



## Long-Term Bridge Performance Program

Federal Highway Administration

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Federal Highway Administration

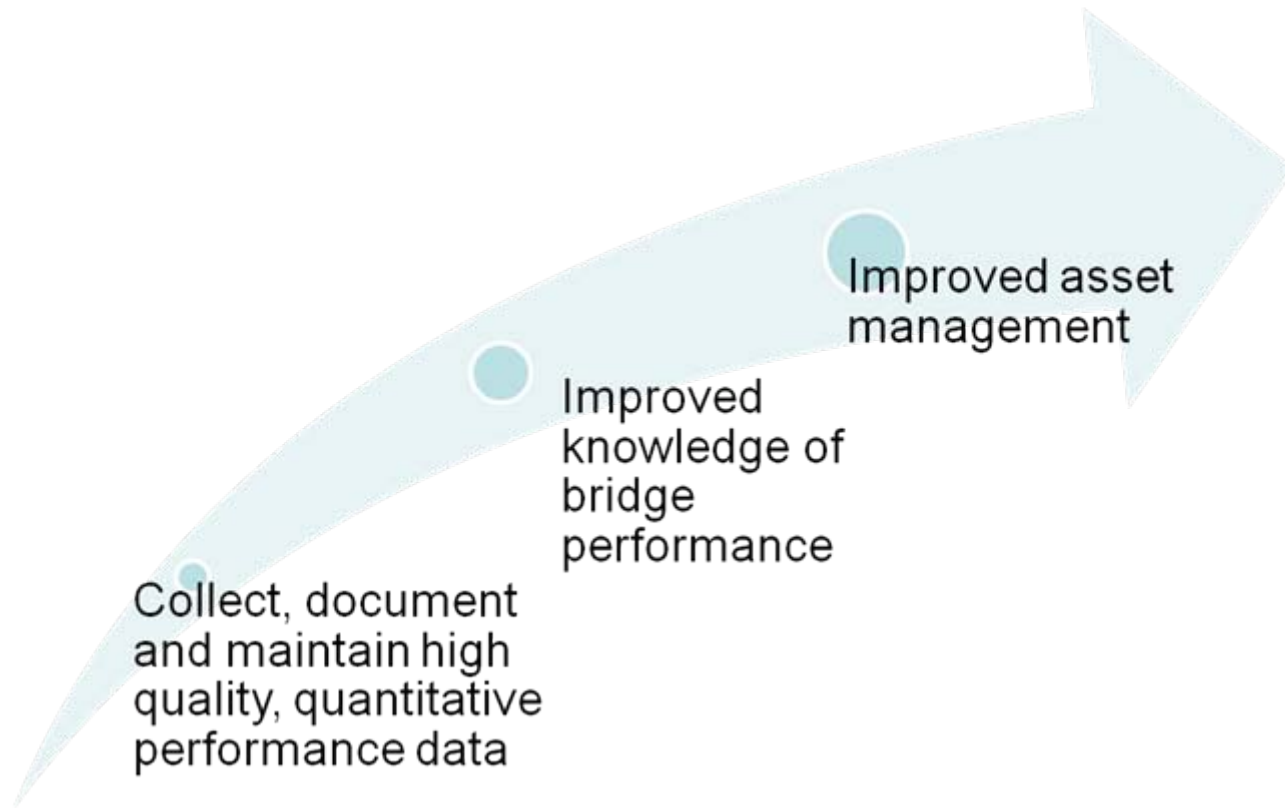
Turner-Fairbank Highway Research Center

McLean, Virginia



## Long-Term Bridge Performance Program

# LTBP Program Objective





# Program Objectives

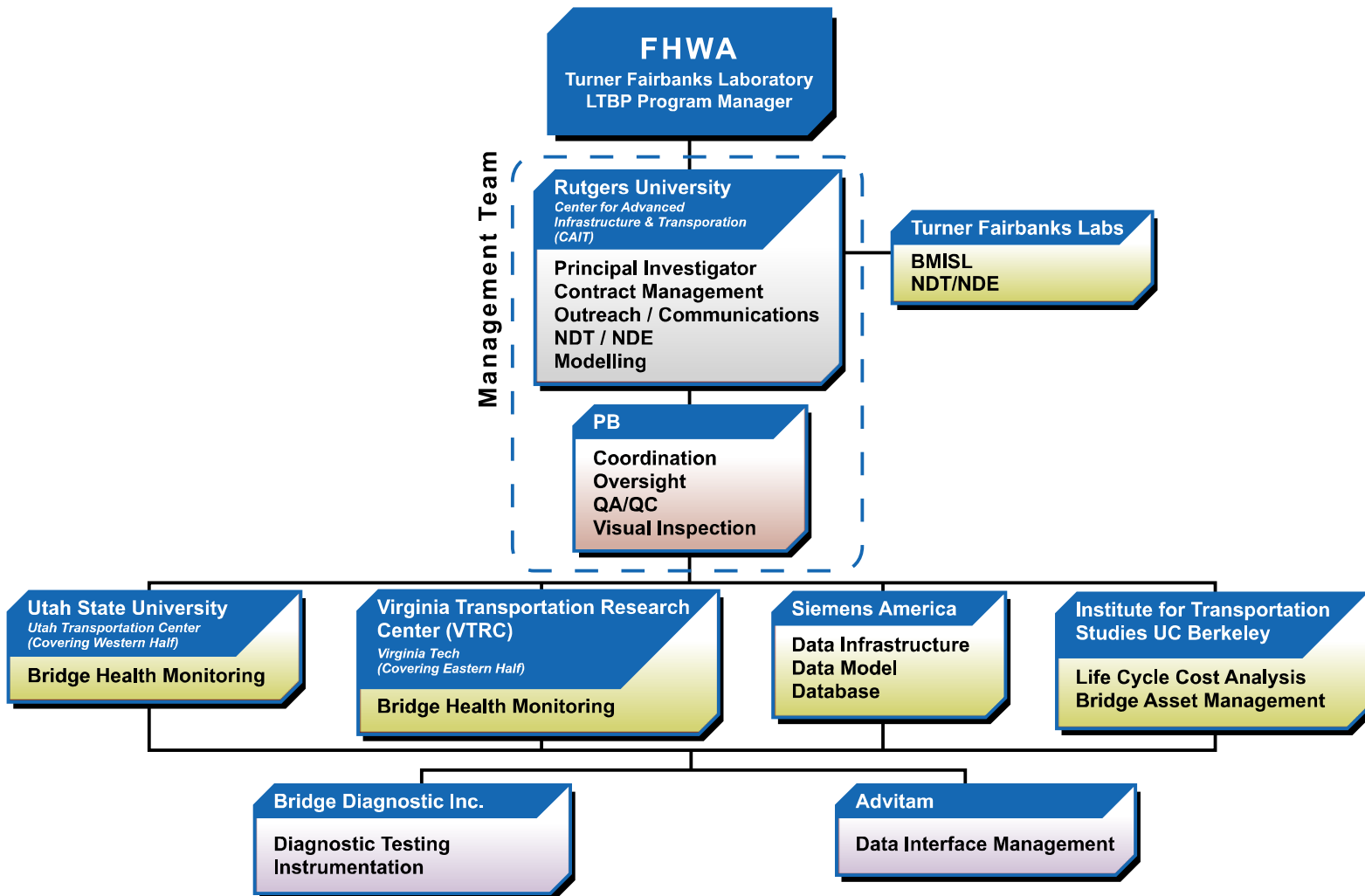
- Over the next five years, LTBP will **inspect, document, evaluate, and periodically monitor** a representative sample of bridges nationwide, taking advantage of advanced condition monitoring technologies in addition to detailed visual inspections.
- The **high-quality data** gathered in the process and the subsequent **data analysis and data mining** aim to significantly enhance our knowledge of bridge performance.



