be taking on work that advances these four actions to increase disaster resilience in the United States and abroad.

Fuel Supply in an Emergency

Securing the Weakest Link

HERBY LISSADE

The author is Chief, Office of Emergency Management, California Department of Transportation, Sacramento, and Chair of two National Cooperative Highway Research Program Project Panels: on the Catastrophic Transportation Emergency Management Guidebook and on Preplanned Recovery and Accepted Practices for Replacement of Transportation Infrastructure.

At 3 a.m., a large magnitude earthquake hits Southern California. Responders rush to their vehicles to start the complex and arduous job of assessing the impact on people and on the surrounding infrastructure.

The responders have done everything right in preparing for this event, including topping off the fuel tanks of their vehicles every night. The responders enter an environment that has no lights—the electrical grid is off line, water lines are broken, and gas lines and standard communications are not operable.

As hours pass, it becomes evident that a critical resource is not available to the responders or to the public at large—fuel. Many commercial fuel sites are available, but the fuel cannot be accessed for the responders or the public until the electrical grid is back on line. At best, restoration may take several days

This scenario identifies issues that are not unique to California but are global in scale:

◆ How can commercial fuel sites be staffed and on line during emergencies, especially along routes designated for evacuation?

◆ Although some states extend grants to assist commercial fuel sites in purchasing emergency generators, the grants often fall short of the amounts needed for purchase and installation.

Protecting an Asset

The California Department of Transportation (Caltrans) has learned by experience that access to fuel at all times is essential to emergency response. During emergencies and catastrophic events, Caltrans has had to compete with the public for fuel at commercial sites. On many occasions, the commercial sites would be off line with the loss of electrical power. In some instances, fuel was not available for first responders or for the traveling public, let alone for Caltrans.

Caltrans has 403 maintenance stations throughout the state; of these, 220 have on-site bulk fuel storage tanks for diesel, biodiesel, or unleaded gasoline. In addition, Caltrans owns many sources of E85 fuel—that is, 85 percent ethanol blend. Other state agencies, including the California Highway Patrol and the California Department of Forestry and Fire, rely on Caltrans' bulk fuel in areas that have a limited

PHOTO: BRIAN KINGSLEY

After Superstorm Sandy, fuel was difficult to come by; several states imposed gasoline rationing.

availability of commercial fuel. Many bulk fuel sites can generate their own power; a major power outage would not affect the refueling of vital emergency-service vehicles.

Moreover, Caltrans has bulk fuel sites in strategic and densely populated areas such as the San Francisco Bay Area and Southern California. These resources represent an immediate and deployable resource for emergency responders.

Fuel has a direct bearing on the means and resources to respond to emergencies and to maintain California's infrastructure. Protecting and carefully managing this asset ensures that fuel is available whenever it is needed.

Exposed by Sandy

Superstorm Sandy hit the Eastern Seaboard with a vengeance in late October 2012, driving a record storm surge that killed more than 100 people. The Category 3 hurricane also exposed the fragility of the fuel supply chain in the United States.

The storm affected every link of the fuel supply chain, from tankers halted by debris in the water, to flooded refineries, to refineries and commercial fuel depots shut down by power failures, to tanker trucks redirected by emergency agencies, to service stations—more than half of the region's service stations were not able to operate because of the loss of electrical power. Residents struggled to acquire fuel; some states imposed gasoline rationing.

Emergency and continuity of operations plans must be improved nationwide to address these kinds of situations, but new legislation also is needed. The legislation at the least should address facilities that support critical transportation routes, particularly evacuation or lifeline routes.

New York State has made positive improvements since Superstorm Sandy—for example, requiring certain gas stations to install quick-connect plugs for emergency power generators, through grants and other means. During an emergency, power generators can be mobilized for delivery to gas stations that have the quick-connect plugs. Optimally those gas stations should have generators in place and not have to rely on quick-connect plugs—but that is another funding issue.

Applying the Lessons

Several lessons for the fuel supply chain have emerged from recent disasters at home and abroad:

◆ Readily available fuel, even in abundant supply, is useless unless it can be pumped from the storage tanks during a power outage.

◆ Emergency responders should not be competing with each other and with the traveling public for fuel.

◆ Although many states have enacted legislation and awarded grants to assist fuel distribution sites to acquire emergency generators, the grants often are insufficient to offset the capital investment of buying and installing the generators.

◆ Legislation should be enacted to identify critical fuel sites—for example, those that support lifeline routes and disaster supply chains—and to support those sites in dispensing fuel.

◆ First and second responders should evaluate their access to fuel supplies. Funding may be needed to create bulk fuel sites that do not depend on the electrical grid, to support responders.

Emergency managers are keenly aware of the interdependencies between transportation modes and utilities. A wind storm knocking down power lines or a cyberattack on the power grid can make this interdependence evident. Otherwise robust state emergency plans, county evacuation plans, continuity of operations plans, or emergency operations plans at any level of government need to incorporate well-thought-out courses of action to close the gap in what may be the weakest link—access to fuel.

Photo: Jonathan Henderson, Gulf Restoration Network

Flooding at the Phillips 66 Alliance Refinery near Belle Chasse, Louisiana. Storms can disrupt every part of the fuel supply chain.

Social Media in Disaster Preparation, Response, and Recovery

SARAH M. KAUFMAN

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Social media have become an essential source of information before, during, and after disasters. Social networks like Twitter, Facebook, and Tumblr—instantaneous, far-reaching, and interactive—have become the convergence point for a range of information sources, dialogues, and dynamic content.

A survey conducted by the New York University (NYU) Rudin Center for Transportation Policy and Management found that during Superstorm Sandy, social media were the second-highest-rated source of information, ranking higher than other popular sources such as television and radio news, news websites, and community groups.

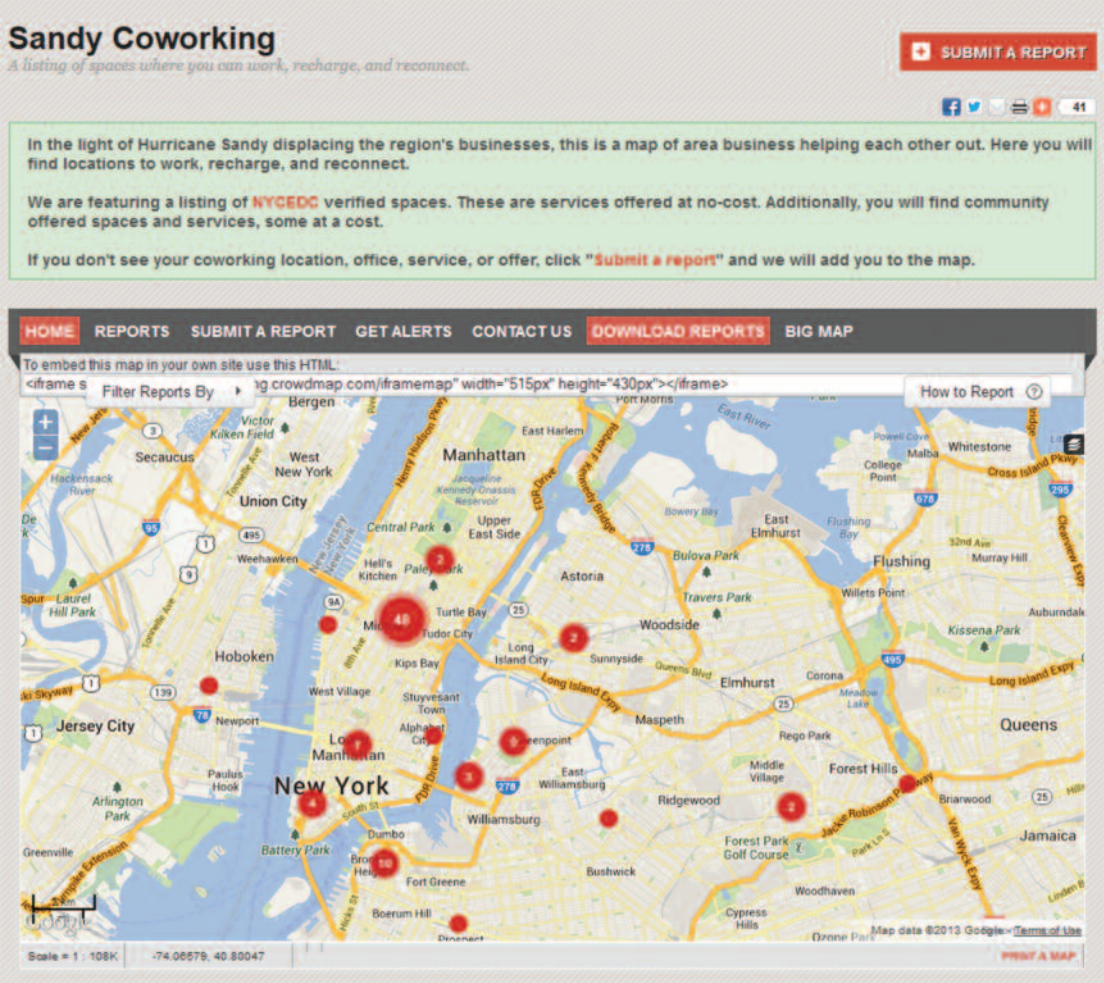
Building Audiences

Before an event, transportation agencies should already have built up their social media audiences by combining service and marketing messages that inform and engage. The increased numbers of followers, "likes," and fans will connect to a larger number of people to receive and relay important messages, motivate them to change their behaviors, and amplify the information to their friends. As a result, travelers will be safer and will move to stable locations in an emergency more efficiently.

Before, during, and following an event, agency messaging must travel two ways on social media. First, messages must include information, such as road closures; warnings, for example, to watch out for falling branches; and review, such as where to call for insurance assistance. Second, communications and postings from the public are especially important, providing information about field conditions that the agency may not yet have discovered, such as downed power lines on side streets; the public also may post urgent inquiries, for example, about which hospitals are accessible. Members of the public often turn to social media for more immediate assistance, especially when their telephone land lines are inoperable.

PHOTO: ANTHONY FINE

Social media enabled residents of areas affected by Superstorm Sandy to share images of the damage, as well as of relief efforts.



Through the New York Tech Meetup website, many companies were able to make work space available to displaced employees from other companies during the recovery after Superstorm Sandy.

Put to the Proof

During Superstorm Sandy, New York City–area agencies made impressive use of social media platforms—including Twitter, Facebook, Instagram, Flickr, YouTube, and Tumblr—to share information about recovery efforts, documentation, and response to inquiries. The agencies recognized the importance of photos and videos to show damage and restoration; this helped the public to understand, practice patience, and support recovery efforts.

These agencies faced challenges in deploying social media during and after the storm, including network and power interruptions, complicated coordination and approvals of messaging, and the resource-intensiveness of crisis communications. During Sandy, local agencies confronted the question of timeliness versus quality—is 100 percent accuracy more important than quick dissemination? After Superstorm Sandy, local government agencies reported that releasing information rapidly and risking inaccuracies is often preferable to waiting, because customers will receive information that is potentially incorrect from other sources; the incorrect information must be—and typically is—quickly refuted.

The public also engaged in social media activity, to gain and share information and to check in with family and friends. Even in areas struck by power outages, social media activity continued at a high rate. A highlight of the early recovery from Sandy was watching various companies provide working spaces to displaced companies through a map interface set up by the New York Tech Meetup; this service resulted in new alliances and helped avoid lost productivity.

Harnessing Social Media

Social media have emerged as the primary source of information during disasters, reaching large numbers of people instantaneously. Social media are accessible through multiple channels, including many that operate when electrical power is out. The NYU Rudin Center for Transportation Policy and Management is continuing to focus on social media and how transportation agencies can take advantage of these new communications tools.

Ferries to the Rescue

Lessons for Resilience on Waterways

ROBERTA E. WEISBROD AND ADAM ZARANKO

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Staten Island Ferry crew and landside staff set heavy water moorings in advance of Superstorm Sandy, October 2012, at the Ferry Maintenance Facility piers in New York City harbor.

PHOTO: NEW YORK CITY DOT

Ferries are valued for their role in economic development but also have proved their worth in responding to emergencies:

◆ After the Loma Prieta earthquake of 1989 damaged the Bay Bridge, authorities rapidly revived the Oakland–San Francisco ferry that had not operated for decades.

◆ In metropolitan New York–New Jersey, in response to the terrorist attack on September 11, 2001, the entire maritime community, including ferries, joined in evacuating lower Manhattan, and ferry services were rapidly put in place to compensate for destroyed routes (*1, 2*).

◆ Ferries played critical roles in supplying transport during New York City's 2004 blackout and 2005 transit strike (*3*).

◆ In 2009 a New York Waterway ferry rescued all the passengers from the plane that ditched, after a bird strike, into the Hudson River, the event known as the Miracle on the Hudson.

These examples demonstrate the role of ferries in immediate evacuation and in long-term recovery operations.

Riding Out the Superstorm

During and immediately after Superstorm Sandy in 2012, ferries again showed their resilience and their value in aiding the recovery of the New York City region. Superstorm Sandy brought relatively little rain but ferocious high winds and an ocean surge of up to 14 feet at high tide on the night of a full moon. Floods swept into lower Manhattan and across the shorelines of Brooklyn, Queens, Staten Island, and New Jersey, especially Hoboken. The superstorm's impact was widespread in terms of extent and of the population and infrastructure affected, cutting off power for millions for extended periods.

During the storm, ferries stood fast. The Staten Island Ferry crew stayed with the vessels and rode them through the storm, working with shore staff at dockside. Throughout the night at the Ferry Maintenance Facility piers, crews and staff were "tending the moorings and working the engines." As the storm approached, frequent gusts were clocked at more than 75 knots "before [the] weather station failed" (*4*).

By contrast, all other modes were severely disrupted. The widespread flooding caused power outages; traffic lights in lower Manhattan were out; floods filled the tunnels, closing several subway lines con-

necting Brooklyn and Manhattan; and the Port Authority Trans-Hudson (PATH) subway trains linking New Jersey cities and New York City were inoperable.

But the ferries kept running. At times ferries were the only form of transit between lower Manhattan and Brooklyn or New Jersey. As a result, ridership expanded on the New York Waterway's East River Ferry and Hudson River Ferry. Between Hoboken and New York, ridership jumped 64 percent during the months with no PATH service (5).

Blazing New Routes

New routes were rapidly established. Superstorm Sandy extensively damaged the portion of the subway system that connects the Rockaway peninsula to the rest of Queens—effectively severing the Rockaways from New York City's transit system. To provide a transportation alternative for residents while the subway line was being restored, the New York City Economic Development Corporation quickly established a temporary ferry service between the Rockaways and lower and midtown Manhattan (Figure 1, below). Seastreak Ferry Company operates the weekday rush hour service; the highly subsidized fare of $2 each way includes parking at the Rockaway ferry landing. The service is continuing through the month of August to support ongoing restoration efforts.

To provide transportation options for the citizens of the hard-hit Staten Island shore (6), the New York City Department of Transportation established a temporary ferry service operated by New York Water Taxi between Great Kills and lower and midtown Manhattan for 8 weeks. The subsidized $2 fare included shuttle service and parking.

FIGURE 1 Map of Rockaway ferry service, operated by Seastreak Ferry Company.

Photo: Brian Craine, NYCEDC

The Seastreak Ferry Company's weekday rush-hour service provided transportation to residents of the Rockaways while subway service was being restored.

Lessons for Planning

The success of New York ferries stemmed from preparation. Before the storm, the City secured ferry landings, removing and storing gangways and disconnecting power, to protect the assets from storm damage. As a result of these measures, the damage to landings was minimal; after inspection, three days after the storm, the City reinstituted the East River Ferry service. Like the publicly owned and operated Staten Island Ferry, the privately owned and operated New York Waterway had protected its vessels by keeping them crewed throughout the storm.

