U.S. Department of Transportation
Federal Highway Administration

Federal Highway Administration
RESOURCE CENTER

~~MEPDG~~ Darwin-ME Status and Implementation Efforts

Idaho Asphalt Conference
October 22, 2009

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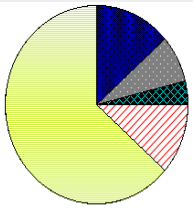
What's Being Used (2007 survey)

Asphalt Design:



	Response Total	Response Percent
AASHTO 1972	6	12%
AASHTO 1981	0	0%
AASHTO 1986	0	0%
AASHTO 1993	33	63%
Individual State design procedure	7	13%
Combination of AASHTO & State procedure	4	8%
Other	2	4%
Total Respondents	52	

Design Guide Implementation Team

Does SHA Use or Plan to Use ~~MEPDG~~ DARWIN-ME?

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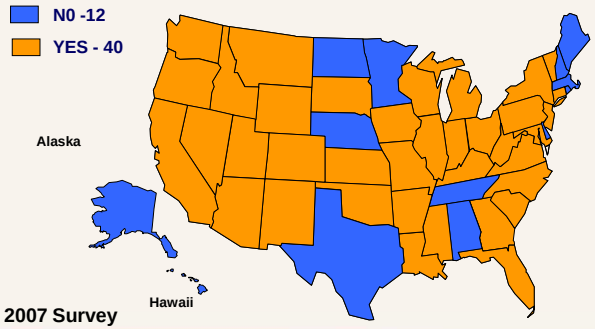

2007 Survey

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Timeframe for Implementation

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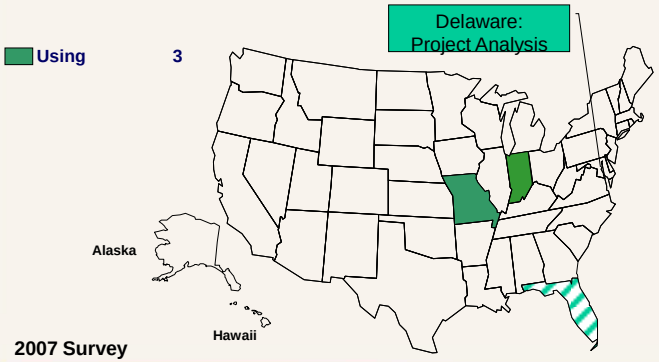

2007 Survey

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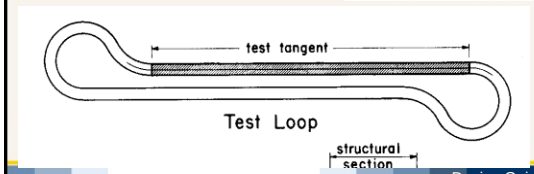
Why change ??

AASHO Road Test (late 1950s)



(AASHO, 1961)

1950s Construction Methods...

Figure 57. Compacting subbase.

Figure 29. Bituminous concrete construction.

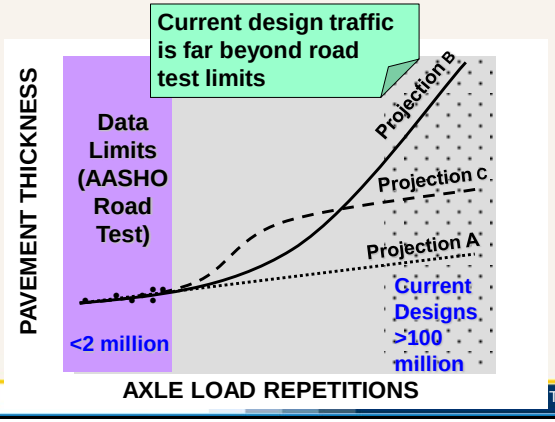
(AASHO, 1961)

1950s Vehicle Loads...

