

# Crumbling Infrastructure and the 35W Bridge

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## **Introduction**

Since the collapse of the 35W Bridge, much attention has been devoted to the network of infrastructure crisscrossing the nation and its fast approaching expiration. The roadways and bridges will deteriorate over time if it continues to be neglected. The lack of attention given to the infrastructure is hard to fix because of reactive policy making. Railroads were the first transnational infrastructure installed later followed by the development of the highway system which were made to support travel, as well as, invigorate the economic growth of the nation.

The extensive transportation network created a situation requiring some form of transportation regulation. The Department of Transportation was formed in 1966 to perform this task and a primary goal was to keep the infrastructure safe. While it appeared that the DOT had devoted their attention and services completely to aviation safety after 9/11, August 1, 2007 quickly shed light on the failings of other transportation issues.

This case study will examine the history of infrastructure, the development of the DOT, and dissect the collapse of the 35W Bridge exploring the how, why, and aftermath. Finally, the paper will discuss past policy revisions in response to similar catastrophes, who is involved and how their relationships and policy modifications may help eliminate this type of incident from occurring in the future.

## History of Infrastructure and Policy

Pressure was building to construct superhighways in the 1930s during the Roosevelt administration. The project would not only provide employment to the tens of thousands unemployed during the great depression but also serve to connect developments across the nation. The Federal-Aid Highway Act of 1938 initiated a feasibility study to explore the possibility of a network of roads crisscrossing the nation. This study prompted the Federal Highway Act of 1944 and led to the development of transnational infrastructure by authorizing the 65,000 kilometers "National System of Interstate Highways." The construction was slow, but was stimulated in 1956 when President Eisenhower signed legislation creating the National System of Interstate and Defense Highways, which laid out 41,000 miles of road for mobilizing military equipment and personnel.<sup>1</sup> A decade later on October 15, 1966 the Department of Transportation (DOT) was established. DOT's purpose is to support different modes of transportation with the following mission:

...to develop and coordinate policies that will provide an efficient and economical national transportation system, with due regard for need, the environment, and the national defense. It is the primary agency in the federal government with the responsibility for shaping and administering policies and programs to protect and enhance the safety, adequacy, and efficiency of the transportation system and services.<sup>2</sup>

Since its inception, DOT has been involved with a variety of related projects from affordable housing to urban development and has led to the development of various administrations to coordinate projects and policy. DOT is comprised of the Office of the Secretary and eleven operating administrations among which include the Federal Highway Administration, Federal Motor Carrier Safety Administration, the National Highway Traffic Safety Administration, the Federal Transit Administration, Research and Special Programs Administration, Bureau of Transportation Statistics and the Surface Transportation Board. Despite its ubiquitous role in DOT, the Federal Government's role in developing transportation infrastructure and policy has been confused leading to excess aid for some transportation needs and inadequate support for others. In 1970 the Highway Safety Act authorized the creation of the National Highway Traffic Safety Administration which took over some of the work of the Federal Highway Administration allowing it to focus on two primary functions: design, construction and maintenance, and highway and automobile safety. Ideally, the division of responsibility with greater transparency would provide a more focused purpose. With improved interaction among the department's administrations, DOT would be as President Johnson envisioned, "one of the essential building blocks in our preparation for the future" and as Najeeb Halaby, administrator of the independent Federal Aviation Agency hoped, that the DOT would provide a "secure decisive transportation policy" (DOT Library).

<http://www.globalsecurity.org/military/facility/ndhs.htm>

<sup>2</sup> <http://dotlibrary.dot.gov/Historian/history.htm>

In addition to encouraging the department to play a leading role in crisis management response, Samuel Skinner, Secretary of Transportation during the Bush Sr. administration, established a National Transportation Policy which formulated the following objectives: to maintain and expand America's national transportation system; to nurture a sturdy financial footing for transportation; to keep the nation's transportation industry vigorous and competitive; to guarantee that the transportation system enhances public safety and the national security; to maintain the environment and the quality of life; and to ready American transportation technology and expertise for the next century (DOT Library). With these objectives in mind, Bush Sr. signed into law the Intermodal Surface Transportation Efficiency Act in 1991 which would restructure the department's highway, highway safety, and transit programs. In response to an efficiency analysis of the Federal Government forged by the Clinton Administration, Secretary of Transportation Federico Pena announced the DOT Strategic Plan in 1994. Investing strategically in transportation infrastructure and putting people first were two of the seven goals outlined in the strategic plan.

