Virginia Polytechnic Institute and State University
Charles E. Via Jr. Department of Civil Engineering

Welcome and Overview of VTTI Center for Sustainable Transportation Infrastructure

VirginiaTech
Invent the Future

Gerardo W. Flintsch
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Professor of Civil and Environmental Engineering

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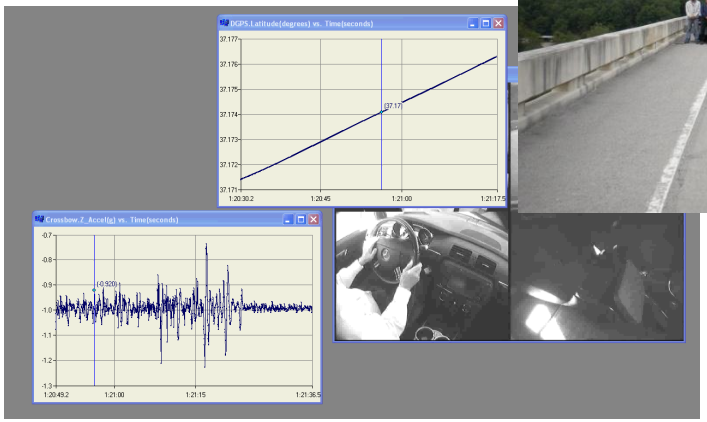
Outline

1. Introduction to CSTI
2. Examples of Past, Current & "Developing" Projects
3. Sustainable Pavements



Part 1 – Introduction

Center for Sustainable Transportation Infrastructure

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VTTI's Mission

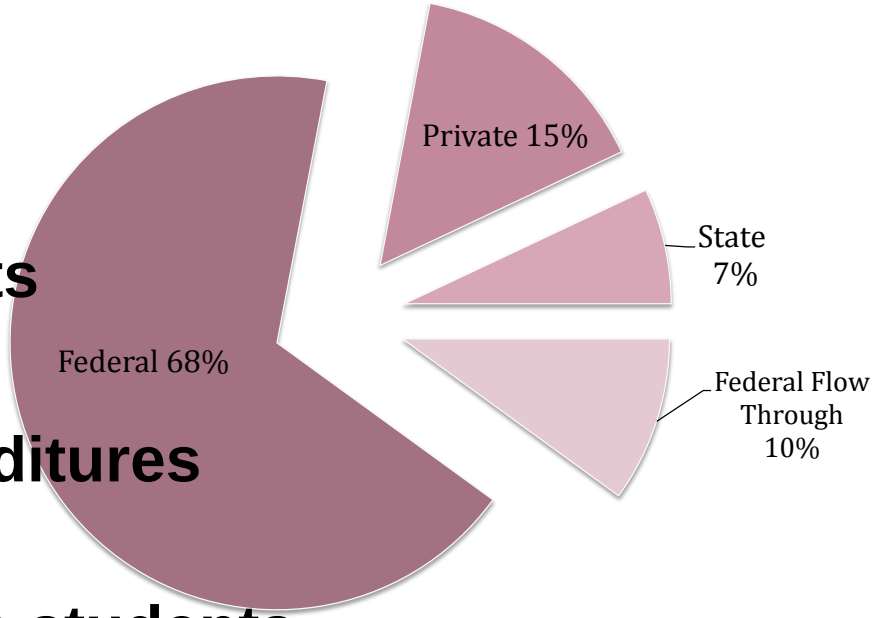
Conduct transportation research with the goal of:

- ***Saving Lives***
- ***Saving Time***
- ***Saving Money***

Second largest transportation institute in the U.S.

VTTI

- ✓ **Established in August 1988 by US DOT as a University Transportation Center**
- ✓ **Largest university-level research center at Virginia Tech**
- ✓ **More than 300 faculty, staff and students**
- ✓ **Working on over 150 projects**
- ✓ **$80 Million Awarded**
- ✓ **$22 Million in Annual Expenditures**
- ✓ **Largest supporter of both undergraduate and graduate students**



VTTI Research Areas

- Human Factors and Safety (naturalistic studies)
- Transportation Technology
- Sustainable Transportation Infrastructure (CSTI)
- Traffic and Mobility
- Injury Biomechanics
- Transportation Policy
- Product Development

Center for Sustainable Transportation Infrastructure

- **Partnership between the Virginia Tech Transportation Institute (VTTI) and the Via Department of Civil and Environmental Engineering (CEE) Transportation Infrastructure and Systems Engineering (TISE) Program**

Looking for solution to the Infrastructure Challenges

CSTI Vision

A worldwide leader in transportation infrastructure research and education

- ✓ **Conduct high-impact research for accelerating the renewal, increasing safety, reducing life-cycle costs, and ensuring sustainability of transportation infrastructure systems**
- ✓ **Be a paradigm of collaboration among governments, academia, and industries**
- ✓ **Provide excellent environment, resources, and instruction for students to learn fundamental concepts, acquire advanced knowledge, and gain practical experience**

Laboratories

- The Virginia Smart Road
- SuperPave binder test equipment
- HMA characterization / performance
  - Dynamic modulus, resilient modulus, creep compliance, fatigue, low temperature and rutting evaluation
  - Mobile Load Simulator (MLS)
- Non-destructive Testing & Sensing Technologies

Virginia Smart Road

Main Research Objectives

- Design and construct pavements with minimum life cycle cost
- Build safe, smooth-riding, silent, and durable pavements
- Provide more accurate assessment of the infrastructure structural health
- Improve investment decisions by providing better asset data & decision-support tools
- Make our transportation infrastructure materials, systems and programs more sustainable

VIRGINIA SUSTAINABLE PAVEMENTS RESEARCH CONSORTIUM

- **Collaboration to advance the state of pavement engineering in the commonwealth, the United States, and the World**
  - **Focus on strategically selected high-impact research projects on pavement materials, performance, design, maintenance and management**
  - **Excellent partnership to pursue national and international funding opportunities**

VA-SPRC – Benefits

- ✓ **Allowed for competing for large-scale national projects**
- ✓ **High ROI / benefit-cost ratio**
  - → **Seed investment of ~$600K** (plus several VDOT-sponsored projects)
  - → **Attracted > $4.2 M since FY07 in external research funding**
  - → **While producing cost-saving, practical, implementable outcomes for VDOT**

Part 2 – Example of Projects
Past, Current & "Developing"