# Program Objectives

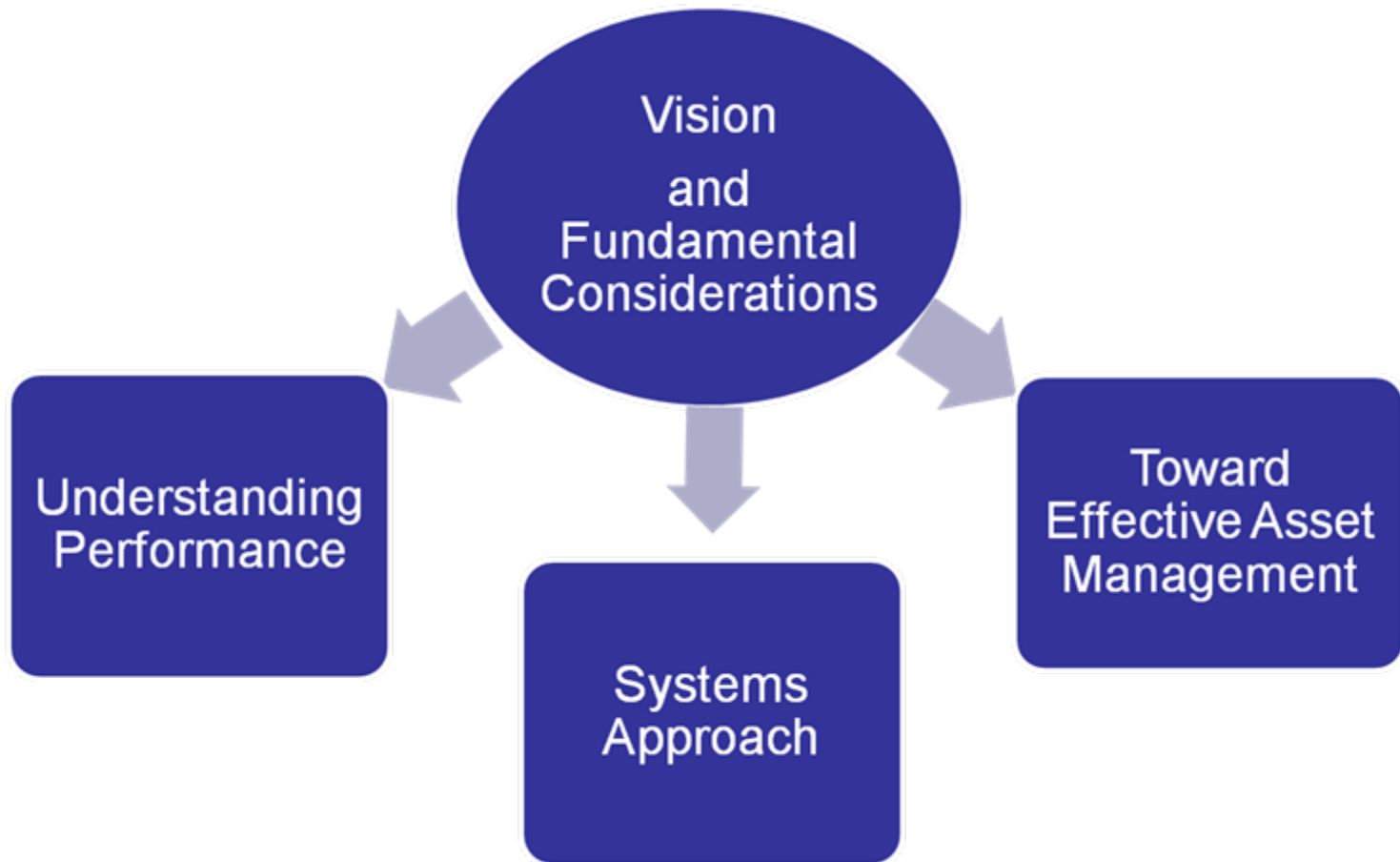
- Among the study's objectives are improved **life-cycle cost and predictive models**, better understanding of **bridge deterioration** and more effective **maintenance and repair strategies**.
- LTBP results should also support improved **design methods and bridge preservation practices** and help develop the next generation of bridges and **bridge management systems**.

