Using PMS Data to Relate Materials & Construction Data to Performance

- Study for FHWA by TRDI as Subcontractor to Battelle with following staff & consultants:
  - Ronald Hudson, PMS Expertise (Project Leader)
  - Carl Monismith, Superpave Expertise,
  - Charles Dougan, AASHTO and DOT Expertise,
  - Pim Visser, Technical Coordination & Support.

- SUPERPAVE USED AS EXAMPLE

PMS Conceived as Framework to Adapt to Local Environment

- Objectives of THD/UT/TTI study in 1960's:
  - Develop descriptions of properties of materials used in roadway structures;
  - Develop measuring properties in manner applicable to pavement design and evaluation;
  - Develop pavement design methods using measured values of material properties, for all locations, environments and traffic loads.
- Goal: formulate overall pavement problem in broad conceptual and theoretical terms

General Structure of Systematic Pavement Management :

Coordinated modules at several organizational levels accessing a common database

PMS COMPONENTS

- Pavement condition analysis
- M&R needs analysis
- Optimize budget allocations
- Prioritize M&R projects
- Select best life cycle strategies
- Design pavement structure
- Program/Track routine maintenance

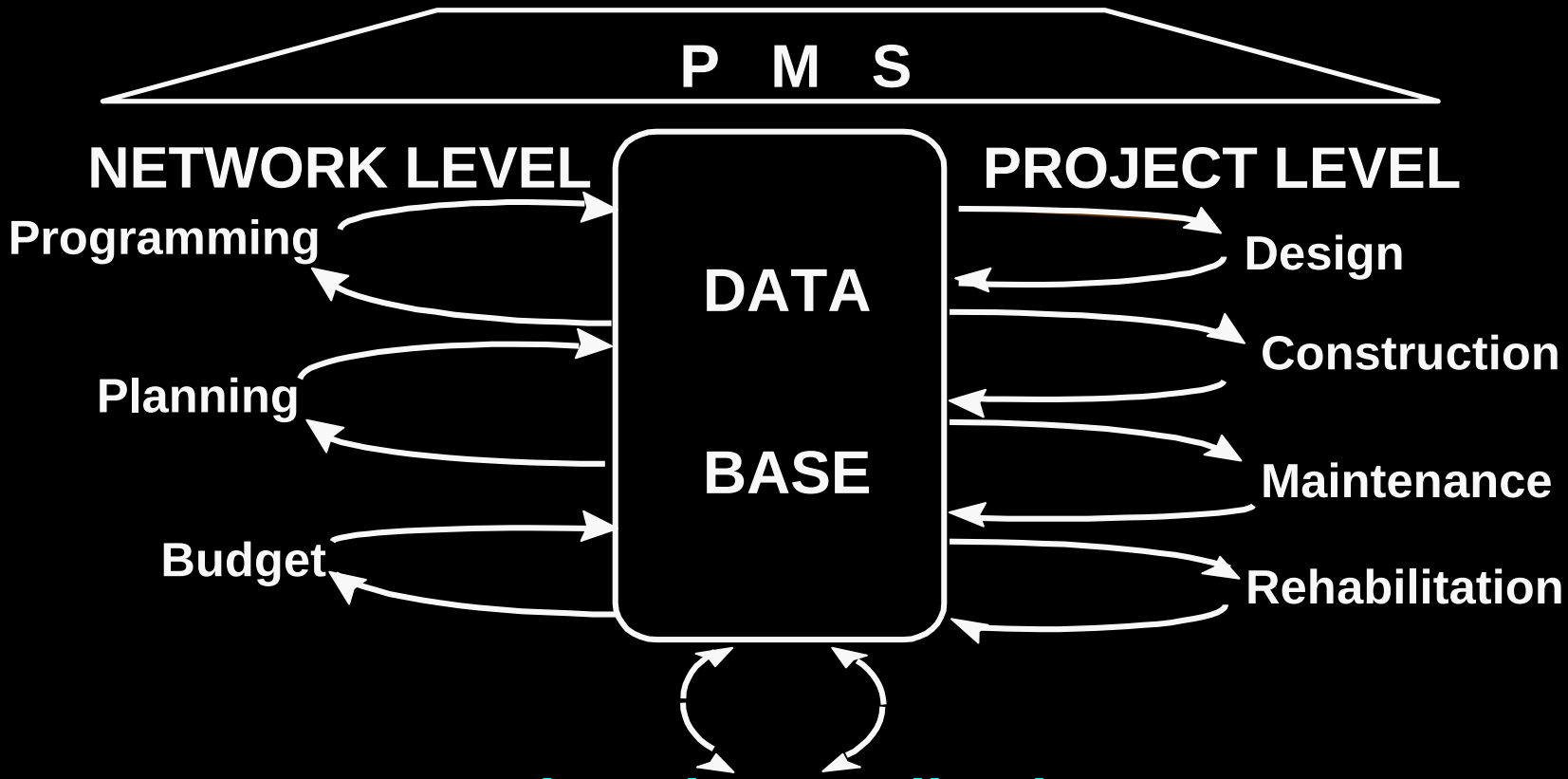
Phase 1 - Collecting Information

- The following States provided valuable information on PMS and Superpave:
  - Maryland SHA Sam Miller & staff,
    FHWA Jitesh Parikh,
  - Indiana DOT John Weaver & staff,
    FHWA Lee Gallivan,
  - Florida DOT Bruce Dietrich & staff,
    FHWA Greg Schiess
  - Arizona DOT Larry Scofield & staff,
  - Washington DOT Linda Pierce & staff
    Univ. of Washington Joe Mahoney & staff.

Phase 2 – Pathfinder Study

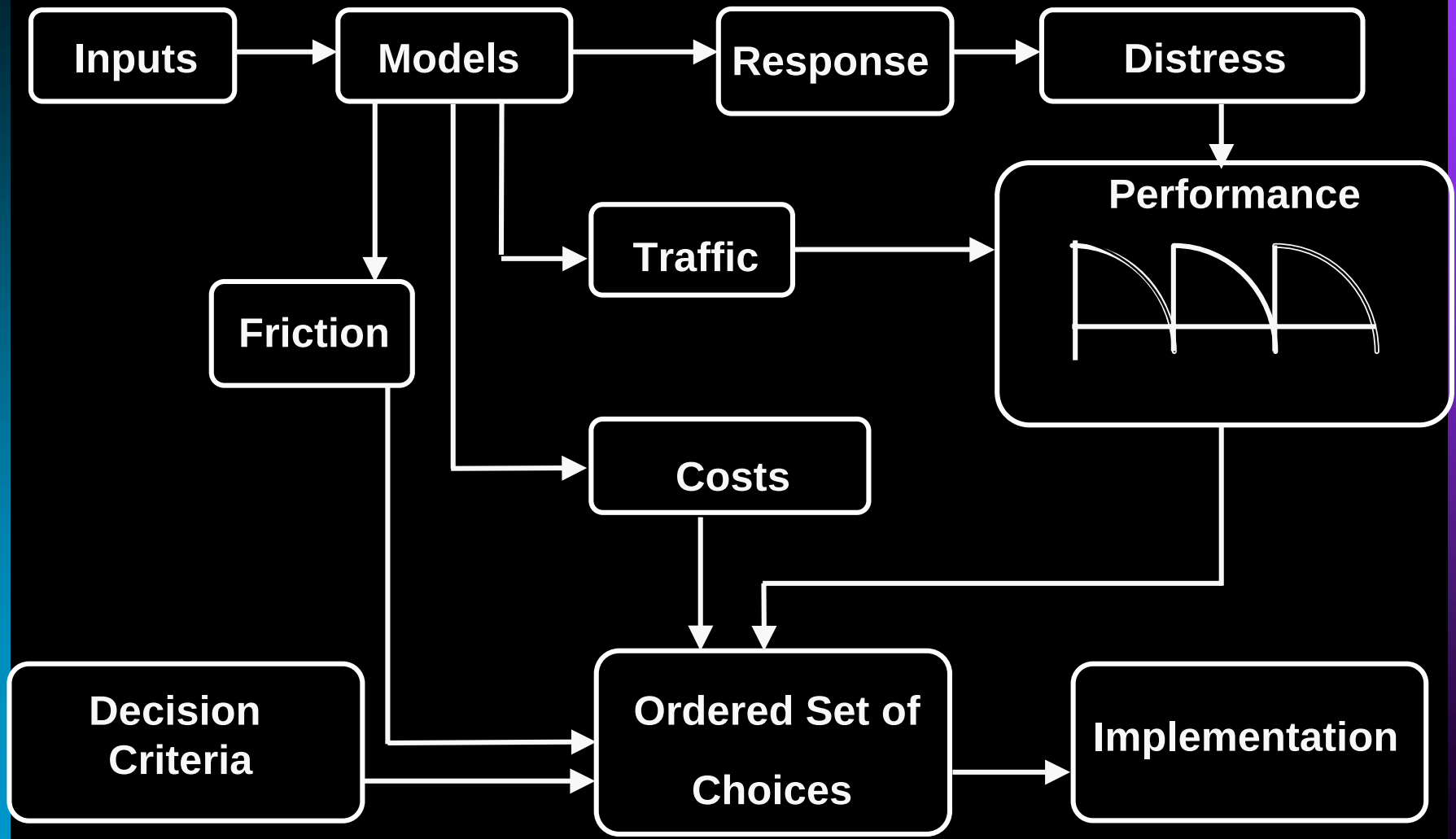
- Pathfinder study in Maryland to:
  - establish what data are required to link performance to materials and construction data,
  - collect all relevant data and put these in electronic format, and
  - load these into web-based system for storage, linking, evaluation and reporting.