These successes offer lessons for improved planning. Protective measures resulted in significantly faster commencement of service. Ferry service was in high demand after the storm—with few transportation alternatives as offices began to reopen, ridership on ferries more than doubled in the week after the storm.

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Photo: Brian Craine, NYCEDC

Seastreak Ferry fares included parking at the landing.

Emergency Management and Business Continuity Within Commercial Aviation

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Many people think of emergency management and business continuity as two independent endeavors, with emergency management in the public sector and business continuity in the private sector. Yet the two endeavors converge and are key to the security of both. Both are essential in responding to and recovering from an emergency incident, because these incidents can compromise the infrastructure and the capability of business and other organizations to provide services.

In aviation, the convergence of emergency management and business continuity can affect airlines, airports, air traffic control, and all associated transportation modes. Any comprehensive emergency management or emergency operations plan should

PHOTO: PAUL SABLEMAN

A 2011 tornado in St. Louis, Missouri, damaged the main terminal of the Lambert–St. Louis International Airport. The airport reopened less than 24 hours later.

Operational and Business Continuity Planning for Prolonged Airport Disruptions

To help U.S. airports prepare for potential disruptions to operations, the Airport Cooperative Research Program (ACRP) launched a project to explore the practical capacity needed for operational resilience and to provide airports with a tool for developing a plan.[1] Risk Solutions International (RSI), a consulting firm that specializes in business continuity planning, was selected to manage the project, and the findings are expected for release later this year as ACRP Report 93.

RSI reviewed the limited public literature about business continuity planning in the airport sector. The firm interviewed representatives of 40 U.S. airports to assess business continuity practices and found that few had embraced an effective level of operational resilience planning.

RSI conducted business impact assessments at several airports, to identify and document how essential business and operational functions work normally, how their loss would affect the airport's mission, and how the functions would be recovered and restored when the material disruptions had ended. RSI interviewed representatives of organizations that have operational responsibility at airports or that represent key airport constituencies, such as federal agencies, aviation associations, industry organizations, and airlines.

RSI used the data to design and develop a software tool for airport business continuity. The self-contained, intelligent survey application administers a series of up to 2,000 questions about the human resources, the technologies, the plant and equipment, and the processes that comprise every airport operating and business function. The questions are conditional, so that the path each airport takes through the survey reflects the airport's unique operating circumstances. The tool builds a business continuity plan "on the fly" in HTML, which the airport can view in progress; the airport then can generate custom plans in a PDF format that draw on all the data input from the survey questions.

A business continuity plan developed with the tool can range from 500 pages for large, complex airports, to much smaller plans for airports or fixed-base operators—that is, aircraft service centers—that have a narrower scope and operational complexity. The tool is the first software of its kind written for a unique sector of critical national infrastructure and is designed to be effective for a variety of facilities.

[1]ACRP Project 3-18, Operational and Business Continuity Planning for Prolonged Airport Disruptions. http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2799.

describe a step-by-step procedure for response and recovery and should include appendices with checklists to ensure that important issues are addressed in a crisis. This clear-cut, practical approach will be of greatest value to the end user.

A major challenge is to integrate the National Incident Management System (NIMS) and the Incident Command System (ICS) into aviation emergency management and business continuity. A presidential directive for homeland security, Management of Domestic Incidents, establishes NIMS and ICS as the standards for federal response to nationally significant incidents. Aircraft rescue and firefighting at airports, however, have focused on the command and control of a contained scene, and the procedures do not readily carry over into incident management for airport operations. This leads to interoperability problems, especially with outside agencies.

Systematic observation suggests that more personnel in airport management and in communications and maintenance should complete the ICS online training courses. Without this critical training within the aviation industry, the interface with outside groups for public mutual aid response may break down in critical areas such as operations, communication, logistical support, and continuity and recovery planning.

U.S. aviation is a major strategic concern for homeland security, encompassing approximately 450 commercial airports and 19,000 additional airports, heliports, and landing strips including civil and joint-use military facilities. All of these are vulnerable to harm and destruction by intention or by natural occurrence. Aviation facilities have proved instrumental in evacuations, patient movement, and search-and-rescue efforts and can serve as cache locations for intermodal logistics. Aviation long has been a choice target for terrorists, and aircraft and airport terminals can serve as a prime facilitator for the spread of disease.

Two pathways are vital. One incorporates NIMS training and interfaces with comprehensive business continuity planning. The other makes NIMS and ICS a standard part of commercial aviation's comprehensive emergency management and emergency operations planning. The goals are increased interoperability among organizations involved in public mutual aid and a much more efficient, timely, and cost-effective resolution of emergencies.

Collaborative Contingency Planning for Airports

Improving Passenger Service for Airline Travelers in Emergencies

Anyone traveling by plane recently is likely to have experienced a delay at a terminal or on an aircraft or to have been rerouted midflight to a different airport. These inconveniences, caused mainly by bad weather and airplane mechanical issues, have prompted government regulations to improve customer service for airline passengers. The rules mandate that airlines and airports create and coordinate contingency plans to improve the response to what are termed "irregular operations."

With the sponsorship of the Federal Aviation Administration, the Transportation Research Board funded and managed an Airport Cooperative Research Program (ACRP) project to provide guidance on the collaborative development of contingency plans. The project produced ACRP Report 65, *Guidebook for Airport Irregular Operations (IROPS) Contingency Planning*, which gives the aviation industry direction for working together to create contingency plans.[1]

The guidebook includes collaborative approaches to several situations that most affect passengers, as identified in preliminary research. One suggestion is to create protocols for managing flights rerouted to airports that were not expecting the arrivals. The airports need contingency procedures for dealing with the surge of passengers in terminals and in security areas, as well as with the increased numbers of aircraft that may exceed the gate capacity to deplane travelers. Another suggestion is to create off-hour staffing plans for Transportation Security Administration and Customs and Border Protection personnel, as well as for concessions representatives, to accommodate passengers after normal airport hours.

The guidebook also suggests improvements in passenger conditions during extended stays in terminals—for example, to provide cots and blankets or hotel lodging for overnight stays. Planning for passengers with special needs—especially for those who need medicine, language assistance, or supplies such as diapers—is another topic covered.

The guidebook—supplemented with three online interactive resources, including topics, tools, and a model plan—can assist the aviation industry in developing collaborative contingency plans that close current gaps in customer service during irregular operations, potentially improving the passenger experience. Fort Wayne International Airport and Buffalo Niagara International Airport were among the first to develop and implement irregular operations plans applying the guidelines in ACRP Report 65.[2] According to terminal services supervisor Daniel Rak, Fort Wayne International Airport's stakeholder units documented individual plans and then developed a comprehensive, coordinated plan for the airport to respond quickly in an event.

[1]www.trb.org/Publications/Blurbs/166569.aspx.
[2]ACRP Impacts on Practice, April 2013.

Planning for the Worst, Teaming with the Best

Instituting an Emergency Management Program in Idaho to Maximize Performance

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The realignment of the Idaho Transportation Department (ITD)—incorporating significant changes in the agency's management approach—placed a new emphasis on emergency planning, training, and response. The state's new management strategy shifts away from a traditional, so-called silo structure with its narrow hierarchies to a broad, team-focused approach. By extending the breadth of emergency management, the department can capitalize on the strength, expertise, and experiences of key personnel who normally are not associated with emergency planning.

"The reorganization into cross-functional teams has created a more efficient and effective transportation department," notes ITD Director Brian Ness. He points to the emergency program as a primary example: "Realignment elevated the emergency program manager to a direct reporting relationship with our chief deputy; this allows the manager to speak with the voice and authority of our executive team. It also provides better access to those who make critical decisions and improves visibility for emergency management."

Turning Points

Imagine the following scenario: around 6 p.m. on a lazy Friday, just north of a remote town at the bottom of a small canyon, a massive and rapid-moving landslide buries part of the only major north–south U.S. highway in the state, along with the major northern Chicago-to-Seattle rail line traversed by 30 freight trains per day and by Amtrak passenger trains, a county road, and more.

This scenario became a reality in Idaho on October 16, 1998, with a catastrophic impact on the state's transportation system. A 500-foot-wide landslide involved an estimated 400,000 cubic yards of material, undermined the highway, and—1,200 feet downslope—buried and scoured a county road and the Burlington Northern–Santa Fe Railroad tracks. The slide severed Idaho's primary north–south route, necessitating a 112-mile highway detour.

Photo: Jim Van Sky, Big Country Helicopters

Saturated slopes above US-95 near Bonners Ferry in northern Idaho deposited rocks, mud, and debris across the highway and the Burlington Northern Santa Fe Railroad tracks on October 16, 1998. The massive slide severed the state's primary north–south route for 10 days and interrupted rail service for nine days.

Now imagine the emergency manager for the state's department of transportation (DOT) recognizing the lack of resources, expertise, staff, communications, and networks to address a problem of this magnitude. What can be done? The event may be unique, but most state DOT emergency managers have a similar story; the event was a determining factor in ITD's taking deliberate measures to reorganize its approach to major disasters.

Another critical turning point was a training exercise at a Federal Emergency Management Agency (FEMA) workshop for the state's Bureau of Homeland Security; the exercise focused on a major earthquake. As the scenario progressed, several major shortcomings in the ITD program became obvious, along with issues to overcome to provide continuous support 24 hours a day, seven days a week, to the department, the governor's office, the news media, and the public.

Adequate but Flawed

ITD's emergency management services were not prepared to respond effectively and efficiently or to manage a large, unexpected event well beyond the scope of a routine disaster. Yet the department had coped with major disasters—earthquakes, floods, wildland and forest fires, and winter storms; moreover, the state's Emergency Operations Center (EOC) had been manned around the clock for long periods of time, when necessary.

Maintenance office staff volunteered for backup. Several staff members covered shifts at the EOC, to answer phones and to coordinate with other agencies. The procedure was adequate but had many flaws.

Hoping for the best, agency management had not intentionally and decisively built a support team or guided human resources to respond effectively. The process in place was adequate—at least before events like the September 11, 2001, terrorist attacks and Hurricanes Katrina and Rita and before sophisticated planning efforts like the National Incident Management System, the Incident Command System, the National Response Framework, and the Emergency Support Functions.

Reviewing the Problems

The landslide and the FEMA workshop revealed the following problems with ITD's previous approach:

◆ **Planning.** Idaho needed a plan that was innovative and "outside the box," that improved on any other process. Traditional approaches would fail.

◆ **Office position and location.** On ITD's organizational chart, the Emergency Program office was six levels removed from the chief executive, as part of the Mobility Group in the Highway Operations and Safety Office of the Operations Section of the Highways Division. This made for an inefficient and awkward operation, because the Emergency Program manager had to work regularly with federal, state, and local agencies, as well as with other ITD districts, divisions, sections, and offices, but had no formal authority or commission as a representative of ITD upper management—except for decades of tradition.

◆ **Office depth.** If a major event required the agency to provide 24-hour support seven days a week for an extended period, the emergency office would not be able to comply. The agency also had no established order of succession for the emergency manager, without whom the emergency office would not be able to function adequately.

◆ **Office diversity.** Little effort had been made to identify and organize available expertise within the department and state. Attempts to keep track of all the experts in house, as well as contractors, consultants, associations, and available retirees, had proved impossible. When subject-matter experts were needed, the only resources were spotty memories, past relationships, or the Yellow Pages.

Photo: Risdon Photography

Idaho Transportation Department (ITD) Director Brian Ness participates in a session on Current Strategies for State DOT Leadership at the 2013 TRB Annual Meeting. Ness recently guided the reorganization of the agency, including a focus on emergency planning, training, and response.

Emergency managers know from experience that quick deployment of specialized personnel and resources is critical during a crisis. Moreover, learning to work well with other agencies avoids potentially debilitating conflicts. Another pressing task is to develop situational networks that allow for current and accurate flows of information and for deployment of critical resources.

Like many rural states, Idaho does not have the luxury of hiring extensive emergency staff, building an impressive facility, or setting aside a large budget for an emergency program. Nonetheless the task and commitment stand—to provide the best service to the traveling public during emergencies.

Photo: George Armstrong, FEMA

FEMA hosts a discussion-based workshop in Atlanta, Georgia, on planning for earthquake response—similar to the workshop that imparted new insights for ITD's Bureau of Homeland Security.

The Transition

To support, sustain, and maintain an emergency program today requires a staffing system that is not only adaptable but taps into properly trained personnel, so that the department can have the appropriate expertise, authority, and critical thinking to respond in a disaster or large emergency—in other words, a system that assembles the best team possible. ITD proceeded to build a support team by pooling expertise structurally and operationally.

Instead of planning for the worst and hoping for the best, ITD decided to plan for the worst and team with the best in planning for, responding to, and recovering from major disasters. Several major reports influenced this decision and contributed to the final product:

◆ National Cooperative Highway Research Program (NCHRP) Report 525, Volume 16, *A Guide to Emergency Response Planning at State Transportation Agencies*[1];

◆ Mineta Transportation Institute Report 9-10, *Handbook of Emergency Management for State-Level Transportation Agencies*[2];

◆ Security and Emergency Management: An Information Briefing for Executives and Senior Leaders of State Departments of Transportation, produced through the Transportation Pooled Fund Program of the Federal Highway Administration[3]; and

◆ A peer review in October and November 2008 by the American Society of Civil Engineers, which analyzed ITD's emergency capabilities from three geographic perspectives, combining Districts 4, 5, and 6; Districts 1 and 2; and District 3 and the headquarters in Boise. The comprehensive review, conducted by three teams under the leadership of transportation professionals from Minnesota and California and with membership from seven states, looked at opportunities for improvement throughout the department and concluded:

> While ITD appears to have a well-organized emergency management plan, it does not appear adequately communicated throughout the organization. Since it affects the entire ITD and is intended to serve the entire state, the emergency management unit could report to the departmentwide manager level.

Team-Focused System

As ITD examined and evaluated its needs, several points arose:

1. Conventional wisdom was not working.
2. The emergency management office was not in the best organizational location and position.
3. The office staffing lacked sustainable depth.
4. A method for tapping into subject-matter expertise should be established.

How could the office become a proactive leader in emergency management and be the best it can be, instead of serving as a reactive Band-Aid? How could the office creatively build capability that works for the whole department, taps into the range of expertise available, and maintains a high level of performance throughout the duration of an event?

Instead of building a conventional office with staff and budget, ITD decided to invest in a revolutionary strategy—to create a broad, team-focused system and program that could tap into all the expertise, staff, and resources that the department and state had to offer, when needed. By building the best cross-functional team possible for deployment anywhere in the state at any time, the ITD team can grow as fast as necessary, as big as necessary, for as long as necessary.

Many in the department have—or know where to find—the necessary experience and know-how. ITD sought to create a team capable of serving all divisions, sections, and districts, that could mobilize all of the department's appropriate assets, and that could reach outside the department to community

[1] http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_525v16.pdf.
[2] http://transweb.sjsu.edu/MTIportal/research/publications/documents/COOP%20COG%20I_Vince_022410.pdf.
[3] www.fhwa.dot.gov/security/emergencymgmt/profcapacitybldg/docs/hsemexecsrrleaders/hsem_srexecs.cfm.

and state expertise if needed. The plan was to create a structure that

◆ Can be replicated if the program manager is not available,

◆ Can expand as large as needed or operate with only one person,

◆ Can reach out to tap the highest level of expertise and talent, and

◆ Can quickly acquire expertise from Idaho's best universities, agencies, associations, and the private sector.

