Collapse

A Case Study of the Minneapolis I-35W Bridge Disaster with Exercises

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Key Questions

- Were there any pre-existing vulnerabilities to the bridge or surrounding area?
- Did any direct or indirect threats predate the collapse?
- Who or what could have caused the collapse, and how might that affect the rescue, recovery, and rebuilding efforts?

Case Narrative

Introduction

On 1 August 2007, a bright and hot summer day in Minneapolis, the city's Fire Department was dispatched to the I-35W Bridge just after 6:00 p.m. at the height of rush hour. Upon their arrival, firefighters encountered a massive incident scene: the entire eight-lane span had fallen into the Mississippi River, taking with it more than 100 vehicles that had been traveling along the interstate highway only moments before. Additional first responders rushed to the scene as the county's Incident Command System swung into action. By 7:55 p.m. emergency workers had pulled the last live victim from the rubble and completed the rescue effort. Investigators arrived on the scene the next day, and authorities began work on the enormous recovery effort. As they surveyed the destruction — a gruesome heap of twisted metal and concrete peppered with crushed vehicles that resulted in 13 deaths, 145 injuries, and untold millions in economic losses — they began the difficult task of unraveling the mystery of who or what had caused the bridge to collapse.[1]

Photo 1: The I-35W bridge lay in the Mississippi River on 2 August. Photo courtesy of Minnesota Department of Transportation.

The Nation's Transportation Sector: Vast and Vital

The I-35W Bridge is part of the vast, vital, open, and interdependent Transportation Sector that is critical to our country's economic health.[2] The sector includes six modes of transportation: Aviation, Maritime, Mass Transit, Highway Infrastructure and Motor Carrier, Freight Rail, and Pipeline. These modes move "millions of passengers and millions of tons of goods" through a complex system of "4 million miles of roads and highways, more than 100,000 miles of rail, 600,000 bridges, more than 300 tunnels and…sea ports, 2 million miles of pipeline, 500,000 train stations, and 500 public-use airports."[3] U.S. Highway Infrastructure — including some 55,000 interstate bridges — supports 86 percent of private travel and 80 percent of the Nation's entire freight volume, and is a key element in our Nation's defense mobility.[4] When President Eisenhower signed the Federal-Aid Highway Act in 1956, the Nation's highway system carried a mere 65 million cars and trucks, but by 2006, the number had reached 246 million.[5] Looking ahead, freight volume alone is projected to double between 2007 and 2020.