Components of Ideal PMS

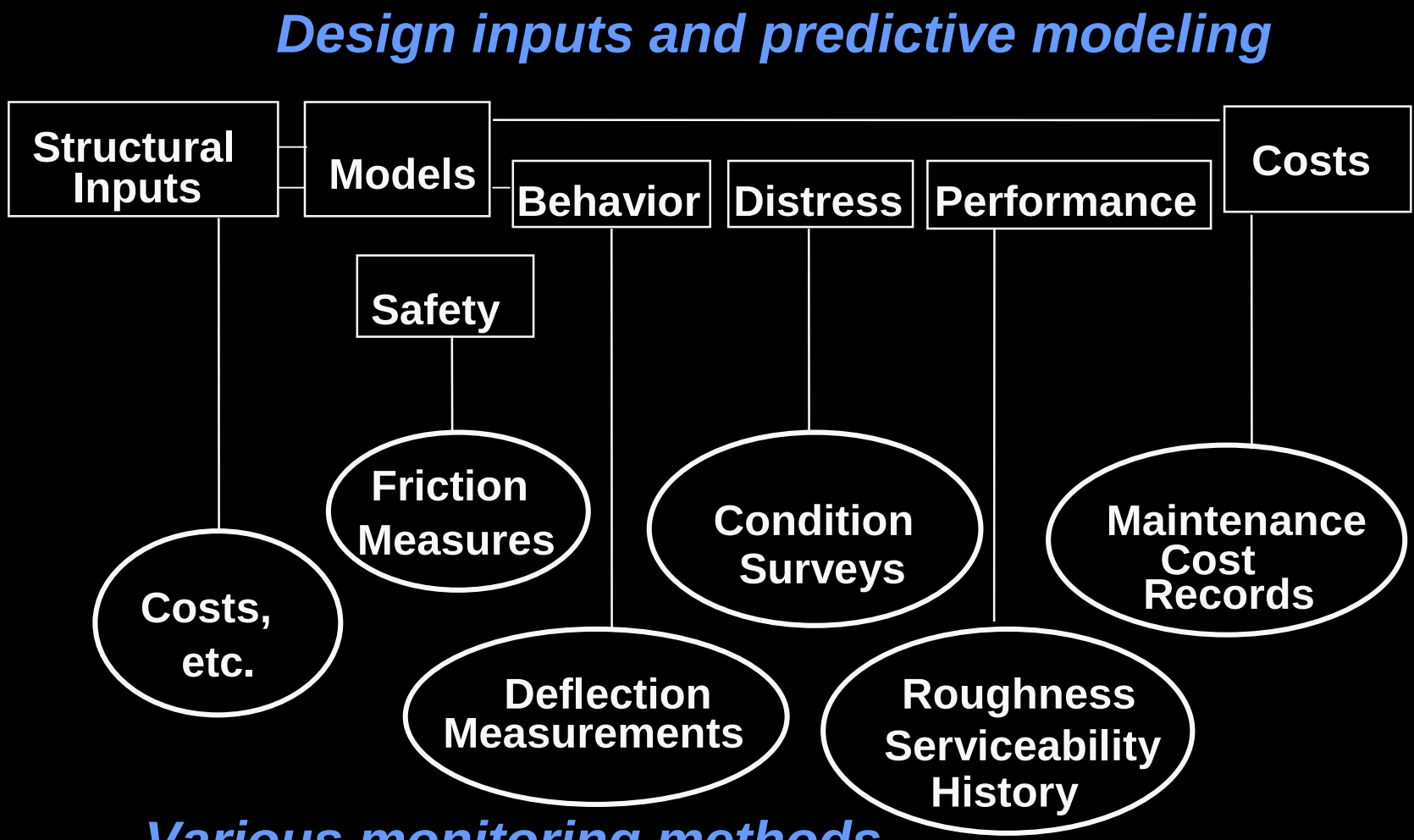


Engineering Applications
i.e. Analysis of Superpave,
Evaluation AASHTO 2002

Major Components of a Project Level Pavement Design System



Uses of Evaluation Information

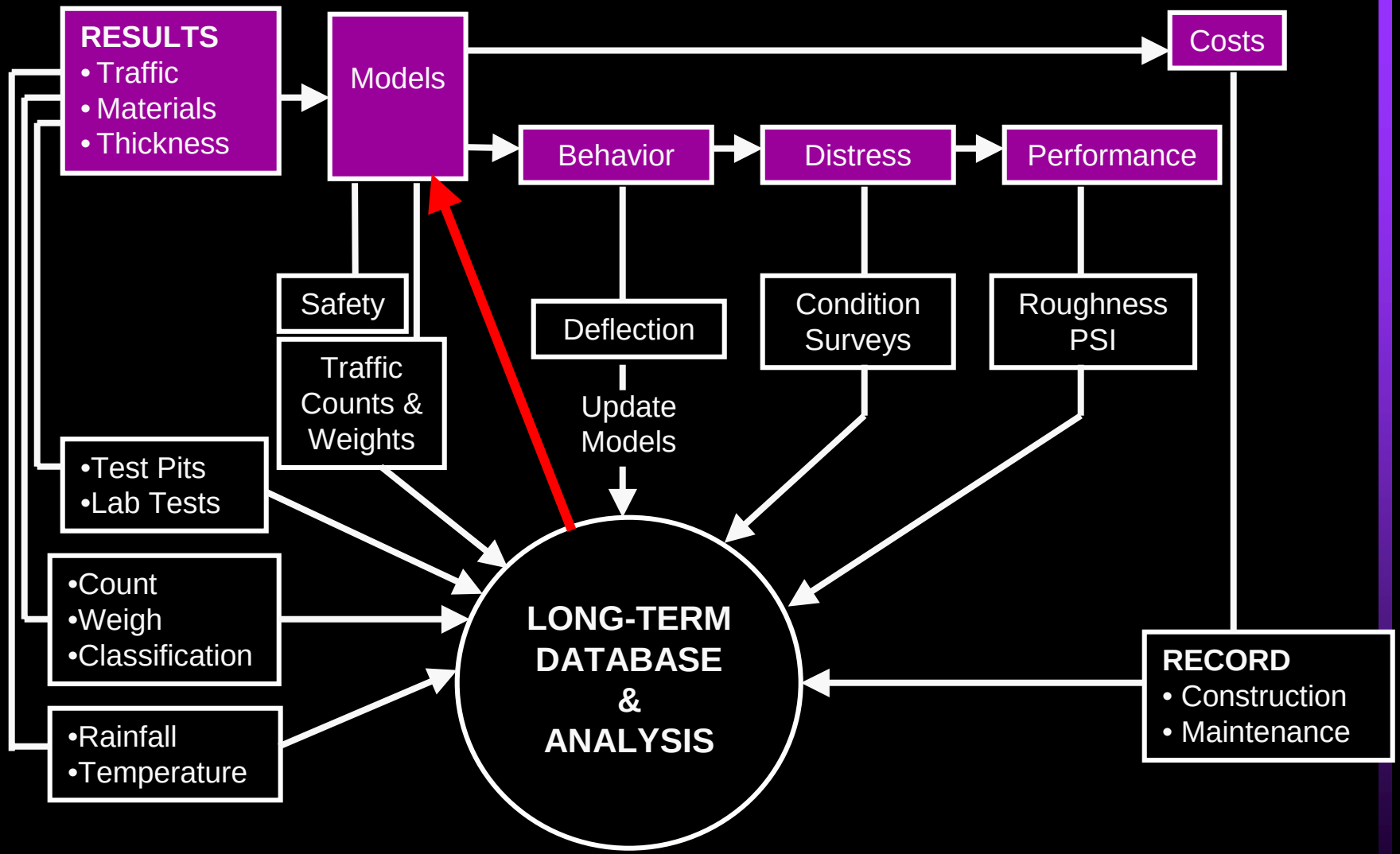


Function of Pavement Evaluation in PMS

- Check design predictions
- Reschedule rehabilitation
- Improve design models
- Improve construction and maintenance
- Updating network programs

A quote by Aaron J. Ihde which properly defines a PMS Database:

“The primary factor in bringing about scientific discovery is not necessity or individual genius, but the relentless pressure of accumulating knowledge”.


RESULTS
• Traffic
• Materials
• Thickness
Models
Costs
Behavior
Distress
Performance
Safety
Traffic Counts & Weights
Deflection
Update Models
Condition Surveys
Roughness PSI
•Test Pits
•Lab Tests
•Count
•Weigh
•Classification
•Rainfall
•Temperature
LONG-TERM DATABASE & ANALYSIS
RECORD
• Construction
• Maintenance