As new modes of transportation have entered the scene over time, policy and budgets have adapted but providing a safe environment and sound infrastructure has always been a primary goal and there are multiple committees within the department working to achieve that goal. While that is still true, after 9/11 it appears that most policy and budget considerations were in response to aviation safety which may explain why infrastructure that was built half a century ago has not received proper attention toward the end of its lifespan and has failed. The department's mission is to "enhance the safety, adequacy, and efficiency of the transportation system and services." The recent collapse of the 35W Bridge is just one example of inadequate transportation infrastructure.

Bridge failures of the past have led to modifications in the standards and inspections of infrastructure. In the past century there have been several notable failures: the Tacoma Narrows Bridge in Washington (1940), the Silver Bridge in West Virginia (1967), the Mianus River Bridge in Connecticut (1983), the Schohaire Creek Bridge in New York (1987), the Hatchie River Bridge in Tennessee (1989) and the Autoroute 19 Bridge in Quebec (2006)<sup>3</sup>. The Silver Bridge collapse in 1967 led to the development of the National Bridge Inspection Standards in the 1970s requiring biennial safety inspections for bridges exceeding 20 feet in total length on public roads (35W Bridge was almost 2,000 feet). "Very good" rated bridges can be inspected every four years but most bridges are inspected every two while others are even more frequent. The results of these inspections are maintained by the National Bridge Inventory Database and given those findings the Federal Government is currently supply State DOTs over \$4 billion for bridge replacement, rehabilitation and preventive maintenance.<sup>4</sup>

<sup>3</sup> Aileen Cho, Tom Ichniowski, and Willaim Angelo. 8/8/2007. Engineers Await Tragedy's Inevitable Impacts. Transportation Infrastructure.

<http://enr.construction.com/features/transportation/archives/070808b-1.asp>

<sup>4</sup> <http://www.dot.gov/affairs/factsheet080207.htm>

## History of 35W Bridge

The 35W Bridge is located northwest of the University of Minnesota and parallel to the Cedar Avenue Bridge. Designed by Sverdrup and Parcel, the bridge was built in 1964 by Hurcon Inc and Industrial Construction Company and approximately \$5.3 million dollars and three years later it was open to traffic. The bridge was originally striped for two lanes of traffic and an acceleration/deceleration lane but a third lane was added by striping in the shoulders of the bridge in both directions in 1988. "The 40-year-old bridge was considered a bit of a marvel when in 2001 it became the first of its kind in the U.S. to be equipped with an anti-icing system. A computerized system sprayed an anti-icing chemical based on sensors that collected data on pavement temperature, ice and moisture."<sup>5</sup> The bridge carried roughly 140,000 vehicles a day, including 5,700 commercial vehicles and was able to safely carry trucks weighing 80,000 pounds and even up to 159,000 pounds which is standard capacity for bridge design today according to the ratings for structurally capable bridges. A deficient bridge is one that is considered poor with structural ratings of 4 and below and while it probably will not collapse elements should be monitored and repaired. The 35W was first deemed deficient in 1990 by the federal government citing significant corrosion in the bearings, but in order to repair it the entire deck would have needed to be elevated. However, because the bearings were not sliding the corrosion was considered a minor issue. Later that year fatigue cracks and more corrosion were discovered in the steel joints of the bridge which were repaired. The bridge was reported deficient again in 2005 when a federal inspection rated it 50 out of 100 for structural stability. While deficient federal inspectors did not anticipate immediate replacement but just after the collapsed, federal officials alerted states to inspect like bridges immediately.<sup>6</sup> While Minnesota has 1,097 bridges that are rated deficient most deficient bridges are still safe to use while it undergoes repairs. An inspection in June 2006 gave the bridge a 4, a rating that would allow the state to continue operating the bridge without any load restrictions (0 = Shut down, 9 = perfect).<sup>7</sup>

In 1990 the bridge had been inspected every two years prior to 1993 when inspections were increased to an annual event upon which inspectors determined reconstruction for the bridge would be scheduled for 2020-25. A critical fracture inspection was completed in 2006 and a special inspection of the welding was initiated in the spring of 2007; unfortunately this inspection was not to be completed until the fall of 2007. The design of the 35W Bridge consisted of a deck steel tress which has a life span of about 50 years (Fact Sheet). The use of the steel tress was to avoid impeding river traffic with impeding bridge piers.