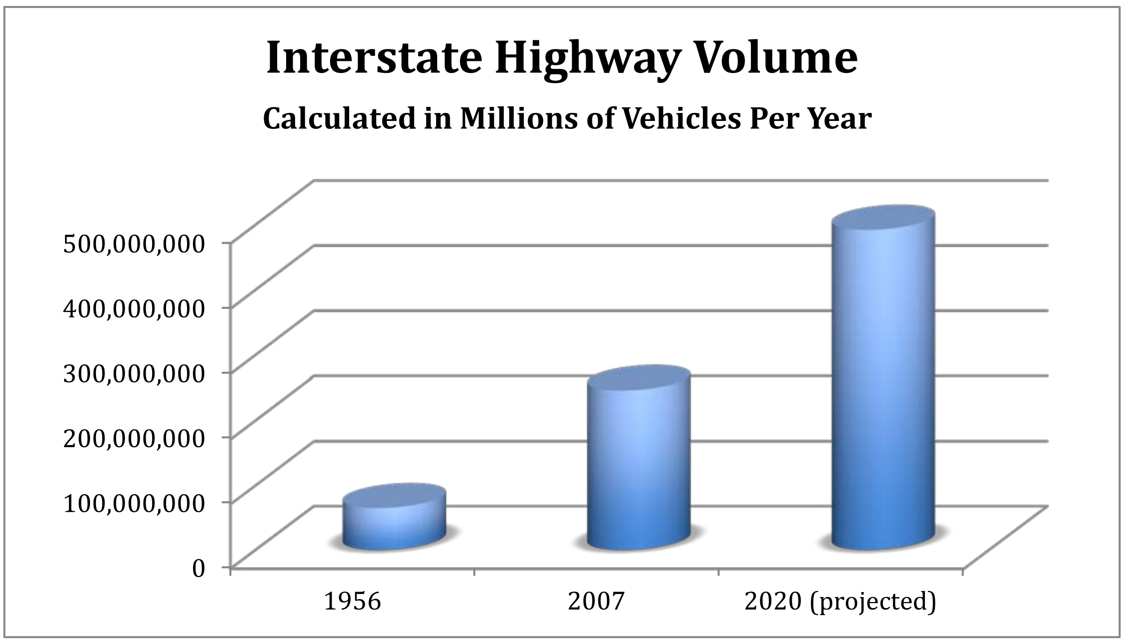


Table 1: Interstate Highway Volume

Given the Sector's importance for our Nation's economic wellbeing and defense, it is not surprising that between 1997 and 2004 total capital highway expenditures by Federal, State, and local governments increased by 44.7 percent to $147.5 billion. As the U.S. highway infrastructure — commissioned by Eisenhower in the 1950s and built rapidly through the 1960s and 1970s — ages, the distribution of funding has shifted from construction toward rehabilitation and replacement. Spending by all levels of government on roadway resurfacing and reconstruction and bridge rehabilitation and replacement rose from $23 billion to $36 billion during the same time period.[6]

As part of these investments in infrastructure, all levels of government are participating in securing and improving the resilience — the ability to withstand natural disasters, manmade accidents, or attacks — of the U.S. transportation framework. The 2009 National Infrastructure Protection Plan (NIPP) envisions a Transportation Sector that is "secure, resilient, and enables legitimate travelers and goods to move without undue fear of harm or significant disruptions of commerce and civil liberties."[7] The sheer size and openness of the system, however, creates a significant security challenge for Federal, State, and local homeland security professionals and private businesses alike. Just three months before the I-35W Bridge collapsed in 2007, the Department of Homeland Security finalized the Transportation Sector input to the NIPP, which spelled out three goals for the sector:

- Prevent and deter acts of terrorism using or against the transportation system;
- Enhance the resilience of the transportation system; and
- Improve the cost-effective use of resources for transportation security.

A Monumental Challenge: Bridge Collapses in History

Although some of our Nation's bridge collapses have resulted from single-point failures, most — as tends to be the case with catastrophic events — have been the products of the complex interaction of multiple precipitating factors.[8] Manmade causes have included structural problems caused by poor engineering, component defects, disrepair, and collisions by ships, vehicles, and railcars. Natural causes such as severe weather events — primarily high winds, earthquakes, and flooding — have also contributed to bridge collapses, while some causes have been a cascade of both manmade and natural events.

- In 1967, the West Virginia Silver Bridge collapsed during rush hour traffic due to the failure of a corroded eyebar whose defect was exacerbated by a heavier load than the design specifications for the bridge allowed.[9]
- The Tacoma Narrows Bridge in Washington was the third longest suspension bridge in the world when it opened in 1940, but within five months it collapsed after 40 mile-per-hour winds caused the bridge to undulate so vigorously that the under-designed suspension cables broke, plunging the bridge into Puget Sound.[10]
- In other cases a significant precipitating event caused damage, such as the 1972 Sidney Lanier Bridge collapse in Georgia that was caused by a ship collision, or the 1989 San Francisco Bay Bridge collapse precipitated by the Loma Prieta earthquake. Although the bridges did not suffer a complete collapse, they did incur enough damage to disrupt commerce and take human lives.

Minneapolis: A City of Bridges…

Situated along the east and west banks of the Mississippi River, the twin cities of Minneapolis and St. Paul depend on their connecting network of bridges (see Photo 2).

In fact, the name Minneapolis is in part derived from the Dakota American Indian word for water. Together, Minneapolis and St. Paul comprise the most populous and busiest metropolitan area along the two thousand mile stretch between Chicago, IL and Seattle, WA and have a gross metropolitan product of $147 billion — fourteenth in the Nation.[11,12]