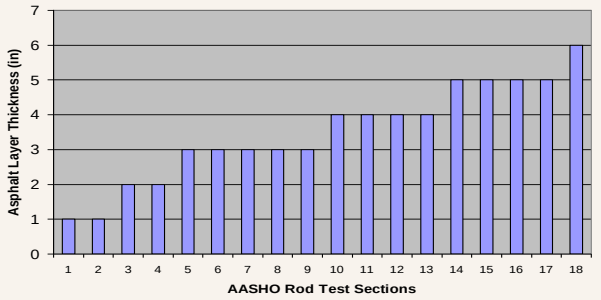
Figure 23. Test vehicles, showing typical axle arrangements and loadings.

(AASHO, 1961)

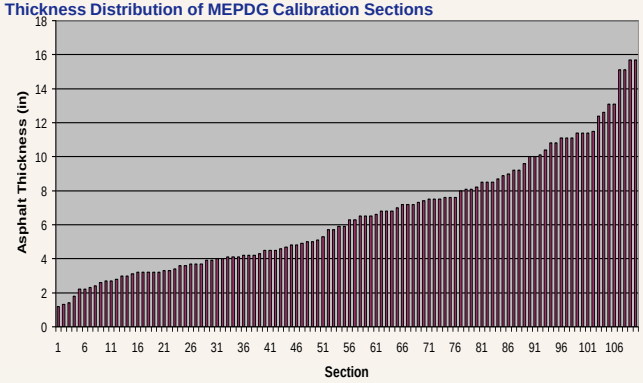
Limitations AASHTO Loadings



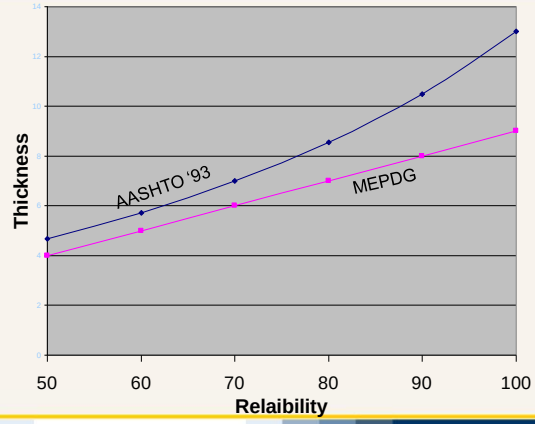
Maximum Asphalt layer thickness at the AASHO Road Test?