Establishing the Structure

One of the first major steps was to relocate the Emergency Program under the direct supervision of the ITD chief deputy. Next was to create the position of duty officer and then to establish an Emergency Response Council that consists of specialist coordinators, advisory coordinators, and division or mode coordinators, to be activated as needed; and finally to select a program advisory group. Figure 1 (page 36) shows the organizational chart for the Emergency Program Office.

Emergency Duty Officers

Emergency duty officers build experience and capabilities in high-level management, to be able to carry on and fill the role of emergency program manager if the manager is unavailable or if the position is vacant. Many agencies apply this model to develop experience among larger groups. The method allows many employees to maintain familiarity with issues they normally may not encounter at work. This approach also builds response capabilities to staff any and all emergencies, 24 hours per day, seven days a week, year round. The executive team and division administrators select the emergency duty officer candidates.

Emergency Response Council

The Emergency Response Council consists of the experts with whom the emergency manager or duty officer consults, including specialist coordinators, division or mode coordinators, and advisory coordinators (see Figure 1 for additional details).

◆ The specialist coordinators are experts in areas that past experience has indicated will be needed in certain situations. The coordinators in turn identify resource support needs and contacts, creating specialized teams and expertise to respond to a major event.

◆ The division or mode coordinator represents all divisions of the department and can tap into internal resources, such as the field staff who provide status reports on a situation and who manage local department response teams.

◆ The advisory coordinator ensures compliance with national standards for emergency structures, so that ITD can coordinate communications, terminology, processes, and organization with other groups during disasters.

Program Advisory Group

The Program Advisory Group consists of subject-matter experts who are assisting the emergency program manager throughout the organizational process and beyond. The group has provided advice on the Emergency Program's support structure, training program, job descriptions, and emergency contact lists.

Developing a Model

Idaho is a mostly rural state, without the major financial, human, or technical resources to support a large office and staff. Nonetheless, ITD is determined to provide the best-organized and highly competent emergency program, to meet the needs and expectations of citizens, friends, and families.

"In creating this program, we developed capabilities that will help other state DOTs become national leaders in transportation-related emergency management," Ness observes. "Our model should enable state DOTs to become the obvious leaders among other agencies in responses to disasters and emergencies that could cripple communities."

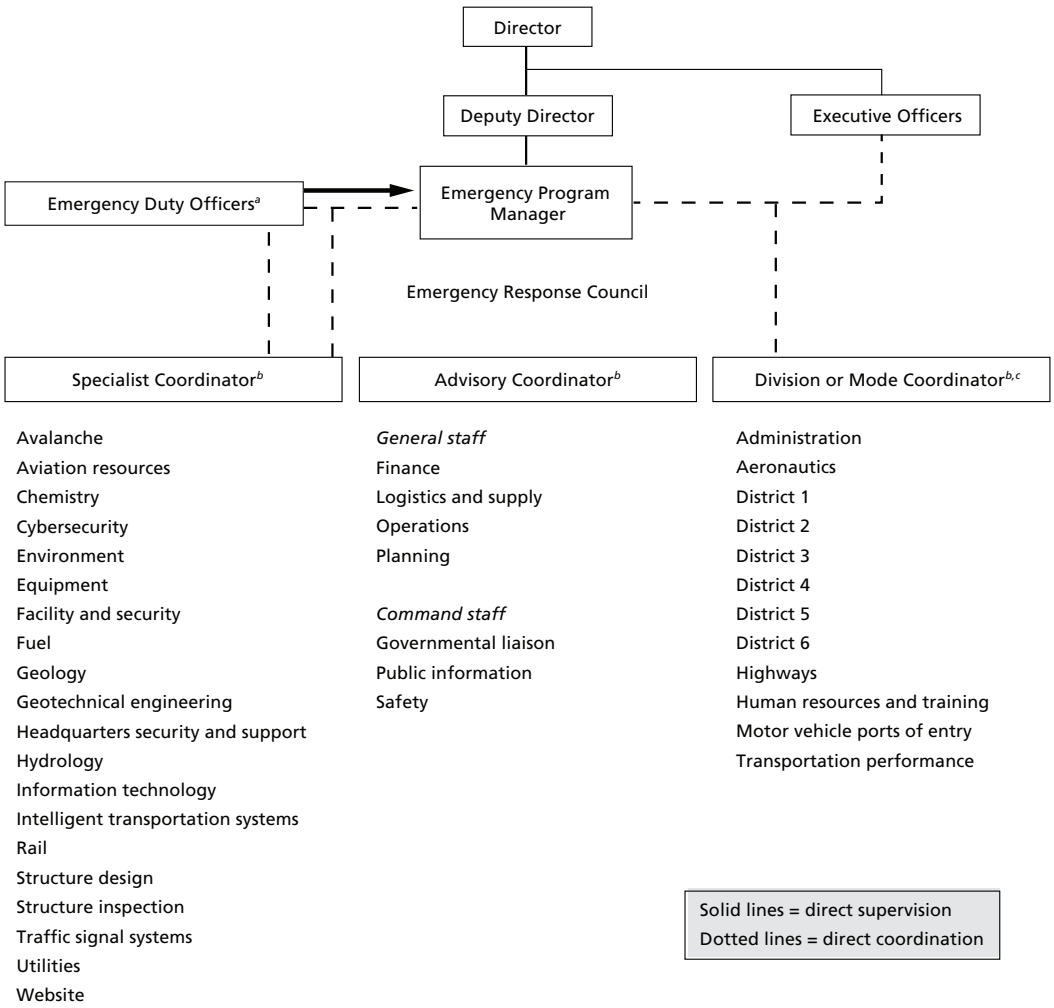
Management Support

An agency seeking to institute an effective emergency management program must have strong support for the project from the highest level of agency management. Without this demonstrated commit-

Photo: Roger Davidson

Idaho's Payette River floods the surrounding streets. Although ITD often had dealt with floods, earthquakes, and other disasters, training exercises revealed a need for a new approach to answer a major, unexpected event.

FIGURE 1 ITD Emergency Program Office organizational chart.



[a] The Emergency Duty Officers are on call around the clock for one week, generally during off hours and rotate every 9 weeks. If an event occurs, they assume coordination as Acting Emergency Program Manager (EPM) until the EPM is available. They also may be activated to fill the EPM position on a rotation for around the clock, year-round operations.
[b] The Specialist, Advisory, and Division lists identify the subject-matter experts who can be called to assist the EPM as needed. The Specialist, Advisory, and Division Coordinators are activated when an event becomes too large for the EPM or Acting EPM to manage.
[c] Each division and district has a designated, trained Disaster Coordinator responsible for working with the Emergency Management Office; trained, specialized expertise may be assigned to the Emergency Management Office during an emergency.

ment, the best intentions will not succeed or endure. ITD executives have provided essential leadership throughout the process.

NCHRP Report 525, Volume 16, *A Guide to Emergency Response Planning at State Transportation Agencies*, emphasizes this point:

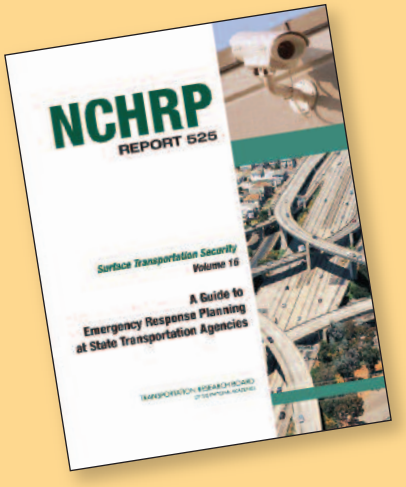
> Meeting an agency's emergency response needs requires an organized management response—championed at the executive level—based on clear agency policy and commitment in the form of program and organizational arrangements. It is essential that state transportation agency executives become familiar with the changing context and challenges facing emergency response, in addition to the challenge of the 4Cs—multiple agency communication, cooperation, coordination, and consensus system.

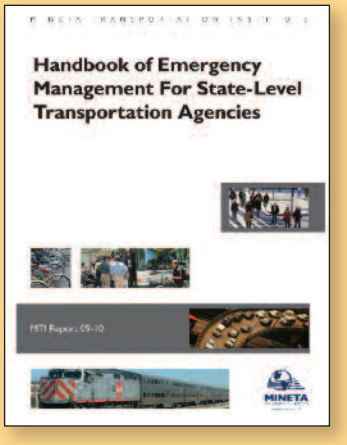
State transportation agency top-level leadership is necessary to give the emergency response process and resource requirements the prominence they need to compete for funding resources and organizational attention. The planning and actual response processes—and the intensive coordination required—cannot take place without clear top-down leadership and an accountability framework.

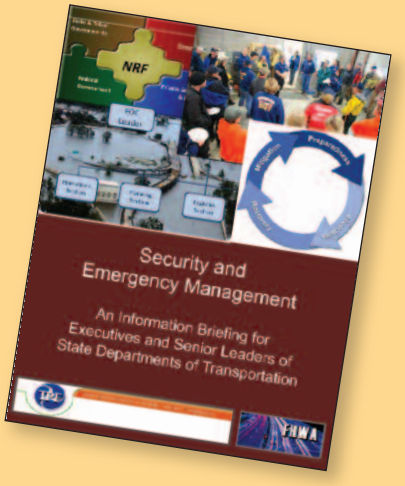
Three Key Resources for State-Level Emergency Response Plans

A Guide to Emergency Response Planning at State Transportation Agencies

Terrorist threats and environmental disasters, both natural and manmade, have raised the profile of emergency response management. The U.S. Department of Homeland Security, which consolidated federal emergency management and response agencies after the September 11, 2001, terrorist attacks, has led initiatives in emergency response planning. Along with their regular duties, transportation agencies across the country now must assume responsibility for large-scale evacuations resulting from natural disasters and must address no-notice evacuations, shelter-in-place situations, and quarantine events in response to biological outbreaks, epidemics, pandemics, and other threats. These efforts often are led by designated state and regional emergency management agencies.







National Cooperative Highway Research Program Report 525, Volume 16, *A Guide to Emergency Response Planning at State Transportation Agencies*, assists transportation agencies to plan for emergencies, evacuations, and mobility-limited situations, taking into account the need for consistency on procedures, protocols, relationships, and resources.[1]

Handbook of Emergency Management for State-Level Transportation Agencies

State transportation agencies must have plans for the continuity of their government functions and essential services during any catastrophic disaster, as well as to ensure clear and safe roadways for first responders. Continuity of government and continuity of operations plans augment the emergency operations plan that addresses "normal" emergencies, with an overall emergency management structure in place to support implementation of the plans.

Because transportation agencies typically have significant experience with normal emergencies and routinely work with state police and state fire agencies in disasters, some elements of a mature emergency management capability have not been emphasized. Mineta Transportation Institute Report 09-10 helps establish priorities for managing emergencies, disasters, and catastrophes.[2]

Security and Emergency Management: An Information Briefing for Executives and Senior Leaders of State Departments of Transportation

Plans, concepts, and terminology used by the security and emergency management community are surveyed in this briefing, part of the Federal Highway Administration Transportation Pooled Fund Study 5(161).[3] The publication also serves as a checklist for determining the organizational structure, degree of preparedness, and response capabilities of transportation organizations. Respondents included the departments of transportation in California, Florida, Georgia, Kansas, Mississippi, Montana, New York, Texas, and Wisconsin, as well as the U.S. Department of Homeland Security Transportation Security Administration.

Emergency management, a national response framework, emergency operations plans, incident command systems, operations centers, leadership, and organizing a state emergency management program are among the topics addressed in the presentation.

[1]www.trb.org/Main/Blurbs/164691.aspx.

[2]http://transweb.sjsu.edu/MTIportal/research/publications/summary/MTI-0910.html.

[3]www.fhwa.dot.gov/security/emergencymgmt/profcapacitybldg/docs/hsemexecsrrleaders/hsem_srexecs.cfm.

Transportation Hazards and Security Summit and Peer Exchange

Advancing Research and Applications for Agencies

STEPHAN A. PARKER

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Surface transportation agencies are uniquely positioned to take swift and direct action to protect lives and property—the agencies have policy responsibility, public accountability, large and distributed workforces, heavy equipment, and robust communications infrastructure. The agencies also provide a stable base for campaigns to mitigate or reduce exposure to risk through all-hazards capital investments.

The American Association of State Highway and Transportation Officials (AASHTO) established the Special Committee on Transportation Security and Emergency Management (SCOTSEM) to help state departments of transportation (DOTs) prepare the following:

◆ Risk management plans for assets they control or influence;

◆ Deterrence, surveillance, and protection plans; and

◆ Emergency response plans, including capabilities for handling traffic for major incidents on and off the transportation system.

Since 2007, SCOTSEM and the National Cooperative Highway Research Program (NCHRP) Project 20-59 Panel on Surface Transportation Security Research have cosponsored the Transportation Hazards and Security Summit and Peer Exchange. Delegates from more than 30 state DOTs participated in the August 2012 program, and approximately 40 states sent delegates to the August 2013 event.

Members of the U.S. Army Corps of Engineers St. Louis District Flood Fight team provide technical assistance to the Missouri Department of Transportation (DOT) along the roadway during a flood in June 2013.

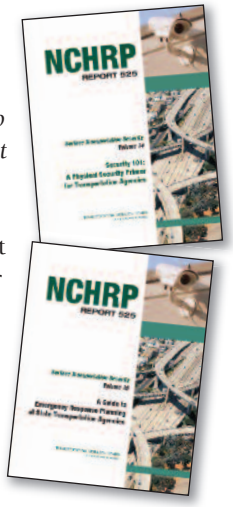
PHOTO: U.S. ARMY CORPS OF ENGINEERS

Setting a Baseline

At the 2012 meeting, AASHTO announced that more than two-thirds of the state DOTs had adopted the suggested guidance and procedures from two volumes of NCHRP Report 525, *Surface Transportation Security*:

◆ Volume 14, *Security 101: A Physical Security Primer for Transportation Agencies*, and

◆ Volume 16, *A Guide to Emergency Response Planning at State Transportation Agencies*.



Adoption of these reports set a new baseline for activity for SCOTSEM. At the 2013 meeting, researchers began gathering information to develop three products:

◆ The National Needs Assessment for Ensuring Transportation Infrastructure Security (2016–2022);

◆ The All-Hazards Security and Emergency Management Research Implementation Plan (2014–2016); and

◆ The second edition of *Fundamentals of Effective All-Hazards Security Management for State DOTs*.

Advancing Agency Initiatives

Through presentations, workshops, and other activities, the annual information exchange brings together researchers and the intended users of the research for technology transfer, data collection, research needs gathering, and research dissemination, as well as for professional development. The program updates the state members of AASHTO on research commissioned by AASHTO and by states. The following groups coordinated the 2013 event:

◆ **AASHTO SCOTSEM**, the "voice and leader" for state DOTs in developing an all-hazards approach

to transportation security and emergency management among all modes. The committee works through partnerships between AASHTO, its state members, other agencies, and professional organizations to advocate for security and emergency management, research program implementation, policy development, and training and awareness.

◆ **AASHTO Special Committee on Wireless Communication Technology**, which represents AASHTO and its member organizations before the Federal Communications Commission and on the national level, monitoring regulatory and policy issues in wireless communications and assisting bodies involved in standards development. The committee studies current and developing technologies for applicability to highway maintenance operations, emergency response, security, and intelligent transportation systems programs and serves as a resource for technical information, solutions, and advice involving transportation-related wireless systems and equipment.

◆ **NCHRP Project 20-59 Panel on Surface Transportation Security Research**, which provides all-hazards, all-modes oversight and project selection guidance for the coordinated security research under TRB's Cooperative Research Programs. SCOTSEM provides direction for the NCHRP security-related projects, and the American Public Transportation Association (APTA) Executive Committee Security Affairs Steering Committee provides direction for the security-related projects under the Transit Cooperative Research Program. A key goal is to assist transportation agencies in adopting the National Incident Management System, which—as former Department of Homeland Security Secretary Tom Ridge has stated—"provides a consistent nationwide approach for federal, state, territorial, tribal, and local governments to work effectively and efficiently together to prepare for, prevent, respond to, and recover from domestic incidents, regardless of cause, size, or complexity."

