



CRITICAL INFRASTRUCTURE

Keys to a Sustainable and Resilient Future

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JULIUS CAESAR

There is a tide in the affairs of men
Which, taken at the flood leads on to fortune;
Omitted, all the voyage of their life
Is bound in shallows and in miseries.
On such a full sea are we now afloat;
And we must take the current when it serves,
Or lose our ventures.

- Brutus to Cassius

Shakespear's *Julius Caesar*, Act IV Scene 3



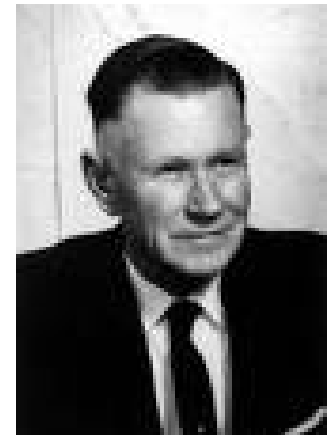
INFRASTRUCTURE

**Pervasive, functioning
infrastructure is the key to our
economic well-being and
success**

INFRASTRUCTURE AS THE KEY

**“We do not have great highways because we are a great nation,
we are a great nation because we have great highways”**

**-- DeWitt C. Greer (1902-1986),
Chair Texas Highway Commission**



INFRASTRUCTURE AS THE KEY

- ✦ **Great Bridges**
- ✦ **Skyscrapers**
- ✦ **Dams and Levees**
- ✦ **Power Plants and Power Distribution Systems**
- ✦ **Water and Wastewater Purification, Treatment and Reuse**



INFRASTRUCTURE AS THE KEY

✦ A century of advancements:

- Power
- Travel
- Communications
- Life expectancy



INFRASTRUCTURE AS THE KEY

“... The greatest advances in improving human health were the development of clean drinking water and sewage systems. So, we owe our health as much to civil engineering as we do biology.”

- Lewis Thomas, Former head of Yale Medical School & Memorial Sloan-Kettering Cancer Center

INFRASTRUCTURE

2

Our systems are occasionally damaged, but we learn from these failures

LEARNING FROM FAILURE

“The history of engineering . . . may be told in its failures as well as in its triumphs. Success may be grand, but disappointment can often teach us more.”

- Henry Petroski, *To Engineer is Human*

LEARNING FROM FAILURE

- **1971 San Fernando Earthquake**
 - New standards for expansion joints
 - Reinforcing schemes for single-column bents
- **1987 Whittier Narrows earthquake**
 - Further adaptation of the standards
- **1989 Loma Prieta (World Series) Earthquake**
 - Accelerated a risk assessment program of the 24,000 bridges in California
- **1994 Northridge Earthquake**
 - Bridges retrofitted performed better
- **Richard Land, Caltrans, ASCE Critical Infrastructure Summit**



INFRASTRUCTURE

3

Resilient infrastructure provides benefits during a disaster event, and quicker rebound

RESILIENT INFRASTRUCTURE

☀ Hurricane Katrina

- Lack of resilience cost lives, destroyed property, delayed the rebound



☀ L'Aquila Earthquake, Italy

- 'virtual resilience' minimized loss of life and hastened the emergency response



RESILIENT INFRASTRUCTURE

“Resilience of our infrastructure or, more broadly, of our society, is a core ingredient of our success and prosperity”

- Dr. Stephen Flynn, Sr Fellow for Counterterrorism and National Security Studies, Council on Foreign Relations**

INFRASTRUCTURE

1

Infrastructure is the key

2

We learn from Infrastructure failure

3

Resilient infrastructure speeds recovery

🔦 What is our current condition?

INFRASTRUCTURE

- ✦ **US Infrastructure is the best, most pervasive, most advanced in the world**
 - Ingenuity, creativity, priority
 - Proactive public policy
- ✦ **We are a prosperous nation because of it**
- ✦ **We are in a precarious state**

INFRASTRUCTURE CONDITION

Overall Grade: D

Aviation	D
Bridges	C
Dams	D
Drinking Water	D-
Energy	D+
Hazardous Waste	D
Inland Waterways	D-
Levees	D-

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Public Parks & Recreation	C-
Rail	C-
Roads	D-
Schools	D
Solid Waste	C+
Transit	D
Wastewater	D-

INFRASTRUCTURE CONDITION

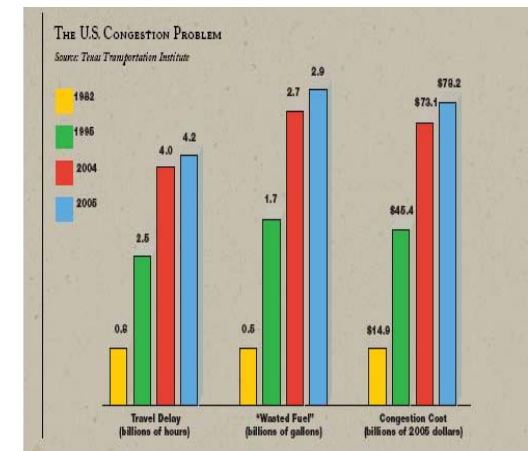
- ✚ 27% of the 590,750 bridges nationwide are structurally deficient or obsolete
- ✚ Blocked or broken pipes result in 10 billion gallons of raw sewage flowing into US surface waters annually