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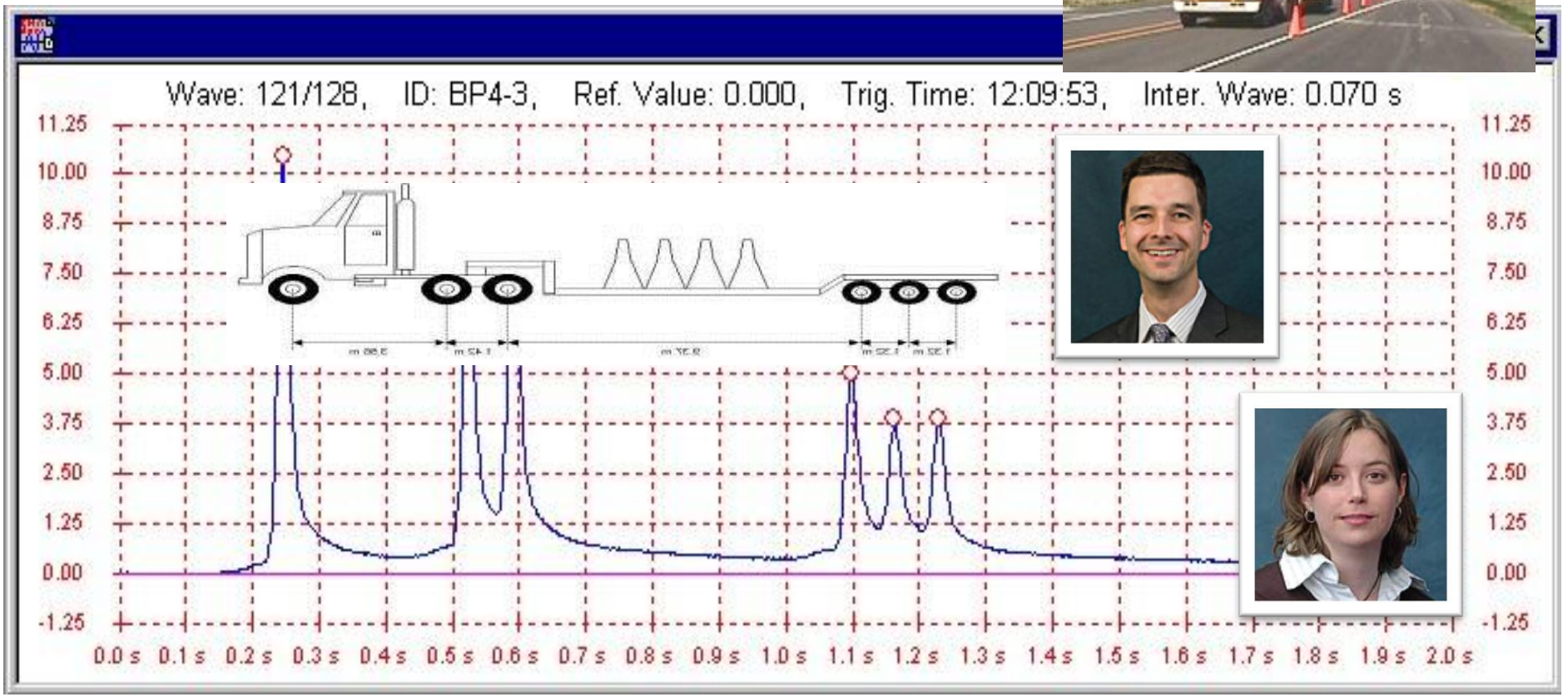
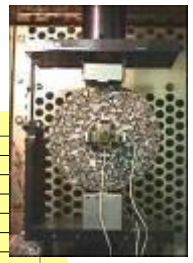
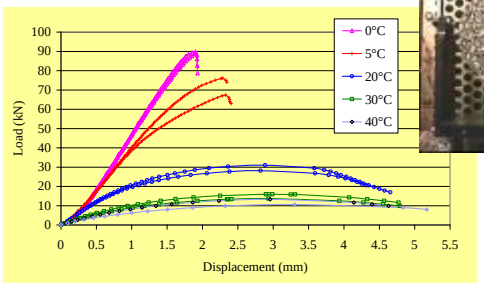
Smart Road Pavement Research
ME Pavement Design

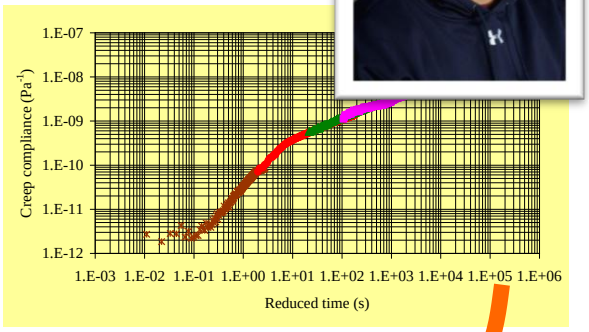


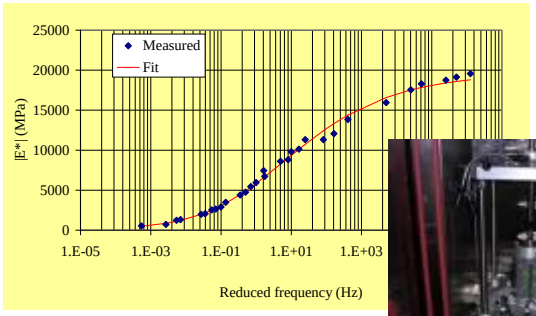
Asphalt Materials Characterization in Support of Implementation of the MEPDG

- **Full hot-mix asphalt (HMA) characterization to support the implementation of mechanistic-empirical pavement design procedures in Virginia.**









Application of Digital Images to measure HMA Uniformity

Center for Sustainable Transportation Infrastructure, VTTI

Virginia Tech Transportation Institute

Pavement Surface Properties Consortium

A Research Program at the Virginia Smart Road

- **$1,5M program *f*ocused on enhancing the level of service provided by the roadway transportation system through optimized pavement surface texture characteristics**

Pavement Surface Properties Consortium – Current Projects

- **Organize annual equipment "rodeos"**
- **Seasonal monitoring**

- **Evaluation of new technologies**
- **Evaluation of high-friction systems**
- **IFI** (International Friction Index) **Implementation**
- **Continuous Friction Measurements Technology Deployment**

- **Development of new technologies**

Example of Evaluation of New Technologies: High-Friction Surfaces

- Identification of Products and Sites
- Construction and Installation Data Collection
  - Constructability and maintainability
- Field Evaluation
  - Friction (DFT & Griptester)
  - Macrotexture (CTMeter)
- Cost / benefit analysis
- **Now approved as low-cost safety counter-measure**