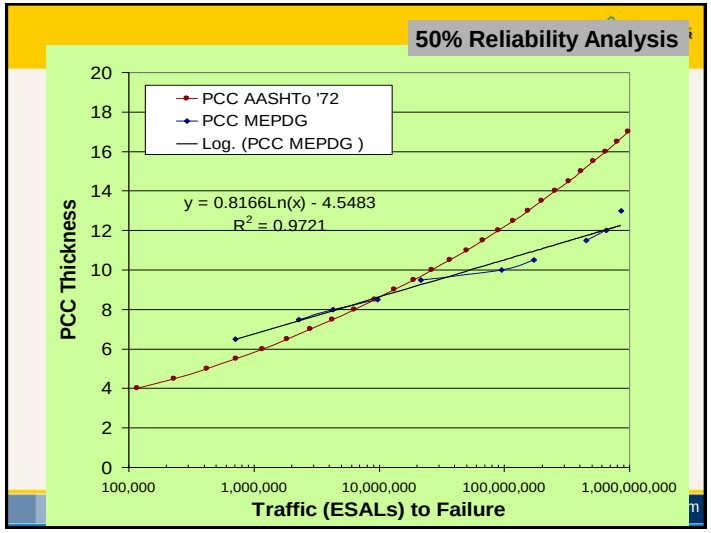


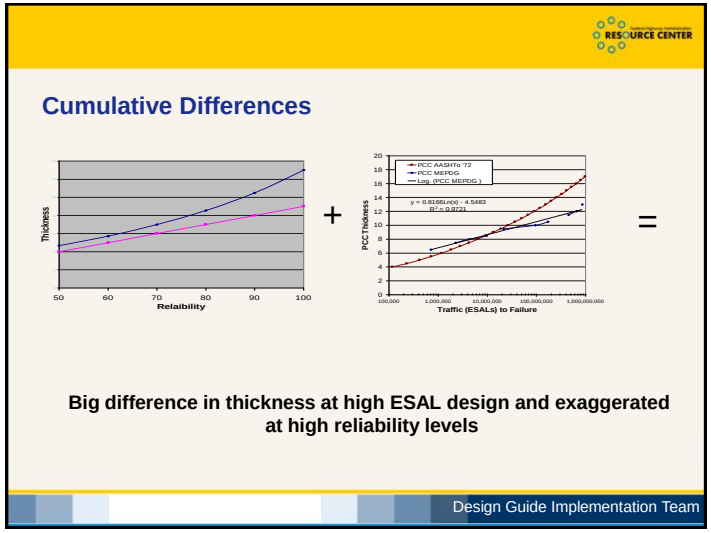
Thickness Distribution of MEPDG Calibration Sections



Practical Design Aspect (Conceptual)




50% Reliability Analysis
PCC AASHTo '72
PCC MEPDG
Log. (PCC MEPDG)
y = 0.8166Ln(x) - 4.5483
R2 = 0.9721
PCC Thickness
Traffic (ESALs) to Failure
100,000
1,000,000
10,000,000
100,000,000
1,000,000,000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Cumulative Differences
Thickness
Reliability
Traffic (ESALs) to Failure
Big difference in thickness at high ESAL design and exaggerated at high reliability levels
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~~MEPDG~~ DARWIN-ME from Research to Reality
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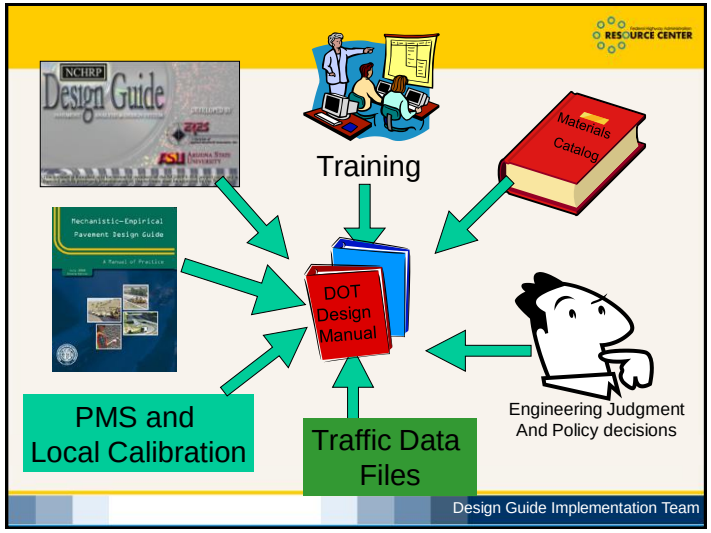
DARWIN -ME
"The ~~MEPDG~~ is an analysis tool, not a pavement design program."
– Various Unnamed Sources
Design Guide Implementation Team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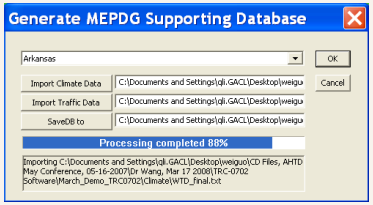
NCHRP
Design Guide
Training
Materials Catalog
Mechanistic-Empirical Pavement Design Guide
DOT Design Manual
PMS and Local Calibration
Traffic Data Files
Engineering Judgment And Policy decisions
Design Guide Implementation Team

Prep-ME
Arkansas Software Capabilities:

Import Raw Data
Traffic Data Check
Interpolate Climate and Traffic Data
Retrieve Material Data

