INDOT will plan, build, maintain and operate a superior transportation system enhancing safety, mobility and economic growth.
Pavement Condition Data

- Data supports development of information
- Information supports decision-making

- However, with or without information, decision-making will happen
The art of directing the great sources of power in nature for the use and convenience of man, as the means of production and of traffic in states, ...
INDOT Profile

- Six district offices
- 3,404 employees
- $1 billion/annual capital expenditures
- 28,400 total roadway lane miles
- 5,300 INDOT-owned bridges
- Assists 42 railroads in planning & development of more than 3,880 miles of active rail lines
- Supports 69 Indiana State Aviation System Plan airports
The Problem

- How do we substantiate that we’ve selected the most judicious use of taxpayer monies to do the projects we do?
Definitions - Flexible

Key:
1: A.C. surface course
2: base
3: sub base
4: compacted road
5: subgrade
6: concrete surface
7: roadbed
HMA pavement cross section

- 1.5” Surface
- 2.5” Intermediate
- 3”+ Dense graded base
- 3” Open graded base
- 3” Dense graded base
- 14” Soil treatment
- Soil subgrade
- Foundation Soil
Stress and strain in rigid pavement – Curling stress

Daytime Downward Curling

(+) Positive Gradient

Nighttime Upward Curling

(-) Negative Gradient

JPCP

Drainable Base

Soil Subgrade

Tension

Compression
JPCP cross section

11” – 13” J PCP
3” Open graded stone
6” - 12” Dense graded stone
14” Soil treatment
Soil subgrade
Foundation Soil
Design inputs

- Traffic
  - Traffic Volume Adjustment Factors
    - Monthly Adjustment
    - Vehicle Class Distribution
    - Hourly Truck Distribution
    - Traffic Growth Factor
  - Axle Load Distribution Factors
  - General Traffic Inputs
    - Number Axles/Truck
    - Axle Configuration
    - Wheelbase
- Climate
- Structure
  - Design Features
  - Drainage and Surface Properties
  - Layers
    - Layer 1 - JPCP

For Help, press F1
JPCP design feature, layers, and material properties
HMA design properties, layers, and thermal cracking

Inputs
- Traffic
  - Traffic Volume Adjustment Factors
    - Monthly Adjustment
    - Vehicle Class Distribution
    - Hourly Truck Distribution
    - Traffic Growth Factor
  - Axle Load Distribution Factors
- General Traffic Inputs
  - Number Axles/Truck
  - Axle Configuration
  - Wheelbase
- Climate
- Structure
  - HMA Design Properties
  - Layers
    - Layer 1 - Asphalt concrete
    - Layer 2 - Asphalt concrete
    - Layer 3 - Asphalt concrete
    - Layer 4 - A-7-6
    - Layer 5 - A-7-6
  - Thermal Cracking
Run analysis
Option 1

- **Performance curves:**
  - **HMA:**

![Performance Curves Diagrams]

1. **Predicted IRI**
   - Threshold Value: 160.00
   - @ Specified Reliability
   - @ 50% Reliability
   - Initial IRI: 74.1

2. **Predicted Total Rutting (Permanent Deformation)**
   - Threshold Value
   - @ Specified Reliability
   - @ 50% Reliability

3. **Predicted AC Bottom-Up Cracking (Alligator)**
   - Threshold Value: 10
   - @ Specified Reliability
   - @ 50% Reliability

4. **Thermal Cracking: Total Length vs. Time**
   - Threshold Value: 500
   - @ Specified Reliability
   - @ 50% Reliability
Option 2

- **Performance curves:**
  - **Jointed Plain Concrete:**

![Graphs showing performance curves for Jointed Plain Concrete](image-url)
Historical Project Selection

- **Historical pavement AM - Pre 1970s**
  - We’ve been managing pavements since there have been roads!
  - AASHTO Road Test (1950s-60s)
    - Limited loading weights and cycles compared to today
    - Now 50-yrs old data
    - Truck weights and age vastly different
  - BEST WE HAD AT THE TIME!
Historical Project Selection

- **Historical pavement AM - 1970s/80s**
  - Subject matter expert based project selection
  - Case-by-case
  - Informal network analysis
  - Professional memory based

- Developing objective theory
- Establishing some objective measures
  - IRI, roughness, etc.
Historical Project Selection

- **Historical pavement AM - 1990s**
  - Initially interstate only ('91-'92)
    - INDOT interstate program centrally managed
    - Van trips post-data analysis, SME input
    - dTIMS AM software obtained
  - Limited models!
  - Data limitations!
    - IRI / Rut / PCR (10% sampling)
Historical Project Selection

