Framing the Issue

- You feel sick and schedule a doctor visit.
- You can’t talk to your doctor (bridges don’t speak).
- Your doctor uses a blood pressure cuff, reflex hammer and tongue depressor.
- Your doctor then concludes you need emergency surgery.
- Then why accept a rudimentary condition assessment protocol for infrastructure when more precise technology is readily available?
Advanced Condition Assessment Technologies (ACAT): A suite of commercial condition assessment technologies used to more accurately define current asset condition; e.g. structural health monitoring.

Bridge Management: Protocols and decision processes used to assess, maintain, rehabilitate, or replace bridges.

Asset Management (AM): A modern framework required by MAP-21 to more effectively deploy limited financial resources; Congress requires all DOTs to have AM plans that are data-driven and risk-adjusted.

National Bridge Inspection Standards (NBIS): A visual inspection protocol in place for >40 years to assess bridge condition.
Bridge Management History

- Silver Bridge – West Virginia
- Collapsed 12/15/67
- Heavy traffic loads; cold.
- 46 killed; 9 injured.
- Federal Legislation enacted.
- Visual inspection of every US bridge (>20 ft.) every 2 years.
- **National Bridge Inspection Standards** – NBIS.
So What is NBIS?

- Initiated in 1972 by FHWA.
- All State DOTs staff-up inspection teams – “Bob and Rob”.
- ~3 weeks of training + refreshers.
- Tools are hammers, clipboards, chains, steel rules, pencils, cameras, eyes.
- Major bridge components rated 0-9.
- “Bob and Rob” do OK for about 30 years until FHWA studies the protocol.
- FHWA learns that “Bob and Rob” are not all that precise.
- “Bob and Rob’s” imprecision prompts questions about sole reliance on this protocol to make complex decisions.
How Accurate Is NBIS?

- Visual condition ratings varied by +/- 2 states from the mean in a 2000 FHWA study. (1)
- “This methodology is highly subjective and produces variable results.” (2)
- “Visual inspection also does not capture hidden deterioration or damage.” (3)

Is this protocol adequate to make complex investment decisions?

2. Condition Assessment of Highway Structures, Past, Present and Future; TR Circular E-C104
3. IBID
OK, I’m confused......

- “Bob and Rob” provide the raw data to determine how much we need to spend.
- “Bob and Rob” don’t provide very accurate data, according to FHWA and practitioners.
- Interest groups and the press cite “Bob and Rob’s” results to explain funding needs.
- Lawmakers are not willing to raise taxes on gasoline or diesel fuel.
- RARELY do State DOTs take the extra step to use ACAT to precisely determine condition.
- So, our infrastructure problem gets worse every day and nobody wants to pay for it.
- Can somebody help me solve this problem?
Unintended Consequences

— FUNDING:
  • Inflated funding need for bridge rehab and replacement.
  • Taxpayers are then stuck with essentially no alternatives.

— MANAGEMENT:
  • Long-range planning, prioritizing and minimizing costs are difficult.
  • Risk management is reduced to guesstimating.

— ECONOMIC DEVELOPMENT:
  • Unnecessary load limitations and long detours for trucks.

“The actual performance of most bridges is more favorable than conventional theory dictates.” AASHTO MBE, Paragraph 8.2.1.
Challenges That Up the Ante

- Federal bridge funding probably limited for decades.
- Local owners (States, Cities, Counties) also have less funding.
- Owners facing a prolonged “do more with less” environment.
- Knowledge “walking out the door” with boomer retirements.
- AASHTO and FHWA remain near-silent on ACAT technologies.
- MAP-21 requires State DOT Asset Management (AM) Plans.
  - Bridge management now more complex.
  - Owners must optimize limited spending.
  - Owners must quantify and manage system risk.
  - Owners must avoid political prioritization of projects.
Asset Management

Catalog Assets
- What?
- Where?

Asset Condition Assessment
- Macro: “Visual”
- Micro: “Sensors”
  - Data-Driven

Manage Asset Performance
- Structural Analysis
- Life-Cycle Costs
  - Risk-Adjusted
  - Optimized

20th Century ↔ 21st Century
How Much Funding is Needed?

- **ASCE:**
  - For all infrastructure by 2020: $3.6 Trillion
  - For deficient bridges by 2020: $76 Billion

- **T4America:**
  - $30 billion per year
  - $0.17/gallon increased fuel tax

- **FHWA:**
  - Bridge investment backlog: $121 billion
  - $12.8 billion spent annually now; $20.8 billion needed

- **States with largest spending “need”:**
  - #1 - NY with $9B; #2 Penn with $7B; #3 California with $6B

Did somebody forget I have to pay for this?
The Key Policy Question

Should we continue to rely solely on subjective data to support a presumed need for substantially increased infrastructure renewal spending – OR... take every judicious step to reduce infrastructure renewal spending and tax increases?
Example Projects
Safely Deferring Replacement

- **Problem:** City can’t afford to replace 15 load-rated short-span bridges.
- **Customer:** Major City in Southwest
- **Project date:** 2008
- **Objectives:**
  - Conduct initial load test.
  - Stiffen bridge with CFRP wrap.
  - Verify repair using SHM technology.
- **Results:**
  - SHM proved repair worked as intended.
- **Conclusion:**
  - City spends $1 million, then in <18 months saves $3 million versus replacement costs on just one bridge.
Safely Deferring Replacement

- **Problem**: Replacement funds uncertain; need to verify structural adequacy.
- **Owner**: Class I Freight Railroad
- **Project date**: 2012-Ongoing
- **Objectives**:
  - Monitor in-service truss stresses.
  - Monitor substructure displacements.
- **Results**:
  - Highly stressed, but safe to use.
- **Conclusion**:
  - RR spends $500K; analysis supports safe deferral of $75 million bridge replacement.
  - Deferral value >$300,000 per month @ 5%
Problem: Is the third party recommended repair program necessary?

