Pie in the Sky

New Techniques in Binder Property Measurement

Michael.Hauck@asprs.org
Let’s Dream a Little

• Perspective - The Original “Moon Shot”
• Looking Back at WRI’s Own Moon Shot
• Déjà Vu and Lasers Two
Galileo changed the way we look at the world.
Leaving for the Moon, illustration from 'Around the Moon' by Jules Verne (1828-1905) Paris, Hetzel (engraving) (b/w photo), Hildibrand, Henri Theophile (1824-1897) / Private Collection / Archives Charmet / The Bridgeman Art Library
Looking Back a Decade
Transportation Business is Where Oil and Gas Was 20 Years Ago

Example: Shell Manages $178B/yr Of Operations Using Virtual Reality
U.S. DOT Collaborative Program with NASA

ENVIRONMENTAL IMPACT FOR MULTIMODAL CORRIDOR PLANNING CONSORTIUM

Mississippi State University, Lead
www.ncrste.msstate.edu

Dr. Roger King, Consortium Manager
Dr. Charles ‘Chuck’ O’Hara, Consortium Coordinator

DISASTER PREPAREDNESS AND LIFELINES SECURITY CONSORTIUM

University of New Mexico, Lead
www.trans-dash.org

Dr. Stanley Morain, Consortium Manager
Dr. Richard P. Watson, Consortium Coordinator

New Area

Pavement Construction and Maintenance Quality Control / Quality Assurance Western Research Institute, Lead
Dr. Michael Hauck, Consortium Manager

INFRASTRUCTURE ASSET MANAGEMENT AND SAFETY CONSORTIUM

University of California Santa Barbara, Lead
www.ncgia.ucsb.edu/ncrst

Dr. Michael Goodchild, Principal Investigator
Dr. Val Noronha, Project Director

MULTIMODAL TRANSPORTATION FLOW CONSORTIUM

Ohio State University, Lead
www.ncrst.org

Dr. Joel L. Morrison, Consortium Director
Dr. Mark R. McCord, Consortium Research Coordinator
Construction and Maintenance
Quality Control / Quality Assurance
Western Research Institute, Lead

TRACK 3
TRACK 3

Construction and Maintenance
Quality Control / Quality Assurance
Western Research Institute, Lead
Background on the New Program Area

• Construction and Maintenance Represent the Lion’s Share of an Annual $117B Spent on Surface Transportation
  – Congress Wondered if Remote Sensing Offers Opportunities to Help the Nation Spend its Construction and Maintenance Dollars More Effectively

• Concept White Paper Was Floated to Stakeholders
  – AASHTO, AGC, ARTBA, FHWA, NASA, RSPA, TRB

• Addressing this High-Impact Area Is a Logical Extension of the Existing DOT-NASA Joint Program
  – New Team Will Rely on the Current RS Consortia for Expertise and Experience as Appropriate

• First Team Meeting Was 17 Sept 2003 (“Isabel Huddle”) to Organize the Team and Plan a Deployment Program
  – Deployment Plans Are at an Early Stage, Pending Funding

• Team Focus is on End Use, Rather than Technology
Why Construction & Maintenance?
Today: Destructive QC/QA Procedures
and Laboratory Torture Tests
Tomorrow: Remote Sensing Technologies
Why Remote Sensing Makes “Sense”

**Users**

Most Important Highway Improvements (percent of survey respondents)

- Traffic flow: 30%
- Safety: 25%
- Pavement conditions: 20%
- Work zones: 15%
- Maintenance response time: 10%
- Bridge conditions: 5%
- Travel amenities: 5%
- Visual appeal: 5%

**Science**

Fig. 3 - Percent of Road-Related Fatalities In Which Poor Road Conditions or Outdated Alignments Are A Factor

- Other: 64%
- Poor Road Conditions: 36%

15,000 Fatalities per Year

**Safety**

Annual Highway Infrastructure

- Annual FHWA R&T
- Annual Savings Due to Superpave

**Pay-Factor**

Savings

- Highway and bridge construction & rehabilitation: 55%
- Engineering, ROWA, safety: 25%
- Enhancements, environment: 5%
- Transfers to Federal Transit Administration: 8%
- Administration, Federal lands: 7%

Leverage
It Makes Intuitive Sense
Asphaltenes -- Snowflakes of Oil

Hyperspectral Image, UCSB

Atomic Force Microscope Image, WRI
Highway Users’ Perspective

Most Important Highway Improvements (percent of survey respondents) *

1. Traffic flow
2. Safety
3. Pavement conditions
4. Work zones
5. Maintenance response time
6. Bridge conditions
7. Travel amenities
8. Visual appeal

* FHWA User Survey
Safety Perspective

Fig. 3 - Percent of Road-Related Fatalities In Which Poor Road Conditions or Outdated Alignments Are A Factor

- 15,000 Fatalities per Year (36%)
- 27,000 Fatalities per Year (64%)

Source: U.S. DOT data
Financial Perspective

Follow the money...