- **Historical pavement AM - 1990s**
  - Non-interstate model developed ‘96-’97
    - Limited models
    - Data limitations
    - IRI / Rut / PCR (10% sampling)
  - Computer processing improvements
Current Project Selection

- Decision-Support Information needed:
  - Traffic: AADTT, truck volumes
  - Condition: IRI, rut, cracking type & severity, friction, structural adequacy, drainage,
  - Inventory: location, geometrics
  - Materials: soils, HMA mix, PCC mix
  - History: maintenance, construction, jurisdictional
Current Project Selection

- **How is the road?**
  - Condition adequacy

- **What do you need to do?**
  - Engineering perspective
  - Business perspective
Current Project Selection

- Initial engineering perspective
  - No problems
  - Minor flaws
  - Major flaws
  - REAL MAJOR PROBLEMS
Current Project Selection

- Engineering problem - AM perspective
  - No problems
  - Lack of maintenance
  - Rough ride
  - Beginning of structural deterioration
  - Advanced structural deterioration
  - Structurally failed
  - Roadside / drainage problems
Current Project Selection

- **Business owner perspective**
  - It is about money
  - Is the pavement unacceptable or not?
  - How much is it going to cost to address?
  - How long will it not be a problem?

- Different managerial approaches depending on the previous question’s answer
Current Project Selection

- Pavement is unacceptable now
  - Do something now!
  - WORST FIRST maybe

- Priority of effort
- Not necessarily a strategic fix
- GET IT OUT OF UNACCEPTABLE category
- Maybe least bad solution?
Current Project Selection

- **Pavement is acceptable**
  - Least cost of ownership approach
    - $/lane-mile year of service purchased
  - Optimized cost-effective right-treatment at right time for right cost approach
  - Or bridging strategy or approach
Current Project Selection

- Possible fixes
  - Do nothing
  - Routine maintenance
  - Reactive maintenance
  - Preventative maintenance or PPI (pavement preservation initiative) treatment
  - Structural treatments

- Each approach has several optional treatments
- Options have cost, time & benefit ranges
Current Project Selection

- Comprehensive list of **NEEDS**!

- Process this list through business guidance
  - Priority of resourcing / effort
  - Effectiveness of relative improvements
  - Priority of relative improvements
  - Funding
Current Project Selection

- Problem assessment and statement
- Possible solutions
  - Treatment options
- COA screening and evaluation
  - Worst first worst, but necessary
  - Engineering economics intervention point optimization
  - Temporary bridging strategy or approach
Current Project Selection

- **COA screening and evaluation**
  - Delineated factors & considerations
    - Your successor might need to know
    - I call it the “dumb bunny’ innoculation
  - FAS-DC
  - Recorded
    - Where did you use ____________ logic
      - worst first worst, but necessary
      - engineering economics intervention point optimization
      - temporary bridging strategy or approach
Current Project Selection

- **COA screening and evaluation**
  - Engineering economics intervention point optimization
    - Echelons of treatments
      - Routine maintenance
      - Reactive maintenance
      - Preventative maintenance
      - Functional/smoothness treatments
      - Structural minor rehab treatments
      - Structural major rehab treatments
      - Structural pavement replacement

- Cost estimates:
  - Routine maintenance: <$1K/ln-mi/svc yr?
  - Reactive maintenance: ? / TBD
  - Preventative maintenance: $5K/ln-mi/svc yr?
  - Functional/smoothness treatments: $7-20K/ln-mi/svc yr?
  - Structural minor rehab treatments: $10-25K/ln-mi/svc yr(?)
  - Structural major rehab treatments: $25-35K/ln-mi/svc yr(?)
  - Structural pavement replacement: $1Mil/ln-mi/svc yr(+)(?)
Current Project Selection

- speaker note - talk about:
  - $33 vs. $9 Million
  - Last Friday
  - Repeated internal/external examples
  - That which you inspect gets done well
Current Project Selection

- Requirements for Treatment Selection
  - What are my Options?
  - Which One is Best Value?
  - Prove It, and I’ll Spend Taxpayer Dollars!
  - What is the menu of choices?
Pavement-Roadway Future KPI

- Pavement structural capacity
- Pavement functional smoothness
- Pavement geometry, drainage & other statuses
1994 - Started statewide network level data