◆ **TRB Critical Transportation Infrastructure Protection Committee**, which considers issues related to threats from potential physical, chemical, biological, and cyber attacks on critical transportation infrastructure in the United States. The committee develops activities and provides a forum for discussion among the academic community, the private sector, and government agencies, covering such topics as risk assessment, prevention, technology, procedures and applications, emergency preparedness and response, and the integration of security into the planning and operation of transportation systems. The committee also supports outreach by U.S. DOT and other federal agencies to the owners and operators of the nation's transportation system.

PHOTO: TOM SAUNDERS, VIRGINIA DOT

Virginia DOT conducts the 2013 Triennial Emergency Response Exercise at the Richmond International Airport.

◆ **TRB Task Force on Emergency Evacuations**, which focuses on preparedness for emergency evacuations associated with any natural or human-made hazards and with related operational issues, involving evacuations with notice, little notice, or no notice, as well as evacuations of buildings and of urban and regional areas. The task force identifies research needs, encourages and facilitates research, and disseminates findings to enhance the effectiveness and efficiency of operations and to increase safety and survivability for those involved in emergency evacuations. The task force also serves as a resource to governmental and nongovernmental organizations concerned with evacuation planning and operations.

A Pre-Event Recovery Planning Guide for Transportation

In August, TRB's National Cooperative Highway Research Program released Report 753, *A Pre-Event Recovery Planning Guide for Transportation*, to help transportation facility owners and operators in planning for recovery before an event that may affect transportation systems.[1] The report presents the principles and processes for recovery planning for transportation infrastructure and includes decision support tools and resources, such as checklists. A PowerPoint presentation describing the project that developed the guide is available online.

[1]www.trb.org/Publications/Blurbs/169296.aspx.

POINT OF VIEW

Communicating the Urgency for Action on Climate Change

Challenges and Approaches

ROBERT B. NOLAND

The author is a Professor at the Edward J. Bloustein School of Planning and Public Policy and Director of the Alan M. Voorhees Transportation Center, Rutgers University, New Brunswick, New Jersey. He chairs the TRB Special Task Force on Climate Change and Energy.

The following developments should prompt actions by policy makers, particularly by policy makers in the transportation sector, to mitigate and adapt to climate change:

◆ In late October 2012, Superstorm Sandy devastated the New Jersey shore and large parts of New York City.

◆ Global emissions of carbon dioxide have reached a new high as the world recovers from the financial crisis of 2008.

◆ New research suggests that without serious reductions in emissions in the next few years, the ability to limit global warming to 2° Celsius will soon be unachievable (*1*).

◆ New oil drilling technologies are opening up a boom in the U.S. energy industry, promising a plentiful supply of relatively cheap gasoline for the domestic market, but with consequent carbon emissions.

◆ The most recent round of international climate negotiations again failed to agree on a new treaty, instead extending the Kyoto Protocol—which the United States has not ratified—until 2020.

Photo: National Park Service

Superstorm Sandy caused extensive flooding at Assateague Island National Seashore in eastern Maryland. Increases in extreme weather events and other effects of climate change pose a threat to transportation infrastructure.

A Substantive Role

Actions to reduce greenhouse gas emissions and to adapt to a changing climate and more severe weather events such as Superstorm Sandy are a necessity. The increasingly stringent fuel economy standards for the United States—ramping up to 54.5 miles per gallon by 2025, and with the first-ever standards for heavy-duty vehicles going into effect in 2014—are one area of progress. But the message is clear: the science of climate change suggests that substantially more ambitious initiatives are needed, both in planning for adaptation and in implementing policies to mitigate against potentially severe climate impacts in the next 50 years.

Concerted action is needed to reduce the impacts of climate and to protect the large investment in the transportation network. How can transportation professionals play a substantive role in advocating and implementing the most effective policy options? The political and economic obstacles to a nationwide consensus on climate policy have made this task more difficult.

Finding ways to communicate effectively with the public, with private-sector decision makers, and with key policy makers within government agencies is vital, yet all are hesitant to move forward with bold initiatives. Research on communication provides guidelines for transportation professionals working to overcome the various barriers to communication about the issue of climate change; these are presented here.

Urging Action

How can transportation professionals urge action within their agencies, convince the publics they serve, and make an effective case for action to their political leaders? Historically, transportation agency professionals have endeavored to improve the public well-being, first by pulling the country literally

"out of the mud" and then by providing mobility within and between cities and the rural hinterlands.

In building modern roads, the early role of transportation engineers was to apply engineering skills and scientific methods that prioritized investment, improved safety, and developed efficient management and construction techniques. A civil service of transportation professionals emerged. This role has changed over the years, and today the transportation professional's commitment to improve public well-being must include dealing with climate change.

The Intergovernmental Panel on Climate Change (IPCC) has stated that "most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations" (*2*). These concentrations mainly are the result of emissions of carbon dioxide from the combustion of fossil fuels.

The IPCC assessed a measured and conservative body of research findings from more than 20 years into the causes and implications of climate change; this body of research is well within the bounds of evidence established by the scientific method. Nevertheless, segments of the population express doubt that climate change is occurring. Transportation professionals in many states and metropolitan areas may be reluctant or unable to mount major efforts to halt climate change because of resistance from the public and elected officials, to whom they are accountable.

Research teams have sought to understand why segments of the population doubt or question the science that has determined that climate change is a serious threat. Various influences on public opinion have been identified as hindering major policies to reduce carbon emissions. These include perceptions of the scientific debate and the methods by which scientists communicate, the role of the media in communicating science, and the actions of vested interests that oppose any action to reduce carbon emissions.

Scientific Communication

The research that underpins the understanding of climate change is based on theoretical modeling of atmospheric conditions and on empirical measurements of changes in the atmosphere and the oceans. Mathematical models that express the interactions between the atmosphere, oceans, cloud formation, and surface areas of the planet provide a basis for understanding the climatic effects of increases in carbon dioxide and other greenhouse gases. These models are used in forecasting climatic conditions. The goal is to test hypotheses about theoretical relationships.

Much like a highway engineer hypothesizing about how different levels of pavement skid resistance may affect crash rates, atmospheric climate models hypothesize about how increases in greenhouse gases may affect the climate. A difference, of course, is that the highway engineer is able to test different pavement types under real-world conditions, but the atmospheric scientist must wait many years to conclude the experiment of increasing carbon emissions.

Photo: United Nations Framework Convention on Climate Change

Attendees of the 2012 Doha Climate Change Conference in Qatar extended the Kyoto Protocol in lieu of devising a new treaty on climate change.

In both cases, the proof of an effect is never conclusive. Scientific language states that a hypothesis is rejected with a certain level of statistical confidence, not that a hypothesis is accepted with 100 percent certainty; this semantic approach of the sciences, however, has the side effect of confusing decision makers, the media, and the public.

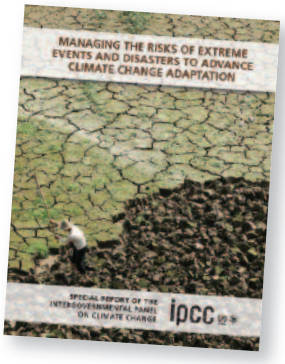
The vast majority of climate researchers have no uncertainty about their conclusions. Scientific discourse typically focuses on uncertainties without repeating the scientific consensus (*3*). Vested interests often have employed this language of science to delay and prevent government action to protect the public welfare. Scholars have dubbed this technique the Scientific Certainty Argumentation Method, or SCAM (*4*).

Public Attitudes

Advocates for action on climate change are concerned about the drop-off of support from the American public. Surveys designed to measure knowledge and concern about climate change have recorded a noticeable reduction in the belief that climate change is occurring and that it is caused by humans (*5*).

Evidence indicates that economic conditions may affect these beliefs; concern about climate change decreases when economic conditions are bad, as in the past few years. A newer survey suggests that the recent economic upturn is associated with an increase in beliefs that climate change is occurring (*6, 7*).

Viewpoints tend to match partisan attitudes: respondents who express more conservative viewpoints—or individualistic world views—have lower



The Intergovernmental Panel on Climate Change has conducted extensive research on the causes and implications of climate change.

PHOTO: ANHOA GOMA, OXFAM

CNN interviews an Oxfam policy expert at the United Nations Climate Summit in Durban, South Africa. News media reports play a large role in public perception of climate change science.

levels of belief that climate change is occurring and are more likely to distrust scientists (*4*). A 2010 survey found that 40 percent of those with doubt and skepticism about climate change expressed imagery suggesting they believe the issue is a conspiracy (*8*).

Role of the Media

The media play a role in affecting the beliefs of audiences. The media attempt to balance their coverage of the causes and consequences of climate change, pitting the scientific community against the beliefs of a few skeptics; this approach, however, confuses the public. Many of the skeptics who are quoted are supported by conservative think tanks or receive funding from the fossil fuel industry. The media create a false sense of a debate within the scientific community and convey the impression of a lack of consensus that climate change is occurring. As noted, the consensus within the scientific community can be undermined by the language of science, which does not seek to prove but to disprove hypotheses.

Research examining the influence of the media has found a distinct effect associated with cable news coverage of climate change (*9*). An analysis of cable content in 2007 and 2008 found that more conservative media had a much higher proportion of stories and discussion that dismissed climate change and that introduced doubt about it being caused by human activities.

Viewers of conservative media were more likely to oppose action on climate change, but this may be the result of self-selection—that is, individuals predisposed to skepticism about climate science may tend to consume news from outlets that justify their beliefs. The survey found that those who identify as more conservative in their views but watch other news media are more accepting of the need to implement mitigation and adaptation policies after being "exposed to information on the reality and urgency of climate change" (*9*, p. 24).

The communication challenge is further complicated by the deliberate proliferation of disinformation by those who oppose policy action on climate change. The creation of doubt about the scientific research on climate change has proved an effective tactic for those who oppose government action, whether to protect their vested economic interests or to press their ideological opposition to government action (*10*).

Communication Strategies

Scientists often are not good communicators and may simply dismiss the views of skeptics. This can reinforce the perception that to scientists the public has no role in the discussion and should be excluded from decisions that can affect their lives.

An alternative to this counterproductive communication is for scientists to recognize and listen to critics but to emphasize persistently and firmly that the scientific process has resolved the debate about the cause and sources of climate change. Shifting the focus of the discussion to shared values and policy solutions is a more effective communication strategy (*11*)—a key lesson for those in the transportation profession who are proposing policies for climate change mitigation and adaptation.

Recent research has determined that educating the public on the science of climate change may not be an effective means of communicating the risks. Some who become more informed about the science may take a stronger stance against policy action (*12, 13*). This may be an effect of preexisting world views—those who are more individualistic tend to be suspicious of government actions, while those who view the world through a more collective or egalitarian perspective tend to be more suspicious of industry and commerce (*12*). The former may dismiss the impacts of climate change and any policy actions to reduce greenhouse gas emissions, but ironically the better informed they are about climate change science, the more dismissive they are of the science.

This may be explained by the perception that government policy may lead to actions that will disrupt their livelihood. This reaction to information creates a dilemma for transportation professionals who seek to educate the population about the dangers of climate change, because a more educated populace seems to become more polarized on the issue.

Other evidence shows that dire messages about the risks of climate change motivate some people to increase their skepticism; more positive messages, in contrast, can reduce skepticism (*14*). The literature on how individuals respond to communication strategies that seek to induce a response of fear is extensive; these strategies can be ineffective unless matched with simple solutions that individuals can take to reduce their risks; again, this provides a potentially useful clue to more effective communication (*15*).

Presenting Policies

Survey research has identified policy mechanisms that members of the public would support; the level of support, however, varies according to characteristics of the populations (*16*). For example, market segmentation analysis finds that those who are most alarmed about climate change will generally be supportive of regulatory initiatives to reduce carbon emissions—for example, regulations to increase the fuel economy of vehicles. But all market segments, including those who are most alarmed, tend not to support pricing policies, such as a revenue-neutral

POINT OF VIEW presents opinions of contributing authors on transportation issues. Readers are encouraged to comment in a letter to the editor on the issues and opinions presented.

increase of the gasoline tax by 25 cents per gallon.

The broader support for some policies suggests alternative ways to frame the issue for the driving public. For example, encouraging the use of alternative fuels or planning infrastructure for an electric vehicle charging system can provide energy security benefits, can insulate consumers from gasoline price volatility and from dependence on foreign sources of energy, and can provide enhanced driving opportunities.

Planning for adaptation in the transportation sector can be framed as fixing roads and transit systems to deal with severe, unexpected weather events that are occurring with greater frequency. Building better-designed and walkable neighborhoods provides choices to consumers, increases the quality of life, and reduces transportation costs.

Focusing on the shared values and beliefs of the public through a positive message about innovating in response to a challenge may be effective but may have difficulty overcoming the current polarization within society. Better insight and understanding of how the public understands science is a substantial research challenge.

Building a Consensus

Transportation professionals will grapple with the issue of climate change for their entire careers. Engaging and building a consensus on the actions needed for mitigation and adaptation will have a greater likelihood of success if communication is coherent, comprehensive, and effective. This review has provided some suggestions for how to communicate, but obstacles and uncertainties persist about how to convey the message clearly. This is an area that needs increased research.

PHOTO: WASHINGTON STATE DOT

Washington State DOT's Green Highway project fulfills a state directive to improve infrastructure for electric vehicles.

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C. Randall (Randy) Mullett

Con-way Inc.

Randy Mullett began his professional career by entering a management training program and going to work on the front lines as a supervisor for Roadway Express. The Berryville, Virginia, native had recently graduated with a bachelor's degree from Shepherd University in West Virginia.

"It was a rude awakening," Mullett recalls. "College was collaborative; teamwork, accountability, and self-discipline were rewarded. When I landed in the unionized trucking environment of the late 1970s, I dealt daily with confrontation, resistance, and an us-against-them mentality. I had to learn the ropes fast."

Several years later, a former colleague encouraged Mullett to join Con-way, a start-up trucking company that was seeking managers to open facilities in Virginia and in the Southeastern United States. Mullet was working for another motor carrier in Philadelphia at the time, but saw an opportunity to return to his Virginia roots. He took the job as the first manager of the Con-way service center in Winchester, Virginia. "All I knew about Con-way was that they were in the less-than-truckload business, that they focused on next-day service—which few carriers did at the time—and that they were nonunion," he comments.

"[TRB offers] a unique opportunity to interact—in a collaborative and supportive environment—with practitioners from government, industry, and academia on meaty issues that will influence the future of transportation."

After a combined 20 years in operations at the former Roadway Express and Con-way, Mullett obtained a master's degree in business administration from Old Dominion University. "I figured I'd teach when I was done with trucking," he recalls. His career path, however, intersected with Washington, D.C., and with Con-way's emerging need for more direct, hands-on representation in the legislative and political process.

In 2002, Mullett was named Con-way's first director of government relations, with an office in Washington. As Con-way's top public policy executive, Mullett is responsible for government relations, public affairs, and corporate communications, which encompasses news media relations, brand and reputation management, web content governance, social media, internal communications, and corporate social responsibility. In 2008, he assumed additional responsibilities for the company's global corporate security group, and in 2012 his management portfolio expanded to oversight of corporate communications. He also is a member of Con-way's Executive Leadership Team, chairman of the selection committee for the Con-way Political Action Committee, and the company's chief sustainability officer, directing corporatewide initiatives to improve economic and environmental sustainability.