INFRASTRUCTURE CONDITION

✦ Severe highway bottlenecks have increased by 40% during the past five years

✦ Americans spend 4.2 billion hours per year stuck in traffic at a cost of \$79.2 billion in wasted time and fuel



INFRASTRUCTURE CONDITION

- ✦ There are 1,826 deficient, high-hazard dams in the US
- ✦ The US has an estimated 100,000 miles of levees, 85% are locally owned.
- ✦ USACE estimated that 9% of federally inspected levees are expected to fail in a flood event.



INFRASTRUCTURE CONDITION

- ✦ **A five year investment of \$2.2 trillion is needed to remedy our current infrastructure condition**
 - **Only 45% of that is currently in the federal, state, and local budget now**

- 2009 Infrastructure Report Card, ASCE



INFRASTRUCTURE DEMAND

	Population (2005)	Projected Population (2025)	% Increase (2005-2025)
WORLD	6.5 Billion	7.9 Billion	22.3
China	1.3 Billion	1.4 Billion	9.5
India	1.1 Billion	1.4 Billion	26.5
United States	298 Million	350 Million	17.4
Indonesia	223 Million	264 Million	18.4
Pakistan	158 Million	229 Million	45.2
Brazil	186 Million	228 Million	22.3
Bangladesh	142 Million	194 Million	36.6
Nigeria	132 Million	190 Million	44.7

INFRASTRUCTURE CONDITION

✦ Note of optimism:

- public and policy makers starting to pay some attention

PROSPECTS

✦ ARRA (Stimulus Bill)

- \$787 bill - - \$72 bill for infrastructure
- Small, but a significant shift

“A billion here, a couple of billion there, first thing you know it adds up to be real money”

-- late Senator Everett Dirksen

PROSPECTS

“What makes (this investment) so important is that by investing in roads that have earned a grade of D- by America’s leading civil engineers – roads that should have been rebuilt long ago – we can save some 14, 000 men and women who lose their lives each year due to bad roads and driving conditions. Like a broken levee or a bridge with a shaky foundation, poor roads are a public hazard – and we have a responsibility to fix them”.

- President Barack Obama (March 3, 2009, quoted in *Guiding Principles for the Nation’s Critical Infrastructure*)

PROSPECTS

Public / Media Interest



The screenshot shows the History.com website interface. At the top left is the History.com logo, a large gold 'H' with 'HISTORY.COM.' below it. To the right of the logo is the tagline 'HISTORY MADE EVERY DAY™'. Below the logo and tagline is a navigation menu with the following items: HOME, TV SHOWS, VIDEO, THIS DAY IN HISTORY, and TOPICS. The main content area features a large red and black graphic with a gold 'H' and the word 'HISTORY' in white. To the right of this graphic is a 'SCHEDULE' section with the following text: 'Tuesday, July 07 08:00 AM', 'Tuesday, July 07 02:00 PM', and a link 'Search for other upcoming episodes'. Below the schedule is an 'RSS' link and the text 'RSS What is RSS?'.

PROSPECTS

“We are continually faced by great opportunities brilliantly disguised as insoluble problems”

- Lee Iacocca

ASCE INITIATIVES

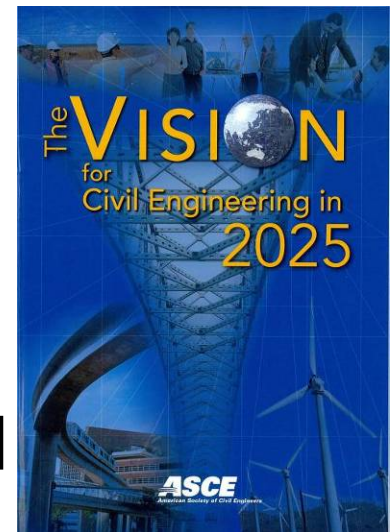


- ✦ **The world is changing**
 - ‘not your father’s engineering profession’
- ✦ **Summit on the Future of Civil Engineering – 2025 (June 2006)**
 - Aspirational vision for civil engineering

VISION 2025

Entrusted by society to create a sustainable world and enhance the global quality of life, civil engineers serve competently, collaboratively, and ethically as:

- **Master builders,**
- **Environmental stewards,**
- **Innovators and integrators,**
- **Managers of risk and uncertainty , and**
- **Leaders in shaping public policy.**



VISION 2025

✦ Components of the Vision that apply directly:

– Sustainability

- includes longer service life, survivability, resilience

– Stewardship over the natural environment

- hazards inherent in earthquakes relate to natural slopes and foundation conditions altered by our civil works

– Innovation in all aspects of our practice

- Implement new methods, techniques, materials, and practices

VISION 2025

You cannot solve a problem with the same sort of thinking that created the problem

- Albert Einstein

VISION 2025

✦ Components of the Vision that apply directly:

