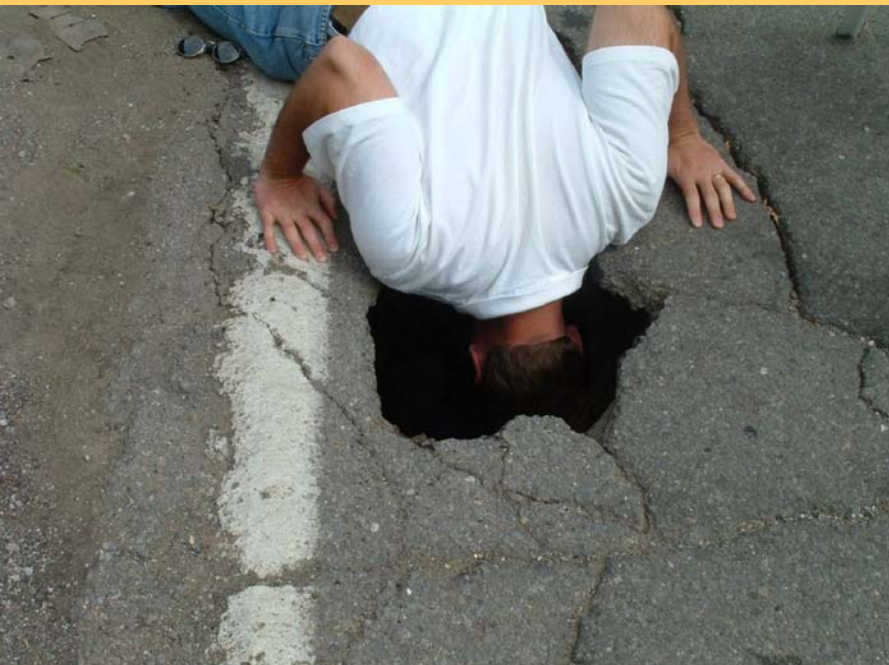




The Effects of Our Decaying Infrastructure On National Security and Culture

Roberto Ballarini

**James L. Record Professor and Head
Department of Civil Engineering
University of Minnesota**



**Foresight After Four
September 16, 2009**

Disclaimer:

What follows is the perspective of an educator who is also a concerned, proud and ultimately optimistic citizen of a great country.

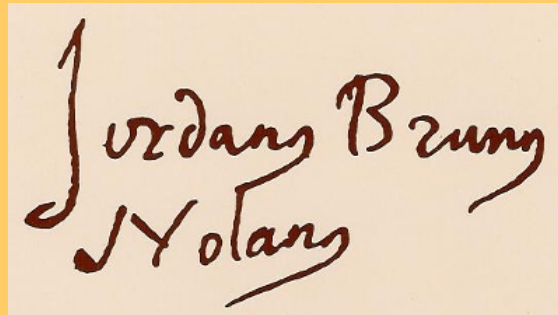
That said:

“Human history becomes more and more a race between education and catastrophe.”

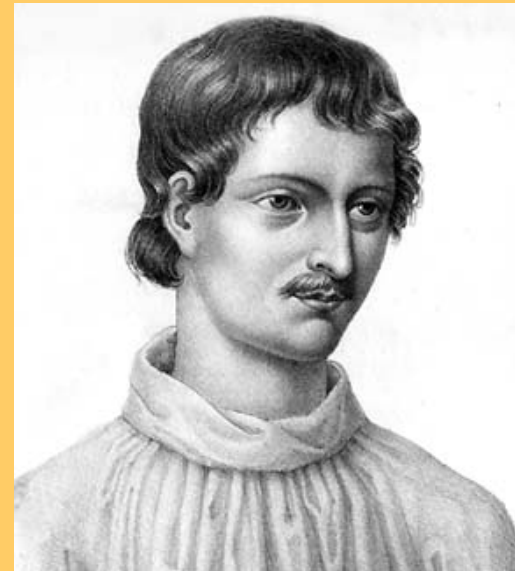
H.G. Wells

Oh difficulties to be endured, cries the coward, the featherhead, the shuttlecock, the faint-heart. The task is not impossible, though hard. The craven must stand aside. Ordinary, easy tasks are for the commonplace and the herd. Rare, heroic and divine men overcome the difficulties of the way and force an immortal palm from necessity. You may fail to reach your goal, but run the race nevertheless. Put forth your strength in so high a business. Strive on with your last breath.

Giordano Bruno, *The Ash Wednesday Supper*

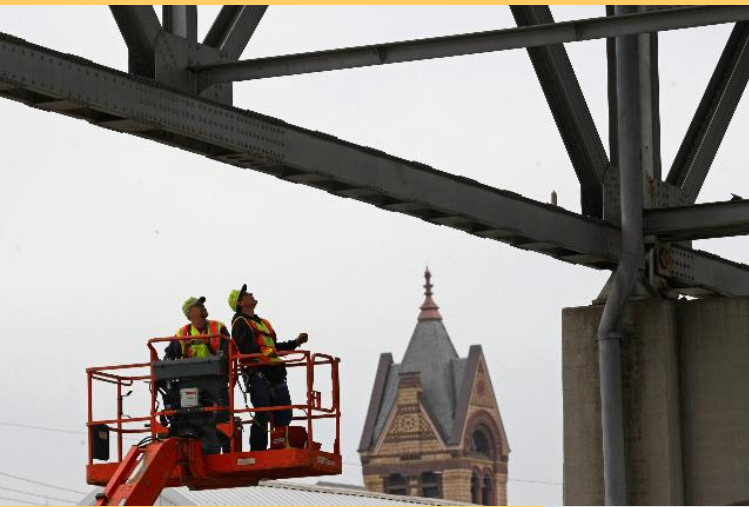


Giordano Bruno
Nolanus



Highway 43 Bridge, Winona, MN

Detour length was 65 miles.



Closed to all traffic June 3
Reopens for cars June 14
Reopens for trucks July 21
Sidewalk reopens October 2

Twain House Remains In Financial Crunch

WFSB Teams Up To Help Save Attraction

POSTED: 7:31 am EDT July 16, 2008

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HARTFORD, Conn. -- One of the state's major tourist attractions is facing a critical [financial](#) shortfall.

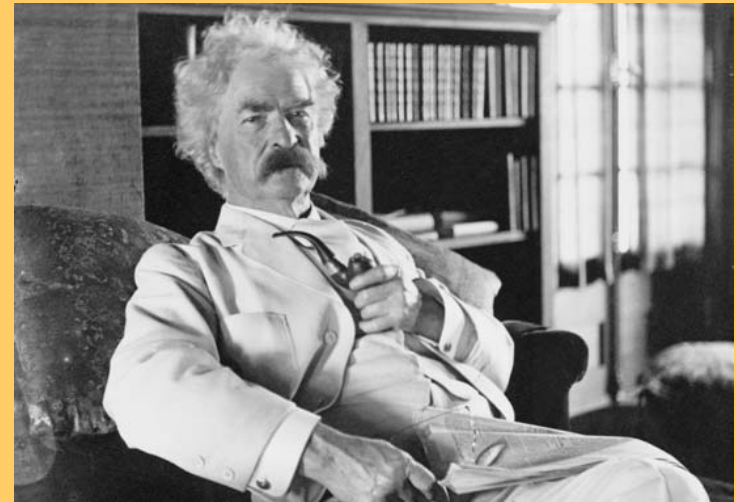
Without an immediate influx of cash, the Mark Twain House could be out of operating [funds](#) within a matter of weeks.

"It's a very difficult cash position right now," said Jeffrey Nichols of the Mark Twain House. "We find ourselves with a few weeks, maybe a month of payroll and other expenses. So it is very tight right now."

Despite the popularity of the Hartford attraction, with 68,000 visitors last year, an aggressive expansion [plan](#) crippled the landmark's financial future.

"It really started in 2003 with the construction of the new facility, the museum center -- originally estimated to cost about \$10 million ... because of cost overruns, it was closer to 19," Nichols said.