Purpose of PMS Engineering Analysis

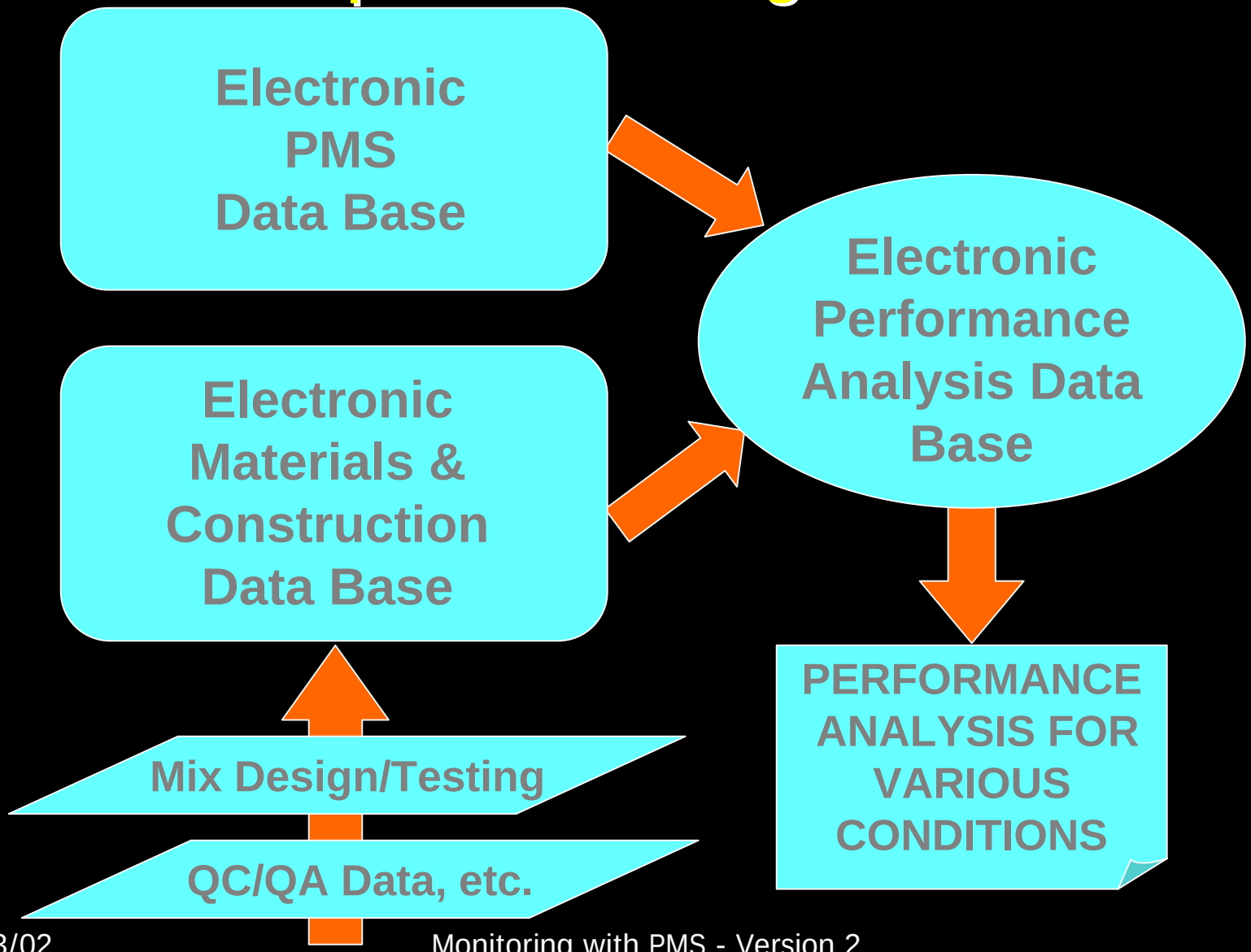
The use of pavement management data to evaluate & improve structural designs (AASHTO 2002), mix designs, materials (Superpave), construction, preservation strategies, rehabilitation, & preventive maintenance of pavements.

But: PMS may not have detailed data!

Sources of Engineering Data other than from PMS database

- Research data files,
- Construction records,
- Mix design and testing records,
- Additional field evaluations,
- Project plans,
- Pavement design data,
- Additional structural evaluation and/or materials testing,
- Maintenance Management Systems.

Concept for Linking Databases



Desirable Components of Electronic PMS Database

- **Common referencing is needed with Project Number, exact Location and Date**
- Climate and Traffic (ESAL and ADT) Data,
- Age of original pavement and last rehab date,
- Details of existing pavement structure,
- Performance Data for various distresses should be linked to exact location (mile post or GPS, Lane and Direction).

Desirable Components of Electronic Materials and Construction Database

- **Common referencing is needed with Project Number, exact Location and Date**
- Mix data, as designed and in-place
- Layer thickness, designed and actual
- Other materials information & construction details
- Effects of maintenance activities
- Batch/lot numbers should be linked to location.