- Administration, Federal lands: 7%
- Transfers to Federal Transit Administration: 8%
- Enhancements, environment: 5%
- Engineering, ROWA, safety: 25%
- Work: 55%

Source: U.S. DOT FY 2000 data
Leverage Perspective

$117B/yr  □  Annual Highway Infrastructure
$0.4B/yr  ■  Annual FHWA R&T
$2.4B/yr  ▨  Annual Savings Due to Superpave

Return on Investment: SuperPave vs. FHWA R&T
R&D Needs Identified by F-SHRP Study *

- Performance-related specifications for new technologies
- Efficient construction equipment and methods
- Non-destructive, real-time sensing to determine readiness for traffic
- Use of modular or prefabricated construction to speed renewal and minimize disruption
- Use of advanced computing technologies, such as web-based management, that could speed up renewal projects by providing for better coordination across disciplines and project stages

* Performed by the Transportation Research Board of the National Academies
Profitability is Linked to Quality Performance

---

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<th>PAY FACTOR SHEET FOR SUPERPAVE (GYRATORY COMPACTOR)</th>
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| BULK DEN. | 148.3 | 0.43 |
| RICE DEN. | 154.1 | 0.29 |

**Compaction Target Value is 7.0% In-Place Air Voids**

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Lab Tech: M.H., J.J., R.M.
Contractor Signature: M.H.
Res Eng/Proj Supv: [Signature]

Date: 11/19/2001
Why Remote Sensing Makes “Sense”

Users
Most Important Highway Improvements (percent of survey respondents)

- Traffic flow: 30%
- Safety: 25%
- Pavement conditions: 20%
- Work zones: 15%
- Maintenance response time: 10%
- Bridge conditions: 5%
- Travel amenities: 2%
- Visual appeal: 1%

Science

- Data type: 2 range
- Data type: 2 range
- Data type: 2 range

Leverage

Savings

- Annual Highway Infrastructure
- Annual FHWA R&T
- Annual Savings Due to Superpave

- Administration, Federal lands: 7%
- Transfers to Federal Transit Administration: 8%
- Enhancements, environment: 5%
- Engineering, ROWA, safety: 25%
- Highway and bridge construction & rehabilitation: 55%

Pay-Factor

Safety

Fig. 3 - Percent of Road-Related Fatalities In Which Poor Road Conditions or Outdated Alignments Are A Factor

- Other: 64%
- Poor Road Conditions: 36%

Annual Highway Infrastructure

Annual FHWA R&T

Annual Savings Due to Superpave

Annual FHWA R&T

Annual Savings Due to Superpave
• Non-Profit Research & Development Organization
  – Formerly Federal Laboratory (1924-1983)
  – Now University of Wyoming Research Corporation

• A Primary Asphalt Research Arm for FHWA
  – One of the Original SuperPave® Contractors
  – Just Held 40th Annual Asphalt Research Conference
  – A Primary Asphalt Research Arm for FHWA
  – Extensive Relationships with Most State DOTs
  – Field Validations Strips with AZ, KS, NV, WY

• Experienced Consortium Leader
  – Highway Research Consortium (WRI, TTI, UNR, UW-M, AAT)
• A Premier Supplier of Pavement Materials
  – Over 40 Years of Asphalt Experience
• Emphasis on Quality and Performance
  – “State of the Art” Research and Laboratory Facilities
• A Leader in Delivering Paving Solutions
  – Owned by Koch Industries
  – 2\textsuperscript{nd} Largest Privately Held US Company (AA+ Credit)
• Koch Performance Roads, Inc. Major Projects with Federal Funding
  – NM Route 44 / US-550
  – VA Route 288, Richmond
  – MoDOT US-63
Planning, Engineering, and Construction Management Firm, Founded in 1884
– One of the Largest Employee-Owned Companies in US
– Global Provider of Infrastructure Services

Emphasis on Service to Client and Community

PB views Sensor Technologies as Key to Sustainability and Cost Effectiveness

A Leader in Creating the “Design-Build” and “Warranty Construction” Business Models
• International Full-Service CAD Support, Customization, and Training Company