A frequent speaker at industry events and at legislative and regulatory forums, Mullett represents Con-way to key constituent groups in Washington and at the state level. In May, U.S. Transportation Secretary Ray LaHood appointed Mullett to the National Freight Advisory Committee, a group established under the 2012 transportation omnibus bill, Moving Ahead for Progress in the 21st Century. The committee will provide advice and recommendations to Congress for improving the national freight transportation system.

Mullett first joined TRB in 2005 as vice-chair of the Task Force on Trucking Industry Research. The task force became a committee the following year; Mullett served as vice-chair until 2012 and remains a member. He also is a member of the Truck Size and Weight Committee and vice-chair of the Oversight Committee for the National Cooperative Freight Research Program. "Working with TRB has given me the opportunity to be involved in highly meaningful research projects important to the industry's future," he observes. "It is a unique opportunity to interact—in a collaborative and supportive environment—with practitioners from government, industry, and academia on meaty issues that will influence the future of transportation."

With Bob Poole of The Reason Foundation, Mullett coauthored a 2006 paper on tolling practices and traffic diversion impacts, "Road Pricing and Trucking: Framing the Issues," published in the International Bridge, Tunnel, and Turnpike Association's quarterly journal. He also has served as a technical expert supporting the Federal Highway Administration's Exploratory Advanced Research Program.

Outside of TRB, Mullett serves on the Board of Directors for the National Association of Manufacturers, the American Trucking Associations, and the American Benefits Council. He is a member of the board of Fueling California, a California-based advocacy organization promoting realistic and effective fuel distribution and management policies. He also is a member of advisory boards at the Old Dominion University Maritime Institute, the University of Michigan Transportation Research Institute, and the Transportation Sustainability Research Center at the University of California, Berkeley. He also serves on the Department of Homeland Security's Highway and Motor Carrier Sector Coordinating Committee.

Eric C. Shen

Port of Long Beach

As Director of Transportation Planning at the Port of Long Beach, California, Eric C. Shen scans past successes and looks to the future for strategies to facilitate the efficient, environmentally friendly travel of goods and services. The second-busiest container cargo port in the United States and part of the eighth-busiest port complex in the world, the Port of Long Beach is a primary gateway for trans-Pacific trade. In 2012, Shen directed a project to secure more than $40 million of state and federal grants to complete the $84 million Green Port Gateway Rail Improvements Project, which will remove a railroad bottleneck and add rail capacity on the docks. It is part of an aggressive 10-year, $4.5 billion capital improvement program for terminal and other infrastructure improvement projects at the port.

"The ability to move people and goods affects quality of life in a community, a region, and a nation."

Since joining the Port of Long Beach in 2007, Shen brought his collaborative and strategic leadership style to many projects, but perhaps the most memorable to date is obtaining the many approvals necessary to fund in full the $1 billion Gerald Desmond Bridge Replacement Project. Construction recently has begun on the new bridge. "The Port of Long Beach is an important economic engine for the entire nation. We strive to offer the best service to our customers by investing in infrastructure and technologies while continuing to implement innovative solutions to minimize environmental impacts on our communities," Shen comments.

Previously, Shen served as manager and principal engineer at the City of Pasadena, California, Transportation Department. He managed citywide transportation planning activities, developed and monitored the city's traffic impact review process, and implemented new initiatives to protect neighborhoods by promoting alternative modes of transportation. He was the principal author of the city's award-winning General Plan Mobility Element, which was selected by the Institute of Transportation Engineers (ITE) as the 2005 Best Transportation Planning Program, and of the Pedestrian Plan, which won an Award of Merit from the American Planning Association Los Angeles Section in 2007. He also worked as a consultant on several mission-critical Intelligent Transportation Systems projects in the United States and abroad.

Shen balances his work at the Port of Long Beach with a longtime love of teaching. He graduated with bachelor's and master's degrees in civil engineering from the University of California (UC), Irvine, and since 1996 has taught courses in transportation engineering and planning at UC Irvine and at the University of California, Los Angeles. Shen currently serves as part-time lecturer at the University of Southern California. "I enjoy the candid dialogue and spirited debate with paraprofessionals," he muses. "These conversations keep my passion for transportation alive, along with the desire to make a long-lasting, positive impact on our community."

Shen attended his first TRB Annual Meeting in 1994 as a graduate student, valuing the sessions "for the insights" and the receptions "for the free food." About a decade later, he assisted a mentor with TRB paper review and soon joined the Critical Transportation Infrastructure Protection Committee and the Transportation Issues in Major U.S. Cities Committee. In 2008, after moving to the Port of Long Beach, he joined the Ports and Channels Committee as chair and the Marine Group as a member. He has worked closely with past Marine Group Chair Jeannie Beckett and with other marine and freight committee chairs to cultivate active participation and to encourage a growing number of research papers.

"My goals during my second term as committee chair are to continue to foster collaboration and interest on a wide spectrum of maritime- and intermodal freight–related research and information exchange," he notes. Shen also serves on two Cooperative Research Programs panels on estimating the impacts of goods movement disruptions and on factors influencing freight modal shift.

"The ability to move people and goods affects quality of life in a community, a region, and a nation," Shen comments. "As our nation finally recognizes the importance of freight movements, transportation professionals must understand the complex interactions among international trade, legacy regulations, modal competitions, sustainable infrastructure, and security." He often reminds his students that "most roads and bridges used today were built by generations before us, and it is our responsibility to preserve and improve that infrastructure."

"Research is the foundation for making our current practice better," Shen observes.

Shen has published many technical papers in traffic operations and transportation planning. He is an active member of ITE, the American Society of Civil Engineers, and the Women's Transportation Seminar (WTS). He serves on the board of directors for the WTS Los Angeles chapter and for the Coalition for America's Gateways and Trade Corridors. In 2003, he received a Distinguished Engineering Alumnus award from UC Irvine. Most recently, the ITE Western District presented Shen with the 2013 Outstanding Educator Award.

Extending the Service Life of Pavement Markings

Iowa Applies Innovation and Technology to Reduce Costs, Increase Safety

OMAR SMADI, NEAL HAWKINS, AND ROBERT YOUNIE

Chair of the TRB Pavement Monitoring and Evaluation Committee, Smadi is Research Scientist, and Hawkins is Director, Center for Transportation Research and Education, Iowa State University, Ames. Younie is State Maintenance Engineer, Iowa Department of Transportation, Ames.

Pavement markings guide motorists and delineate roadways for safe travel. Over the past decade, the Center for Transportation Research and Education (CTRE) at Iowa State University has conducted research to develop new technologies and innovative methods for agencies to manage pavement marking assets.

Problem

Pavement markings have a relatively short service life compared with that of many other roadway assets. The visibility characteristics of markings—their presence and retroreflectivity—deteriorate quickly. Maintaining the visibility of markings at acceptable levels is therefore a major task for agencies' roadway maintenance and safety programs.

U.S. transportation agencies face several issues related to the quality of pavement marking, including variability in the types and performance of marking materials, quality control during installation, damage from traffic and from winter operations, costs, and a lack of performance standards (*1*). The Iowa Department of Transportation (DOT) sought to address each of these issues.

Winter operations contribute to the rapid deterioration of markings.

Application of white line to a grooved surface, which can extend service life.

Solutions

CTRE first conducted pavement marking research to help Iowa DOT improve pavement marking practices. Expectations were that the outcomes also would improve roadway safety.

Before 2004, Iowa DOT had followed material and installation specifications for pavement markings but did not apply measures of performance. State district crews would paint as many miles as possible with waterborne paint, meeting the department's pavement marking specifications to ensure visibility (*2*). In 2004, the Iowa DOT Pavement Marking Task Force began collecting retroreflectivity measurements for pavement markings on all state-owned roads; measurements were taken before the paint season and again after the season.

New Tools

CTRE worked with Iowa DOT to develop tools to manage the pavement markings and improve marking performance. CTRE assessed the installation methods and equipment, the materials—notably, beads and binders—and the application on flat or grooved pavement surfaces.

The initial effort explored ways for the districts to use geographic information system (GIS) tools to

determine their paint programs based on the retroreflectivity values that were recorded in 2004. The district could use the GIS map to determine which lines needed repainting, in which direction of travel.

As more data became available, CTRE developed an interactive tool to allow the central office and field crews to query, analyze, and report data on paint and retroreflectivity. The Iowa DOT Pavement Marking Management Tool assembles reports on pavement marking performance by district or statewide in terms of retroreflectivity, paint data and initial retroreflectivity, materials used, and whether the marking was on a flat or grooved surface.

Figure 1 (below) offers a screen shot of the statewide retroreflectivity values for white edge lines in the fall of 2011. Green represents roads that do not need painting, red indicates roads with marking retroreflectivity below Iowa DOT's threshold of 150 millicandela (mcd), and yellow identifies roads that are in between the two conditions.

The map informs the field crews and district managers about the condition of the pavement markings and supports planning for the next year's paint season. A similar system for managing pavement marking assets was developed for Minnesota DOT using a web-based platform (3).

Operations and Installation

Iowa DOT also used the data to make decisions about operations and installation procedures. Districts lowered the vehicle speeds for painting to 8 to 10 mph from the previous 12 to 15 mph; this reduced bead roll and improved the distribution and embedment of beads, increasing the retroreflectivity of the markings. This practice boosted the average retroreflectivity values statewide for all yellow and white lines.

The next step was to determine and evaluate the performance of pavement marking materials to expand the options available to Iowa DOT. CTRE designed a field study on 12 one-mile roadway sections to assess the performance of two binders and three bead packages applied to flat or grooved surfaces. The binders were waterborne and highbuild waterborne; the bead packages included standard Iowa DOT beads, 1.9 refractive index beads, and American Association of State Highway and Transportation Officials Type III beads.

Close-up view of yellow line deterioration.

CTRE developed the data collection protocol, collected and analyzed the data, and developed recommendations based on observations from two winters. Grooved surfaces showed a potential for extending the life of a marking more than 2 years. Iowa DOT now uses grooving to improve pavement marking retroreflectivity and the quality of service provided to the public.

Cost Savings

On average, the traditional method of painting costs Iowa DOT $210 for 2 lane miles—an expense recurring every year or every 2 years. Applying the paint to grooved surfaces costs the same but lasts for 3 years—a potential savings of $210 to $420 per 2 lane miles in a 3-year cycle.

The savings estimates compared the cost of highbuild paint with Type III beads with the cost of paint-

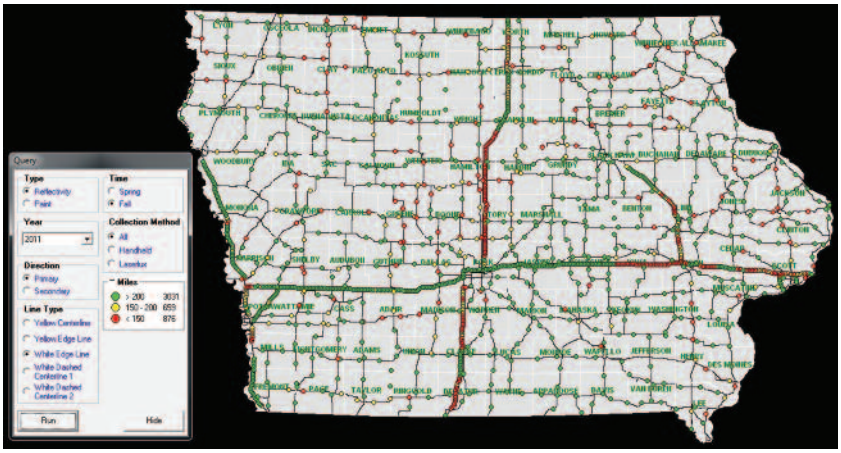

FIGURE 1 Iowa DOT Pavement Marking Management Tool, showing statewide retroflectivity.

Lowering vehicle speeds to 8 to 10 mph during application increased the retroflectivity of the markings.

ing with standard Iowa DOT materials. These savings will be significant when extended to the entire state road network. Iowa DOT therefore has implemented two statewide grooving projects; the results of the projects will be available in 2014.

Safety Findings

CTRE examined the impact of pavement marking on crashes in Iowa, using the retroreflectivity data collected from 2005 to 2010. The study explored the statistical relationship between the probability of a crash and the retroreflectivity of longitudinal pavement markings.

Pavement marking retroreflectivity deteriorates nonlinearly and varies greatly by location, environmental condition, and other unidentified factors. Nonetheless, analysis of the 5 years of marking retroreflectivity and crash data for Iowa DOT state roads yielded a statistically significant conclusion that crash occurrence increases as the retroreflectivity values decrease for both white and yellow longitudinal pavement markings (*4*).

Iowa DOT has established a minimum retroflectivity of 100 mcd for yellow lines.

Benefits

Iowa DOT central and district staff routinely use the tools developed by CTRE to monitor and manage pavement marking assets. Iowa DOT has established minimum retroreflectivity standards of 150 mcd for white lines and 100 mcd for yellow lines based on the effects of pavement marking quality in reducing vehicle crashes.

Both Iowa DOT and Minnesota DOT have changed their pavement marking installation practices as a result of the research findings. The research showed that pavement grooving protected the markings from the wear of traffic and from winter maintenance operations; as noted, the potential savings ranged from $210 to $420 per 2 lane miles in a 3-year cycle.

From a safety perspective, the researchers documented a decrease in crashes with increased retroreflectivity in longitudinal pavement marking. For example, on a two-lane rural road, the crash probability decreased by 2.5 percent when pavement marking retroreflectivity increased from 50 mcd to 200 mcd.

For more information, contact Omar Smadi, Research Scientist, CTRE, 2711 South Loop Drive, Ames, IA 50010; 515-294-7110; Smadi@iastate.edu; or Neal R. Hawkins, Director, CTRE, 2711 South Loop Drive, Ames, IA 50010; 515-689-7848; Hawkins@iastate.edu.

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EDITOR'S NOTE: Appreciation is expressed to Frank N. Lisle, who retired in May as Senior Program Officer, Maintenance and Preservation, and to G. P. Jayaprakash, Transportation Research Board, for their efforts in developing this article.

Suggestions for Research Pays Off topics are welcome. Contact G. P. Jayaprakash, Transportation Research Board, Keck 488, 500 Fifth Street, NW, Washington, DC 20001 (202-334-2952; gjayaprakash@nas.edu).

CALENDAR

TRB Meetings

September

23–27 Smart Rivers 2013*
Liège, Belgium; Maastricht, the Netherlands

October

10–11 Shared-Use Mobility Summit*
San Francisco, California

16–17 Transit GIS Conference*
Washington, D.C.

21–22 Innovations in Freight Modeling and Data: Integrating Supply-Chain Models and Data into Public-Sector Freight Demand Modeling
Herndon, Virginia

23–25 7th International Visualization in Transportation Symposium: Visualization for Big Data
Irvine, California

TBD Development of a Formalized Process for the Adoption, Development, Maintenance, and Enhancement of TransXML Schemas Workshop
Washington, D.C.

December

12–15 2nd Conference of the Transportation Research Group of India*
Agra, India

2014

January

12–16 TRB 93rd Annual Meeting
Washington, D.C.
www.TRB.org/AnnualMeeting

February

4–5 Road Dust Best Management Practices Conference*
Minneapolis, Minnesota

March

3–4 Transportation Planning, Land Use, and Air Quality Conference*
Charlotte, North Carolina

April

1–4 Joint Rail Conference*
Pueblo, Colorado

9–11 5th International Transportation and Economic Development Conference*
Dallas, Texas

14–16 5th International Conference on Women's Issues in Transportation*
Paris, France

14–17 Transport Research Arena Conference*
Paris, France

16–18 4th International Conference on Roundabouts
Seattle, Washington

22–25 NAFTANEXT: Energizing Sustainable Trade Corridors Across North America: The Intersection of Energy, Environment, Jobs, and Growth*
Chicago, Illinois

28–30 10th National Conference on Transportation Asset Management
Miami, Florida

TBD Innovations in Travel Demand Forecasting 2014
Baltimore, Maryland

May

6–8 American Association of State Highway and Transportation Officials Geographic Information Systems for Transportation Symposium*
Burlington, Vermont

21–22 Development of Freight Fluidity Performance Measurements
Washington, D.C.