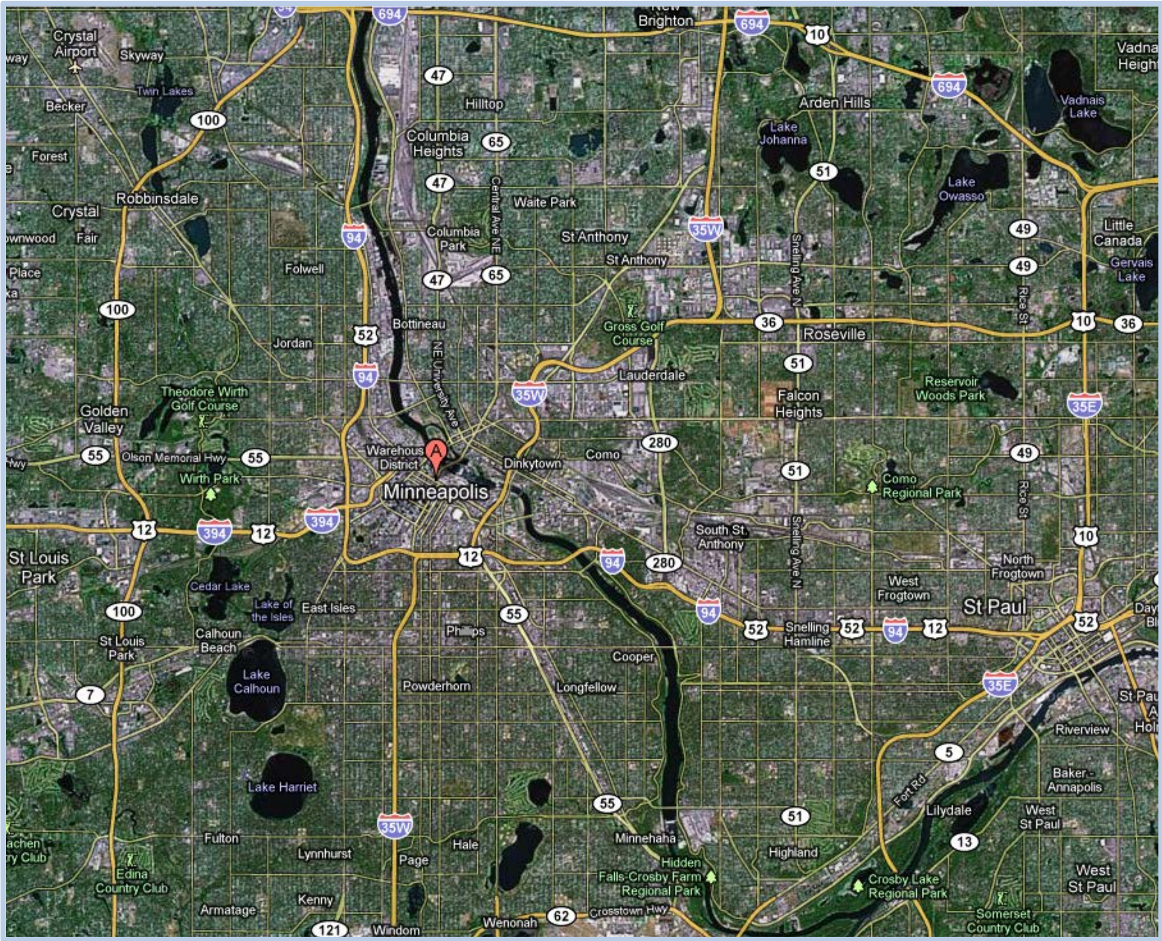


Photo 2: The greater Minneapolis-St. Paul area sits along the Mississippi River. A series of interstates and other primary and secondary roads cross the river at several points.

Interstate I-35 is a major U.S. North-South corridor that stretches nearly 1,600 miles — the entire expanse of the country — from Lake Superior in the North to Laredo, Texas in the south. The interstate crosses the Mississippi at only one point, the I-35W Bridge in Minneapolis-St. Paul, which is a critical juncture for the Nation's commercial and commuter traffic. The bridge design dates to the early 1960s and features a split deck and truss system that is 1,907 feet long and eight lanes wide (see Figure 1). The firms Huron Incorporated and Industrial Construction Company began work in 1964 and the bridge opened to traffic in 1967. In its early years, average daily traffic peaked at 66,000 vehicles a day; by 2004 that number more than doubled to 144,000, including approximately 5,000 commercial vehicles.[13] A study by engineers at the University of Minnesota in 2001 indicated that the bridge had "many poor fatigue details on the main truss and floor truss systems" that were compounded by a "lack of redundancy in the main truss system...therefore, if one member were severed by a fatigue crack, that plane of the main truss would, theoretically, collapse."[14] A 2006 study by the URS Corporation for the Minnesota Department of Transportation recommended, *inter alia*, retrofits to add internal redundancy to the main truss system.[15] Renovations in 1977, 1998, and those ongoing in 2007 were aimed at improving safety and performance on the bridge by upgrading the deck material and thickness, and installing a median barrier, traffic railings, and a de-icing system.