# Long-Term Bridge Performance Program



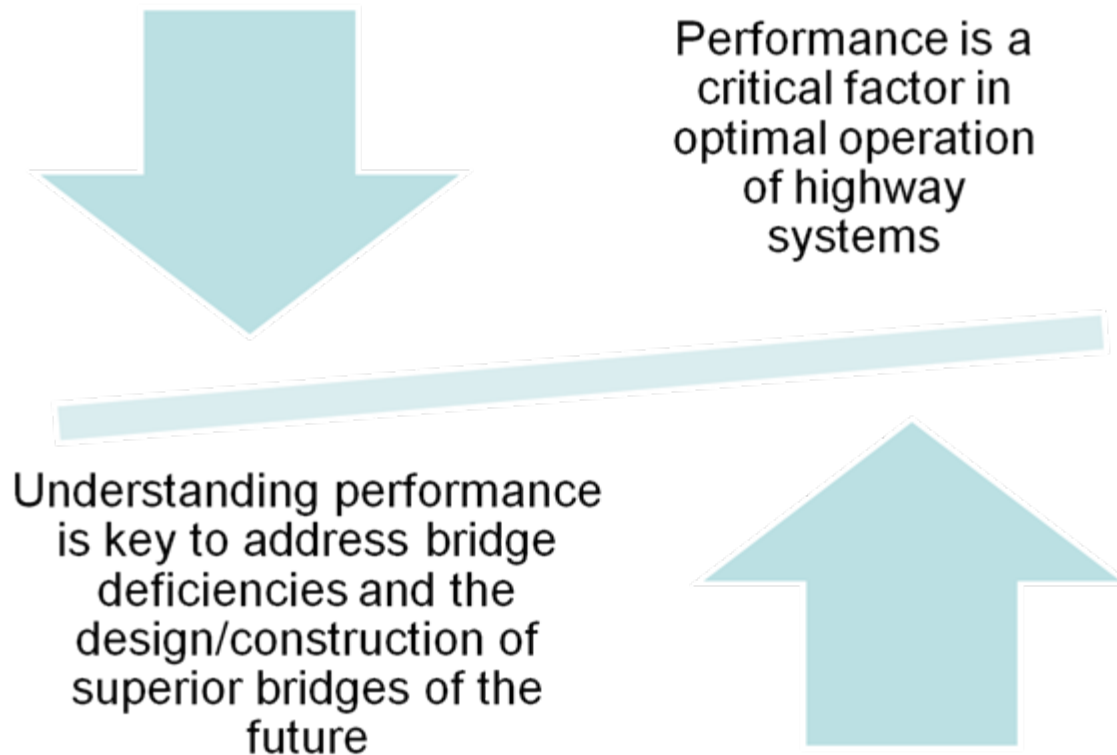


## Long-Term Bridge Performance Program





# Understanding and Evaluating Performance





# Understanding and Evaluating Performance

- **How do we define bridge performance objectively?**
- **Are current measures (sufficiency and condition rating) sufficient to describe performance of critical nodes of a multi-domain system?**
- **Does “health index” account for interactions important to bridge and highway system performance?**
- **What are the critical design, fabrication and construction parameters, loading and behavior mechanisms, operational as well as maintenance practices that have significant impacts on bridge LC performance?**





# Understanding and Evaluating Performance

- **How do we rationally estimate LCC given the complexity of multidomain infrastructure system?**
- **Challenge is to formulate performance in terms of rational, measurable indices that correlate with the performance of the entire system**



## Long-Term Bridge Performance Program

# Goals and Performance Categories

### Structural Condition & Integrity

- Types, Materials and Specifications
- Clearance
- As built material and construction quality
- Traffic loads –trucks
- Environment – climate, air quality and marine atmosphere
- Snow and ice removal operations
- Type, timing and effectiveness of preventive maintenance
- Type, time and effectiveness of restorative maintenance and rehabilitation
- Hydraulic designs and scour mitigation programs
- Soil characteristics and settlement