<sup>5</sup> Elizabeth Stawicki. August 2, 2007. *Collapse mystifies officials, experts*. Minnesota Public Radio.

<sup>6</sup> Elizabeth Stawicki. August 2, 2007. *Why did the bridge collapse?* Minnesota Public Radio

<sup>7</sup> <http://www.dot.state.mn.us/i35wbridge/pdfs/factsheet.pdf>

Mn/DOT had repaired cracking in the approach spans and was monitoring other structural deficiencies found in 1997. In 2001 the University of Minnesota evaluated the fatigue stresses within the truss and determined that it was less than the threshold and therefore the deck should be safe from cracking but the main truss should be inspected every two years and the floor trusses every six months. In 2006, Mn/DOT conducted another fatigue stress study to determine collapse potential. Three recommendations were outlined in January of 2007 from that study:

1. add redundant plating over fracture critical truss members
2. conduct visual examination of suspected weld details of fracture critical truss members and remove defects
3. do a combination of both 1) and 2).

Because no cracks were found during inspection initiated in the Spring of 2007, Mn/DOT did not plate any truss members and intended to finish the inspection later when the current construction was complete which totally \$9 million included concrete and joint repair and/or replacement, lighting and guardrail installation and overlay work for the outside lanes.

## The Collapse

Mary Logan: "We heard some noise, the car started to rock, and we went down, I've been told, 40 feet."

Kris and Brent Olson: "All of a sudden it was like the road started moving. A section went down in front of me and a section behind us went down, but ours kind of stayed in the air. It felt like an earthquake. It just rumbled, it just rumbled. And then things went down and we got out of the car and started running and there was this big dust storm."

Source: Annie Baxter. August 2, 2007. *Survivors, witnesses tell of escapes, rescues at bridge collapse.* Minnesota Public Radio

Just after 6 P.M. on August 1, 2007, with rush hour traffic still flowing over the 35W Bridge, the structure gave out. Early speculations for the collapse included fatigue, corrosion and the 90+ degree Fahrenheit days leading up to the disaster; the temperature theory was quickly disregarded. Henry Petroski, a structural engineering professor at Duke University, said that the engineers designing the bridge would have considered Minnesota's temperature ranges such that the expansion joints would have allowed for movement with extreme shifts in temperature. Petroski added that most temperature related problems are associated with cold temperatures, not hot. "When it gets very cold bridges can fail, because the metal gets very brittle when it's cold. So if there are existing cracks, that could be aggravated." Others believe that, triggered by the construction the bridge. With the daily traffic loads and probable fractures or cracks the bridge was fatigued. David Schulz, director of Infrastructure Technology at Northwestern University: "I would be stunned if this didn't have something to do with the construction project. I

think it's a major factor." Abolhassan Astaneh, a civil engineering professor from the University of California, Berkeley: "[Truss bridges are not as reliable as suspension and other bridge types]. One of these four arches that they had in this bridge -- if one member of one of these four arches cracks, the bridge is gone. So it is not one of the very resilient systems." Still others believe corrosion played an integral role. Gene Corley, an expert on why bridges and buildings collapse and the lead investigator in various disaster investigations such as the World Trade Center and the Murrah building in Oklahoma City said "[the design of the steel bridge made it susceptible to rusting]. It's rusting of the reinforcing bars that are in the concrete. That's not a problem that's likely to cause collapse, but the type that IS likely to cause collapse is the rusting of the main members of the bridge, the truss members that were supporting the bridge" (Stawicki, \*Why did the bridge collapse?\*). Supporting the corrosion theory is evidence brought to light in "Foul Play," an article from \*Newsweek\* reporting on the birds' contribution to corrosion. "Pigeon dung can be a serious issue—it's acidic and will easily eat away almost any metal," explains engineer William Schutt, president of Matcor, a corrosion-protection firm in Doylestown, Pa. "It can wash into and then rust the bolts and rivets of bridges if they're not cleaned and checked properly."<sup>8</sup>

More recent reports regarding the probable cause of the collapse include the de-icing mechanism, the added weight from construction equipment in excess of 285 tons, increase in oversized truck loads, and while fatigue cracks and lack of redundancy seem to be the biggest factors in its failing there is of course the issue of human error from designers and construction workers to inspectors and policy makers. Was the design sound, was the concrete mixed properly, did the inspectors do a proper examination, and are current policies sufficient?