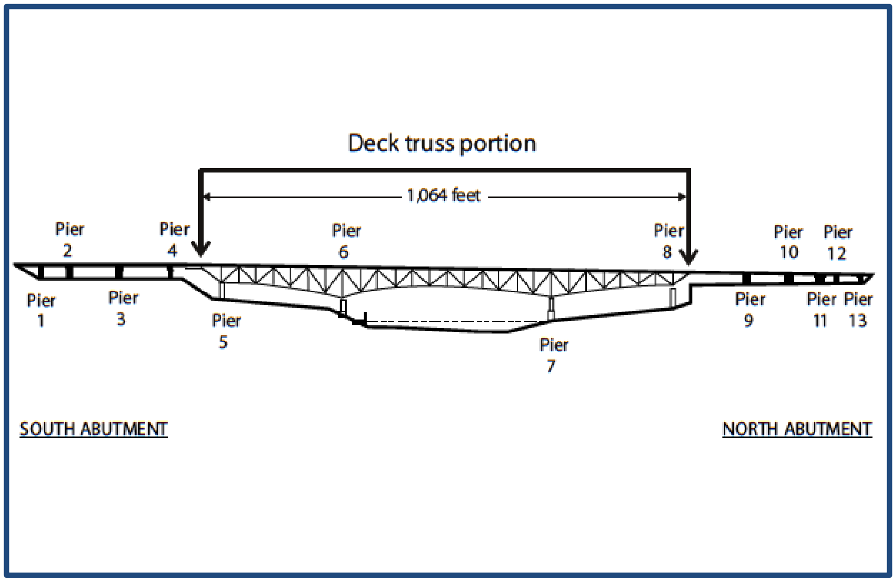


Figure 1: I-35W Bridge Schematic as it appeared in the National Transportation Safety Board Assessment. The entire deck truss portion of the bridge collapsed on 1 August 2007.

...And a Potential Target for Terrorists

The frequency of terrorist attacks against public transportation infrastructure increased alarmingly in the years prior to 2007. In 1990, there were less than 20 such attacks documented worldwide; between 2000 and 2007, there were between 80 and 120 such attacks recorded each year. While the 1977 explosion on Route 1 Bridge in Florida Homestead and Key West was the only documented attack on U.S. highway infrastructure, there had been numerous examples of planned bridge attacks by terrorists. In February of 1982, police discovered approximately 40 pounds of liquid explosive left in a parked car beneath the Bay Bridge in San Francisco.[16] In the 1993 "Day of Terror Plot" in New York City, militants planned near simultaneous bombings against the George Washington Bridge, the Lincoln and Holland tunnels linking New York to New Jersey, the Statue of Liberty, a Federal building, the Diamond District, and the United Nations, which was to be targeted with the help of diplomats from the Sudanese mission. FBI agents broke up the 12-man ring of would-be terrorists as they mixed chemicals for the bombs.[17]

More recently, a 2001 Al-Qaeda training manual encouraged "blasting and destroying bridges leading into and out of the cities."[18] Manchester England Metropolitan Police found the manual during a search of an Al-Qaeda member's home in a computer file described as "the military series" related to the "Declaration of Jihad."[19] Similarly, in 2003 a captured Al-Qaeda leader revealed that a bridge in San Francisco or San Mateo was on a list of possible targets for the terrorist network,[20] and in June of that year an Al-Qaeda operative was arrested for plotting to blow up the Brooklyn Bridge.[21] Lastly, in April 2004, the United States Coast Guard received notification of the discovery of a bomb on the Bay St. Louis Bridge in Mississippi.[22]

Belying its image as a quiet and peaceful Mid-western metropolis, Minneapolis in 2007 had no shortage of would-be terrorists willing and able to target its transportation infrastructure. In 1994 and 1995, FBI agents broke up a cell of anti-government extremists not far from Minneapolis who had stockpiled conventional and biological weapons for attacks against Federal officials.[23] In 2006, local officials in nearby Rice County, Minnesota announced that they had foiled a "domestic terrorism plan" and recovered a cache of weapons and bomb-making materials.[24] A short while later, several members of Minneapolis' large Somali-immigrant community — believed to be the most extensive in the U.S. — began providing operational and financial support to al-Shabab, a terrorist group in Somalia with ties to al-Qaeda. A top FBI counterterrorism official estimated that more than a dozen American recruits, most from Minneapolis, have died fighting for al-Shabab since 2006,[25] and although none had to date tried to attack in the US prior to the I-35 bridge collapse, intelligence gathered by law enforcement officials suggested that they would.[26]

Assessing the Threat: A Community Approach

The Department of Homeland Security (DHS) — including the Transportation Security Agency (TSA), United States Coast Guard (USCG), and Homeland Infrastructure Threat and Risk Analysis Center (HITRAC) — produces threat assessments derived from information received from both government and private industry. DHS analysts work together with subject matter experts at the Surface Transportation Information Sharing and Analysis Center (ISAC), Public Transit ISAC, Highway ISAC, Maritime ISAC, ISAC Council, Association of American Railroads Operations Center, and other information-sharing bodies to ensure the proper dissemination of intelligence.