Splash–Spray Assessment Tool Development Program

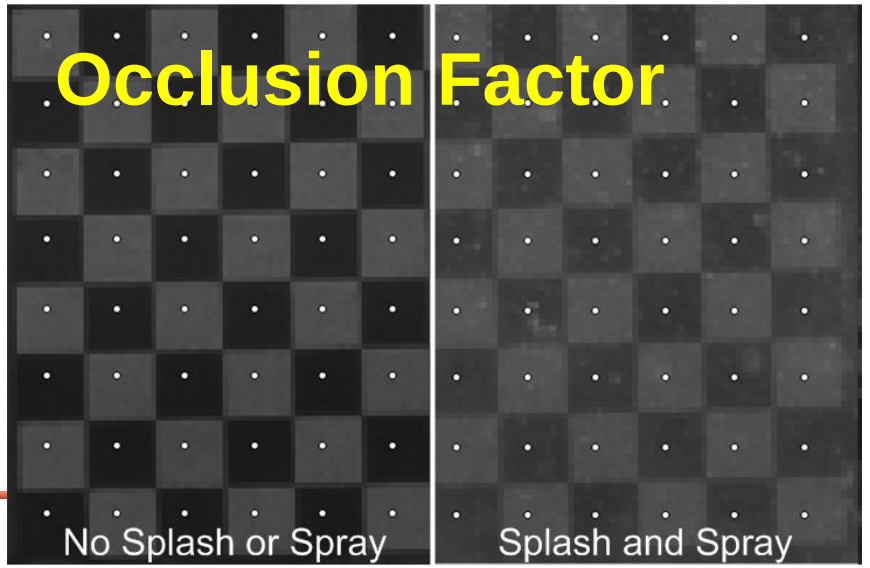
FHWA DTFH61-08-R-00029

Model Development

→ Validation

→ Threshold Criteria

→ Technology Transfer



TRL

NTEC
Nottingham Transportation Engineering Centre

applied pavement TECHNOLOGY

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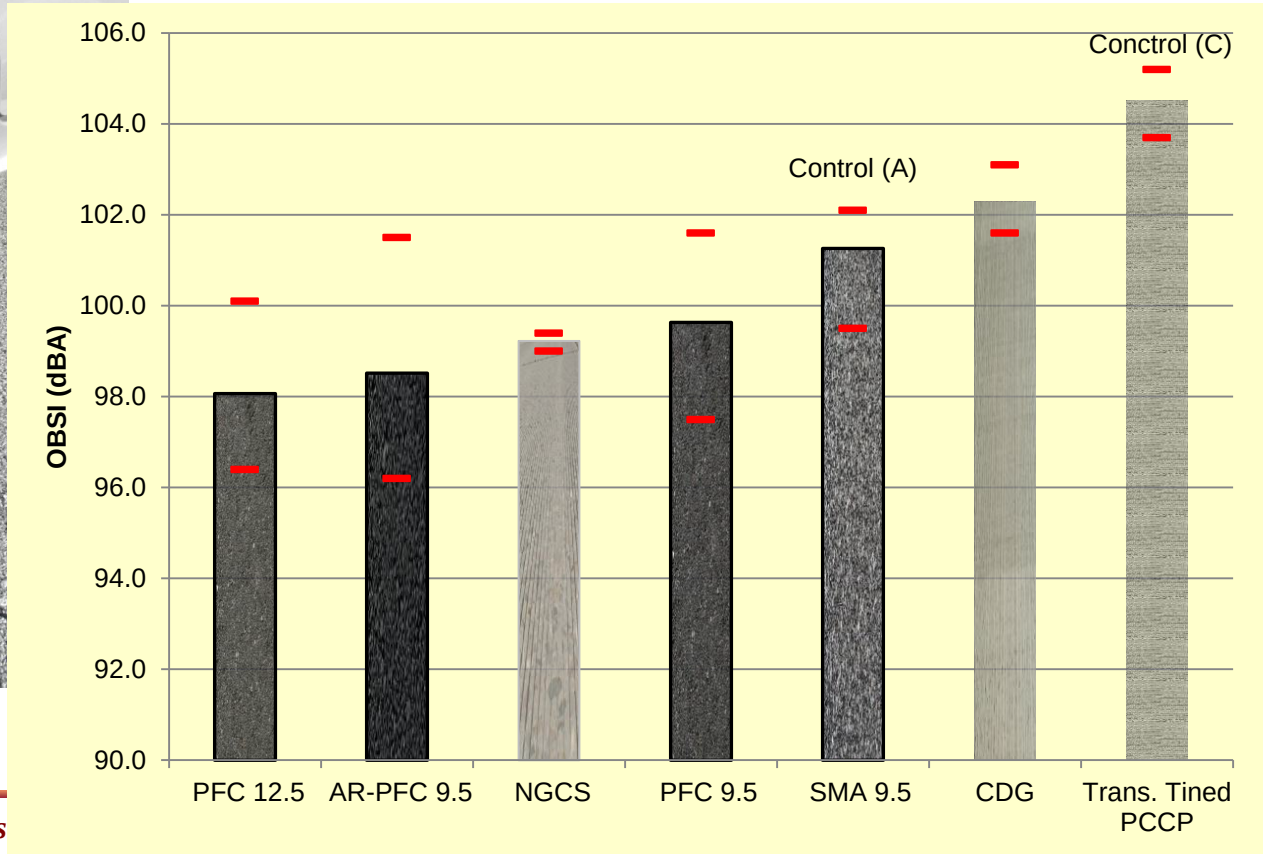
Development and Demonstration of Pavement Friction Management Programs

DTFH61-09-R-00035

Objective:

- **Determine criteria and develop methods, for establishing investigatory (desirable) level and intervention (minimum) levels for friction and macro-texture for different friction demand categories or classes of highway facilities for at least four states.**
- **Assist at least four states in developing PFM Programs.**
- **Demonstrate state-of-the-art friction (and macro-texture) measurement equipment.**