- FHWA requirements for pavement management system (PMS)
- Vendor was PaveTech from Oklahoma
  - Collected a video log of the state maintained system
  - Used acoustic sensors & accelerometers to collect roughness and rut data
  - Collected video of the pavement surface
    - Used to rate the distress of the pavement surface
    - Based on the PCR manual
    - First tenth mile at each RP evaluated
HISTORICAL DATA

- **Distress**
  - Pavement Condition Rating (PCR)
  - 100-0 Scale (100=excellent)
  - Rated by vendor using video of to count and rate cracks
  - Directional PCR reported at each RP

- **Roughness**
  - Measured by 3 point acoustic profilometer
  - IRI (International Roughness Index)
  - Average IRI per directional mile

- **Rut**
  - Measured by 3 point acoustic rut bar
  - Average depth of ruts per directional mile
1997 – 2008

- Pathway Services selected as data collection vendor
- Same standards used for reporting
- Switched to 5 point laser system for roughness and rutting
  - Allows for reporting in each wheel path
- Video take off used continued for distress
- Distress data continued as first tenth mile by RP
- Starting in 2002, IRI and rut reported by tenth mile in each wheel path
HISTORICAL DATA

2009 – 2011

- Pathway Services continued as vendor
- Stopped collecting distress data
- Only reported IRI and rut data, no distress data collected
- Reported on tenth mile sections in each direction and each wheel path
- Used a scanning laser to collect IRI and rut data
**CURRENT DATA**

- Previous systems used one laser in each wheel path, one in the middle and one along each edge of the lane to collect profile data.
  - Only measured a narrow band of profile data.
  - It was hit or miss to collect areas of bad condition.
  - It was used to measure the profile only.
  - Cracks were collected from the video, no width or depth information.
  - It was the best system at the time.
Current Data

- New systems used 3D lasers to collect continuous profile data as the van drives
  - New systems used 2 or more 3D lasers to collect profile data
  - IRI and rut can be determine using the data
  - A 3D image of the pavement surface can be created using the data
  - Crack location, length, width and depth can be determined from the profile data
CURRENT DATA

■ 2011 and beyond
  ■ Uses a 3D laser system to collect IRI, rut and distress data
    ■ Uses 2-3D lasers and accelerometers to collect continuous data over the entire network
IRI and rut summarized to any length desired

- Typically use tenth mile segment to summarize
- Can be summarized in shorter or longer segments depending on the need of the analysis
- IRI reported as inches per mile
- Rut reported as depth of rut in inches
- Used to report condition for:
  - Key Performance Indicators (KPI)
  - Highway Performance Monitoring System (HPMS)
  - Project selection
  - Ad Hoc condition
- Other data that can be reported includes texture and faulting
Distress data has changed the most

- Pavement distress is identified using a 3D profile of the pavement surface
  - Extent and severity of the crack is reported
  - Width and depth of the crack is reported
- It is now possible to collect and report distress data over the entire network rather than a sample at each RP
- The distress data is compiled automatically based on algorithms developed by Pathway Services and INDOT
  - It aggregates the location of individual into a descriptor of the distress. For example: longitudinal crack, fatigue crack, etc.
- The distress data can now be summarized to any length required
The lane being measured is divided into zones:

- **Structural distress**
  - Right and left wheel path (WP)
  - Outside Edge (Edge) (along the right shoulder)

- **Functional Distress**
  - Non-Wheel path (NWP) (between the wheel paths and along the left shoulder or cl of road)
  - Right shoulder (SHLD)
### Distresses collected and reported by Pathway Services