– Risk assessment and management

- Haven't been quantified nor communicated to the project owners or the impacted public - must have a fundamental shift in this approach

– Key decisions are non-technical

- imperative that we get involved in the policy discussions and influence priorities

VISION 2025

“The big questions of what to do next are not technical, or only partly technical, they are primary political”

– Samuel Florman, *The Existential Pleasures of Engineering*

VISION 2025

- ✦ *Achieving the Vision for Civil Engineering in 2025: A Roadmap for the Profession*
 - focused outcome statements and lists of tactics

VISION 2025



Selected Tactics:

- **Develop and promulgate guidelines and tools that enable the civil engineering profession to integrate sustainable and resilient design into its work.**
- **Encourage the discussion of failures in the built and natural environment and promote research initiatives emanating from those failures.**
- **Develop innovative approaches, tools, techniques, materials, policies, and business relationships to mitigate the occurrence and effects of both natural and man-made disasters and their associated risks and uncertainties.**
- **Effectively communicate risks and mitigation options to project colleagues, clients, regulatory agencies, and the public.**
- **Embed risk assessment and risk management methodologies as a core knowledge and skill for civil engineers throughout their education and practice.**

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Five Key Solutions

FIVE KEY SOLUTIONS

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INFRASTRUCTURE

1. **Increase federal leadership** in infrastructure to address the crisis;
2. **Promote sustainability and resilience** in infrastructure to protect the natural environment and **withstand natural and man-made hazards**;
3. **Develop national, state, and regional infrastructure plans** that complement a national vision and focus on **system-wide** results;
4. **Address life-cycle costs** and ongoing maintenance to meet the needs of current and future users; and
5. **Increase and improve infrastructure investment** from all stakeholders.

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CRITICAL INFRASTRUCTURE

- ✦ **Critical Infrastructure Guidance Task Committee**
 - **Critical Infrastructure Summit**
 - *Guiding Principles for the Nation's Critical Infrastructure*

CRITICAL INFRASTRUCTURE

“Facilities and assets so vital that their destruction or incapacitation would disrupt the security, economy, safety, health, or welfare of the public.”

CRITICAL INFRASTRUCTURE

✦ Overarching Principle:

- “Engineers shall hold paramount the safety, health, and welfare of the public and shall strive to comply with the principles of sustainable development in the performance of their professional duties “

- First Fundamental Canon, ASCE Code of Ethics

CRITICAL INFRASTRUCTURE

✦ Four Guiding Principles:

- Quantify, communicate, and manage risk;
- Employ an integrated systems approach;

CRITICAL INFRASTRUCTURE

The hurricane protection system in New Orleans was a complex assemblage of levees, walls, pumps and gates that were a system in name only. "It was not designed as a system, nor operated as one."

- Hurricane Katrina External Review Panel

We must "cease being an industry that focuses on short-term solutions and a single-project perspective",

- Trends Affecting the Geo-community – GeoInstitute and GeoCouncil

CRITICAL INFRASTRUCTURE

✦ Four Guiding Principles:

- Quantify, communicate, and manage risk;
- Employ an integrated systems approach;
- Exercise sound leadership, management, and stewardship in decision-making processes;
- Adapt critical infrastructure in response to dynamic conditions and practice.

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2025**

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CARD**

Key Themes:

- Risk Assessment, Management, Communication
- Systems-based planning and operations
- Innovation and dynamic condition assessment
- Leadership and Public Policy

WHAT SHOULD WE DO?

- ✦ **Develop and improve guidelines incorporating hazard mitigation into design & management processes**
 - Risk assessment, management, communication
 - Become familiar with Key Solutions & Guiding Principles
 - Academic – Practitioner cooperation
- ✦ **Think and act “systems”**
 - Client / public coordination

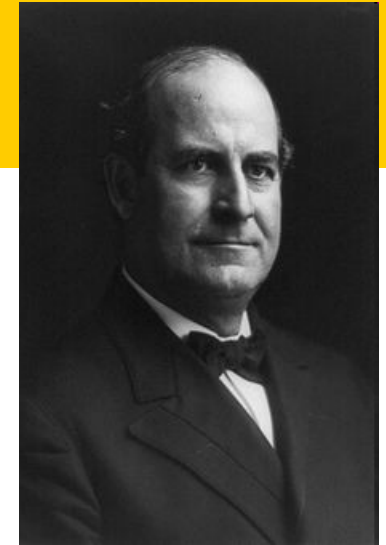
WHAT SHOULD WE DO?

- ✦ **Innovation and dynamic condition assessment**
 - Encourage implementation & creativity
 - Academic – Practitioner cooperation
 - Build adaptive management into systems
- ✦ **Get involved in policy development**

WINDOW OF OPPORTUNITY



**There is a tide in the affairs of men
Which, taken at the flood leads on to fortune;
Omitted, all the voyage of their life
Is bound in shallows and in miseries.
On such a full sea are we now afloat;
And we must take the current when it serves,
Or lose our ventures.**



“Destiny is not a matter of chance; it is a matter of choice.”

-- Statesman William Jennings Bryan