Field Support for VDOT Quiet Pavement Implementation Program



PAVEMENT EVALUATION 2010

October 25–27, 2010

The Hotel Roanoke & Conference Center, Roanoke, Virginia

Virginia Tech Transportation Institute

VTRC Virginia Transportation Research Council

RPUG

TRB

VDOT Virginia Department of Transportation

U.S. Department of Transportation Federal Highway Administration

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Gold Sponsor

Pathway Services Inc.
AUTOMATED ROAD AND PAVEMENT CONDITION SURVEYS

Silver Sponsors

Atwood Systems
IRI and Pavement Reporting Software

Dynatest®

FUGRO

http://www.vtti.vt.edu/conferences/PE_2010.php

WORLD ROAD ASSOCIATION
MONDIALE DE LA ROUTE
1909-2009

Norfolk, VA,

September, 19-21, 2012

7th Symposium on Pavement Surface Characteristics SURF 2012

Smooth, Safe, Quiet, and Sustainable Travel through Innovative Technologies

http://www.vtti.vt.edu/conferences/surf-2012.php

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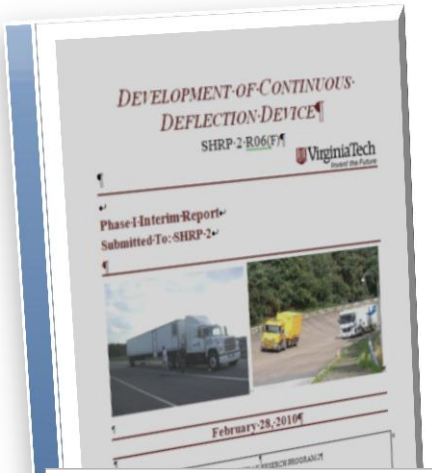
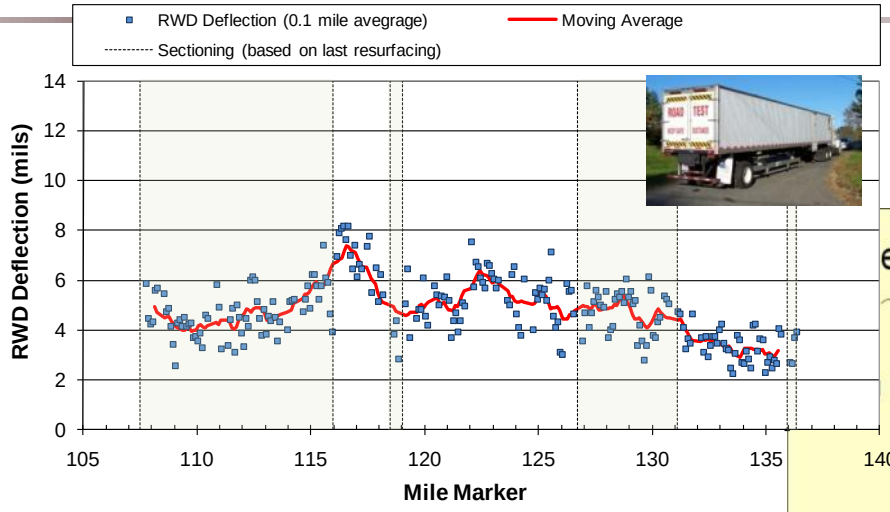
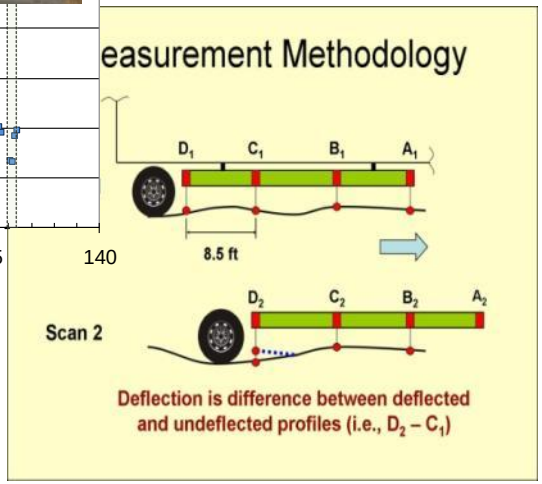
SHRP 2 R06 (F) Development of Continuous Deflection Device