### Safety of User

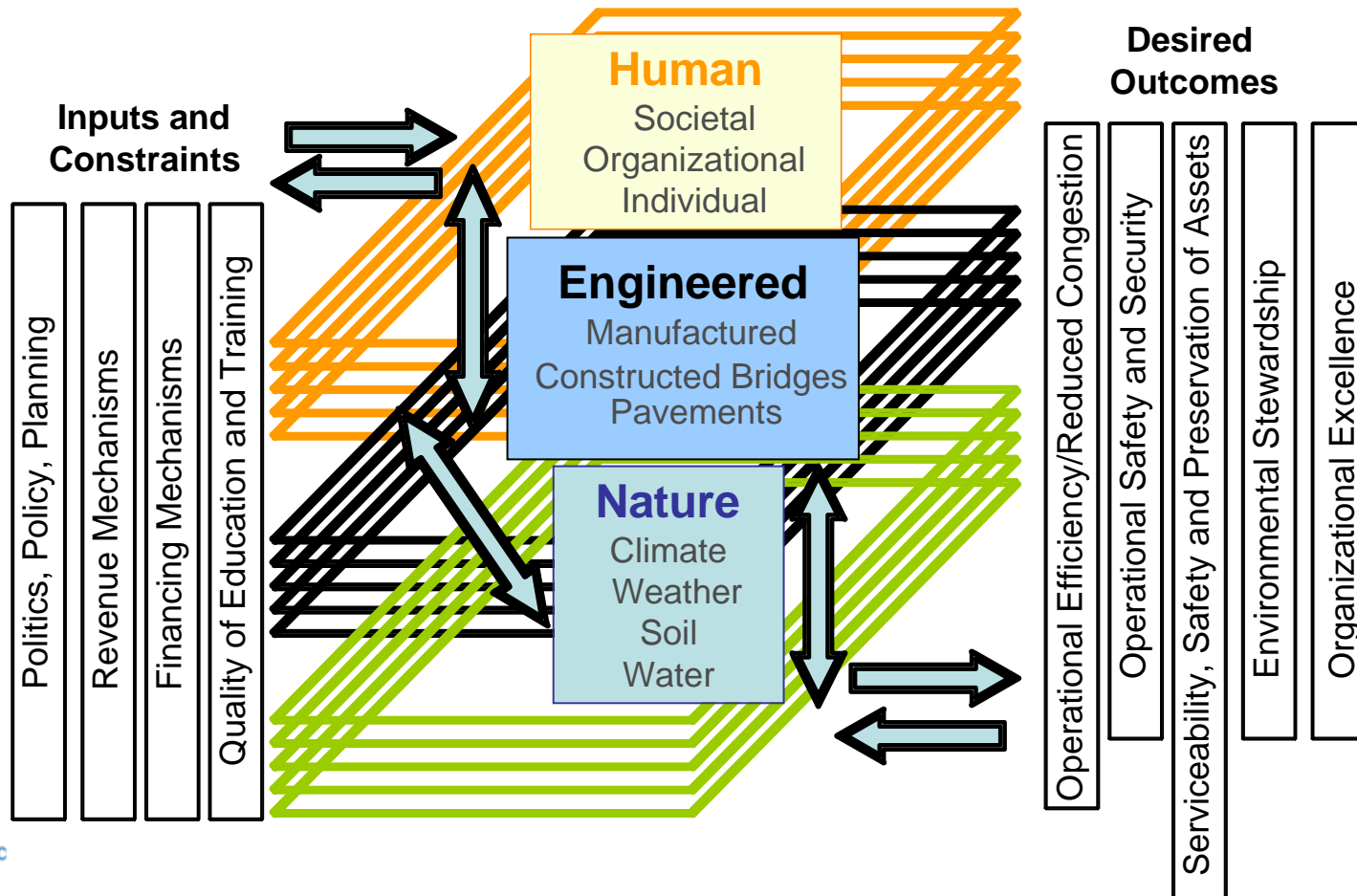
- Structural geometry
- Vertical clearance
- Traffic volume and % trucks
- Posted Speeds

### Cost to User and Agency

- User
  - Accident cost
  - Delay and detour costs to users
- Agency
  - Initial costs
  - Maintenance and rehabilitation costs