- **Transportation Security Administration, Office of Intelligence** (OI): OI reviews, synthesizes, and analyzes transportation-specific intelligence and is the only Federal entity focused solely on transportation security. OI intelligence products assist these critical TSA components in assessing risk and developing appropriate security programs, countermeasures, mitigation strategies, and protection guidance.
- **United States Coast Guard, Intelligence Coordination Center** (ICC): ICC provides all-source, tailored, and integrated intelligence and intelligence services to DHS and its component agencies, such as TSA, the USCG Commandant and staff, the Intelligence Community, combatant commanders, and other services and agencies.
- **Homeland Infrastructure Threat and Risk Analysis Center** (HITRAC): HITRAC conducts strategic intelligence assessments of the transportation network as a whole. Modal analysts liaise with TSA analysts to produce coordinated intelligence analytic products.

This is an edited version of the description that appears in *Transportation Systems: Critical Infrastructure and Key Resources Sector-Specific Plan as Input to the National Infrastructure Protection Plan, Department of Homeland Security*, May 2007, http://www.dhs.gov/xlibrary/assets/nipp-ssp-transportation.pdf, pp. 40-41.

The Collapse: "Screeching Metal, Grinding Concrete, Hurtling Downward"

On the day of the collapse, four lanes of the eight-lane bridge had been shut down to accommodate construction materials and equipment involved in repaving the deck and replacing the de-icing systems in an effort to improve the safety and reliability of the bridge. Due to the closures, traffic volume on that day was relatively light.[27] Just after 6 p.m., the entire deck and truss span of the bridge collapsed (see Photo 3). As one survivor later recalled, there was "screeching metal, grinding concrete, and hurtling downward" as the bridge collapsed into the Mississippi River.[28] Another driver said, "I couldn't imagine concrete could flex like that…I felt like I was in a canoe on a choppy lake, it was rippling that bad."[29] At the time of the collapse, 190 people and 111 vehicles were on the bridge. Twenty-five of the vehicles on the deck were construction-related, and one was a school bus carrying 63 children and the driver.[30]

Photo 2: The collapsed bridge and surrounding area on 2 August 2007. Photo courtesy of the Minnesota Department of Transportation.

The emergency response to the collapse was rapid and well-coordinated. The true first responders were passersby, but within 25 minutes following the collapse, a Unified Command Post led by the Fire Department and a River Incident Command led by the Sherriff's office were set up to the south and the north of the river, respectively. Within an hour and a half, the response effort transitioned from rescue to recovery. Over the following days, a multi-agency, multi-state effort ensued:

> On August 2, 2007, the U.S. Coast Guard established a temporary security zone on the Mississippi River from the Upper St. Anthony Falls Lock and Dam to the Lower St. Anthony Falls Lock and Dam. Access through this portion of the river was granted to emergency vessels only. The Minneapolis Fire Department transferred incident command to the Minneapolis Police Department because the area had been declared a crime scene (because of the possibility that the bridge had been the target of a terrorist attack). The Hennepin County Sheriff's Office continued to be responsible for coordinating public safety dive teams searching the area around the bridge collapse and for using side-scanning sonar to attempt to

locate vehicles and victims reported missing through Monday, August 6.

> On Saturday, August 4, 2007, the sheriff's office requested and received the help of the Federal Bureau of Investigation (FBI) underwater search and evidence response team (USERT) and the U.S. Naval Sea Systems Command (NAVSEA) mobile diving and salvage teams. On August 5, USERT arrived and began river recovery operations. On August 6, Navy teams arrived and, along with USERT, assisted sheriff's office personnel, who continued to coordinate all water recovery operations until the last victim was recovered.[31]

According to the Incident Commander John Fruetel, "everything ran like clockwork, including interaction with law enforcement and Federal agencies."[32] Use of new, interoperable communications allowed Fruetel to communicate with his departments as well as with mutual aid departments. This was especially important because the response was so large and the responders "were so focused on their job that they weren't aware of the size and scope of the incident," according to Fruetel.[33] Indeed, vehicles were on fire, people were in the water, there were hazardous materials issues surrounding a rail car carrying unidentified chemicals, and there were concerns about downed power lines.[34] Luckily for investigators, a motion-activated camera at the Lower St. Anthony Falls Lock and Dam, just southwest of the bridge center span, activated and filmed a total of 10 seconds of the collapse. The video showed the bridge center span separating from the rest of the bridge and falling into the river. FBI agents later retrieved the recorder and forwarded it to the National Transportation Safety Board's vehicle recorder laboratory in Washington, D.C. for analysis.[35] As the scene unfolded, the FBI also began to investigate if there was a link to terrorism or criminal activity. Agents "interviewed victims and ran down leads, and bomb technicians and evidence response teams investigated the scene."[36]

With 13 dead and scores injured, the I-35W Bridge collapse left the city — and the country — in shock and highlighted the challenges of protecting the Nation's critical infrastructure. Despite a heroic response effort, the loss of life and deep economic impact on the city raised questions about how most effectively to prepare for, respond to, and rebuild from such a catastrophic incident.