Officials from the Twain house said that they expect a \$370,000 shortfall by the end of the year.



Outline

What the Nation's infrastructure represents.

What it was, what it is, what will it be?

**What do we do about the existing infrastructure,
and what do we do about replacing it?**

**We need to take care of a very sick and old patient
whose parts were not taken care of.**

We also need to replace the patient.

**There are solutions; they involve the
commitment of lots of money for construction/repair,
education, research, etc., and most importantly, will.**

Brief summary of results of I-35W Bridge collapse



National Security; Roman Aqueduct in Pont du Gard, France
The Romans understood the roles of roads, water distribution, etc., in maintaining their empire.



National pride; Petronas Towers, Kuala Lumpur, Malaysia

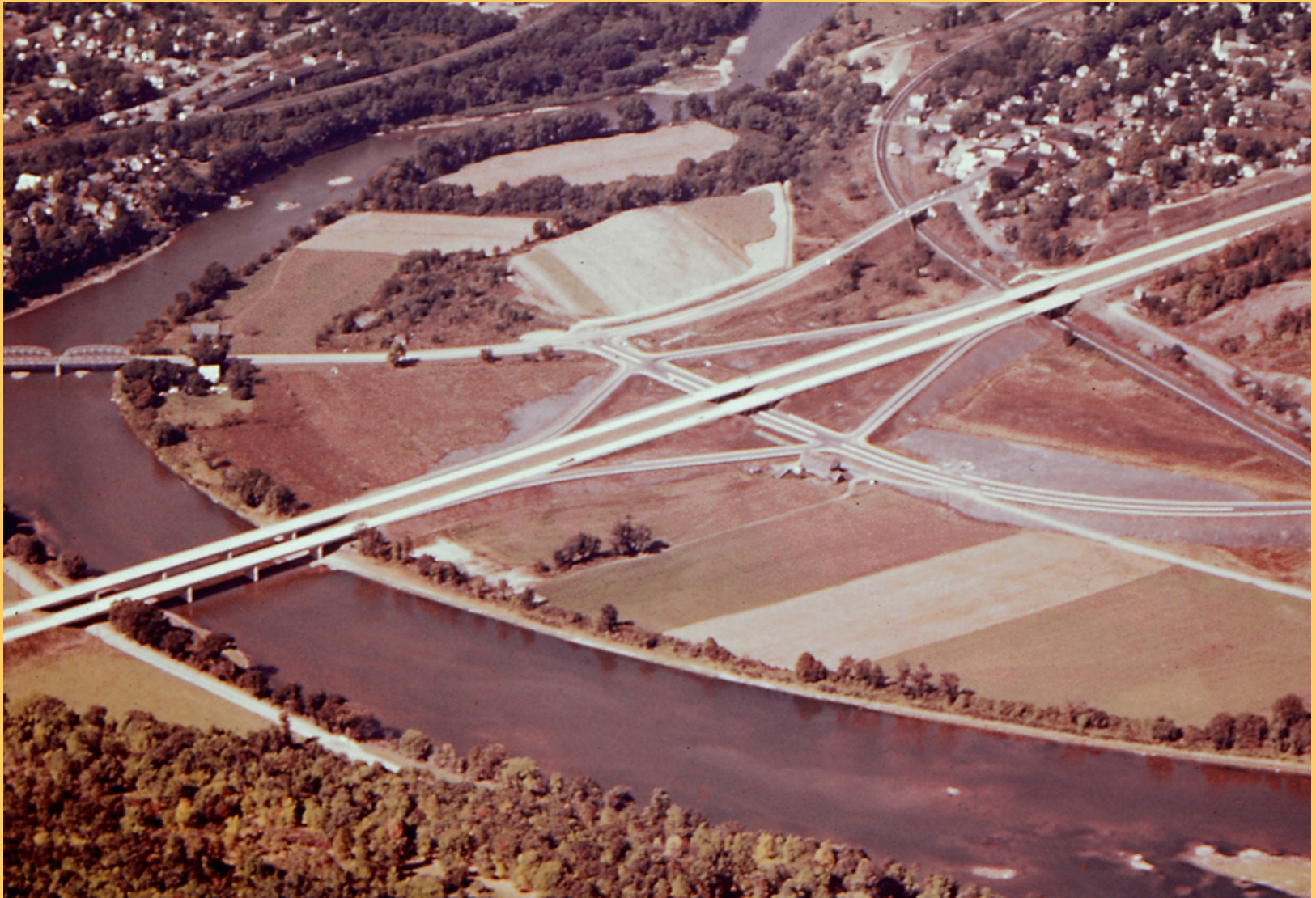


Personal pride; San Gimignano, Italy



**Our infrastructure was a statement of our vision,
wealth, capabilities and pride.**





Interstate system; I-81 Great Bend, PA (1960)

**We had the most impressive infrastructure, especially
given our size:**

Example; Interstate Highways System

**Carries 20% of traffic but only covers 1% of US land
Credited with saving ~190,000 lives and preventing ~12 million
injuries**

Estimated to have saved \$6 for every \$1 spent on its construction

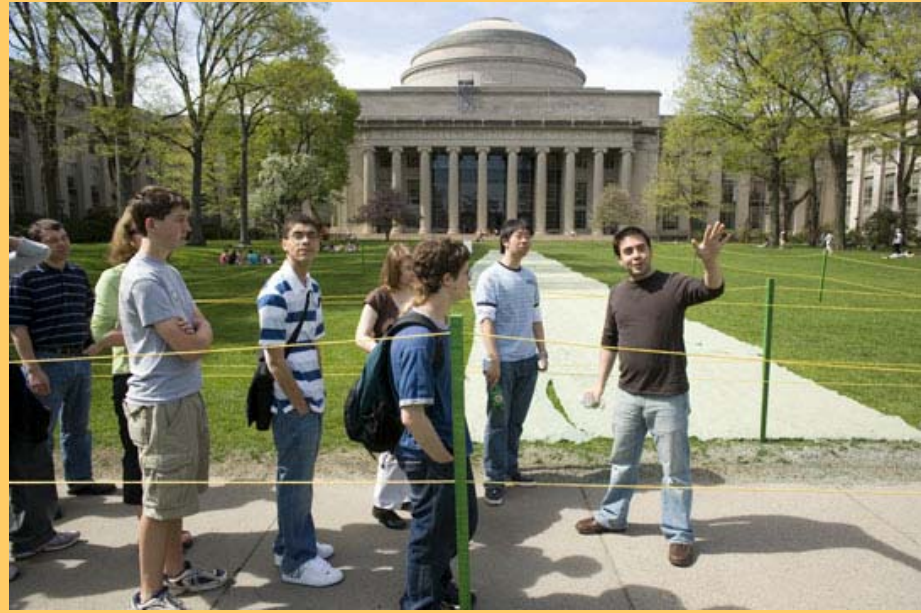
Created good jobs, technical expertise, the economy, ...