26–28 GeoShanghai International Conference 2014*
Shanghai, China

TBD Marine Transportation System Research and Technology Coordination Conference
Washington, D.C.

Additional information on TRB meetings, including calls for abstracts, meeting registration, and hotel reservations, is available at www.TRB.org/calendar. To reach the TRB staff contacts, telephone 202-334-2934, fax 202-334-2003, or e-mail TRBMeetings@nas.edu. Meetings listed without a TRB staff contact have direct links from the TRB calendar web page.

*TRB is cosponsor of the meeting.

Webinars Save State Agencies Money

LISA BERARDI MARFLAK

The Indiana Department of Transportation (DOT), like other state DOTs, needs to ensure that its engineers receive annual professional development hours (PDH) credits to maintain their state engineering licenses. Each of the department's 300 engineers needs 15 PDH credits per year.

Seeking the most cost-effective and efficient way for its engineers to accumulate PDH credits, Indiana DOT began to participate in TRB's webinar program, which offers access to the latest transportation information at the convenience of participants' own computers to more than 9,000 participants each year. The program provides professional development education for engineers, certified planners, airport executives, and lawyers.

The webinar program is produced with funding received from TRB core sponsors—the highway and transportation departments of the 50 states and the District of Columbia and select federal and private sponsors. Employees of the core sponsors receive free access to TRB webinars; approximately two-thirds of webinar attendees work for state departments of transportation or federal transportation agencies.

A response to the budget cuts faced by many transportation agencies, the webinar program was initiated in 2008. Like a conference session, a webinar typically lasts 90 minutes to two hours; includes one or more presenters; and covers topics that include recent TRB publications, case studies, and practical research applications. Presentations from previous Annual Meetings or conference sessions also are highlighted.

By attending TRB webinars, Indiana DOT estimates that it saves a substantial amount of dollars towards engineer training costs. Attendees from the DOT also are impressed by the professionalism of the program and volunteer presenters.

The vast majority of TRB's webinars are created for practitioners. On average, more than 300 people attend each webinar. TRB surveys the participants after the webinars are concluded and incorporates

The author is Program Officer, Electronic Dissemination, TRB.

COOPERATIVE RESEARCH PROGRAMS NEWS

Simplified Full-Depth Precast Concrete Deck Panel Systems

Full-depth precast concrete deck panels are widely used in accelerated bridge construction (ABC). As a prefabricated component, current panel design meets the objectives of ABC by expediting construction, improving quality and durability, improving public and worker safety, and reducing road user impact. Deck panels are connected to supporting beams by shear connectors in formed openings in panels, or shear pockets, to achieve a composite action between beams and precast concrete deck panels on a bridge. Because these deck panel systems are connected to the supporting beams for their full length, the design is similar to traditional cast-in-place decks. Disadvantages, however, include poor bond between the grout and panel soffit and hard-to-access shear pockets and longitudinal beam haunches.

George Washington University has received a $400,000, 36-month contract [National Cooperative Highway Research Program (NCHRP) Project 12-96, FY 2013] to develop recommended guidelines and proposed language for the American Association of State Highway and Transportation Officials' *Load and Resistance Factor Design (LRFD) Bridge Design Specifications* for the design, fabrication, and construction of transverse, full-depth, precast concrete deck panel systems that simplify the connection between the deck panel and beam.

For more information, contact Waseem Dekelbab, TRB, at 202-334-1409 or wdekelbab@nas.edu.

Contribution of Steel Casing to Single-Shaft Foundation Structural Resistance

Bridges often are constructed with a single, enlarged, shaft foundation supporting a column, which in many cases is constructed with a permanent steel casing. When the structural resistance of the shaft is calculated in the design process, the steel casing typically is ignored and only the reinforced concrete section is considered. Although bridge designers would like to account for the added structural resistance of the steel casing, they lack research data on when the steel casing and concrete inner core act as a composite section.

State University of New York–Buffalo has received a $470,000, 36-month contract (NCHRP Project 12-93, FY 2013) to determine at what point along the shaft the section can be considered a composite section. The research should consider axial, flexural, and shear effects under axial and lateral loading for strength and extreme event limit states.

For more information, contact Waseem Dekelbab, TRB, at 202-334-1409 or wdekelbab@nas.edu.

their feedback into the production of future webinars. More than 90 percent of webinar participants report that they are satisfied or very satisfied with the webinars that they have attended.

Approximately 40 to 50 webinars are offered each year. In 2012, TRB's 34 webinars offered a total of 44.5 PDHs to professional engineers, 17.5 certification maintenance credits for the American Institute of Certified Planners, 8 continuing education units for airport executives, and 1.5 continuing legal education credits for lawyers.

For more information on TRB's webinar program, visit www.TRB.org/ webinars or contact Lisa Berardi Marflak at 202-334-3134. Upcoming TRB webinars are announced in the free TRB E-Newsletter; to subscribe, visit www.TRB.org/subscribe.

Webinar Subscriptions Now Available

TRB is now offering institutional webinar subscriptions to organizations that are not core sponsors. The subscriptions provide unlimited access to webinars produced for TRB's webinar series to authorized users of subscribing institutions at a single geographic location.

Annual institutional webinar subscriptions begin at $999. TRB conducts a minimum of 30 webinars per year—subscribers receive each webinar at a cost of less than $33. For additional information or to subscribe, please contact Reggie Gillum at 202-334-2382 or rgillum@nas.edu.

SECOND STRATEGIC HIGHWAY RESEARCH PROGRAM

COLLABORATING FOR SAFETY—Attendees of the Strategic Highway Research Program (SHRP 2) Safety Symposium and Workshop participate in a data-sharing workshop and demonstration, July 12 at the National Academies' Keck Center in Washington, D.C. The symposium featured a discussion with Federal Highway Administration (FHWA) Executive Director Jeffrey F. Paniati and American Association of State Highway and Transportation Officials (AASHTO) Executive Director Frederick G. (Bud) Wright, as well as updates on SHRP 2 and research data from the Naturalistic Driving Study; safety-related activities from Toyota, FHWA, AASHTO, and the National Highway Traffic Safety Administration; and naturalistic driving studies being conducted overseas.

Developing a Pavement-Maintenance Database System

Highway agencies are responsible for the maintenance of highway pavements and generally document their actions as part of a maintenance management system. Information on pavement condition is separately documented as part of a pavement management system. These data collection efforts, however, often do not focus on the analysis needed to improve pavement–maintenance decision making. No widely accepted system is available to identify the data needed to capture factors influencing the performance of maintenance treatments or pertaining to pavement performance. Research is needed to develop a database system that provides a uniform format for collecting, reporting, and storing information on pavement maintenance.

Pavia Systems, Inc., of Seattle, Washington, has been awarded a $249,790, 24-month contract (NCHRP Project 14-31, FY 2013) to develop a database system of pavement-maintenance actions, materials, methods, and effectiveness. The database system will establish a record of actions for use in cost–benefit analysis, to evaluate the effects of maintenance on pavement performance, to select maintenance actions, and to make related decisions.

For further information, contact Amir N. Hanna, TRB, at 202-334-1432 or ahanna@nas.edu.

Proposed LRFD Bridge Design Specifications for Light Rail Transit Loads

Bridges carrying or expected to carry rail transit vehicles are becoming more commonplace in crowded metropolitan areas. In many cases, the bridges are designed to carry the rail transit vehicles only, but in some instances, rail transit is designed to occupy a dedicated lane or to mix with regular highway traffic. For bridges designed to carry light rail transit systems, the responsible agency often requires that the designs satisfy owner-specific and local design codes, various AASHTO bridge specifications, and the *Manual for Railway Engineering*; however, neither the bridge specifications nor the manual specifies the light rail transit loads. Light-rail bridge design involves several additional conditions, such as trackwork design and the interaction between the rails and structure.

Regents of the University of Colorado have received a $350,000, 33-month contract (NCHRP Project 12-92, FY 2013) to develop proposed AASHTO *LRFD Bridge Design Specifications* for bridges carrying only light rail transit vehicles and for bridges carrying both light rail transit vehicles and regular highway traffic.

For more information, contact Waseem Dekelbab, TRB, at 202-334-1409 or wdekelbab@nas.edu.

On-Time Arrival App Wins Six-Minute Pitch

Young Member's Council Sponsors Annual Meeting Challenge

SHANA R. JOHNSON

The TRB Young Members Council sponsored a special session at the TRB 92nd Annual Meeting, "The Six Minute Pitch: Transportation Innovation and Entrepreneur's Challenge," featuring four young transportation professionals with innovative, research-based transportation business ideas—each idea presented in six minutes. Panelists Sean O'Sullivan, Avego and SOSVenturs; Chicago Department of Transportation Commissioner Gabe Klein; Ryan Rzepecki, Social Bicycles; Jeff Chernick, RideAmigos; and Kate Chanba, Carticulate Maps, evaluated the pitches based on their viability in the commercial marketplace and their innovativeness in solving real-world transportation problems.

Robert Rodden, American Concrete Pavement Association, presented the winning pitch, "On-Time Arrival." Rodden, a registered professional engineer, developed the mobile application with Susan Paulus, Lakeside Engineers. Paulus, a professional engineer and Leadership in Energy and Environmental Design Green Associate, was a Federal Highway Administration Eisenhower Fellow, and like Rodden is an active member of TRB standing committees.

Photo: Megan Makoid

The Six-Minute Pitch competition at the 2013 TRB Annual Meeting featured presentations of research-based solutions to transportation problems.

On Time, Every Time

On-Time Arrival analyzes an air traveler's current location and the in-airport traffic conditions to provide an estimated time of arrival at a flight's gate. The idea for On-Time Arrival occurred to Rodden as he sought a solution to help air travelers such as his boss, who tended to arrive at the airport just before the door closed and often risked missing the flight, as well as a coworker who preferred to be at the gate with plenty of time to spare.

When he heard about the Six-Minute Pitch competition, Rodden shared the idea with Paulus, whose expertise focused on the people-moving side of transportation engineering. Using technology similar to BlueTOAD, a device that calculates real-time travel delays through work zones and alternate routes, the On-Time Arrival system assists users in determining when to head to the airport. Bluetooth sensing devices are strategically placed at the airport to isolate the various paths between the airport entrance and each terminal—for example, after parking a car, returning a rental car, or getting dropped off.

By isolating each path, anonymously detecting the media access control addresses of passing devices, and recording the time as they pass, On-Time Arrival can calculate the amount of time it takes to complete any such path. If the airport parking lot is filling up, the system can detect that in the data as well as the delay at each security checkpoint in real time. Details and filters such as accounting for priority access through security are under development.

Susan Paulus and Robert Rodden are developers of the On-Time Arrival app.

Refining the Focus

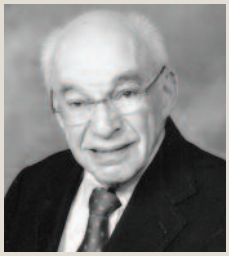
Rodden credits the Six-Minute Pitch for emphasizing the value of their idea and for providing the fuel the developers needed. Before the Six-Minute Pitch, Rodden and Paulus had not shared the idea with many people and did not know how it would be received. Based on panel feedback, they are refining their firm and its focus—On Time Arrival is now ΔT Data, or Delta T Data—and will apply to programs focused on jumpstarting technology startups and connecting startups with potential investors.

For more information on the On-Time Arrival app, visit http://deltatdata.com/. The TRB Young Members Council will be reprising the Six-Minute Pitch for the TRB 93rd Annual Meeting in January 2014. Information on the Six-Minute Pitch session—including instructions on applying to present—will be posted this fall to the Young Member's Council Groupsite, http://ymc.groupsite.com.

The author is Senior Transportation Planner, Foursquare Integrated Transportation Planning, Inc., Rockville, Maryland. *This article was adapted with permission from a February 2012 review by Mobility Lab and from the article "Young Professional Transportation Innovators Win TRB's Inaugural Six-Minute Pitch," which appeared in the spring 2013 edition of* Mobility Matters.

PEOPLE IN TRANSPORTATION

Herbert S. Levinson



Herbert S. Levinson, widely recognized as one of the pioneers of traffic engineering practice and transportation planning, received an honorary doctorate in May 2013 from his undergraduate alma mater, the Illinois Institute of Technology (IIT). Levinson has been an active participant in TRB for more than 50 years, serving on the TRB Executive Committee and on numerous TRB standing committees, conference planning committees, and Cooperative Research Programs panels. He is an Emeritus Member of three standing committees—on Bus Transit Systems, Access Management, and Transit Capacity and Quality of Service.

Levinson began his career in the Traffic Engineering Section of the Chicago Park District in 1949. For 28 years—from the early 1950s until 1980—he worked for Wilbur Smith and Associates, rising from Associate to Vice President and Senior Vice President. At Wilbur Smith he directed a variety of projects and developed innovative approaches to transportation planning and engineering, as well as public transportation and policy.

In 1980 he opened his own transportation consultancy based in New Haven, Connecticut. He has provided consulting services to many public agencies in the United States and abroad on a range of assignments.

In addition to his undergraduate degree in civil engineering from IIT, Levinson completed graduate work at Northwestern University and holds a Certificate in Highway Traffic from the Yale University Bureau of Highway Traffic. He was elected to the National Academy of Engineering in 1994.

Levinson is the recipient of many awards, including the American Society of Civil Engineers' Wilbur S. Smith Award, the Institute of Transportation Engineers' Theodore M. Matson and Honorary Member awards, and TRB's Roy W. Crum Distinguished Service Award. He is a registered professional engineer in Connecticut, Massachusetts, and New York.

INTERNATIONAL RESEARCH— Genevieve Giuliano (*right*), University of Southern California and past TRB Executive Committee Chair, presides over a discussion on the impacts of trade nodes on surrounding cities and mitigation strategies, with (*left to right*) panelists Thierry Vanelslander, University of Antwerp, Belgium, and Jean-Paul Rodrigue, Hofstra University, Hempstead, New York, and copresenter Lanfranco Senn, Bocconi University, Milan, Italy. The EU–U.S. Transportation Research Symposium took place May 30–31 at the National Academy of Sciences Building in Washington, D.C.

IN MEMORIAM

James (Jim) August Scott (1934–2013)

Longtime TRB Senior Program Officer James (Jim) August Scott, 79, died in Charlottesville, Virginia, on July 1. Scott began his 35-year career with TRB, then the Highway Research Board, in 1965. As senior program officer, he provided inspiring leadership to TRB standing committees in planning and worked closely with the U.S. Department of Transportation; state, local, and metropolitan transportation agencies; universities; and the private sector. Scott received an individual achievement award from the National Research Council in 1998 for his integral role guiding the transportation planning field and TRB activities. He retired in 2000.

Scott was born on April 19, 1934, in Madison, Wisconsin. After graduating with a bachelor's degree from the College of St. Thomas—now the University of St. Thomas—in St. Paul, Minnesota, in 1956, Scott served in the U.S. Army for two years. He then attended the University of Wisconsin, receiving a master's degree in urban and regional planning in 1962. He joined the City of Madison Planning Department in 1962 as capital budgeting officer and chief of long-range planning.

Courtesy of the Port of Long Beach

The Gerald Desmond Bridge replacement is an example of a state and local government infrastructure project.