## Long-Term Bridge Performance Program

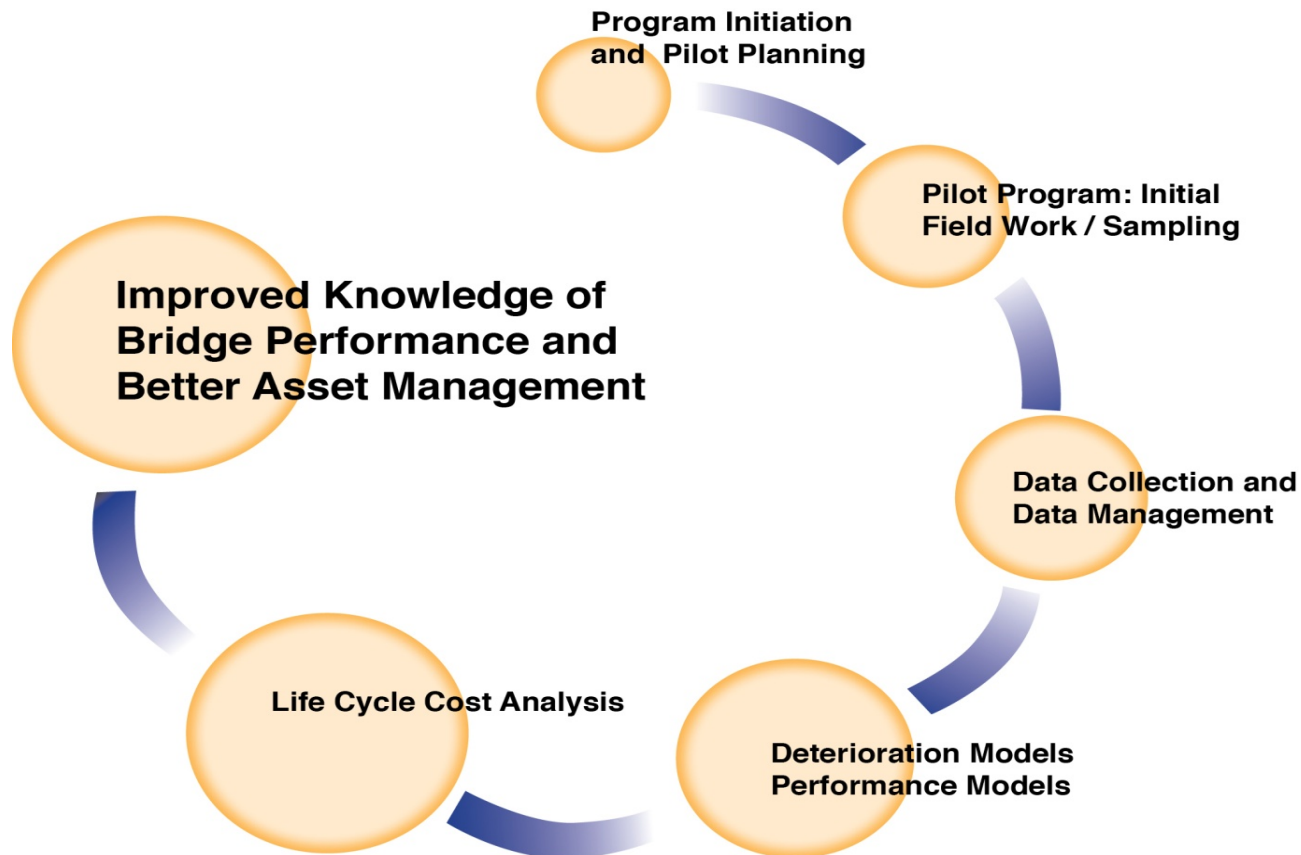
# Highway Transportation as a Multidomain, Multidisciplinary, Layered System-of-Systems





## Long-Term Bridge Performance Program

# Program Approach



# Long-Term Bridge Performance Program

Developmental Phase - 5/08

Completion of Developmental Phase - 11/08

Initiate Pilot Program - 9/08

Complete Long Term Data Collection 08



**TASKS & OBJECTIVE**

- Develop a national consensus that the program is critical for a more efficient nationwide bridge management system
- Review Pilot Program to determine lessons learned and area for improvement
- Develop future Phase Program that is:
  - Manageable
  - Comprehensive
  - Repeatable
  - Achievable
  - Measurable
  - Representative