Infrastructure includes cultural projects!



and Education: Morrill Grant Land College Act of 1862

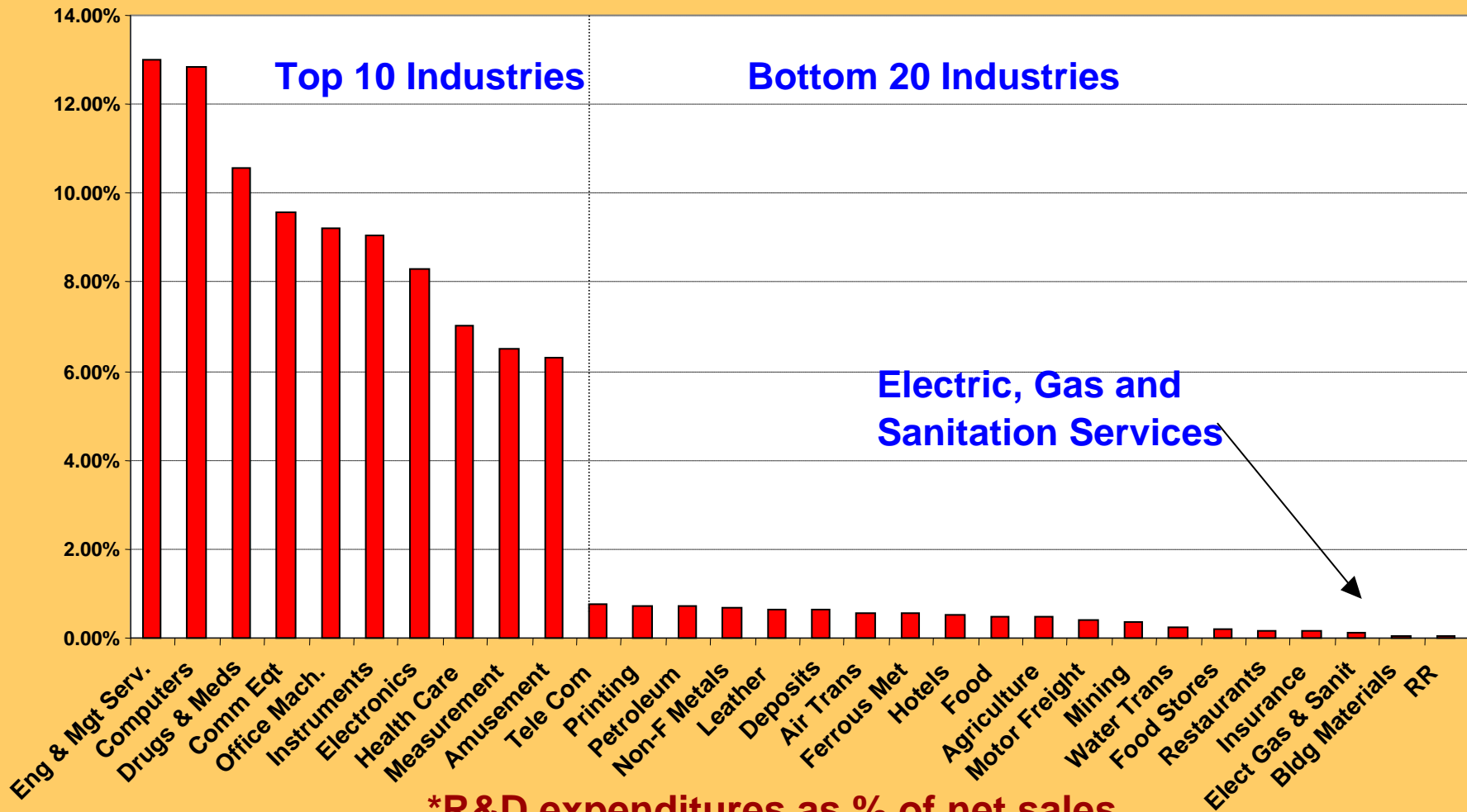


Investment in Infrastructure

- **1950s and 1960s ~4% of GDP**
- **1982 to 2007**
 - **U.S. population – 226 to 300 million**
 - **U.S. GDP - \$3 to \$13 trillion**
 - **current infrastructure investment < 2% of GDP**

China today ~ 9% of GDP

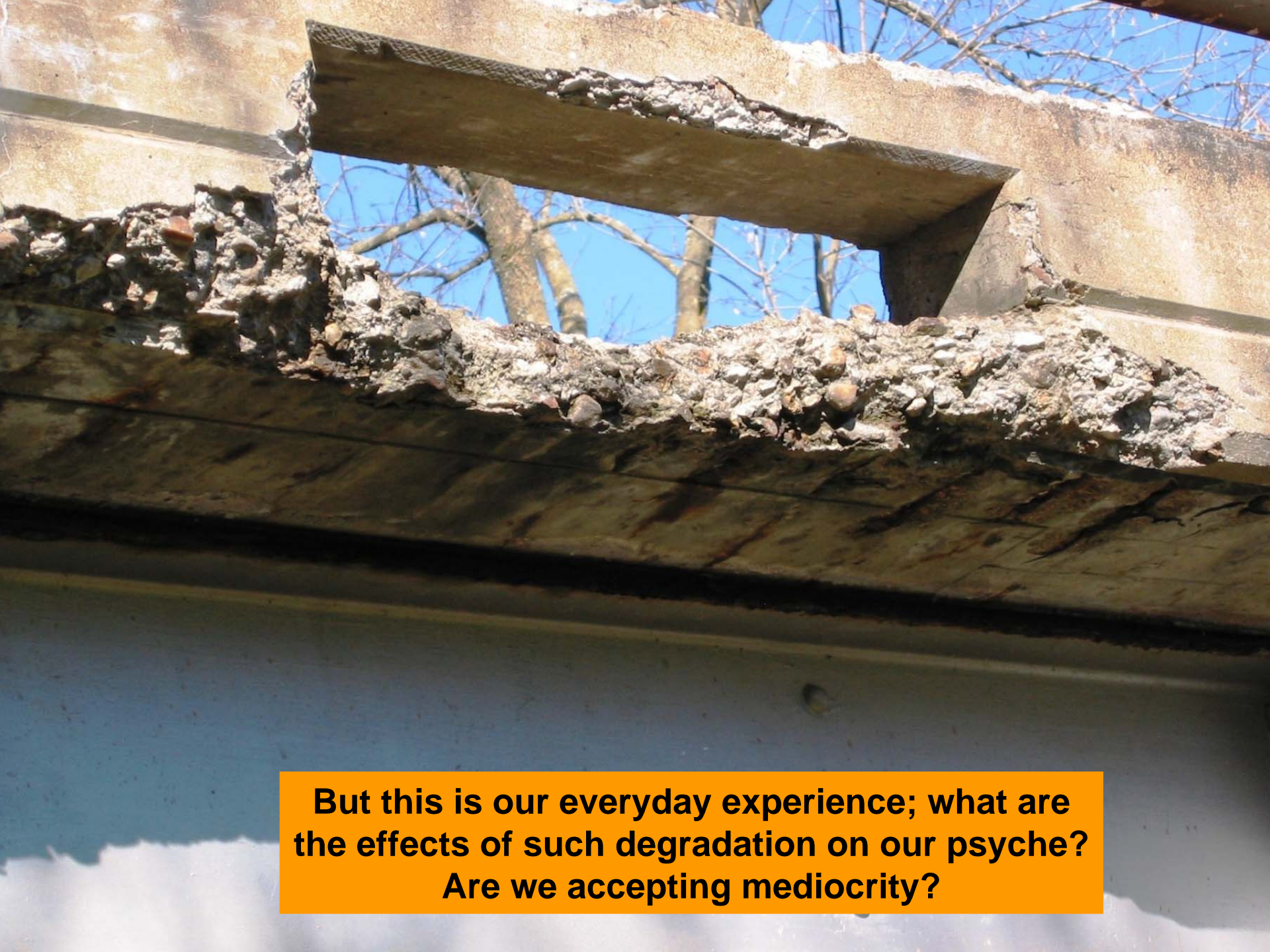
Context: R&D Expenditures*



*R&D expenditures as % of net sales



**Most of us see this kind of road and view
only when vacationing**



**But this is our everyday experience; what are the effects of such degradation on our psyche?
Are we accepting mediocrity?**





Rockefeller Road Bridge, Cleveland, Ohio

A Fuller Spectrum of News

- U.S. News ▶
- Crime & Punishment ▶
- U.S. Life ▶
- U.S. Security ▶
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- Weather ▶
- Blogs Etc. ▶
- Local News ▶
- Newsweek ▶
- Multimedia ▶
- Most Popular ▶
- NBC NEWS**
- Today Show ▶
- Nightly News ▶
- Dateline NBC ▶
- Meet the Press ▶

Sinkhole swallows up SUV in New York street

Shocked driver escapes serious injury; vehicle rested on gas main



WNBC-TV

The SUV rests in the Brooklyn street sinkhole.