State and Local Governments Supporting Infrastructure Delivery

State and local governments are responsible for approximately three-quarters of all infrastructure spending in the United States, according to a joint report from the Urban Land Institute (ULI) and Ernst & Young. Although federal sources supply 25 percent, infrastructure spending comprises 2.4 percent of gross domestic product—not a drastic reduction from its peak in the 1960s.

State and local governments are advocating local tax increases and higher user fees and tolls to pay for key infrastructure investments, according to the report. Some state and local governments are experimenting successfully with design–build construction and public–private partnerships such as turnkey delivery, long-term performance responsibilities, and financing for new infrastructure projects and maintenance.

Some financial services organizations also are investing in infrastructure, encouraged by strong institutional investor interest for projects that are well into construction and that pose limited revenue risk. Infrastructure banks can facilitate creative financing of local projects as well, according to the study, with several cities and regions exploring pooled resources to fund shared infrastructure projects and promote growth.

For more information, contact Trish Riggs, ULI, at 202-624-7086 or priggs@uli.org.

Poll Measures Value of Transportation Infrastructure

A new national opinion poll on infrastructure and transportation assets shows that Americans place a high value on the nation's road and transit network, but also that most people are not aware of how much they pay in federal and state gas taxes. The research was commissioned by the American Road and Transportation Builders Association (ARTBA).

According to ARTBA, nearly 90 percent of respondents stated that transportation infrastructure is important in maintaining a strong economy and 83 percent felt that infrastructure was vital to national defense and emergency response capabilities. Slightly more than three-quarters of respondents stated that driving a motor vehicle is "very" or "extremely" important in their daily lives, while 21 percent of all respondents and 34 percent of low-income respondents answered similarly about public transportation. Seventy-one percent of Americans polled connected increasing traffic congestion with higher consumer goods prices, and nearly three-quarters of respondents agreed that investment in transportation infrastructure should be a core federal government function.

FIGURE 1 Average monthly U.S. household expenditures, 2007–2011. (Note: The number of American households is an average from the U.S. Census Bureau QuickFacts. Annual household expenditures for phone service, television, and Internet are adjusted by household usage rates. Motor fuel tax figures are from the Federal Highway Administration for 2011.)

Most respondents, however, did not know how much they paid in taxes on motor fuel per month, according to ARTBA. Federal Highway Administration data show that the average U.S. household pays $46 per month in gas taxes—24 percent of respondents estimated that the amount they paid was more than double the national average and 22 percent underestimated the amount.

For more information and to view the press release, visit http://www.artba.org/article/are-good-roads-and-transit-worth-as-much-to-you-as-household-electricity-or-cable-service.

INTERNATIONAL NEWS

Triennial Program Convenes Young Researchers

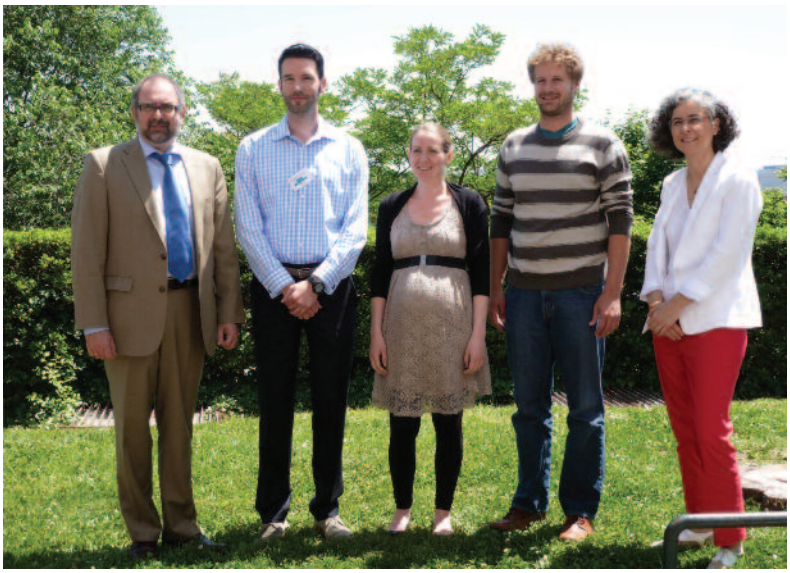
Young transportation researchers from more than a dozen organizations across Europe and the United States converged to present research, network with peers, and receive tips from international transportation experts at the Young Researchers Seminar 2013, June 5–7 in Lyon, France. Organized by the European Conference of Transport Research Institutes (ECTRI) and the Forum of European Road Safety Research Institutes (FERSI), the triennial seminar focused on the following research areas:

- Transportation economics policy and travel behavior,
- Sustainability and the environment,
- Safety,
- Intelligent transport systems and traffic, and
- Civil and road engineering.

Best paper awards went to Markus Schumacher, Federal Highway Research Institute of Germany (BASt), who won the first prize for his paper, Assessing Fitness to Drive Under Long-Term Treatment with Opioid Analgesics. Second prize was presented to Steve Hankey, University of Minnesota, for his paper on measuring air pollution using a mobile, bicycle-based platform. Kira Hyldekær Janstrup, Technical University of Denmark, received the third prize for her paper on using the capture–recapture method to estimate road accidents in Denmark.

In recognition of the Memorandum of Understanding signed by TRB and ECTRI in 2006, members of TRB's International Activities Committee have independently supported the travel of American students to participate in the Young Researchers Seminar. This year, Jorge Prozzi of the University of Texas at Austin sent two of his students and served as a tutor at the seminar. The United States sent a total of five delegates, including Prozzi and Hankey.

For more information on the seminar, visit www.ectri.org/YRS13/ indexyrs13.html.



(*Left to right:*) Raschid Urmeew, FERSI Secretary General; Markus Schumacher, Federal Highway Research Institute of Germany; Kira Hyldekær Janstrup, Technical University of Denmark; Steve Hankey, University of Minnesota; and Caroline Alméras, ECTRI Secretary General.

Continued Decline in International Road Deaths

Deaths among road users have reached record low numbers, according to the International Traffic Safety Data and Analysis Group (IRTAD). Countries with the largest reductions in road fatalities were New Zealand, with a reduction of 24 percent between 2010 and 2011; Norway, with a reduction of 19 percent; and Spain, with a reduction of 17 percent. Spain also experienced the largest long-term drop, with a 64 percent reduction in road deaths between 2000 and 2011. Most of these reductions are attributable to increased passive safety features of cars, according to the report, with the largest safety gains affecting car passengers.

The report notes, however, that road safety varies between countries in terms of fatalities per 100,000 people. Among countries in the Organisation for Economic Co-operation and Development (OECD) studied by IRTAD, a three-fold difference prevails between the countries with highest safety performance and those with the lowest, reflecting the difference between developed countries with effective road safety policies and developing countries with increasing automobile use and few safety measures.

Among vulnerable road users—pedestrians and cyclists—the reduction in road deaths is smaller. Between 2000 and 2010, pedestrian and cyclist deaths in OECD–IRTAD countries fell by only one-third, and those of moped and motorcycle riders by only 14 percent.

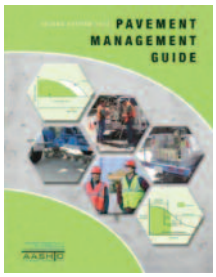
To see the full report, visit http://internationaltransportforum.org/Pub/new.html.

Review of the Research Program of the U.S. DRIVE Partnership: Fourth Report
Board on Energy and Environmental Systems, Division on Engineering and Physical Sciences, and National Research Council. National Academies Press, 2013; 185 pp.; $48; 978-03-0926-831-8.

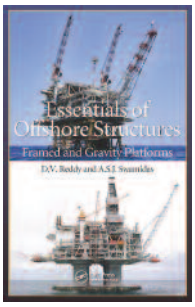
A follow-up to previous National Research Council reviews of the FreedomCAR and Fuel Partnership, this report examines the U.S. Driving Research and Innovation for Vehicle Efficiency and Energy Sustainability (DRIVE) Partnership. The partnership aims to facilitate the development of efficient, clean light-duty vehicle and energy infrastructure technologies. U.S. DRIVE's research and development and technology validation programs are under way for internal combustion engines and conventional and alternative fuels, automotive fuel cell power systems, hydrogen storage systems, batteries, electric propulsion systems, hydrogen production and delivery, and materials that could reduce vehicle weight.

Pavement Management Guide, 2nd Edition
American Association of State Highway and Transportation Officials (AASHTO), 2012; 200 pp.; AASHTO members, $95; nonmembers, $114; 1-56051-545-6.

The updated edition of the 2001 *Pavement Management Guide* from AASHTO is a resource for transportation agencies and others in effective pavement management, for assessing and justifying funding needs for pavement preservation and rehabilitation, and for setting attainable performance goals.



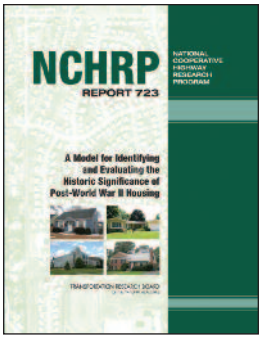
Essentials of Offshore Structures: Framed and Gravity Platforms
D. V. Reddy and A. S. J. Swamidas. CRC Press, 2013; 684 pp.; $129.95; 978-14-2006-882-5.



This volume explores the engineering of offshore drilling platforms for exploration and production, offering a demonstration—in theory and in application—of the relevant procedures of structural, fluid, and geotechnical mechanics. Presented are theory, solutions, and useful visual illustrations of offshore structures, along with samples of current and older structures. Topics addressed include force modeling, seabed soil characteristics, materials, corrosion, risk analysis, and design codes.

The books in this section are not TRB publications. To order, contact the publisher listed.

TRB PUBLICATIONS



A Model for Identifying and Evaluating Historic Significance of Post–World War II Housing
NCHRP Report 723

Many post–World War II housing structures are now more than 50 years old and must be considered by transportation planners in compliance with Section 106 of the National Historic Preservation Act. Presented in this volume is a methodology for identifying and evaluating postwar housing resources as well as a national context to understand the development of postwar housing and guide the evaluation of postwar residential types.

2012; 172 pp.; TRB affiliates, $51; nonaffiliates, $68. Subscriber categories: highways; public transportation; environment.

Application of LADAR in the Analysis of Aggregate Characteristics
NCHRP Report 724

This report describes a laser detection and ranging (LADAR)–based system for measurement of aggregate characteristics over a range of particle sizes.

2012; 86 pp.; TRB affiliates, $40.50; nonaffiliates, $54. Subscriber categories: highways; geotechnology; materials.

Guidelines for Analysis Methods and Construction Engineering of Curved and Skewed Steel Girder Bridges
NCHRP Report 725

Guidance is presented on the appropriate level of analysis needed to determine the constructability and constructed geometry of curved and skewed steel girder bridges. Also included are improvements to 1-D and 2-D analyses that require few additional

TRB PUBLICATIONS *(continued)*

computational costs.

2012; 185 pp.; TRB affiliates, $51; nonaffiliates, $68. Subscriber categories: bridges and other structures; highways.

A Guidebook for Nighttime Construction: Impacts on Safety, Quality, and Productivity
NCHRP Report 726

Authors present suggested guidance on the conduct of nighttime highway construction and maintenance operations and address work zone risk analysis planning and implementation, construction nuisances to neighbors and workers, and work zone illumination methods.

2012; 122 pp.; TRB affiliates, $42.75; nonaffiliates, $57. Subscriber categories: highways; materials; design.

Effective Experiment Design and Data Analysis in Transportation Research
NCHRP Report 727

Factors in designing experiments, along with 21 examples illustrating the experiment design process, are presented in this volume, a companion to NCHRP CD-22.

2012; 80 pp.; TRB affiliates, $40.50; nonaffiliates, $54. Subscriber category: research.

Guidelines for Evaluating and Selecting Modifications to Existing Roadway Drainage Infrastructure to Improve Water Quality in Ultra-Urban Areas
NCHRP Report 728

This report provides guidelines for evaluating and selecting hydraulic modifications to drainage infrastructure intended to mitigate potential highway runoff impacts. Supplementing the report is a Microsoft Excel–based design and sizing tool, available for download or on CD-ROM.

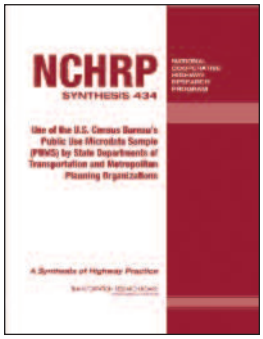
2012; 167 pp.; TRB affiliates, $57.75; nonaffiliates, $77. Subscriber categories: environment; hydraulics and hydrology; highways.

Automated Enforcement for Speeding and Red Light Running
NCHRP Report 729

The guidelines in this report are designed to help transportation agencies start and operate automated enforcement programs to improve highway safety by reducing the number of violations for speeding and red-light-running.

2012; 76 pp.; TRB affiliates, $39; nonaffiliates, $52. Subscriber categories: operations and traffic management; safety and human factors.

Use of the U.S. Census Bureau's Public Use Microdata Sample (PUMS) by State Departments of Transportation and Metropolitan Planning Organizations
NCHRP Synthesis 434



A reference for transportation planners, this volume surveys the ways that state departments of transportation (DOTs) and metropolitan planning organizations use—and develop their own tabulations from—the U.S. Census Bureau's sampled records, made available in PUMS data products.

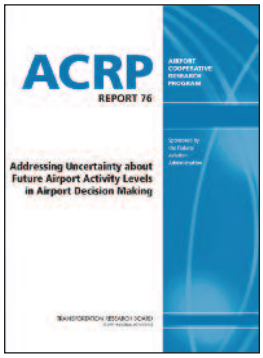
2012; 73 pp.; TRB affiliates, $38.25; nonaffiliates, $51. Subscriber categories: data and information technology; highways; pedestrians and bicyclists; planning and forecasting; public transportation; society.

Local Policies and Practices That Support Safe Pedestrian Environments
NCHRP Synthesis 436

This synthesis documents the tools and strategies used by municipalities to improve the safety, convenience, and accessibility of the pedestrian experience.

2012; 85 pp.; TRB affiliates, $40.50; nonaffiliates, $54. Subscriber categories: highways; pedestrians and bicyclists; policy; safety and human factors; society.

Addressing Uncertainty About Future Airport Activity Levels in Airport Decision Making
ACRP Report 76



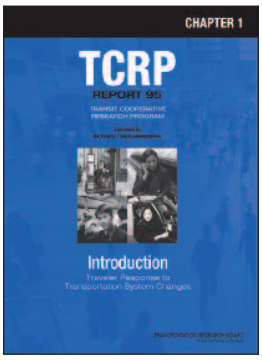
A systems analysis methodology is presented to augment standard airport master planning and strategic planning approaches and includes a set of tools for improving the understanding and application of risk and uncertainty in air traffic forecasts.

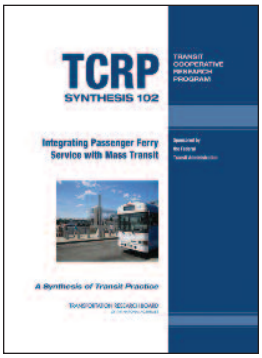
2012; 141 pp.; TRB affiliates, $47.25; nonaffiliates, $63. Subscriber categories: aviation; economics; planning and forecasting.