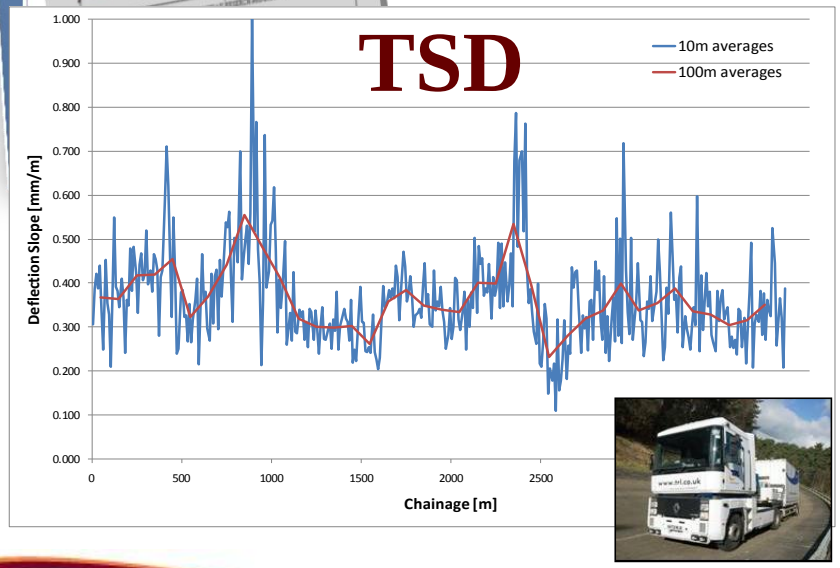


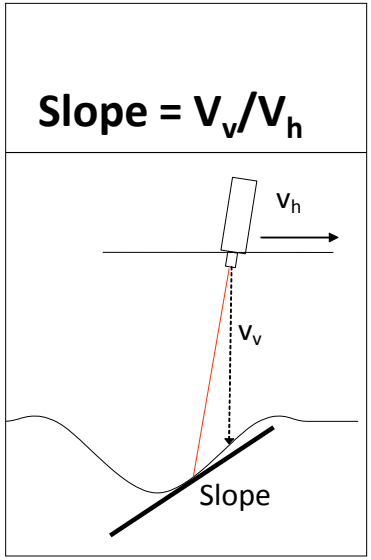
RWD

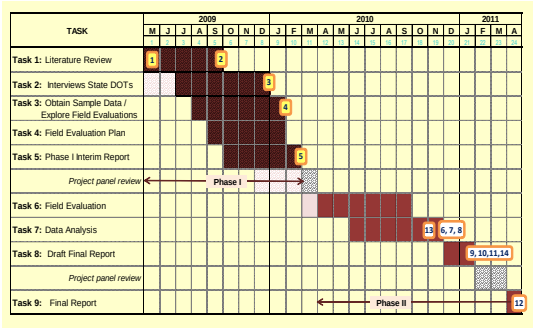




TSD

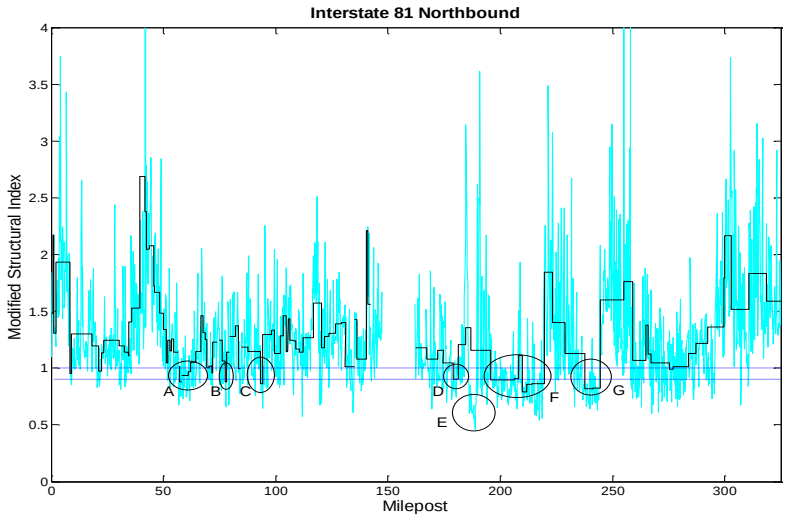




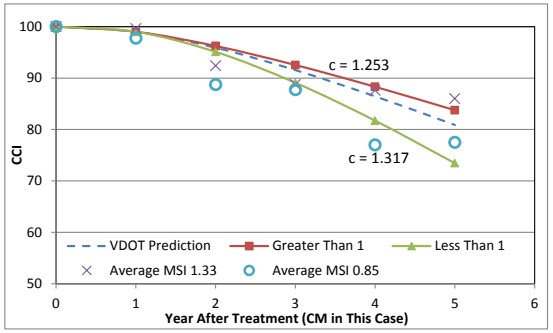


Development of a Network-Level Pavement Structural Capacity Index

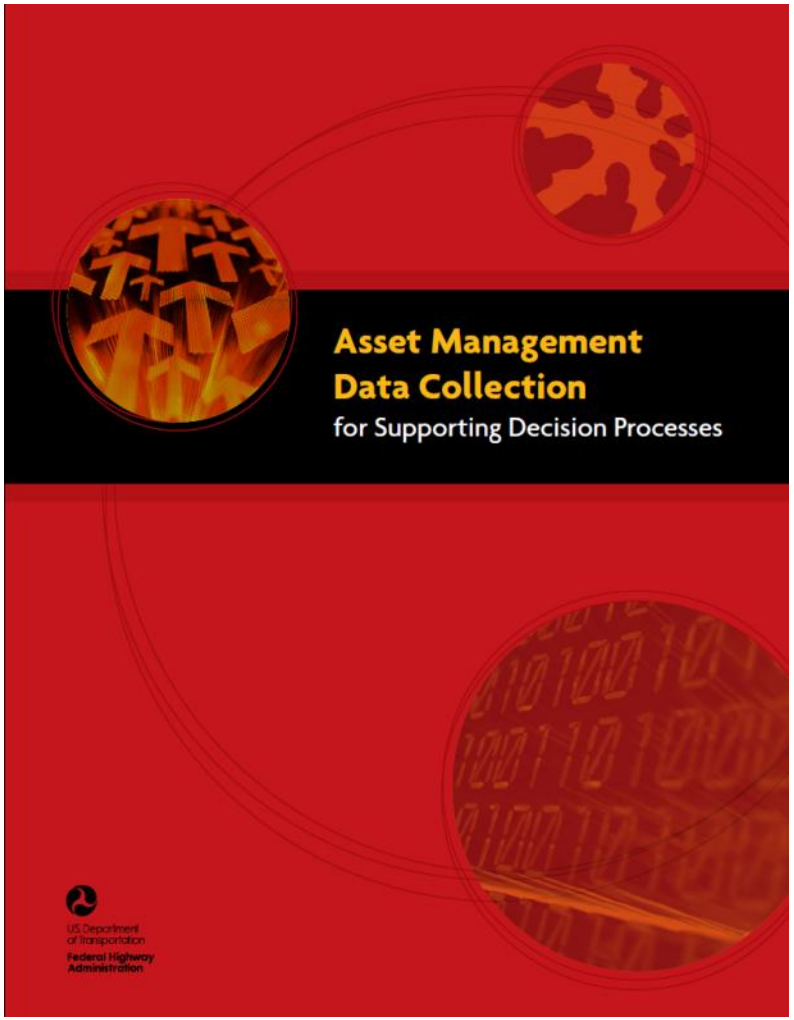
- **Developed tools to analyze pavement structural capacity at the network level**
  1. **Network-level "structural" pavement condition index**
  2. **Framework to specify structural capacity thresholds based on non-destructive evaluation and analysis.**
  3. **Algorithm to scope pavement projects at the network level**



$$CCI(t) = 100 - e^{a-b*c^{LN\left(\frac{1}{T}\right)}}$$



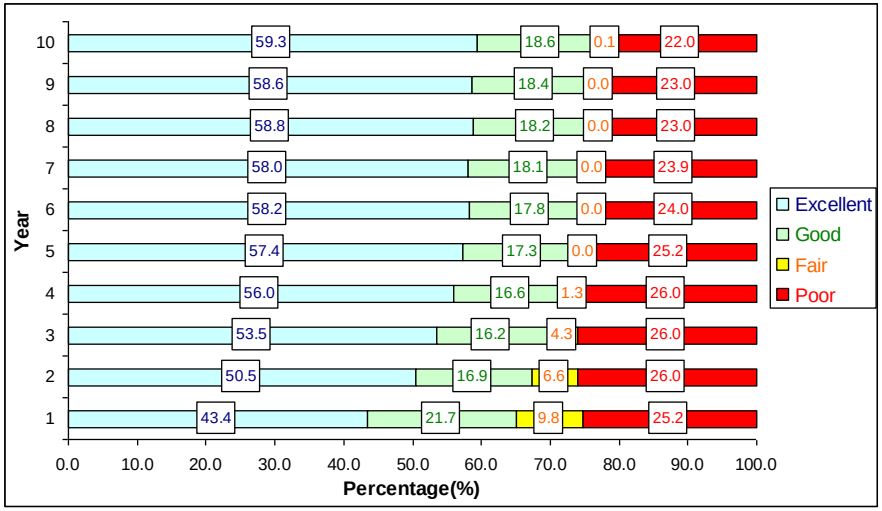
Linking Asset Management Data Collection with Decision Making