- Dynamic Modulus
- CTE
- M_r

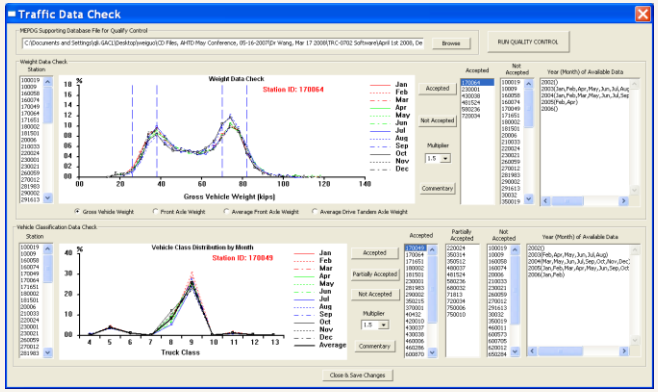
Software Capabilities-Import Raw Data



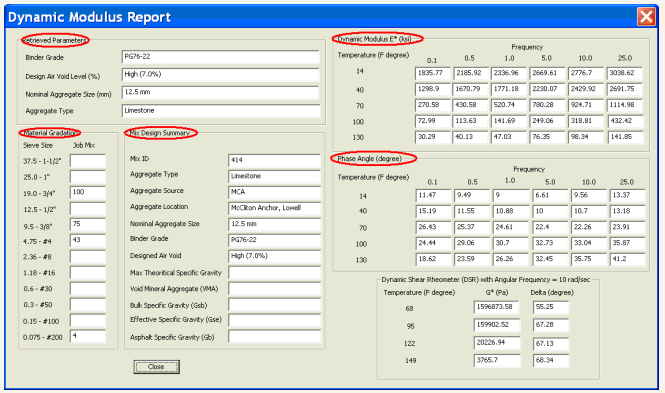
Climate: icm files

Traffic: AHTD Traffic Monitoring Data

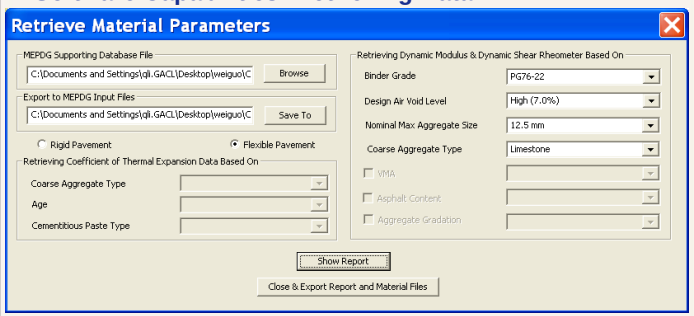
Software Capabilities-Traffic Data Check



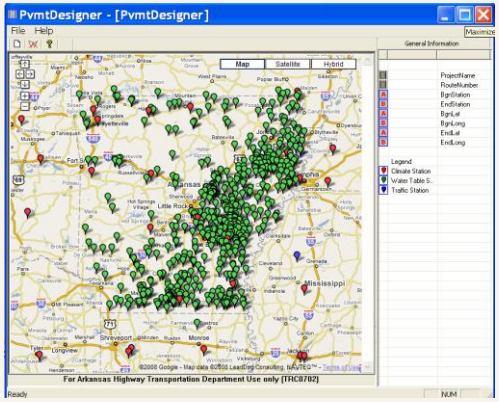
Software Capabilities-Materials E*



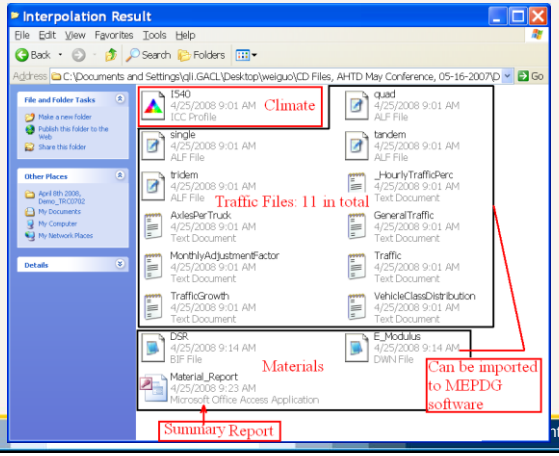
Software Capabilities- Retrieving Data



Software Capabilities-Geo-Mapping Utility



Software Capabilities-Generated Files



Use the experts in your Backyard……

Arkansas DOT contracted with University of Arkansas
Dr. Kevin Hall

Indiana DOT contracted with INDOT Research / Purdue University
Dr. Tommy Nantung

Indiana DOT HMA Materials Characterization

Dynamic Modulus
- District - 6
- Nom Max Aggregate Size - 3
- Binder Type – 3

- **Binder Characterization**
  - 3 Binders DSR data
- **Traffic Data**
  - WIM Station Data Analyzed
  - Load Spectra defined by Volume

What to Change for Design?