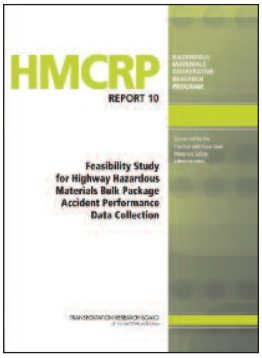
Guidebook for Developing General Aviation Airport Business Plans
ACRP Report 77

This guidebook helps airport managers develop and implement a business plan and maximize an airport's financial self-sufficiency. The role, value, and the compelling reasons for having an airport business plan, applicable to all sizes of airports, are identified. The guide highlights the elements of a business plan and addresses each step of the development and

TRB PUBLICATIONS *(continued)*







implementation process. The print version of the report includes a CD-ROM.

2012; 163 pp.; TRB affiliates, $57.75; nonaffiliates, $77. Subscriber category: aviation.

Airport Ground Support Equipment (GSE): Emission Reduction Strategies, Inventory, and Tutorial
ACRP Report 78

This report, which includes a three-module tutorial on CD-ROM, presents an inventory of GSE at airports, identifies potential strategies to reduce emissions from powered GSE, and provides a tutorial that describes GSE operations and emission reduction technologies for use by owners and operators.

2012; 78 pp.; TRB affiliates, $50.25; nonaffiliates, $67. Subscriber categories: aviation; environment; vehicles and equipment.

Evaluating Airfield Capacity
ACRP Report 79

Presented in this report are available methods to evaluate airfield capacity; guidance on selecting an appropriate method for capacity analysis; best practices in assessing airfield capacity and applying modeling techniques; and specifications for new models, tools, and enhancements. A CD-ROM with a prototype capacity spreadsheet model accompanies the print edition.

2012; 163 pp.; TRB affiliates, $65.25; nonaffiliates, $87. Subscriber categories: aviation; design; operations and traffic.

Traveler Response to Transportation System Changes: Chapter 1—Introduction
TCRP Report 95

This volume describes the *Traveler Response Handbook* and its development, offering guidance to prospective users. The *Handbook* consists of 15 stand-alone topical chapters.

2013; 79 pp.; TRB affiliates, $41.25; nonaffiliates, $55. Subscriber categories: planning and forecasting; public transportation; operations and traffic management; pedestrians and bicyclists.

Paratransit Emergency Preparedness and Operations Handbook
TCRP Report 160

Guidance, strategies, tools, and resources to help paratransit service providers plan and prepare for, respond to, and recover from a range of emergencies are included in this volume.

2013; 101 pp.; TRB affiliates: $43.50; nonaffiliates, $58. Subscriber categories: public transportation; security and emergencies.

Integrating Passenger Ferry Service with Mass Transit
TCRP Synthesis 102

This synthesis examines the integration between land- and water-based transit systems and explores successful aspects of seamless integration.

2013; 45 pp.; TRB affiliates, $33; nonaffiliates, $44. Subscriber categories: administration and management; planning and forecasting; policy; public transportation; safety and human factors; security and emergencies; society; terminals and facilities.

Feasibility Study for Highway Hazardous Materials Bulk Package Accident Performance Data Collection
HMCRP Report 10

Methods to collect and analyze performance data for U.S. DOT-specified hazardous materials bulk packages are presented, and the institutional challenges to data collection are identified and evaluated. The volume offers a methodical approach for developing and implementing a reporting database system to collect and characterize information about damage to U.S. DOT-specified hazardous materials bulk packages in accidents, whether or not the damage resulted in a leak.

2013; 121 pp.; TRB affiliates, $53.25; nonaffiliates, $71. Subscriber categories: freight transportation; motor carriers.

Technical Assessment of Dry Ice Limits on Aircraft
HMCRP Report 11

A technical approach to determining the maximum quantity of dry ice that may be safely carried aboard aircraft is presented in this volume, along with guidelines for helping to determine safe limits for dry ice on commercial airplanes. A CD-ROM–based software tool is included with the print edition.

2013; 53 pp.; TRB affiliates: $42; nonaffiliates, $56. Subscriber categories: aviation; freight transportation.

Interactions Between Transportation Capacity, Economic Systems, and Land Use
SHRP 2 Report S2-C03-RR-1

Presented in this volume are stakeholder needs, limitations of available tools, and future research; a design for Transportation Project Impact Case Stud-

TRB PUBLICATIONS *(continued)*

ies; a handbook for practitioners; and economic impact data analysis findings.

2012; 50 pp.; TRB affiliates, $34.50; nonaffiliates, $46. Subscriber categories: economics; highways.

Concrete Materials 2012
Transportation Research Record 2290

The papers in this volume explore such topics as chemical admixtures, the durability of concrete made with recycled concrete aggregates, reducing the clinker content of cement, and photocatalytic concrete pavement.

2012; 167 pp.; TRB affiliates, $55.50; nonaffiliates, $74. Subscriber categories: materials; environment.

Information Systems, Geographic Information Systems, and Advanced Computing 2012
Transportation Research Record 2291

Papers in this volume examine traffic monitoring systems, travel time reliability, horizontal curve information vehicle detection and tracking, strategies to reduce greenhouse gas emissions, and more.

2012; 134 pp.; TRB affiliates, $58.50; nonaffiliates, $78. Subscriber category: data and information technology.

Maintenance and Preservation 2012
Transportation Research Record 2292

Carbon emissions from road maintenance, hot-mix asphalt overlay, micromilling, sonic methods to detect concrete bridge deck delamination, and remote sensing of bridge performance are among the topics covered in this volume.

2012; 178 pp.; TRB affiliates, $51.75; nonaffiliates, $69. Subscriber categories: maintenance and preservation; pavements; bridges and other structures.

Asphalt Materials and Mixtures 2012, Vol. 1
Transportation Research Record 2293

Subjects addressed in this volume include damage and thixotropy in asphalt mixtures, fine-graded permeable friction course, the impact of water on asphalt aging, and the temperature effects of porous asphalt pavement.

2012; 130 pp.; TRB affiliates, $51.75; nonaffiliates, $69. Subscriber categories: materials; pavements; environment.

Asphalt Materials and Mixtures 2012, Vol. 2
Transportation Research Record 2294

Authors present research on reclaimed asphalt pavement mixtures, geosynthetic material in reclaimed asphalt pavement, the performance of warm-mix asphalt mixtures, filler fractional voids, warm-mix asphalt additives, and more.

2012; 114 pp.; TRB affiliates, $48; nonaffiliates, $64. Subscriber categories: materials; pavements; environment.

Asphalt Materials and Mixtures 2012, Vol. 3
Transportation Research Record 2295

The measurement of hydraulic conductivity in porous mixes, surface friction performance of chip seals, asphalt pavement surface texture, and open-graded friction course mixtures are among the topics explored in this volume.

2012; 71 pp.; TRB affiliates, $38.25; nonaffiliates, $51. Subscriber categories: materials; pavements.

Asphalt Materials and Mixtures 2012, Vol. 4
Transportation Research Record 2296

This volume includes research reports on dynamic modulus master curves, asphalt concrete fatigue analysis, an asphalt mixture performance tester evaluation, determining damage development in hot-mix asphalt, and more.

2012; 152 pp.; TRB affiliates, $55.50; nonaffiliates, $74. Subscriber categories: materials; pavements.

Finance, Pricing, Economics, and Equity Issues
Transportation Research Record 2297

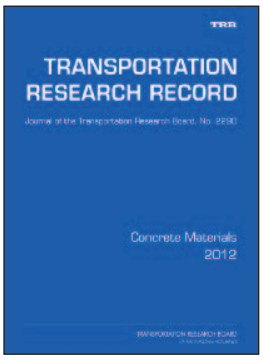
Research on a marginal-cost vehicle mileage fee, the role of context in the equity effects of congestion pricing, nonpublic funding options for Interstate safety rest areas, the relationship of transportation access and connectivity to local economic outcomes, and other topics is presented in this volume.

2012; 180 pp.; TRB affiliates, $58.50; nonaffiliates, $78. Subscriber categories: finance; economics; policy.

Traffic Control Devices, Visibility, and Highway–Rail Grade Crossings 2012
Transportation Research Record 2298

Topics addressed in this volume include timing yellow and red traffic signal intervals, stop paddles with embedded lights for street crossing guards, mit-

The TRR Journal Online website provides electronic access to the full text of more than 13,000 peer-reviewed papers that have been published as part of the Transportation Research Record: Journal of the Transportation Research Board *(TRR Journal) series since 1996. The site includes the latest in search technologies and is updated as new TRR Journal papers become available. To explore the TRR Online service, visit www.TRB. org/TRROnline.*



TRB PUBLICATIONS *(continued)*

igating the dilemma zone problem, nonstandard symbol signs, and high-beam usage on low-volume rural roads.

2012; 103 pp.; TRB affiliates, $46.50; nonaffiliates, $62. Subscriber categories: operations and traffic management; safety and human factors; rail.

Pedestrians 2012
Transportation Research Record 2299

Pedestrian behavior, accessibility and connectivity in a pedestrian network, midblock crossings, bicycle and pedestrian studies using data from the National Household Travel Survey, a dedicated short-range communication system for pedestrians, and more are examined in this volume.

2012; 179 pp.; TRB affiliates, $58.50; nonaffiliates, $78. Subscriber category: pedestrians and bicyclists.

Aviation 2012
Transportation Research Record 2300

Authors present research on airport surface safety, infection-spreading links in an air traffic network, advanced parallel runway operations, taxi dispatching at high-volume airports, landing fees, leveraging fuel cost differences in aircraft routing, and more.

2012; 161 pp.; TRB affiliates, $55.50; nonaffiliates, $74. Subscriber category: aviation.

Operational Effects of Geometrics and Access Management 2012
Transportation Research Record 2301

Motor vehicle speeds for urban sustainability, using centerline and shoulder rumble strips on high-speed two-lane rural highways, and the safety and operating characteristics of Texas Super 2 highways are among the topics explored in this volume.

2012; 85 pp.; TRB affiliates, $44.25; nonaffiliates, $59. Subscriber categories: operations and traffic management; design; safety and human factors.

Travel Demand Forecasting 2012, Vol. 1
Transportation Research Record 2302

Authors present research on sketch planning, tour-generation models, probit Bayes estimators, legislation for innovations in travel demand modeling, trip distribution models, and more.

2012; 200 pp.; TRB affiliates, $60.75; nonaffiliates, $81. Subscriber category: planning and forecasting.

Travel Demand Forecasting 2012, Vol. 2
Transportation Research Record 2303

The papers in this volume examine topics including regional modeling of nonmotorized travel, green and active access to rail transit stations, socioeconomic model systems for activity-based modeling, trip rates and accessibility, and estimating rest area use.

2012; 124 pp.; TRB affiliates, $48; nonaffiliates, $64. Subscriber category: planning and forecasting.

Pavement Management 2012, Vol. 1
Transportation Research Record 2304

Research on the sustainability of perpetual pavement designs, pavement rehabilitation and management decisions, traffic-speed deflectometers, realistic life-cycle cost analysis, a model to estimate pavement structural numbers, and region segmentation of pavement images for crack detection is presented in this volume.

2012; 204 pp.; TRB affiliates $60.75; nonaffiliates, $81. Subscriber category: pavements.

Pavement Management 2012, Vol. 2
Transportation Research Record 2305

This volume includes papers on topics such as temperature gradients for ultrathin bonded concrete overlays on asphalt pavements, concrete slab curling effects on joint load transfer responses, joint load transfer for jointed precast concrete pavements, and the implications of climate change for flexible pavement design and performance.

2012; 176 pp.; TRB affiliates $58.50; nonaffiliates, $78. Subscriber category: pavements.

Pavement Management 2012, Vol. 3
Transportation Research Record 2306

Pavement rehabilitation, strength and deformation characteristics of pavement sections, and surface properties–vehicle interaction are addressed in this volume.

2012; 195 pp.; TRB affiliates $58.50; nonaffiliates, $78. Subscriber category: pavements.

Planning 2012
Transportation Research Record 2307

The 15 papers in this volume examine aspects of transportation planning, including a new approach in community-based transportation planning, potential high-speed rail routes from a megaregion perspective, factors influencing walking in a small urban region, an alternative planning tool for a small metropolitan planning organization, and smart growth trip generation methodologies.

2012; 149 pp.; TRB affiliates $55.50; nonaffiliates, $74. Subscriber categories: planning and forecasting; education and training; administration and management.

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TR NEWS

TR News welcomes the submission of manuscripts for possible publication in the categories listed below. All manuscripts submitted are subject to review by the Editorial Board and other reviewers to determine suitability for *TR News*; authors will be advised of acceptance of articles with or without revision. All manuscripts accepted for publication are subject to editing for conciseness and appropriate language and style. Authors receive a copy of the edited manuscript for review. Original artwork is returned only on request.

FEATURES are timely articles of interest to transportation professionals, including administrators, planners, researchers, and practitioners in government, academia, and industry. Articles are encouraged on innovations and state-of-the-art practices pertaining to transportation research and development in all modes (highways and bridges, public transit, aviation, rail, marine, and others, such as pipelines, bicycles, pedestrians, etc.) and in all subject areas (planning and administration, design, materials and construction, facility maintenance, traffic control, safety, security, logistics, geology, law, environmental concerns, energy, etc.). Manuscripts should be no longer than 3,000 words (12 double-spaced, typed pages). Authors also should provide charts or tables and high-quality photographic images with corresponding captions (see Submission Requirements). Prospective authors are encouraged to submit a summary or outline of a proposed article for preliminary review.

RESEARCH PAYS OFF highlights research projects, studies, demonstrations, and improved methods or processes that provide innovative, cost-effective solutions to important transportation-related problems in all modes, whether they pertain to improved transport of people and goods or provision of better facilities and equipment that permits such transport. Articles should describe cases in which the application of project findings has resulted in benefits to transportation agencies or to the public, or in which substantial benefits are expected. Articles (approximately 750 to 1,000 words) should delineate the problem, research, and benefits, and be accompanied by one or two illustrations that may improve a reader's understanding of the article.

NEWS BRIEFS are short (100- to 750-word) items of interest and usually are not attributed to an author. They may be either text or photographs or a combination of both. Line drawings, charts, or tables may be used where appropriate. Articles may be related to construction, administration, planning, design, operations, maintenance, research, legal matters, or applications of special interest. Articles involving brand names or names of manufacturers may be determined to be inappropriate; however, no endorsement by TRB is implied when such information appears. Foreign news articles should describe projects or methods that have universal instead of local application.

POINT OF VIEW is an occasional series of authored opinions on current transportation issues. Articles (1,000 to 2,000 words) may be submitted with appropriate, high-quality illustrations, and are subject to review and editing.

BOOKSHELF announces publications in the transportation field. Abstracts (100 to 200 words) should include title, author, publisher, address at which publication may be obtained, number of pages, price, and ISBN. Publishers are invited to submit copies of new publications for announcement.

LETTERS provide readers with the opportunity to comment on the information and views expressed in published articles, TRB activities, or transportation matters in general. All letters must be signed and contain constructive comments. Letters may be edited for style and space considerations.

SUBMISSION REQUIREMENTS: Manuscripts submitted for possible publication in *TR News* and any correspondence on editorial matters should be sent to the Director, Publications Office, Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001, telephone 202-334-2972, or e-mail jawan@nas.edu.

◆ All manuscripts should be supplied in 12-point type, double-spaced, in Microsoft Word, on a CD or as an e-mail attachment.

◆ Submit original artwork if possible. Glossy, high-quality black-and-white photographs, color photographs, and slides are acceptable. Digital continuous-tone images must be submitted as TIFF or JPEG files and must be at least 3 in. by 5 in. with a resolution of 300 dpi. A caption should be supplied for each graphic element.

◆ Use the units of measurement from the research described and provide conversions in parentheses, as appropriate. The International System of Units (SI), the updated version of the metric system, is preferred. In the text, the SI units should be followed, when appropriate, by the U.S. customary equivalent units in parentheses. In figures and tables, the base unit conversions should be provided in a footnote.

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