The National Transportation and Safety Board determined that the southern end of the bridge shifted fifty feet to the east while the rest fell in place, an important bit of evidence for their ongoing investigation which may take upwards of a year to complete. In addition to reviewing video and samples of bridge debris, the NTSB will simulate the collapse with sophisticated computer programs that are able to account for temperature, speeds, load and bridge conditions in hopes of identifying the point of failure. This will provide engineers with a greater understanding of the wear and tear of design and materials as well as maintenance and repair failings. One scenario that the NTSB is already modeling is the capacity of the bridge. As mentioned previously, the bridge was originally striped for four lanes of traffic with a projection of 66,000 vehicles and a truck weight limit of 73,000 lbs. Since then, it has become an eight-lane structure with over 140,000 vehicles daily and weight limits up to 80,000 lbs. While the bridge was designed to accommodate traffic over the entire width of the bridge and changes were made to reinforce it; weight and frequency increases certainly played a role in the exhaustion of the bridge.<sup>9</sup>

<sup>8</sup> Eve Conant. August 25, 2007. *Foul Play?* Newsweek

<sup>9</sup> Sea Stachura. August 8, 2007. *The big question: Why did the bridge fall down?* Minnesota Public Radio

Mark Rosenker, NTSB chair has said "his agency is not responsible for inspecting bridges. But he says the work of the NTSB may cause the authorities responsible for bridge maintenance to stiffen their standards [and] as we continue through this investigation, if we find regulations in any way that do not appear to be rigorous, that do not appear to be appropriate to make sure that bridges do not fall down, we will immediately make a recommendation."<sup>10</sup>

## **The Aftermath and Days Ahead**

Thirteen people died and more than 100 people were injured. Providing direct access to downtown Minneapolis, the collapse of 35W has also resulted in great economic loss. Any devastation such as the one 'witnessed' just eight weeks ago incurs great costs. Initial estimates by Mn/DOT concluded that costs for the loss of 35W would total \$400,000 per day. Further analysis by DEED and Mn/DOT estimated a loss to Minnesota's economy to be \$17 million in 2007 and \$43 million in 2008. These estimates were found by assigning monetary values to auto travel time and commercial travel time which has been increased significantly on congested detour routes.<sup>11</sup> Mn/DOT established a detour immediately and only anticipated minor traffic impacts but has since found this not to be the case.<sup>12</sup> "Bridge Detours Hard on Neighborhoods" was covered by the Star Tribune last week reporting that Central Avenue trips increased from 20,000 a day to 27,000 and warned motorists that with this increase in local traffic there is greater potential for conflict between motorists and between motorists and pedestrians.<sup>13</sup> In addition to road-user economic loss, it has been estimated that businesses have lost over \$500,000 per day.<sup>14</sup> If we begin to estimate the value of life, which was most recently priced around \$4 million and productivity lost for those injured; not to mention rescue efforts, clearing and rebuilding, the numbers rise even more dramatically.

Since the collapse, Mn/DOT, city, state and federal officials have been addressing the issues of what went wrong, how it can be resolved quickly and safely, and who is responsible. As mentioned above, the "what went wrong" will be an ongoing process and the process for addressing "how can it be resolved quickly and safely" has already begun. By August 8th preliminary design teams had been established, by August 21st a layout had been submitted to the city council, on August 23rd the RFP had been released, and on September 14th technical proposals had been received. The financial proposals were received on the 18th and the following day the project was out to bid. Public involvement has been rather extensive including open houses, legislative hearings, neighborhood association and community meetings, Speaker's Bureau presentations, city, state and federal agency meetings, emails alerts, a 35W Bridge website, and handouts. This

<sup>10</sup> Brandt Williams. August 3, 2007. *NTSB gets some early clues about the cause of the collapse.* Minnesota Public Radio.