Sensitivity of Inputs for Concrete

Parameter	Roughness	Faulting	Percent Slabs Cracked
Permanent Curl/Warp Effective Temperature Difference	VS	VS	VS
Joint Spacing	VS	VS	VS
Dowel Bar Diameter	MS	MS	NS
Pavement Thickness	S	MS	VS
Modulus of Rupture	S	NS	VS
Modulus of Elasticity	S	NS	VS
20-year/28-day Ratio	S	NS	VS

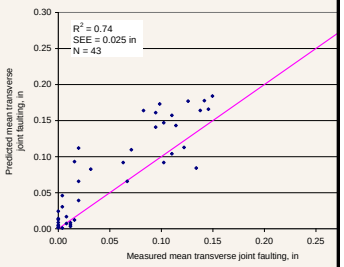
Indiana DOT: MEPDG Guide for Designers

Local Calibration Potential

All models can be adjusted **(Tools, Calibration, Coefs.)**

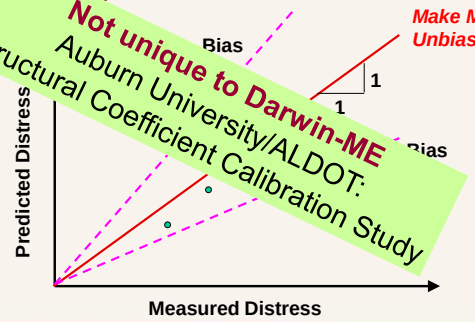
Key effect: **Eliminate "bias" of prediction (significant over prediction or under prediction of distress).**

Possible effect: **Reduce residual of prediction (depends on quality of data).**



Statistical Optimization

ΣE_{rr} ... 0



A few thoughts on calibration:

- **Step 1: Become comfortable with MEPDG as it stands**
- **Step 2: Does it reflect current pavement performance?**
  - Use actual performance data & engineering experience
  - Results from MEPDG will be different than AASHTO 93
- **Step 3: Is there a bias in MEPDG prediction ?**
- **Step 4: Does the MEPDG capture special material properties ?**
  - OGFC, SMA, Polymer, WMA, Rubber Asphalt, etc…
  - Unique Structural Design

Good Calibration and Implementation Document

Montana DOT

http://www.mdt.mt.gov/research/projects/pave/pave_model.shtml

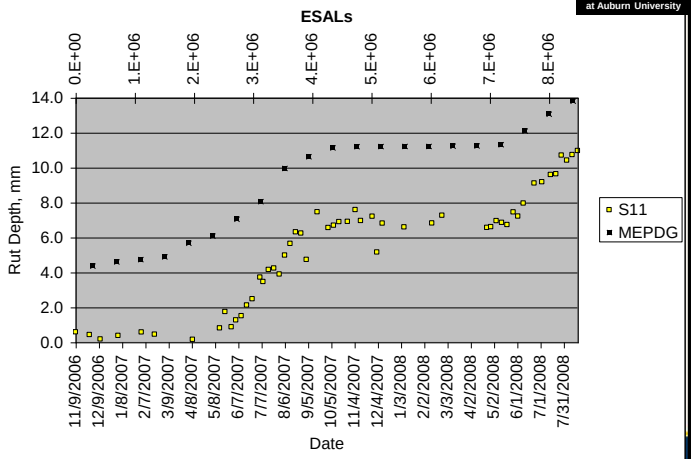
Major Findings:

- Preservation Practice Extend Performance
- Most models adequate for design
- Re-calibrate unbound materials rutting