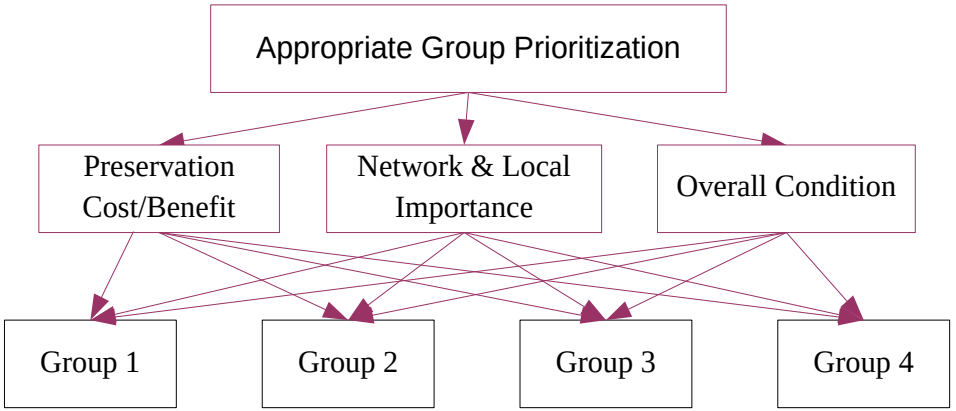


1. Investigate how data collection is linked with decision processes – especially at the Project Selection level
2. Propose a framework for effective and efficient data collection to support Project Selection decision

Multi-criteria Network-Level Optimization Models for Pavement Preservation Programming

- Reflect agency goals & performance targets
- Handle multiple objectives
- Considers probabilistic constraints
- Easy to understand and simple to implement





Outreach/ Service Example: Implementing a Pavement Management System for Christiansburg, VA

- **Worked with municipal engineers to determine pavement condition following the PCI procedure**
- **Implemented a municipal Pavement Management System using MicroPAVER**
- **PMS analysis showed that pavement condition improved with the a preventive maintenance program**

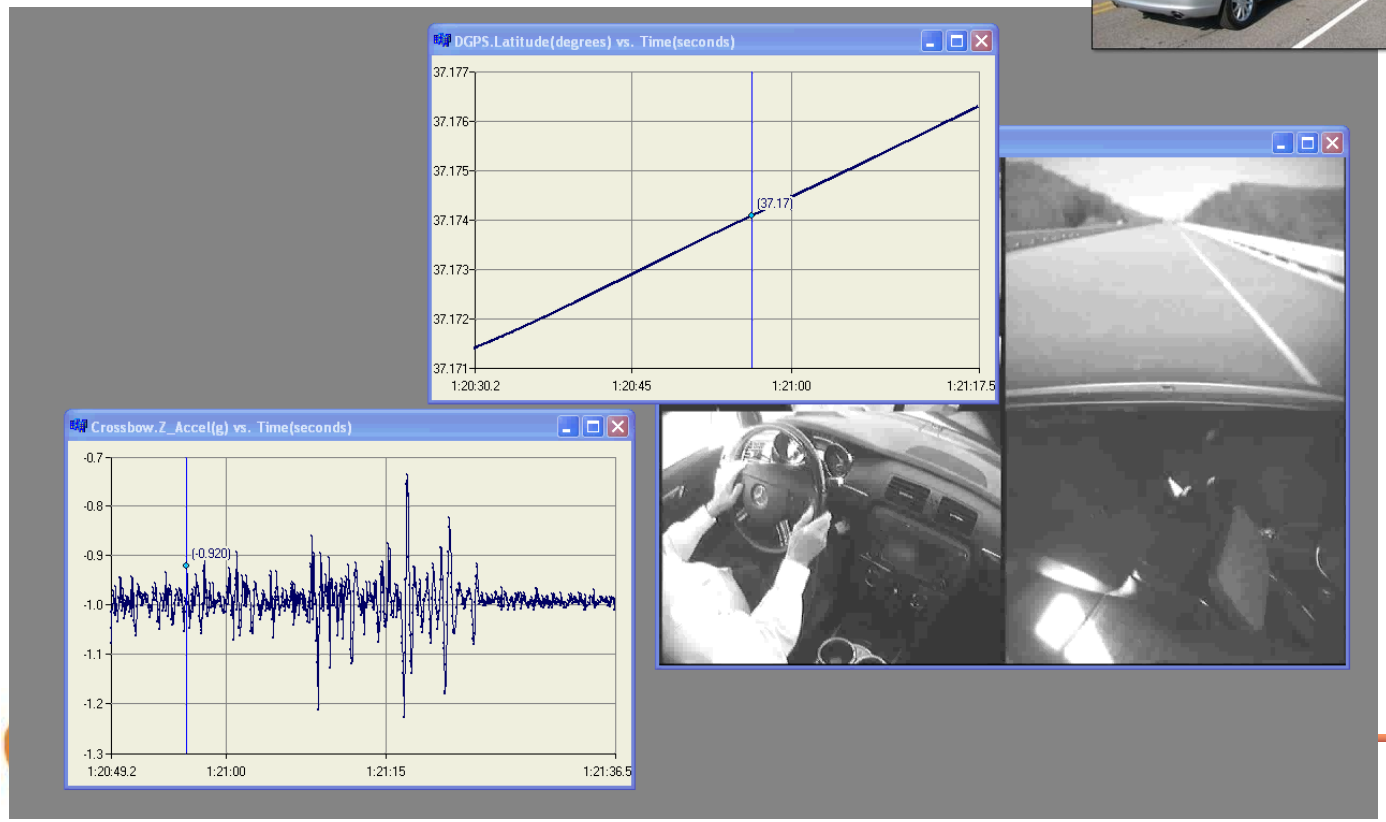
		2012 PCI		2031 PCI	
		Without PM	With PM	Without PM	With PM
Budget	$1,000,000	73	76	55	64
	$750,000	73	76	48	57
	$500,000	72	75	45	49

Developing Area Example 1: **A Sustainable Multi-Objective Cross-asset Infrastructure Management**