**Water main break;
SUV sitting on gas main.**

Ap Associated Press

Updated: 11:32 a.m. CT March 27, 2006

NEW YORK - A city street collapsed under a sport utility vehicle early Monday, leaving the vehicle nose down into a deep sinkhole that officials said was caused by a water main break.

The driver of the SUV escaped without serious injuries but was taken to a hospital for treatment of shock, said Fire Department spokesman Brian Conlon.

Stand and be counted



[get involved.](#)

What keeps you up at night? Gut Check America is your chance to tell us what really matters in our country and to help determine what topics MSNBC.com covers. [Click here to learn more and](#)

Photo features



[The Week in Pictures](#)

Violation of conservation of cars assumption



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Aging N.Y. pipes raise concerns of more blasts

Steam pipes rarely inspected; air tests ease health worries in Manhattan



Timothy A. Clary / AFP - Getty Images

A destroyed tow truck sits in a hole Thursday at the site of an underground steam pipe explosion in New York. The Wednesday explosion tore a crater in Lexington Avenue near Grand Central Terminal, sending residents running for cover amid a towering geyser of steam.

**83 years old steam pipe,
and part of a system put
into service in 1882!!!**



NBC video

Launch

N.Y. worries
July 19: The explosion of a weathered steam pipe has more than just New Yorkers pondering the repercussions of an aging infrastructure. NBC's Ron Allen reports.

Nightly News

o: NYC steam explosion



Courtesy of Dennis Martenson

MAR 19 2004

Let us not forget about external threats

Working Premise #1



This is ugly!



Courtesy of Dr. Massoud Amin

Working Premise #2

...But this is uglier!



Oklahoma City, 1995



Saudi Arabia, 1996



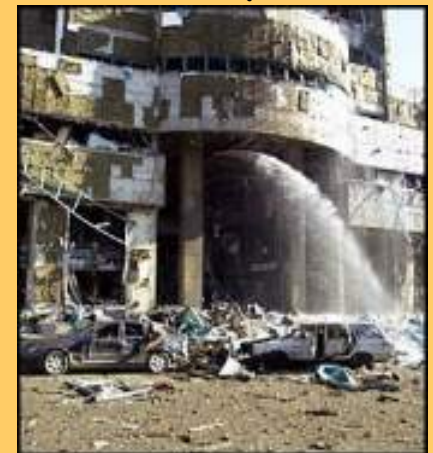
Tanzania, 1998



Mozdok, 2003



Baghdad, 2003



Istanbul, 2003

New approaches for evolving threats

Challenge



Can we have this?

Without this?



Courtesy of Dr. Massoud Amin

ASCE Report Card

PROGRESS REPORT	
America's Infrastructure	
DATE 2003	
Roads	D+ ↓
Bridges	C ↔
Transit	C- ↓
Aviation	D ↔
Schools	D- ↔
Drinking Water	D ↓
Wastewater	D ↓
Dams	D ↓
Solid Waste	C+ ↔
Hazardous Waste	D+ ↔
Navigable Waterways	D+ ↓
Energy	D+ ↓
America's Infrastructure GPA	D+
Total Investment Needs (estimated five-year need)	\$1.6 Trillion



ASCE

PROGRESS REPORT
America's Infrastructure

Roads D+ ↓

Traffic congestion costs the economy \$67.5 billion annually in lost productivity and wasted fuel.

“Civil engineers are the doctors of infrastructure,-- and we have a patient that's sick and getting sicker.”

ASCE Executive Director James E. Davis

- | | |
|-----------------|-----------------------|
| ↑ = Improving | A = Exceptional |
| ↔ = No Progress | B = Good |
| ↓ = Declining | C = Mediocre |
| | D = Poor |
| | F = Inadequate Trends |

Future — Investment Needs (5-year needs)

- **Report Card on America's Infrastructure¹**
 - Aviation – \$67 Billion
 - Bridges – \$ 628 Billion (includes Roads)
 - Dams – \$ 5 Billion
 - Drinking Water – \$ 115 Billion (includes Wastewater)
 - Energy (National Power Grid) – \$ 50 Billion
 - Hazardous Waste – \$ 41.6 Billion
 - Navigable Waterways – \$ 50 Billion

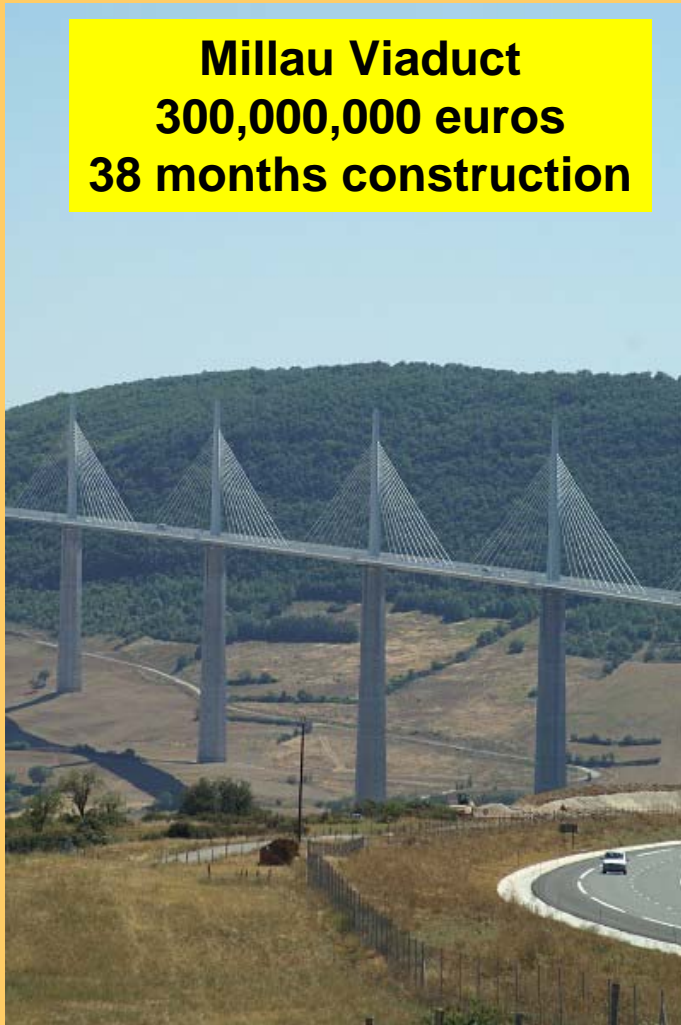
¹ **American Society of Civil Engineers (ASCE) - 2005**

- Public Parks & Recreation – \$ 3.3 Billion
- Rail - \$ 61 Billion
- Roads - \$ 628 Billion (includes Bridges)
- Schools – \$ 268 Billion
- Security – new category and estimate not possible
- Solid Waste – no reliable estimate
- Transit – \$219.5 Billion
- Wastewater – \$ 115 Billion (includes Drinking Water)