<sup>11</sup> Department of Employment and Economic Development and Mn/DOT. REMI economic impact model <http://www.dot.gov/affairs/factsheet080207.htm>

<sup>13</sup> September 12, 2007. *Bridge Detours Hard on Neighborhoods.* Star Tribune

<sup>14</sup> Mn/DOT representative. Transportation and Public Works Committee Meeting. September 20, 2007

involvement was one of four proposal evaluation criteria. Public involvement represented 15% of the decision, while quality accounted for 50%, aesthetics 20% and enhancements 15%. While aesthetics were highly stressed at the Transportation and Public Works Committee Meeting, quality (specifically safety) was a primary concern. Mayor Rybak said "We will do everything possible so it never happens again" (Rybak, TPWC Meeting). The quality portion of the proposal was evaluated for experience, quality control, safety measures and performance evaluation. Additionally, Mn/DOT has established a partnership with the Occupational Safety and Health Administration to ensure maximum safety throughout the process. With a technical score of 91.7 determined by cost, time and technical capability, the Flatiron Constructors and Mason Construction will be rebuilding the 35W Bridge and expect to finish the bridge in 437 days with a budget of \$234 million. The only thing left to finalize is the project design. Project Review, as presented by the Minneapolis City Council, is a mandatory process with statutory timelines for actions that cannot be waived. Because the 35W Bridge is located entirely within Minneapolis, it is the city's responsibility to undertake project review. Mn/DOT submits a construction project layout to the local government and after reviews, a public hearing and an official city council meeting, all of which have specific deadlines, the city must submit a written response to Mn/DOT. Before the process started the city asked that the bridge be transit ready and to enhance public access under the bridge for a potential greenway and Mn/DOT complied. The public hearing was September 20, 2007 so the council now has 90 days to review the layout and respond. The city may approve the layout, disapprove the layout, or disapprove the layout with requests for changes. The city may make recommendations for capacity, access and right of way it but does not have authority to influence aesthetics. While there is some red tape with the approval process with most projects, because this an interstate issue, Mn/DOT basically has free reign to move forward with what they submit despite disapproval or requests for changes. An interesting component to rebuilding the 35W Bridge is the design-build format which allows the design to change during construction without review unless changes affect access, traffic capacity or right of way.<sup>15</sup>

Now there is just the matter of who is at fault. The public hearing at the TPWC Meeting shed light on a few concerns that addressed the issue of fault; one being the speed and method of which the new bridge was to be built, a design-build format with completion 437 days. Another issue was the factor of accountability. With so many parties involved it is difficult to determine where fault lies. Some one or some agency should be held accountable, but there are the designers, constructors, inspectors, state and federal transportation departments, city planners, city council members, and policymakers all to consider.

Designers are responsible for designing a sound structure that considers any and all variables from weather patterns, cement mixture, reinforcement structures, traffic loads, repair implications, etc that may jeopardize the integrity of the structure. Designers should even design with some added insurance for unanticipated shocks.

<sup>15</sup> Interstate 35W Bridge Project Review Process. City of Minneapolis Council

Constructors are responsible for constructing a structure according to the design approved being sure to follow all processes and procedures to produce a sound structure and in the event that they encounter conflicting building and design elements, again follow the proper procedure to remedy the situation such that there is no question about the integrity of the structure.

Inspectors are responsible for completing detailed and extensive inspections of the structure being sure to not only examine common deficiencies but have a keen eye for abnormalities that may not be easily recognized-inspections should never be routine.

State and Federal Transportation Departments are responsible for hiring experts in the field to conduct inspections and to design and construct sound structures. They are also in a position to request modifications to policy that would impact budgets or procedures that could enhance their tasks.

City Planners have a responsibility to the public. The American Planning Association believes a planner's first allegiance is to the public, to represent their needs and rights to a safe and healthy environment from a stimulated economy to providing affordable housing to safe infrastructure ensuring the public that their tax dollars are being well spent. It is also their responsibility to present a variety of options to elected officials on behalf of their constituents that would guide action and policy.

City Council Members have a similar relationship with the local community as that of city planners but have the ultimate responsibility of selecting the most beneficial actions and programs for the community based on recommendations made by the public and planners.