Recommended Reading

Department of Homeland Security. *Transportation Systems: Critical Infrastructure and Key Resources Sector-Specific Plan as input to the National Infrastructure Protection Plan.* May 2007. http://www.dhs.gov/xlibrary/assets/nipp-ssp-transportation.pdf.[1]

National Transportation Safety Board. *Collapse of I-35W Highway Bridge, Minneapolis, MN, August 1, 2007*, Highway Accident Report, http://www.dot.state.mn.us/i35wbridge/ntsb/finalreport.pdf.

U.S. Fire Administration. *I-35W Bridge Collapse and Response, Minneapolis, MN*, USFA-TR-166/August 2007, http://www.usfa.dhs.gov/downloads/pdf/publications/tr_166.pdf.

Nunnally, Patrick, Roberto Ballarini, Minmao Liao and Thomas Fisher. *The City, The River, and the Bridge: Before and After the Minneapolis Bridge Collapse,* University of Minnesota Press, 2011.

[1] The forthcoming 2010 version of this report is not yet publicly available.

Collapse: Critical Infrastructure Security in Exercises

This case highlights the challenges of planning and response in a high-vulnerability, multi-threat environment that is a nexus of multiple infrastructure modes. The exercises model robust critical thinking and small group processes to provide a roadmap for tackling the types of challenges faced by Critical Infrastructure Security and Resilience (CISR) professionals.[37] They also reinforce the ability to recognize critical infrastructure, identify man-made and natural threats and vulnerabilities, pinpoint potential secondary affects, and think creatively to adapt risk management principles to a changing environment.

The goal of the exercises is to employ sound critical thinking about planning, response, and recovery activities, not simply to model the known outcome. As such, the exercises help the learner employ a robust and structured approach to these activities and explicitly identify the value added by using them. Many times, the value of technique lies in the conversation that it prompts about evidence, factors, assumptions, and gaps that would otherwise be overlooked. Learners should judge their performance, therefore, on *how* they have conducted their analyses rather than on the specific case outcome.

Exercise 1: Structured Planning Using Structured Brainstorming

Brainstorming is a process that follows specific rules and procedures designed to generate new ideas and concepts. The stimulus for creativity comes from two or more people bouncing ideas off each other. A brainstorming session usually exposes participants to a greater range of ideas and perspectives than any one person could generate alone, and this broadening of views typically results in a better product.

Structured Brainstorming is a systematic twelve-step process (described below) for conducting group brainstorming. It is most often used to identify key drivers or all the forces and factors that may come into play in a given situation. If, however, a group is not possible, there is still value in thinking as imaginatively and divergently as possible by adjusting the technique for use by one person. The goal of brainstorming, whether used in a group or by oneself, is to think as exhaustively as possible.

Task: Identify all of the various types of vulnerabilities and threats posed to the Minneapolis I-35W Bridge.

Steps

Step 1: Gather a group of CISR learners.

Step 2: Pass out sticky notes and Sharpie-type pens or markers to all participants. Inform the team that there is no talking during the sticky-notes portion of the brainstorming exercise.

Step 3: Present the team with the following question: What are all threats and vulnerabilities to the I-35W Bridge?

Step 4: Ask the group to write down responses to the question with a few key words that will fit on a sticky note. After a response is written down, the participant gives it to the facilitator who then reads it aloud. Sharpie-type or felt-tip pens are used so that people can easily see what is written on the sticky notes later in the exercise.

Step 5: Place all the sticky notes on a wall randomly as they are called out. Treat all ideas the same. Encourage participants to build on one another's ideas.

Step 6: Usually an initial spurt of ideas is followed by pauses as participants contemplate the question. After five or ten minutes there is often a long pause of a minute or so. This slowing down suggests that the group has "emptied the barrel of the obvious" and is now on the verge of coming up with some fresh insights and ideas. Do not talk during this pause even if the silence is uncomfortable.

Step 7: After two or three long pauses, conclude this divergent-thinking phase of the brainstorming session.

Step 8: Ask all participants (or a small group) to go up to the wall and rearrange the sticky notes by affinity groups (groups that have some common characteristics). Some sticky notes may be moved several times, and some may be copied if the idea applies to more than one affinity group.

Step 9: When all sticky notes have been arranged, ask the group to select a word or phrase that best describes each grouping.

Step10: Look for sticky notes that do not fit neatly into any of the groups. Consider whether such an outlier is helpful or the germ of an idea that deserves further attention.

Step 11: Assess what the group has accomplished. Can you identify four or five key factors or forces that might explain why the bridge collapsed?