<table>
<thead>
<tr>
<th>Pavement Type</th>
<th>Area</th>
<th>Distress</th>
<th>Measure</th>
<th>Distress Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt</td>
<td>Wheel Path (WP)</td>
<td>Alligator Cracking</td>
<td>Percent Area</td>
<td>Structural</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Longitudinal Crack</td>
<td>Length (ft)</td>
<td>Functional</td>
</tr>
<tr>
<td>Edge</td>
<td>Alligator Cracking</td>
<td>Percent Area</td>
<td>Structural</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Longitudinal Crack</td>
<td>Length (ft)</td>
<td>Structural</td>
<td></td>
</tr>
<tr>
<td>Non-Wheel Path (NWP)</td>
<td>Alligator Cracking</td>
<td>Percent Area</td>
<td>Functional</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Longitudinal Crack</td>
<td>Length (ft)</td>
<td>Functional</td>
<td></td>
</tr>
<tr>
<td>Lane</td>
<td>Transverse Crack</td>
<td>Number/section</td>
<td>Lane</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Block Cracking</td>
<td>Percent Area</td>
<td>Lane</td>
<td></td>
</tr>
<tr>
<td>Concrete</td>
<td>WP</td>
<td>Longitudinal Crack</td>
<td>Length (ft)</td>
<td>Functional</td>
</tr>
<tr>
<td></td>
<td>NWP</td>
<td>Longitudinal Crack</td>
<td>Length (ft)</td>
<td>Functional</td>
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<td>Number/section</td>
<td>Lane</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Transverse Spalling</td>
<td>Number/section</td>
<td>Lane</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Longitudinal Spalling</td>
<td>Number/section</td>
<td>Lane</td>
</tr>
<tr>
<td></td>
<td>Corner Crack</td>
<td>Number/section</td>
<td>Lane</td>
<td></td>
</tr>
<tr>
<td>Concrete</td>
<td>Shoulder (Shdr)</td>
<td>Longitudinal Crack</td>
<td>Length (ft)</td>
<td>Not Used at this time</td>
</tr>
<tr>
<td>Asphalt</td>
<td>Shoulder (Shdr)</td>
<td>Alligator Cracking</td>
<td>Percent Area</td>
<td>Not Used at this time</td>
</tr>
<tr>
<td></td>
<td>Longitudinal Crack</td>
<td>Length (ft)</td>
<td>Not Used at this time</td>
<td></td>
</tr>
</tbody>
</table>
Pathway Services also provides a Right-of-Way view of the network.
Other data can be extracted from the data collected by the vendor:

- Horizontal and vertical profile of the network
- Lane and shoulder widths
- Number of travel lanes
- Length and width auxiliary/turn lanes
- Intersection and bridge locations
- Sign locations

It is a matter of setting up what you want and running the system to extract the data.
CURRENT DATA

- This data can be imported into a pavement management system along with other required information
  - Contract data
  - Inventory information
  - Condition data

- The pavement management system:
  - Divides the network into analysis sections
  - Analyzes the section based on the attributes of the section
  - Gives a “first cut” of possible treatment for a road
Other data is needed to effectively predict possible treatments for a road section

- Deflection from the falling weight deflectometer
  - Starting to collect on new roads annually
  - Data is available for select sections from 2004-present

- Coring data
  - Need to centralize the data
  - Need to standardize the collection of coring data

- Friction data
  - Available from the 1990’s to present
  - Annual cycle on interstates and

- Ground penetrating radar (GPR)

- Geotech data
Most of this data is collected by

- The Research Division and the districts
- We need to standardize and centralize the storage of the data
  - It would reduce the duplication of effort
  - We would have a searchable record of data
  - One place to look for information
  - Could be used by different areas of INDOT
    - Pavement design
    - Asset/pavement management
    - Research
    - JTRP
    - And others
DATA REPORTING & USES

- Identify trends
  - Compare year over year to assess network
  - Identify which areas are in best/worst shape
- Warranty
  - Identify raveling
- Pivots Tables
  - Rutting, IRI, Cracking
  - By district, area, county, road
DATA REPORTING & USES

- Use data for project selection
  - KPI, IRI

- Cracking data
  - Identify distress
  - Raveling calculation
  - Cracking, potential patching %

- Potential candidates list to districts
  - Crack seal
  - 1 layer Overlay
  - More than single layer
DATA REPORTING & USES

- Modeling vs reality
  - MEPDG vs assumptions
  - Make models better
  - Identify flaws - design, construction, materials.

- Reports
  - GASb
  - Reports/On demand executive
RESULTS: ROADWAYS

Pavement Surface Conditions Over 10-Years for Current Funding Trends

Assumes Flat $322M Annual Investments 2018-2024

IN policy for CAFR reporting, minimum requirement (12.2%)

Pavement condition should remain relatively static at the current investment levels.

Joint Transportation Committee

9/23/14
Roadways: Priorities

Current Service Level

11.4% Poor in 2024

$394M Annual Investment
10-Years
1,305 Miles of Poor Pavement

INDOT’s Target Service Level

≤7.5% Poor in 2024

$498M Annual Investment
10-Years
826 Miles of Poor Pavement

INDOT’s Recommended Service Level

≤4.75% Poor in 2034

$561M Annual Investment
20-Years
533 Miles of Poor Pavement

What is the acceptable result for the taxpayer?

Joint Transportation Committee

Take care of what we have
DATA REPORTING & USES

- Crack density research
  - Calculate potholes, JTRP
  - Crack density, FHWA - MAP 21
  - For KPI (replace IRI) identify optimum treatment time for network
- dTIMS, GIS
  - One dataset of multi layer system
Questions?