Customer: Northeastern Toll Road

Project date: 2005

Objectives:
- Monitor key tensile and compressive strains.
- Calibrate a finite element model to analyze current condition and recommended repair program.

Results:
- Recommended safe deferral of $875,000 steel repair program.

Conclusion:
- Owner spends $150,000; analysis supports net savings of $725,000 in <18 months.
Safely Deferring Repair

- **Problem**: Will severe corrosion require an expensive structural repair program?
- **Owner**: Southeastern DOT
- **Project date**: 2009
- **Objectives**:
  - Monitor key locations for strain and temperature.
  - DOT monitored strains so they would not exceed certain maximum values.
- **Results**:
  - Bridge safely handled truck traffic.
  - Overweight vehicles identified and stopped.
- **Conclusion**:
  - **Owner** spends $125,000 and saved $700,000 by monitoring vs. repair.
• **Problem:** Deck framing reaching end of life; unexpected steel cracking.

• **Owner:** Upper Midwest Toll Bridge

• **Project date:** 2012-Ongoing

• **Objectives:**
  • Measure displacements at as-designed locations and proposed repairs.
  • Monitor for several months to confirm repairs worked as expected.

• **Results:** Repair method worked as intended.

• **Conclusion:**
  • Owner spends $75,000; analysis supports safe deferral of ~$25,000,000 repair program.
  • Deferral value >$100,000 per month @ 5%.
Load Rating; Deferred Repair

- **Problem**: Truss bridge does not load rate from visual inspection; repair estimated at $2 million.
- **Owner**: Regional Railroad
- **Project Date**: 2014
- **Objectives**:
  - Evaluate stress in load bearing members.
  - Rate for intended load and speed.
- **Results**: Bridge rates; no repair needed.
- **Conclusion**:
  - Owner spends <$100,000 to get proper load rating; avoids $2 million dollar repair project in <2 months.
The Commissioner Can’t Sleep

- State residents want the bridge problem solved.
- The simple solution (>>>taxes) isn’t acceptable.
- DOT staff is non-committal on using better technology.
- Technology providers keep telling you they can help your state reduce funding demand.
- Economic development is hampered, e.g. detours.
- The press and Governor are hounding you weekly.
- Liability is a concern you don’t want to ponder.
- **So, Mr. or Ms. Commissioner, what’s the answer?**
The Answer is Simple

- Continue improving NBIS protocol.
- But, when major bridge systems are rated 5 or below, evaluate use of ACAT if an ROI is probable.
- Use ACAT generated information to:
  - Safely Extend Asset Life™
  - Repair vs. replace
  - Drive lower life cycle costs
  - Conduct a credible risk analysis
  - Prioritize investments
  - Enhance user safety
  - Remove unnecessary load postings

- The ACAT industry offers proven, commercial, cost-saving solutions!!
When to Use Technology

- When the owner needs options due to funding constraints.
- NBIS says global superstructure condition is problematic:
  - Significant section loss
  - Visible cracking
  - Out-of-plane bending
- Scour critical conditions.
- When repair estimates exceed $300,000.
- When replacement estimates exceed $2 million dollars.
When to Use Technology

• To optimize an Asset Management program:
  – Data-driven
  – Risk-adjusted
  – Objective prioritization
• For more realistic load ratings.
• To monitor known defects.
• To monitor heavy truck permit crossings and confirm damage for insurance recovery.
• Probabilities for SHM success:
  – Improved load rating >50%
  – Safe project deferral >40%
Rx to Consider for NY Bridges

- For 2,200 structurally deficient bridges:
  - Prioritize SD bridges by risk and economic impact.
  - Judiciously deploy ACAT when expected ROI is probable.
  - Re-adjust investment priorities based on ACAT results.
  - Monitor known defects to defer replacement, consistent with user risk.

- For 2,000 (est.) load restricted bridges:
  - Prioritize posted bridges by criticality (first responder) and economic impact.
  - Implement state-wide load testing program to resolve issue over next 10-15 years.

- For 4,200 functionally obsolete bridges:
  - Prioritize investments according to economic impact.
  - Start these projects ONLY AFTER current system risks are substantially reduced.

Expected Technology Cost: ~$5-7 million per year for ~15 years.
Model DOT Policy Statement

• DOTs Should Consider Adopting this Policy Statement:

- *Whereas,* we believe substantial investment is required for infrastructure renewal, we acknowledge that current condition assessment methods are subjective, highly conservative and can lead to overspending.

- *Whereas,* we will aggressively adopt and judiciously deploy cost-effective condition assessment technologies to reduce the taxpayers financial burden AND enhance user safety at the same time.

- *Whereas,* the replacement of functionally obsolete bridges and/or addition of new capacity will only take place AFTER we have substantially reduced the overall system risk from bridges already in service.

- *Therefore,* we will not ask our taxpayers for more money until we have exhausted all less expensive technical/operational alternatives for infrastructure renewal, consistent with effective risk management.
Take the Easy Path.....OR

I took the one less traveled by; and that has made all the difference.