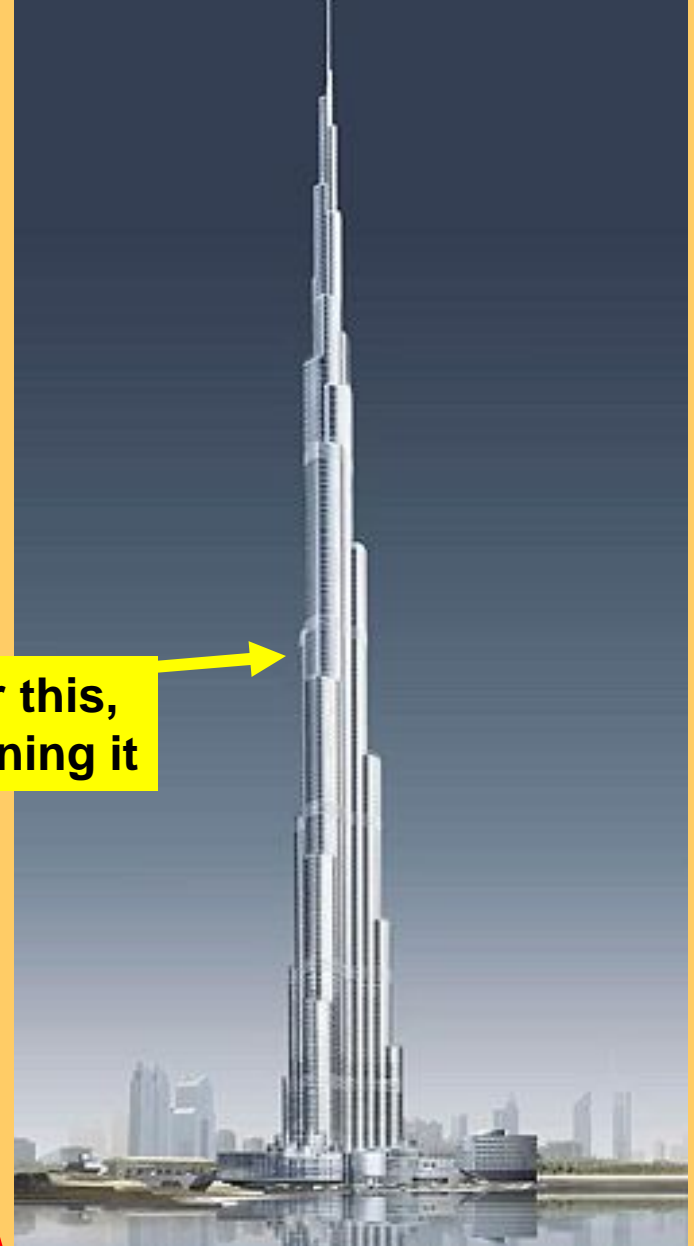
We must act soon, because the world is flat, and our Earth neighbors are doing so!

Other nations understand the value of infrastructure.

**Millau Viaduct
300,000,000 euros
38 months construction**



**We payed for this,
and are designing it**



**Burj Dubai
Completion 2008
Skidmore, Owings and Merrill**

Beijing-Shanghai High-Speed Line, China

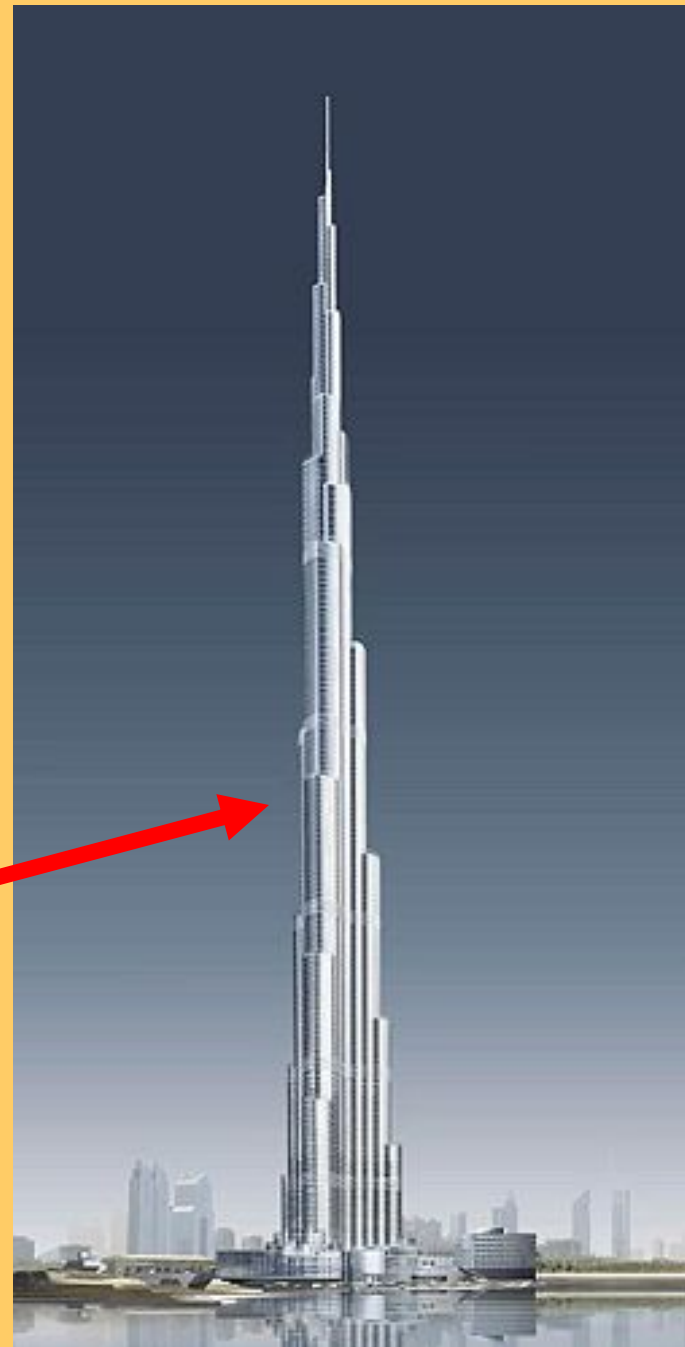
~\$32 B





Double Whammy:

**Congestion caused by
Evacuees of Hurrigan Rita**





Burj Al Arab Hotel

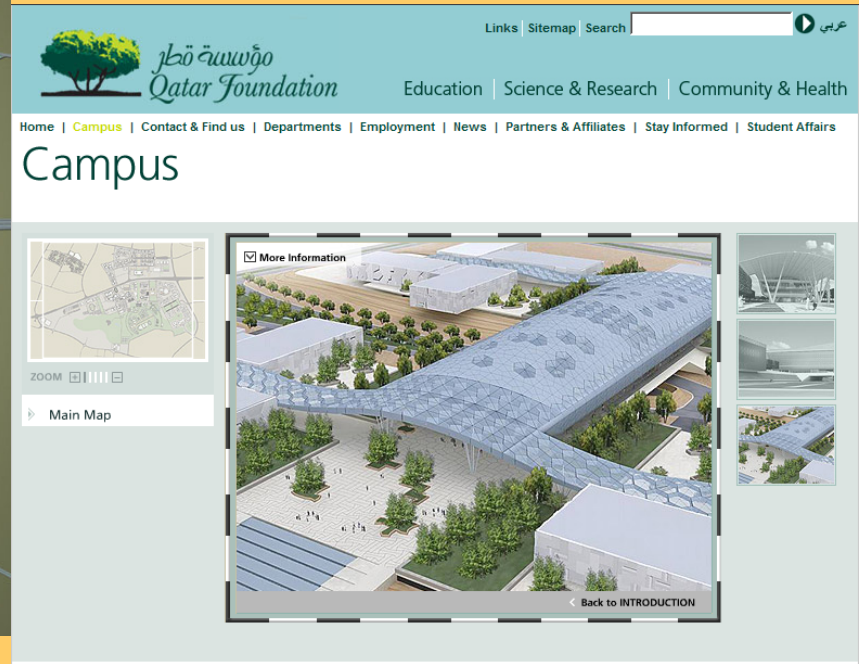
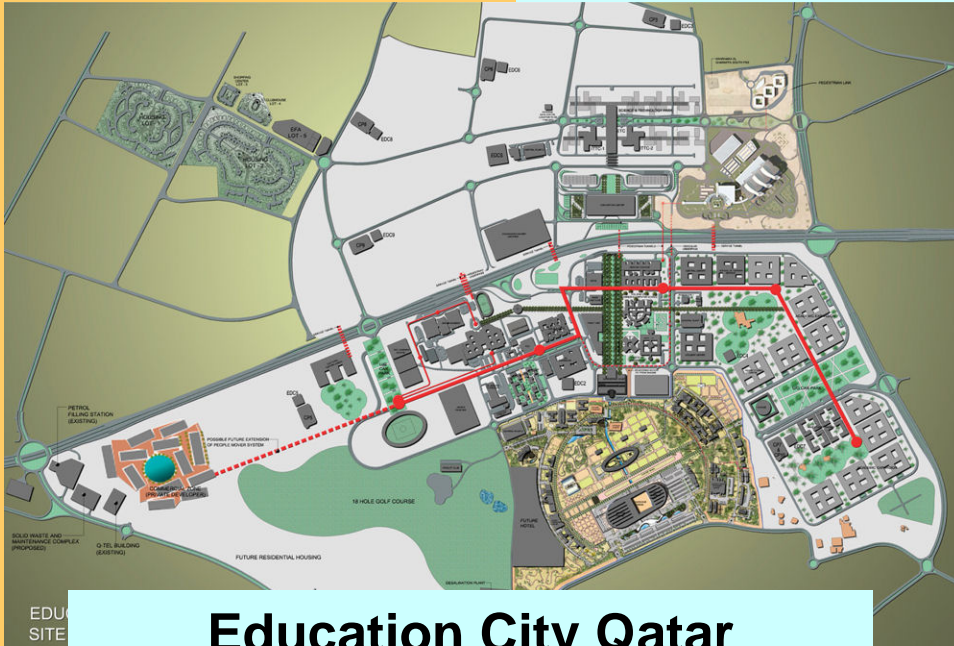