Step 12: Present the results, describing the key themes or dimensions of the problem that deserve investigation.

Analytic Value Added

Did our ideas group themselves into coherent affinity groups? Were there any outliers or sticky notes that seemed to belong in a group all by themselves? Did the outliers spark new lines of inquiry? Did the labels we generated for each group accurately capture the essence of that set of sticky notes? What additional information should we track down about the threats and vulnerabilities we generated? Where does that information reside and to whom should we speak about it?

Exercise 2: Effective Response Using Hypothesis Generation and Paired Comparison

Hypothesis Generation is part of any rigorous analytic process because it helps to avoid common pitfalls such as coming to premature closure or being overly influenced by first impressions. Avoiding a rush to judgment is extremely important in a crisis situation. Instead, this technique helps to ensure that one has thought broadly and creatively about a range of possibilities. The goal is to develop an exhaustive list of hypotheses that can be scrutinized and tested against both existing evidence and new data that may become available in the future.

This case is well suited to the form of hypotheses generation outlined below, which employs a group process that can be used to think creatively about a range of possible explanations. Using a group helps to generate a large list of possible hypotheses; group the lists; and refine the groupings to arrive at a set of plausible, clearly stated hypotheses for further investigation.

Paired Comparison, or prioritization, is a quick way to rank hypotheses. The results can be taken individually or aggregated if one is working with others. While the ranked hypotheses are helpful to gain a sense for the group's leanings about the likelihood of the cause of the bridge collapse, it is the conversation and thinking surrounding those rankings that can offer insights and prompt thinking about gaps, assumptions, and collections strategies as a situation unfolds.

Task: Use Hypothesis Generation to create a list of alternative hypotheses that explain the I-35W Bridge Collapse.

Steps

Step 1: Ask each member of the group to write down on separate 3-by-5-inch cards or sticky notes up to three plausible alternative hypotheses or explanations. Think broadly and creatively but strive to incorporate the elements of a good hypothesis:

- It is written as a definite statement.
- It is based on observations and knowledge.
- It is testable and falsifiable.
- It contains a dependent and an independent variable.

Step 2: Collect the cards and display the results. Consolidate the hypotheses to avoid duplication.

Step 3: Aggregate the hypotheses into affinity groups and label each group.

Step 4: Use problem restatement and consideration of the opposite to develop new ideas.

Step 5: Update the list of alternative hypotheses.

Step 6: Clarify each hypothesis by asking, Who? What? When? Where? How? and Why?

Step 7: Select the most promising hypotheses for further exploration.

Task: Use Paired Comparison to prioritize the hypotheses.

Steps

Step 1: Create a table with each of the hypotheses across the top and down the side. See Table 1 for a template. Use as many rows and columns as needed to accommodate the number of hypotheses to be prioritized.

Step 2: Looking at the cells below the diagonal row of dark blue cells, compare the item in the row with the one in the column. For each cell, decide which of the two items is of greater priority. The hypotheses may be compared by likelihood in this case, but ensure that the reason for the likelihood is noted, not simply taken for granted. For example, Hypothesis 2 is more likely than Hypothesis 3 because of X. Then, place an H2-✓ in the box comparing H2 and H3. See Table 1 for an example.

Step 3: After comparing each set of hypotheses, count up all the checks for each hypothesis. For example, if there are three boxes with checks for H2, then that hypothesis receives a score of three points. The hypotheses with the higher number of checks are more likely than those with a lower number.

Table 2: Paired Comparison Template

	H1	H2	H3	H4	H5
H1					
H2	H2-✓				
H3	H3-✓	H2-✓			
H4	H4-✓	H2-✓	H3-✓		
H5	H1-✓	H2-✓	H3-✓	H4-✓	

Scoring:
H2=4
H3=3
H4=2
H1=1
H5=0

Analytic Value Added

Which hypotheses should be explored further? Do any of the hypotheses highlight gaps that should be filled or assumptions that should be challenged?

Exercise 3: Understanding Secondary Effects Using Starbursting

Anticipating secondary effects is particularly difficult, especially in crisis situations. Starbursting can quickly stimulate useful thinking because it uses prompts to generate a great number of ideas in a short amount of time. This process allows one to consider the issue at hand from many different perspectives, thereby increasing the chances that one may uncover a heretofore unconsidered question or new idea that will yield new insights.

Task: Starburst the potential secondary effects of the I-35W Bridge collapse.