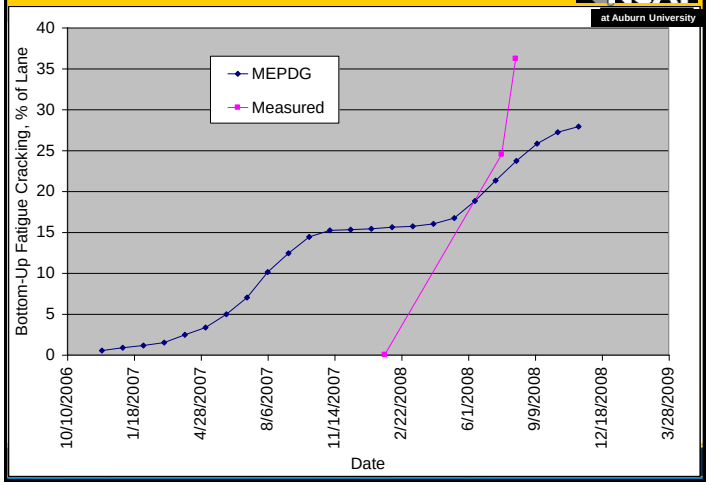
Continual Improvement

- **Continued MEPDG Validation**

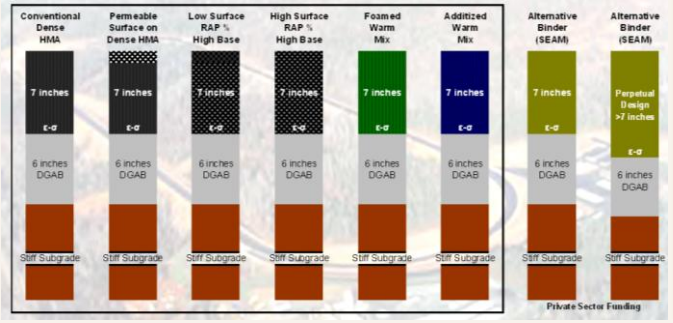
S11– As Built – Rut Depths



S11– As Built – Fatigue Cracking



Continued Validation



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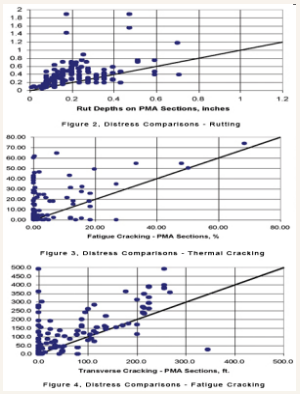
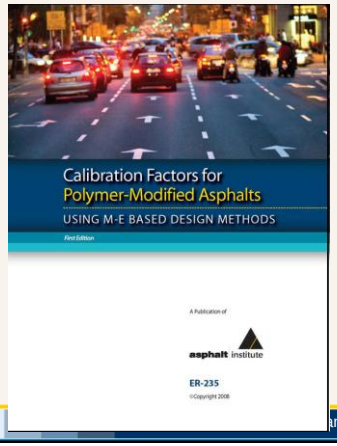
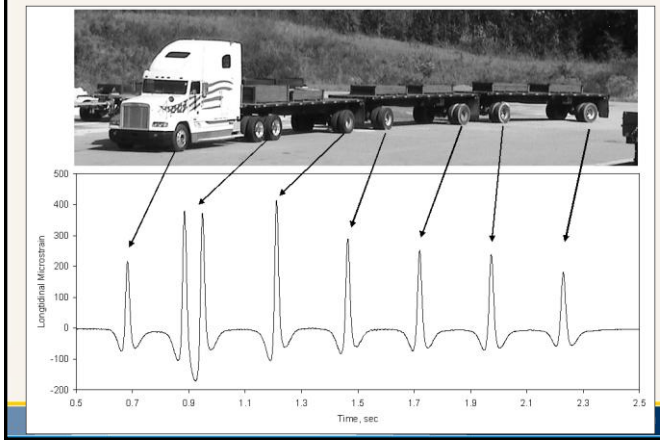
What about Polymers?