**Hydropolis; first underwater resort
hotel, Dubai**



Ski Dubai

It's not just about buildings



Education City Qatar
Carnegie Mellon, Cornell, Texas A&M,
Northwestern



FACULTY & STAFF



Related Information

- [Press Release](#)

Professor Brian Moran

Division Chair, Earth and Environmental Sciences and Engineering

Professor Brian Moran has been appointed Division Chair of Earth and Environmental Science and Engineering at KAUST. As Division Chair, Professor Moran will lead efforts to provide opportunities and facilities for researchers to address important scientific issues pertaining to resources and the environment.

Prior to joining KAUST, Professor Moran served as chair of the department of Civil and Environmental Engineering at Northwestern University, and previously, as chair of the department of Mechanical Engineering. In Civil and Environmental Engineering, he chaired an advisory board in developing a program in Architectural Engineering and Design. In Mechanical Engineering, he established a research thrust in neural engineering in conjunction with Biomedical Engineering and the Rehabilitation Institute of Chicago where he led the department through program review and accreditation.

A native of Ireland, Professor Moran is a Fellow of the American Society of Mechanical Engineers. He was elected a member of the board of directors of the Society of Engineering Science and presently serves as secretary of the society. He co-chaired the Seventh World Congress on Computational Mechanics in Los Angeles in 2006.

He was twice elected by students to the Northwestern Faculty Honor Roll for Teaching and he received the W.M. Keck Foundation Award for Engineering Teaching Excellence. He has published more than 100 technical articles and he is co-author of *Nonlinear Finite Elements for Continua and Structures*. He and his co-authors received a best paper award from SPIE, NDE Symposium in 2005. His research interests are in multi-scale computational science and engineering, fracture mechanics and plasticity, and the use of novel techniques, such as extended finite element and level set methods for the evolution of bacterial biofilms.

Professor Moran earned his bachelors of engineering in Civil Engineering and later his masters of engineering in Mechanical Engineering from the National University of Ireland, Galway. He earned a masters of science in Applied Mathematics and doctorate in Solid Mechanics from Brown University. He received the National University of Ireland Bursary in Civil Engineering for study abroad. Professor Moran spent a year as an IBM Research Fellow at Caltech before joining Northwestern in 1988.

The job ahead of us
We need to concurrently maintain and rebuild

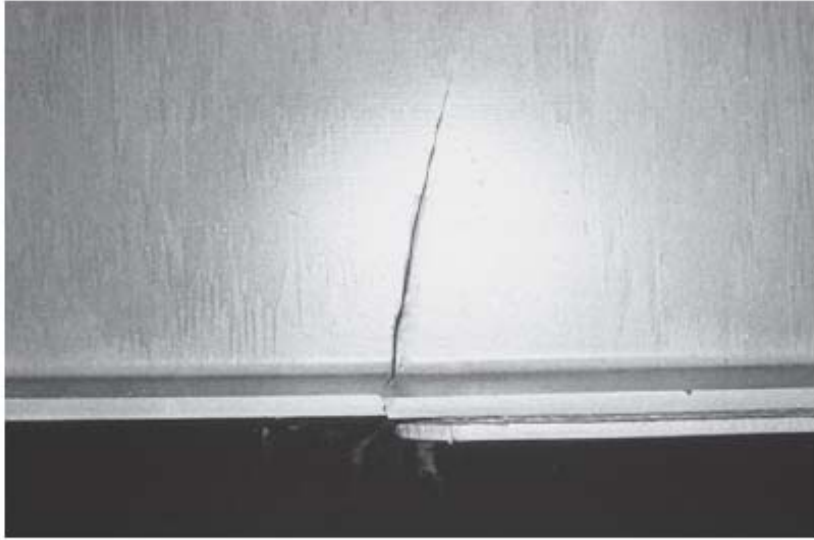


FIGURE 2 Development of fatigue crack at cover plate ends on the multibeam Yellow Mill Pond Bridge in Connecticut in 1976. (Courtesy: John W. Fisher.)

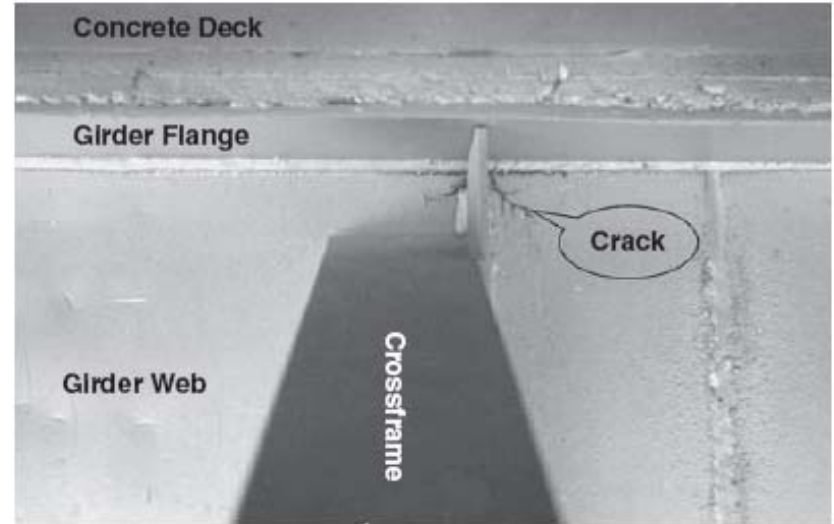


FIGURE 3 Typical web-gap fatigue cracking.

Cracking can lead to noncatastrophic Damage.



FIGURE 16 View of cracked girder in two-girder span of Lafayette Street Bridge in St. Paul, Minnesota, as an example of a bridge that is sufficiently redundant to avoid collapse despite a fracture of the tension flange and the web of one girder.

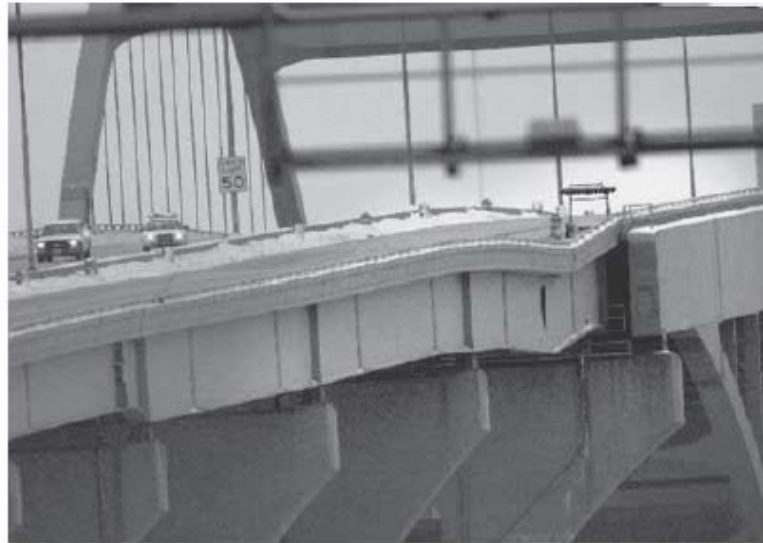


FIGURE 9 Example of bridge deck acting as catenary with hinge at fracture location in end span of the approach spans of the Hoan Bridge in Wisconsin—two of the three girders had full-depth fractures in December 2000.