Policymakers are responsible for adopting the necessary policies to create a functionally sound network of goods and services. Policymakers need to anticipate the domino effect of their decisions and enact policies that are logical, legitimate and feasible/enforceable.

To help guide the decisions made by these parties they rely on each other and innovation.

There are a variety of techniques to gauge when a bridge needs maintenance and repair. Pablo L Durango-Cohen and Naveen Tadepalli developed a model to enhance investments in maintenance and repair of transportation infrastructure. Their model tackles two problems. To quantify the uncertainties of deterioration their model employs a state estimation to process by processing condition data allowing technicians to develop condition forecasts to determine optimal life cycle costs for infrastructure upkeep. The model also quantifies the benefit of combining technologies to monitor infrastructure such that observations can be used to develop strategies for these technologies. Discovering optimal combinations of technologies may guide maintenance and repair

policies. In addition to video, radar, and laser, sensing and communication technologies embedded in the pavement and bridge deck are also utilized to collect condition data. While this has the potential to amass an obscene amount of information, the model developed by Durango-Cohen and Tadepalli has the capacity to manage such a task because its framework is "statistically rigorous and computationally efficient."<sup>16</sup> It is designed specifically to handle condition data and sophisticated statistical tools to utilize advanced technology capabilities to support maintenance and repairs. Previous optimization models include one by Terborgh in 1949 called the "Equipment Replacement Problem" which was later modified in 1955 and in 1960 to be a dynamic control problem. It was further modified in 1979 and 1982 to solve for the maintenance and repairs of transportation specific infrastructure and has now been adapted to use the Kalman filter procedure to process arrays of data and it has been fully integrated with an optimization technique. Models that have been implemented have saved millions because optimization models evaluate long and short term maintenance and repair decisions. For instance, the Markov Decision Process used in Arizona for their highways saved \$14 million in the first year and was forecasted to save \$101 million the following four years. The investment for the success of these technologies such as the Pontis system, a bridge management system used in over 40 states, reflects the magnitude of maintenance and repairs spent on infrastructure in the U.S. which is in billions of dollars per year (Durango-Cohen and Tadepalli).

A more straight forward model is one developed by Moshe Ben-Akiva and Rohit Ramaswamy which predicts pavement performance given traffic conditions, pavement characteristics and environmental factors. Based on poor fit to data results from using traditional pavement performance techniques such as the Pavement Condition Index and the Present Serviceability Index, and inefficient damage specific developed models that require an equation for every type of damage observed (e.g. cracks, potholes...), the authors conclude that pavement performance is unobservable so they have developed a method to define the unobservable characteristics of pavement performance. With no constraints on number or type of deterioration measurement used, the model is flexible to include various data collection strategies and measurement techniques. The model also is able to identify interacting processes of deterioration with a system of equations calculated simultaneously. While the design of the model is complicated-"a latent dependent variable whose value is simultaneously estimated from a set of indications, which are measures of damage on the pavement..." its purpose is straightforward. Because pavement performance should not rely solely on an engineers judgment as is the case with the indices noted above, this model enables professionals to more accurately access the condition of the pavement.<sup>17</sup>

<sup>16</sup> Pablo L. Durango-Cohen and Naveen Tadepalli. January 2006. *Using Advanced Inspection Technologies to Support Investments in Maintenance and Repair of Transportation Infrastructure Facilities*. Journal of Transportation Engineering.

<sup>17</sup> Moshe Ben-Akiva and Rohit Ramaswamy. May 1993. *An Approach for Predicting Latent Infrastructure Facility Deterioration*. Transportation Science.

Durango-Cohen has also collaborated with Chih-Yuan Chu to estimate inspection and deterioration models for infrastructure performance which is similar to the previously described model varies in that it is able to identify trends, seasonality, random errors and even accommodate missing data as explored in their study of a pavement's elasticity and load capacity. The information extracted from this type of model can help agencies better allocate their resources among design, preservation and improvement of infrastructure. While the authors point out a few limitations to their model it does provide a good start and merely encourages the investment in like modeling and technologies because when perfected they have the potential to not only save money but lives. In fact, this particular model is consistent with Durango-Cohen's previous work and other infrastructure deterioration models making its implementation that much more economical.<sup>18</sup>

It would be unreasonable to expect a city council member to understand exactly how these models work or to expect a designer to understand the procedures of enabling a policy adopted by the state or federal government. Therefore all parties must work together to achieve the ultimate goal; in this instance safe infrastructure.