• Specialists in Engineering Information Systems for Transportation Projects
  – Contracts with 20 US State DOTs
  – Partnerships with Bentley Systems (MicroStation®) and AutoCAD®

• Track Record of Commercializing New Ideas by Using Familiar Wrappers
  – Raster Utilization in Roadway Projects and WYSIWYG Editing
  – Video Log Libraries on the Web
  – Design Visualization
  – Electronic Bid Sets on the Web
University of Oklahoma
Institute For Exploration & Development Geosciences

• Expertise in Geophysical, Petrophysical, and Visualization Technologies Used in Energy Exploration
  – Constructed Pavements Are “Man-Made Rocks”
  – Desires Technology Transfer to Transportation Applications
  – Partnering with Walden 3D, Inc. and Dynamic Resources Corp.

• Track Record of “Modernizing” an Industry
  – CAD for Oil and Gas Exploration (Landmark Graphics Corp.)
  – 3D Virtual Reality for Prospecting and Engineering Design
  – Parallel Processing Algorithms for Data Processing
• Commercial Provider of High-Quality Earth Imagery and Geospatial Information Products, Leveraging DoD Technology
  – In-House Facilities at NASA Stennis Space Center
  – Relationships with Sensor Manufacturers
  – Cross-Agreements with Airborne Imagery Providers
• QuickBird Is the Highest-Resolution Civilian Satellite
  – 61 cm Panchromatic and 2.8 m Multi-spectral
  – Highest Collection Capacity and Highest Accuracy
• Other Products Include:
  – Pan-Sharpened Imagery, Mosaics w/ Geometric & Ortho Corrections
  – Color Infrared High Spatial Resolution Satellite Imagery
  – Stereo Imagery and Digital Elevation Models (DEMs)
  – Imagery-Derived Information Extraction and Data Fusion
• News Flash: NIMA Award to Develop Next Generation Super-High Resolution Commercial Imagery System
Possible Research Tasks

• Catalog RS Solutions for Pavements

• Investigate High-Impact Applications
  • Surveying Construction Obstacles
  • Compaction Quality Control / Assurance
  • Surface Levelness Quality Control / Assurance
  • Composition Quality Control / Assurance
  • Detecting Premature Surface Aging
  • Predicting Moisture Damage
  • Detecting Early Signs of Base Layer Failure

• Demonstrate RS Solutions in the Field
  • In Partnership with State DOTs
  • In Partnership with Commercial Interests
“Having to tunnel through Granite when you thought you were going to be tunneling through sand has a significant impact on project delivery.”
Compaction QC / QA

Interpreted GPR image shows cross-section of base and
Composition QC / QA
Detecting Premature Surface Aging
Predicting Moisture Damage
Detecting Early Signs of Base Layer Failure
Deployment Projects

• Construction QC/QA Deployment (1/3)
  – Borrow Pit Optimization w/ CDOT
  – Buried Infrastructure w/ WyDOT

• Maintenance Deployment (1/3)
  – Condition Assessment w/ VDOT
  – Washington Bridge Project w/ Maryland SHA & VDOT

• Research (1/3)
  – Inventory of Available Technologies w/ TRB
  – Sensor tests w/ NASA Lab and Field Sites

• Warranty Construction Project (Future)
Where are we 10+ Years Later?
Transportation Business is Where Oil and Gas Was 20-30 Years Ago

WHY?
“This is the stage of the innovation process -- between the generation of knowledge and the application in the marketplace -- that poses the greatest challenges to the United States.”

Science and Technology: A Report to Congress President’s Office of Science and Technology Policy Bush Administration, 1991
Times Have Changed,
Let’s Try Again
RFID Tags
The World Through A Laser’s Lens
## Commercial Lidar Resolution

### ¼ Wavelength Rayleigh Criterion

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CUSTOM WAVELENGTHS POSSIBLE!
Deflection is difference between deflected and undeflected profiles (i.e., $D_2 - C_1$)
LAYOUT FOR NEVADA I-15 SITE

All Monitoring Sections 500 Feet in Length

- Sinclair (S1, S2)
- Nevada (N1, N2)
- Venezuelan (V1, V2)
- Canadian (C1, C2)

Direction of Traffic (southbound)

::: Core Locations
Is This Really What We Want?
It’s up to smart minds and perceptive businesses to create a new industry.
Pie in the Sky?

You Decide.