Effective retrofitting procedures are available; they cost money.

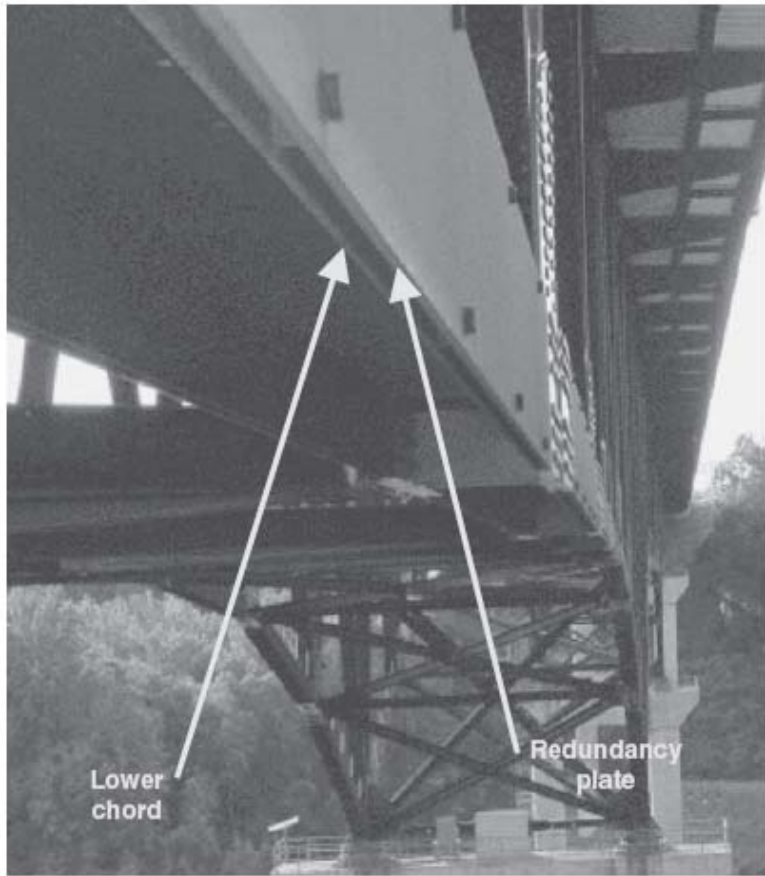


FIGURE 13 Redundancy plate bolted to lower chord of SR-33 bridge near Easton, Pennsylvania. (Courtesy: HNTB.)



FIGURE A10 Bolted doubler plate repair. Dotted line represents crack line beneath doubler plate and circle is the hole drilled at crack tip to intercept further growth.



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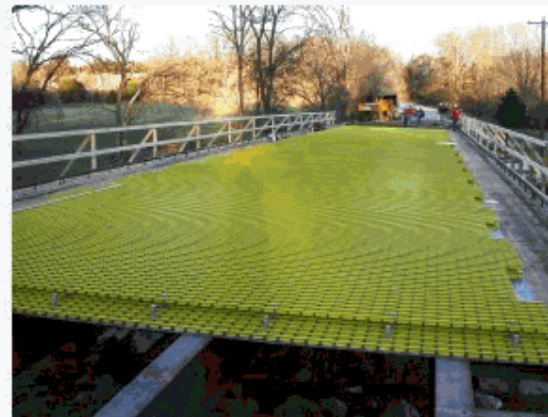
Effective repair is available

Press Release 06-040

Easy Up, Not-So-Easy Down

Builders replace bridge in only days using lightweight, corrosion-resistant composites

[Back to article](#) | [Note about images](#)



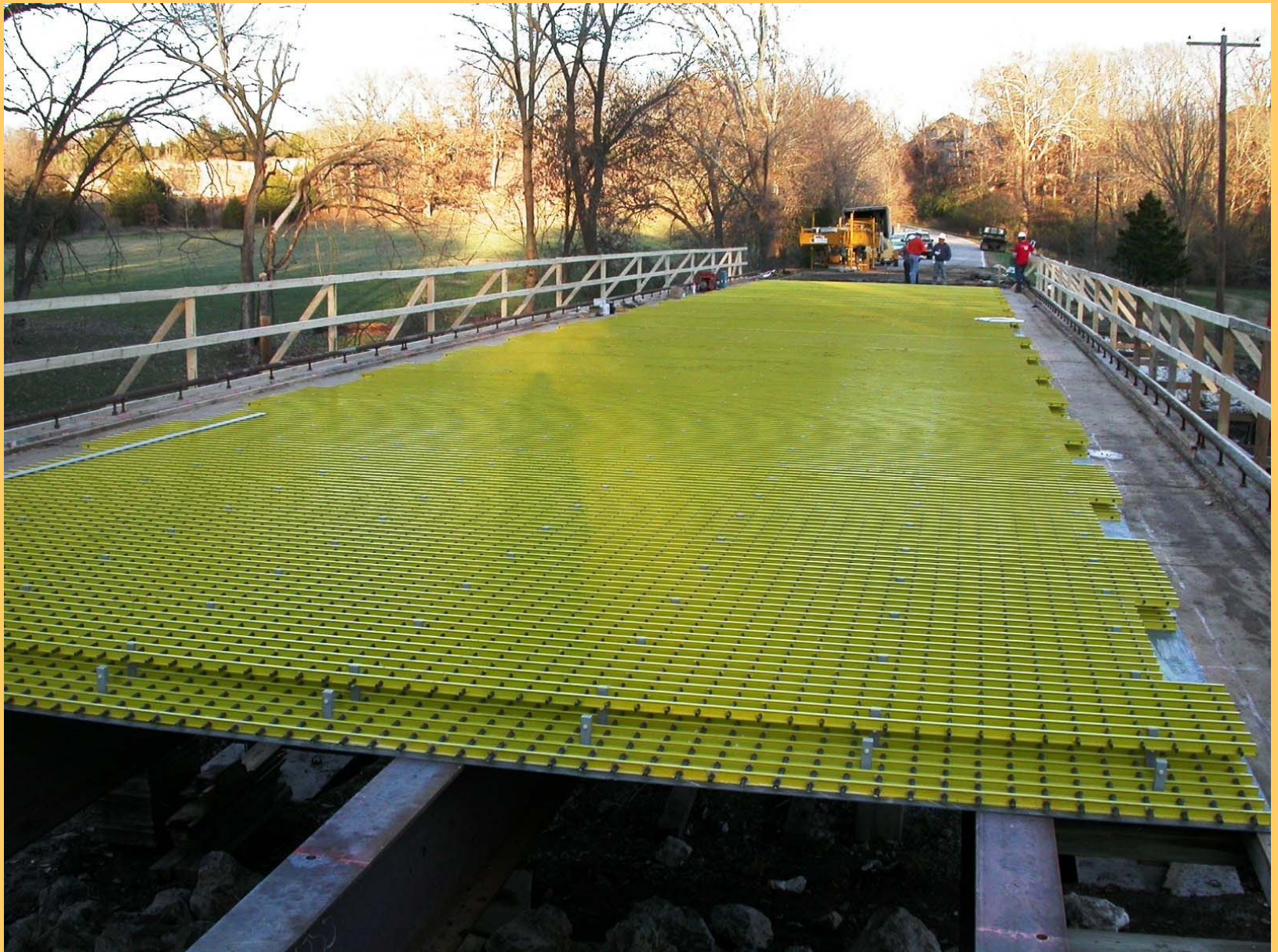
Fiberglass-polymer composites form the core of a renovated bridge deck in Springfield, Mo. University of Missouri at Rolla researchers at NSF's Buildings and Bridges with Composites Industry-University Cooperative Research Center (RB2C I/UCRC) worked with their industry partners and colleagues at the University of Wisconsin at Madison to develop the pre-fabricated, composite plates and cages.