• Implementation plan for Phase II

## Development and Pilot Phase Tasks

Task Number	Task Description	CAIT	PB	UTC	VTRC	Siemens	Advitam	BDI	Emin Aktan
1.1	Road Map	√	X	√	√	√	√	√	√
1.2	Specific data to be collected	√		√	X		√	√	√
1.3	Development of Data Infrastructure					X	√		√
1.4	Protocols for data sampling, collection and Q/A	√	√		√		X	√	√
1.5	Bridge Sampling Methodology	X	√	√	√				√
1.6	Synthesis of bridge monitoring and autopsy methods			X					√
1.7	Protocols for Bridge Monitoring and autopsy			X	√				√
1.8	Communication/Marketing Plan and Products	X	√	√	√				√
2.1	Project Coordination (for fieldwork)	√	X	√	√		√	√	√
2.2.1	Draft Pilot Study Plan	√	X	√	√	√	√	√	√
2.2.2	Pilot Study Execution	X	X	√	√	√	√	√	√

- X Indicates team member with primary responsibility
- √ Indicates team member that will provide significant contributions to the task



# Developmental Phase Tasks

- **Task 1.1: Road Map**
  - **Understanding**
    - **Guide to the LTBP program**
    - **Basis of early communication and marketing plan**
    - **Identify the range of issues, needs, and desired state-of-practice at the end of the LTBP program.**
  - **Approach**
    - **Review lessons learned from similar projects**
    - **Work closely with advisory board and stakeholders**



# Developmental Phase Tasks

- **Task 1.2: Specific Data to be Collected**
  - **Understanding**
    - **Identify key elements**
    - **Type of data**
    - **Determine what relevant data is available from other sources**
  - **Approach**
    - **Work with SHA**
    - **Bring together experienced bridge inspectors for symposium**





# Developmental Phase Tasks

- **Task 1.3: Development of Data Infrastructure**
  - **Understanding**
    - **Open, scalable, extensible software and data infrastructure**
    - **Incorporate tools and algorithms for:**
      - **Life Cycle Cost Models**
      - **New Data analytical Methods**
    - **Easy to use**
  - **Approach**
    - **Experience from previous projects will be leveraged**
    - **Connection with NBI, NOAA, GIS, etc**



# Developmental Phase Tasks

- **Task 1.4: Protocols for Data Sampling and Collection**
  - **Understanding**
    - **Develop protocols for:**
      - **Inspection**
      - **Instrumentation**
      - **Data Quality Assurance**
    - **Determine quantity and frequency of data collection**
  - **Approach**
    - **Protocols need to be coordinated with the rest of the LTBP team**



# Developmental Phase Tasks

- **Task 1.5: Bridge Sampling**
  - **Understanding**
    - **Develop methodology and rationale for sampling bridges**
    - **Recommend type, number, and location**
    - **Final sample shall support the objectives of LTBP program**
  - **Approach**
    - **Multiobjective constrained optimization problem**
    - **Combined top-down heuristic and bottom-up statistical approach**
    - **Work closely with stakeholders**



# Developmental Phase Tasks

- **Task 1.6: Synthesis of Bridge Monitoring & Autopsy Methods**
  - **Understanding**
    - **Synthesize past work for both short-term and long-term monitoring**
      - **Structural Health Monitoring (SHM)**
      - **NDE/NDE techniques**
    - **Include benefits realized from the application of SHM and Autopsy**
  - **Approach**
    - **Work closely with Turner Fairbanks NDE/NDT Laboratory**
    - **Review published literature**



# Developmental Phase Tasks

- **Task 1.7: Protocols for Bridge Monitoring & Bridge Autopsy**
  - **Understanding**
    - **Develop protocols and standards for monitoring and autopsy**
    - **Document protocols for implementation**
    - **Accommodate a variety of sensors, instrumentation, and NDE/NDT methods**
  - **Approach**
    - **Based on findings of Task 1.6**
    - **Take advantage of existing documents**



# Review of Developmental Phase Tasks

- **Task 1.8: Communication and Marketing Plan**
  - **Understanding**
    - **Develop aggressive communication and marketing plan including:**
      - **LTBP Website**
      - **PowerPoint Presentations**
      - **Briefings**
      - **Program Newsletter**
      - **Workshops**
      - **Conferences**
  - **Approach**
    - **Work closely with FHWA and Stakeholders**
    - **Aggressive outreach**