Steps

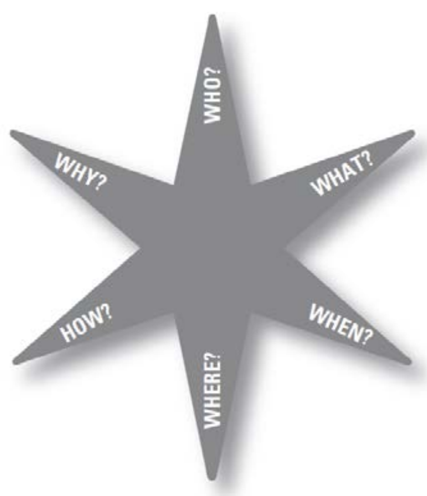
Step 1: Use the template in Figure 1.3 or draw a six-pointed star and write one of the following words at each point of the star: Who? What? When? Where? How? Why?

Step 2: Start the brainstorming session, using one of the words at a time to generate secondary effects about the topic. Do not try to answer the ideas as they are identified; just focus on generating as many secondary effects as possible about the possible secondary effects of the bridge collapse.

An easy way to spark ideas is to ask “How could ‘where’ the bridge collapsed create a secondary effect?” Use this question for each point in the star below.

Step 3: After generating questions that start with each of the six words, the group should either prioritize the questions to be answered or sort the questions into logical categories.

Table 3: Starburst Template



Analytic Value Added

Do any of the questions point directly or indirectly to secondary effects? Does the timing, location, size, or apparent nature of the incident point to any areas for further consideration?

[1] "Economic Impacts of the I-35W Bridge Collapse," *Minnesota Department of Transportation and Department of Employment and Economic Development,* http://www.dot.state.mn.us/i35wbridge/rebuild/municipal-consent/economic-impact.pdf. Accessed September 1, 2011.

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http://www.usmayors.org/74thWinterMeeting/metroeconreport_January2006.pdf

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[16] B.M. Jenkins, "Protecting Surface Transportation Systems and Patrons from Terrorist Activities: Case Studies of Best Security Practices and a Chronology of Attacks (MTI Report 97-04)," San Jose, CA: Mineta Transportation Institute, 2003.

[17] http://www.msnbc.msn.com/id/4677978/ns/world_news-hunt_for_al_qaida/t/al-qaida-timeline-plots-attacks/#.Tjw0F8014ow

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[20] The Blue Ribbon Panel on Bridge and Tunnel Security (BRPBTS), "Recommendations for Bridge and Tunnel Security," Washington, D.C.: American Association of State Highway and Transportation Officials (AASHTO) and Federal Highway Administration (FHWA).

[21] M. McPhee, JG Meek, and S. Brown, "BROOKLYN BRIDGE PLOT Al Qaeda, Ohio Trucker Sought to Destroy Span," *New York Daily News*, 2003

[22] 2004 National Response Team Incident Summaries (NRTIS). Washington, DC: National Response Center.

[23] Johnathan B. Tucker, Toxic terror: assessing terrorist use of chemical and biological weapons, Cambridge: MIT Press, 2000, p. 159.

[24] Egerstrom, Lee and David Hawley, "Authorities Halt Southern Minnesota 'Domestic Terrorism' Plot," *Pioneer Press*, April 3, 2006

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[26] Eli Saslow, "Muslim activist in Minnesota struggles as one-man counter against lure of terrorism," Washington Post, 8 July 2011.

[27] Roberto Ballarini and Taichiro Okazaki, "The Infamous Gusset Plates," Department of Civil Engineering, University of Minnesota, in *The City, The River, The Bridge*, University of Minnesota Press, 2011.

[28] Curt Brown and Jim Foti Coming Together, Minneapolis Star Tribune, August 1, 2008, http://www.startribune.com/local/minneapolis/26181484.html

[29] Curt Brown, "Continued: One year after: Remembering, rebuilding" Minneapolis Star Tribune, August 1, 2008, http://www.startribune.com/26145649.html?page=2&c=y.

[30] National Transportation Safety Board, *Collapse of I-35W Highway Bridge, Minneapolis, MN, August 1, 2007*, Highway Accident Report, http://www.dot.state.mn.us/i35wbridge/ntsb/finalreport.pdf. p, 4.

[31] *Ibid.*, 4.

[32] Paul Pelsuo, "Minneapolis Assistant Chief Speaks about Bridge Collapse," Firehouse.com News, August 24, 2007. http://www.firehouse.com/.

[33] *Ibid.*

[34] *Ibid.*

[35] NTSB, 14.

[36] "FBI helps out," http://www.fbi.gov/news/stories/2007/august/minn082707.

[37] For more cases that employ these and other techniques, please see Sarah Miller Beebe and Randolph H. Pherson, *Cases in Intelligence Analysis: Structured Analytic Techniques in Action*, Washington, DC: CQ Press, 2012.