Credit: *Fabio Matta, UMR*

[Download](#) the high-resolution JPG version of the image. (604 KB)

Use your mouse to right-click (or Ctrl-click on a Mac) the link above and choose the option that will save the file or target to your computer.





Solutions



It comes down to priorities and long-term planning



Let's put the right people into these positions





**Replacement: Leonard Zakim Bridge, Boston
\$115M**

An illuminating look at the vast mega-projects that will bring New York City's underground infrastructure into the 21st Century and beyond.

NEW YORK TRANSIT MUSEUM



The New York Public Library

The Future Beneath Us



The New York Transit Museum and the New York Public Library's Science, Industry and Business Library present a historic exhibit illuminating the vast underground mega-projects that will bring New York City's underground infrastructure into the 21st Century and beyond.

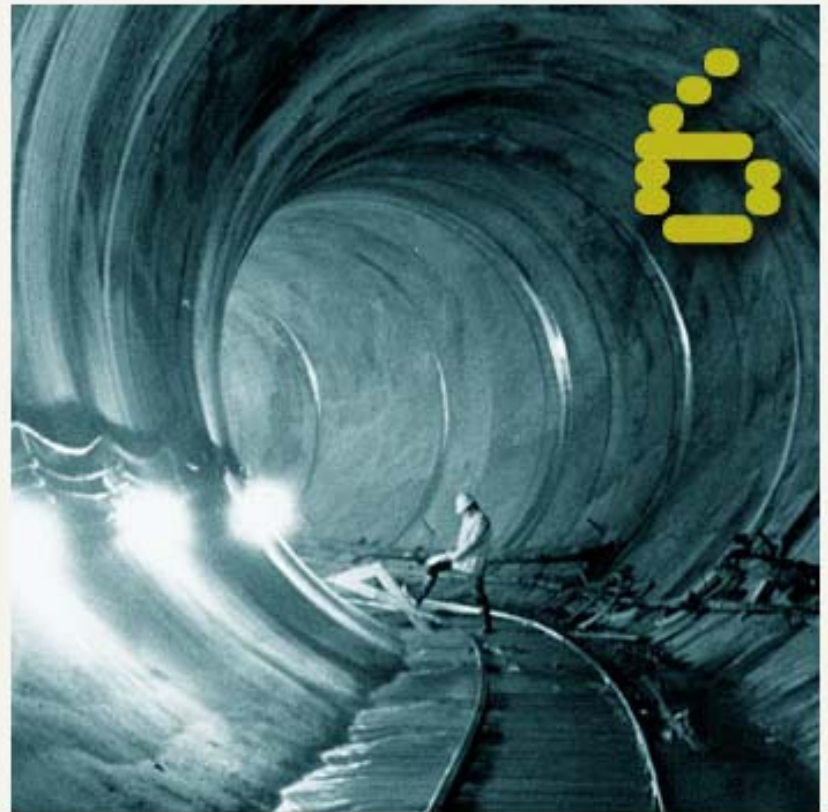
The exhibition, titled *The Future Beneath Us: 8 Great Projects Under New York*, will be shown in two locations in Midtown Manhattan: the New York Transit Museum Gallery Annex and Store at Grand Central Terminal and the Science, Industry and Business Library's striking Cullman Rotunda and Healy Hall on 34th Street and Madison. The exhibit runs from February 2009 through July 5, 2009.

[The Projects ...](#)

City Water Tunnel No. 3

It is the largest and longest running capital project in New York City's history and among the largest engineering projects in the world. When it is finished and all the construction shafts have been closed up, it will have completely disappeared from view, up to 800 feet below ground. The only evidence of its existence will be the assurance that when you and many subsequent generations need to bathe, cook, or fight a fire there will be plenty of water to do so. Its name may be prosaic—City Water Tunnel No. 3—but its function is essential to the life of New York.

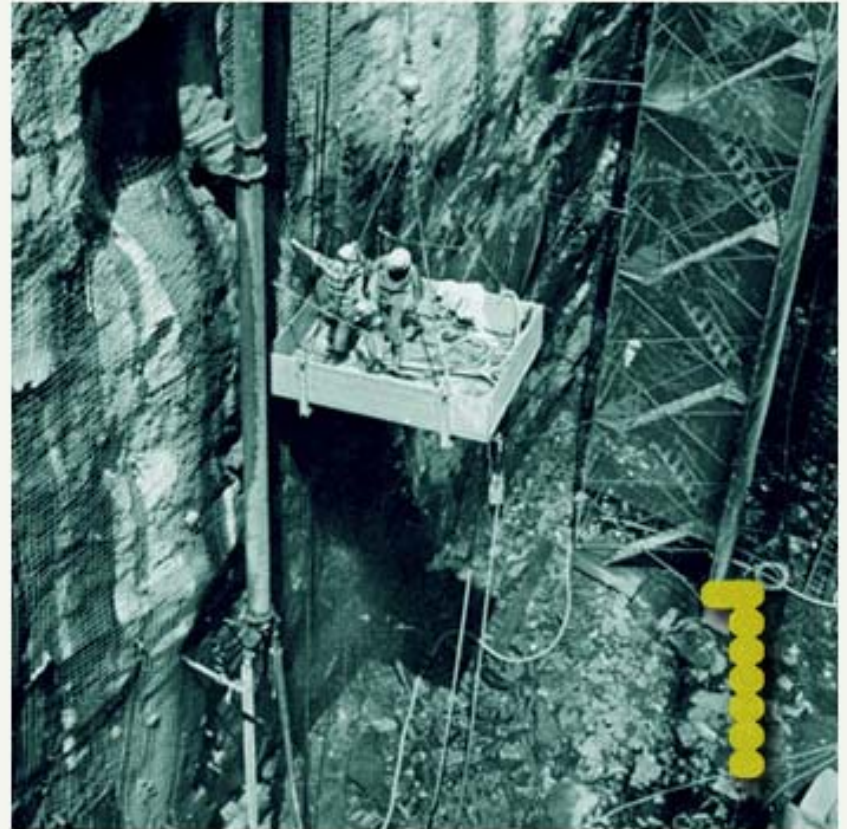
[Learn more ...](#)



East Side Access

Today MTA Long Island Rail Road (LIRR) is the country's largest commuter railroad. Its increasing daily passenger load totals 270,000 travelers -230,000 using Penn Station. By bringing riders into Grand Central Terminal, the East Side Access Project will allow the LIRR to expand capacity to Manhattan and keep up with growing demand.

[Learn more ...](#)





The Mark Twain House & Museum

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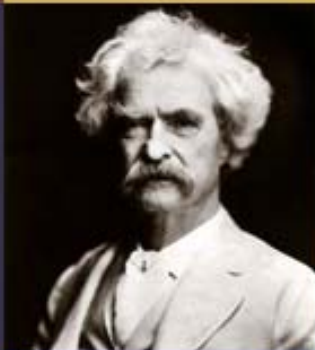
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The Man



The House



Support the Mark Twain House & Museum

The Mark Twain House & Museum is turning the corner on its financial crisis thanks to quick action by a wide range of donors and supporters. We are now able to keep the Hartford legacy of Mark Twain and his home alive, but have a way to go, and can only do it with your support. A lively series of events and exhibits is bringing new visitors to the museum daily. We welcome you to contribute to this effort.

[Donate Now](#)

What's New

COMING UP SEPT. 15: What Would Twain Tweet?

YouTube celebrity Michael ("What the Buck?") Buckley heads a star-studded panel on the uses of social media in our time -- and how the great author himself might have thought of these new ways of expression.

[more...](#)

OCT. 2: Tapping Into Twain

On Friday, Oct. 2, at 5:30, local brewers will offer their wares in the