- **Objective: To develop a framework for optimizing the decision-making, management, and funding process across several assets considering multiple objectives (sustainability) and constraints**

Developing Area Example 2: Probe Vehicles for Road Infrastructure Health Monitoring

Objective: To use data collected from probe vehicles to extract information that could be used to remotely and continuously determine road infrastructure health



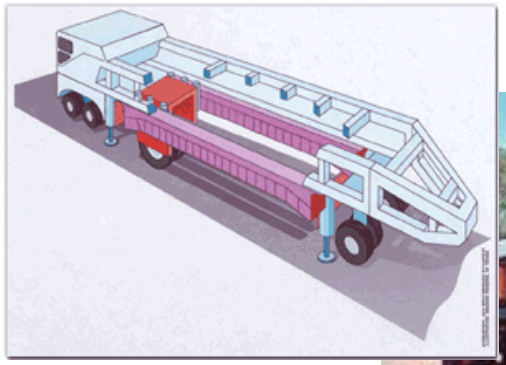
CVI UTC

Pavement Assessment and Management Applications Enabled by the Connected Vehicles Environment – Proof-of-Concept

University of Virginia

Developing Area Example 3: Accelerated Pavement Testing

- **To test new design and concepts before field implementation**
- **Significant quantifiable benefits have been reported by the users**
- Potentially linked with a National Center for Pavement Recycling and Reclaiming



Part 3 – Sustainable Pavements

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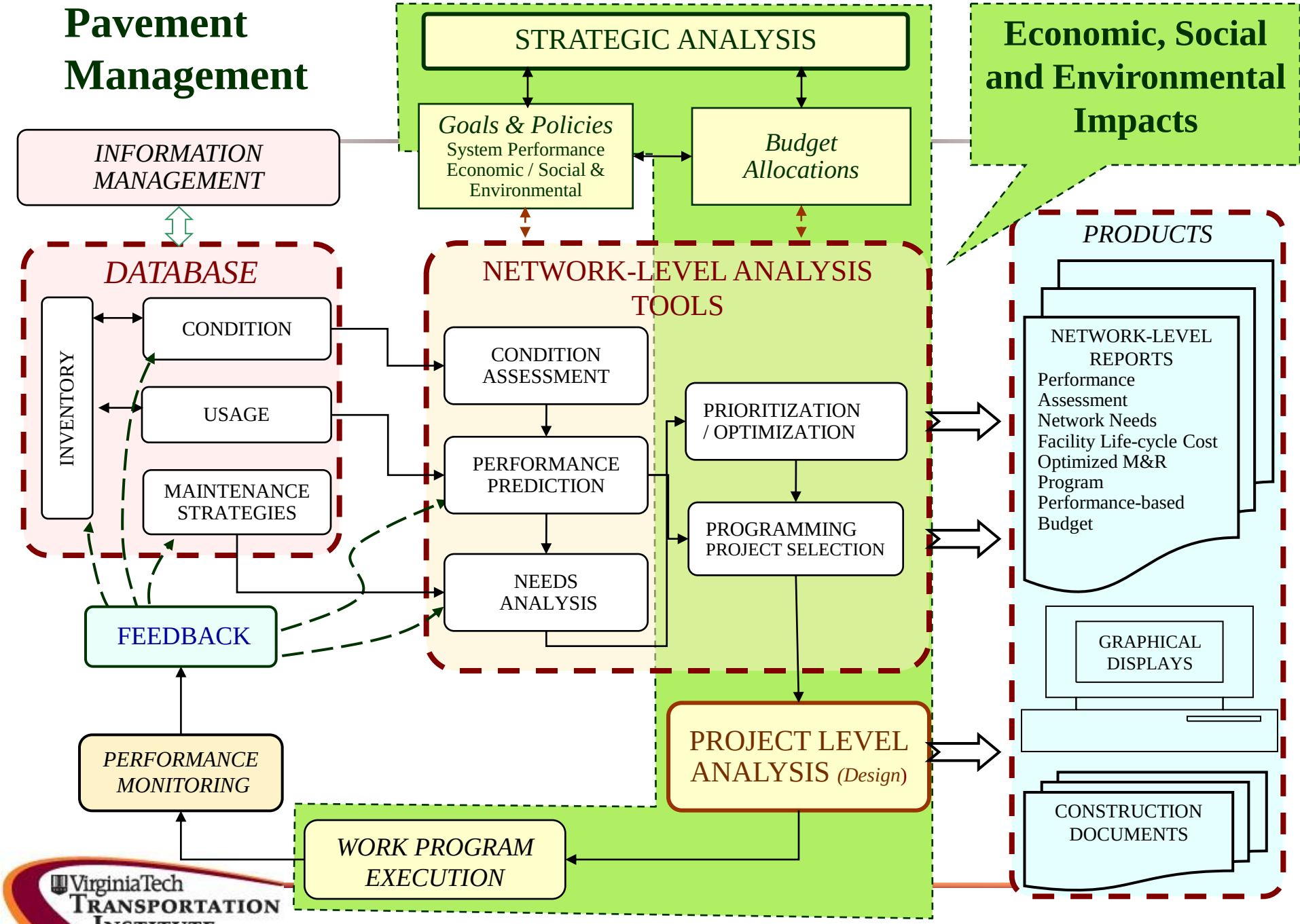
Pavement Management

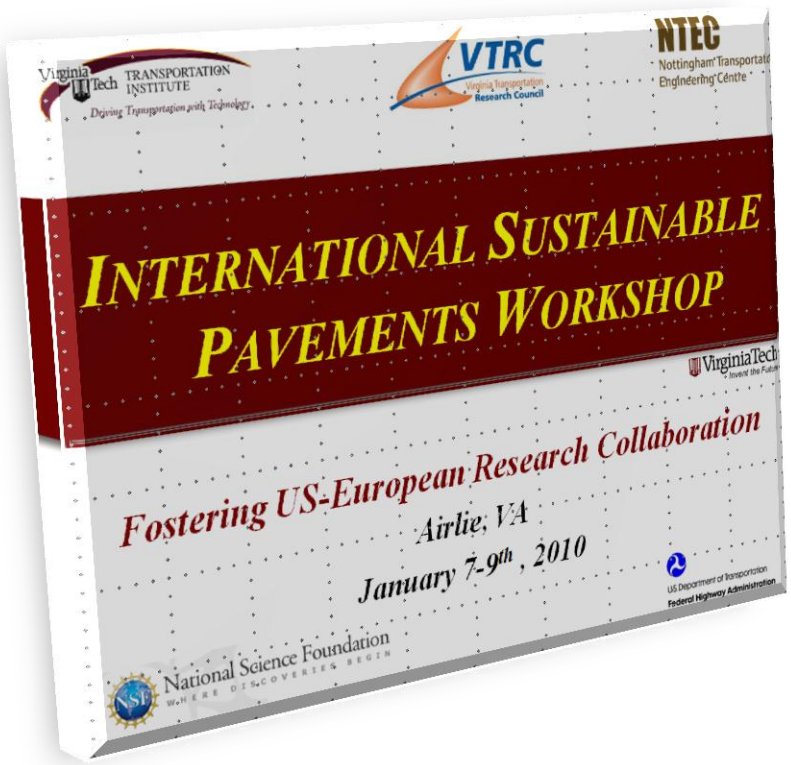


What is a "Sustainable" Pavement?