## **Policy Implications**

The Silver Bridge collapse in 1967 instigated some policy revisions regarding bridge inspections such that they were to be inspected at least every two years. The Mianus River Bridge collapse in 1983 forced the inclusion of fracture-critical inspections and in 1987; the collapse of New York's Thruway Bridge initiated underwater inspections. It is evident that modern policy is reactive, what has been established is now simply being modified in response to devastations or new technologies or information and following suite, the 35W Bridge collapse will undoubtedly lead to policy revision which hopefully will also be preventive. "Extreme events" have already initiated new design load resistance standards for federally funded bridges and are to be implemented by October 1st according to Kelly Rehm, program manager for the American Association of State Highway and Transportation Officials' bridges and structures subcommittee (Cho, Ichniowski and Angelo). New code should increase structure life by 25 years to 75 which will be aided by building redundant structures, something that was not done until the 70s. The 35W Bridge was non-redundant, a design feature that has already been corrected for the rebuild. With 160,570 bridges rated structurally deficient or functionally obsolete there is considerable strain on funding to repair these structures so congress is already looking to provide extra funding along requiring higher inspection standards to avoid these costs in the future. Ironically the morning of the 35W collapse, the following article was published by Reuters News Service, "Congress Eyes Fix for Crumbling Infrastructure."<sup>19</sup> The article discusses the roads, bridges, transit and other aging infrastructure that could now afford to get a "face-lift" if Congress adopted a funding system that was introduced the previous Wednesday. Some recent incidences such as the pipe explosion in Manhattan was one of many presented as evidence for the legislation; the 35W Bridge will most likely convince Congress of the necessity of the bill.

Some policy considerations that could stem directly from the 35W Bridge might include stricter inspections standards in environments that are as extreme as Minnesota or an inspections classification system based on the age of the bridge such that within the last decade of a structures life cycle inspections are increased or more intense. Policy could also establish a mandatory level of technology installations such as structure optimization and deterioration monitoring. Another angle for policy amendments would be to elect one party to be accountable for the integrity of a structure, the idea being the agency would be more motivated to devote all efforts to the safety of the structure where as now, with multiple parties equally responsible, accountability is blurred and the blame game is an endless cycle.

## Conclusion

As discussed in the pages above recent transportation policy has been reactive and while the 35W Bridge collapse was a tragedy for the friends, family and community, the hope that the policy changes would actually be preventive might offer some relief for the future of infrastructure. By discussing the evolution of infrastructure implementation, organization, regulation and those involved at all levels we have established an explanation for reactive policy. With so many actors it is very hard to articulate who should be held responsible and while it may be easier to create more preventive policy when one agency is held accountable and feels the pressure to devote all efforts and resources to ensure the quality of their product is safe to produce anything as extensive as a national highway system it is a collaborative effort. This case study looks specifically at the 35W Bridge, a more in depth look at the bridge's collapse and the aftermath. The primary concern of this paper is the infrastructure of America and seeming neglect. This issue requires immediate attention before more incidents like the collapse of the 35W Bridge occur.

In the past great attention has been paid to the roadways due to their integral role in transportation persons and goods. More recently however it seems the attention of the DOT, local, state and federal government and society has been diverted entirely to the safety of the skies. As this paper has demonstrated, much of this attention needs to be put back on the ground. The collapse of the 35W Bridge has been a wake up call, one that must be answered with progressive, preventive policy. Policy that stresses the importance of extensive inspections near the end of a bridge's life cycle, articulating a responsible party to ensure the devotion of necessary resources for maximum safety or establishing a minimum level of infrastructure data collecting technology might be just the thing to shift the approach to policy from reactive to preventive.

<sup>18</sup> Chih-Yuan Chu and Pablo L. Durango-Cohen. November 2006. Estimation of infrastructure performance models using state-space specifications of time series models. Science Direct.

<sup>19</sup> August 1, 2007. *Congress Eyes Fix for Crumbling Infrastructure*. Reuters News Service

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