Looking at Strains Directly



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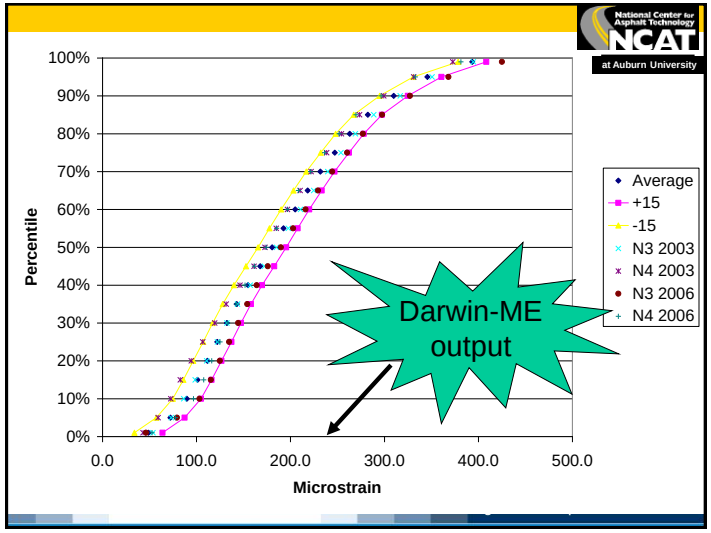


Training Opportunities

NHI #131064 – Introduction to Mechanistic Design

NHI #131109 - Using Mechanistic-Empirical Pavement Design Guide Software

NHI #132040 – Geotechnical Aspects of Pavements

NHI #151018 – Application of Traffic Monitoring Guide

Training / Collaboration Opportunities

FHWA Regional WIM/Traffic Workshop – Boise, Idaho Sept 2009

FHWA Resource Center on request training

MEPDG Regional Meetings

Look out for DARWIN- ME roll out Summer 2010

Previous & On-Going Studies

NCHRP 1-41 – ***Models for Predicting Reflection Cracking of HMA Overlays (2008)***

NCHRP 1-42A – ***Models for Predicting Top-Down Cracking of HMA Layers (2008)***

NCHRP 9-29 – ***Simple Performance Tester for Superpave Mix Design (2008)***

NCHRP 9-38 – ***Endurance Limit of HMA Mixtures to Prevent Fatigue Cracking (2008)***

NCHRP 9-44 – ***Develop Plan for Validating an Endurance Limit for HMA (2008)***

NCHRP 9-44A – ***Validating an Endurance Limit for HMA***

Previous & On-Going Studies

SHRP 2 Project R-21 ***– Composite Pavement Systems***

NCHRP 1-46 ***– Development of AASHTO Pavement Handbook (2008)***

NCHRP 1-47 ***– Sensitivity Analysis of MEPDG (2011)***

NCHRP 4-36 ***– Characterization of Cementitiously Stabilized Layers for Use in Pavement Design and Analysis (not awarded)***

Previous & On-Going Studies

Calibration Documents:

- **NCHRP Digest 284**, December 2003; *Refining the Calibration & Validation of HMA Performance Models: An Experimental Plan and Database*.
- **NCHRP Digest 283**, December 2003; *Jackknife Testing – An Experimental Approach to Refine Model Calibration and Validation*.

FHWA: Use of PMS data for local calibration.

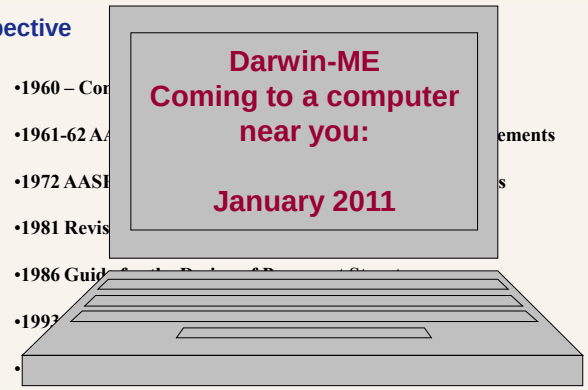
FHWA: Use of deflection basin data in the MEPDG.

What is DARWin ME going to look like?

- **Runtime Improvement**
  - 35-45 minutes to less than 15 minutes
- **Thickness Optimization**
- **Database Structure**
- **New GUI Interface**
- **Backwards Compatible with earlier MEPDG versions**
- **Stand Alone EICM**
- **Sensitivity Analysis**
- **Enhanced Batch Mode features**
- **Structural response output**
- **SI Units**

No Fundamental Theory Changes

Perspective

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$4,317
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