- **Safe** ⇒ **Optimized surface properties**
- **Healthy** ⇒ **Long lasting, well preserved**
- **Affordable** ⇒ **Life-cycle cost analysis** (LCCA)
- **Renewable** ⇒ **Maximize reuse & recycle**
- **Operates fairly** ⇒ **Asset management**
- **Limits emissions**
- **Limits use of resources** ⇒ **LCA-optimized materials, processes, & policies**

A first attempt to define
Source: Sustainable Pavements, Flintsch (2010) Tempe, AZ

International Sustainable Pavement Partnership



http://www.vtti.vt.edu/ISPW/ISPW-2010.html

Research Agenda for Sustainable Pavements

1. ***Sustainability Assessment Methods***
   - 1.1 Indicators
   - 1.2 Sustainability Rating System
   - 1.3 Sustainability Decision Support Tools
2. ***Innovation***
   - 2.1 Financing and Risk
   - 2.2 New Products
   - 2.3 Standard Testing/Certification Practices/ Protocols
3. ***Dissemination***
   - 3.1 Best Practice
   - 3.2 Policy Makers and the Public

Assessing Sustainability: Pavement Construction and Network Sustainability Management Pavement

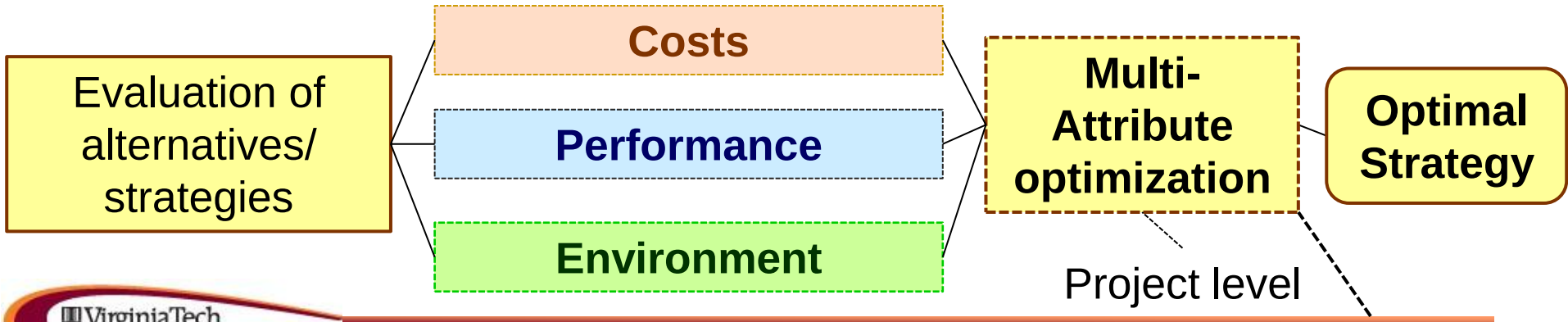
Dwight David Eisenhower Transportation Program Grant for Research Fellowship (GRF)

- **Objective:**
  - ✓ **To develop a decision-support methodology to reliably evaluate and compare the sustainability impacts of highway pavement design, preservation, and renewal alternatives**

U.S. Department of Transportation
Federal Highway Administration

Life Cycle Assessment of Sustainable Road Pavements: Carbon Footprinting and Multi-Attribute Analysis

- **Assess the environmental impacts of road-related practices, strategies, and materials**
- **Implement a procedure to include these eco-efficiency values into a more comprehensive decision support system**



High RAP High Binder Asphalt Concrete Mixes

- **To investigate the effect of increasing the amount of binder content on performance of high RAP surface mixtures (40% and more).**
  - **Compare no Rap, 25%, 40% RAP** (and 100% RAP)
  - **Dynamic Modulus, Beam fatigue, Flow Number, APA and Permeability**

National Sustainable Pavement Consortium

Pooled-Fund TPF-5(268)

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PENNDOT

WISCONSIN DEPARTMENT OF TRANSPORTATION

MDOT

VDOT Virginia Department of Transportation

U.S. Department of Transportation Federal Highway Administration

Objective: enhancing pavement sustainability

- ✓ **Identification and evaluation of novel products, practices, and pavement systems**
- ✓ **Best practices for sustainable pavement management**
- ✓ **Climatic changes adaptation**

National Sustainable Pavement Consortium

Current Projects

- ✓ **Started:**
  1. **Consideration of the Use Phase in the Pavement Life-Cycle Assessment**
  2. **Measuring the Benefits of Emerging Materials and Construction Processes Part 1: Pavement Recycling Project Selection Guidelines**
- ✓ Upcoming: Use of LCA in pavement-type selection

Related Initiative:

National Pavement Recycling and Reclaiming Center

- **Objective:** To develop an independent research group that will be the resource of choice for government and industry for conducting basic and applied research, technology transfer, training, and implementation support on pavement recycling, reclaiming, and reusing technologies and solutions.

Vision

World-class research and technology transfer facility that:

- ✓ **Conducts high-impact research for accelerating the implementation of more sustainable pavement solutions through pavement recycling and reclaiming technologies**
- ✓ **Is a paradigm of collaboration among government, academia, and industry**

National Pavement Recycling and Reclaiming Center

Vision (cont.)

- ✓ **Provides excellent environment, resources, and instruction for practitioners and students to learn fundamental concepts and gain practical experience and know-how on pavement recycling and reclaiming technologies**
- ✓ **Provides pavement design professionals and public agencies with the knowledge and tools necessary to use pavement recycling and reclaiming as a feasible and competitive alternative to traditional pavement preservation and rehabilitation strategies**

Questions?