Electronic Performance Analysis Database - Created by Linking

- **Common referencing is needed with Project Number, exact Location and Date**
- Essential materials and construction data linked to performance data through common referencing
- Possible to study effects on performance of materials, construction techniques, traffic loads, climate, thickness design (AASHTO 2002), etc.

Network Analysis Possibilities

1. Assemble Database for adequate number of sections,
2. The more sections the better - large sample statistics very powerful,
3. Several States can combine Data if good coordination at national level is provided,
4. Effects of variables in the Database can be evaluated and analyzed,
5. Early implementation provides impetus to enter data early – Data backlog does not “build-up”.

Project Analysis Possibilities

- Assemble Database for adequate number of lots or batches,
- The more lots the better - large sample statistics very powerful (lots across projects with similar characteristics can combine data),
- Effects of variables in the database can be evaluated and analyzed, such as:
  - Effects of variability in material properties,
  - Susceptibility of materials or techniques to adverse conditions,
  - Assessing best compaction techniques for certain materials, etc.

Current Limitations (1of 2)

- In most cases the materials, construction, and maintenance data are not now tied to PMS data.
- Most agencies store materials and construction data in flat files, so transfer and analysis of data is difficult.
- Not all relevant data are recorded (e.g. in-place thickness is often missing).
- Linking materials and construction data to an exact location is normally not possible.

Current Limitations (2 of 2)

- Performance data are often averaged over a mile. Distress is often sampled over short distances, e.g. milepost only. Normally only one lane is measured.
- Therefore, difficult to link performance data to materials and construction data.
- Maintenance activities, if not properly recorded and referenced, could distort the analysis.
- DOTs need time to implement the new approach in existing structures.

Phase 2: Pathfinder Study

- Maryland SHA agreed to provide PMS, materials and construction data in electronic format,
  - Sam Miller, Larry Michael, Pete Stephanos, Paul Dorsey, Gloria Burke, and others.
- The University of Washington offered to put the MD data in their newly developed web based evaluation system,
  - Joe Mahoney, George White.
- TRDI coordinated.

Data Fields Proposed by MD

QC/QA Data	Mix Design Data
28 fields:	16 fields:
Electronic: 8	Electronic: 9
Paper: 16	Paper: 6
Not available: 4	Not available: 1
Pavement Design Data	**PMS Data**
11 fields:	16 fields:
Electronic: 0	Electronic: 9
Paper: 10	Paper: 4
Not available: 1	Not available: 3

Difficulty of Data Retrieval in MD

SUBJECT	SOURCE FILES	DIFFICULTY
PMS data	PMS data file	easy
Mix design	QC/QA database	easy
Mix QC and QA	QC/QA database	easy
Inventory Information	Project & Design	Medium
Density QC and QA	QC/QA database	Medium
Pavement Design Recomm.	Pavement design	Medium
Pre-overlay condition	Pavement design	Medium
Ride QC and QA	Construction	Hard
Daily & Project Paving	Construction	Hard
Binder & Aggregate tests	Various files	Unable

Website System with Superpave Data

- Developed by University of Washington, Dept. of Civil & Environmental Eng., in cooperation with WSDOT and NCAT,
- Currently used for some data from DOTs of Washington, Missouri, Texas & Maryland,
- Acts as data warehouse, with sorting, viewing, linking, analysis and reporting capabilities.

Advantages of Website System

- Static GIS map location for each project,
- Graphing and Summary functions,
- Data export to Excel available,
- Handles visual images (e.g. infrared),
- Flexible data presentation for each state,
- Data immediately available to all users,
- Easy to use data across projects or states.

Typical Example
QC Data for One Sub-Lot

Superpave
MD 313 in Caroline Co.- Denton to Goldsboro, 5 MD
Completed on 11/17/1999

PROJECT INFO | MIX DESIGN | CONSTRUCTION | PERFORMANCE | ANALYSIS

▪ Summary ▪ QC Summary ▪ QC Data ▪ QA Data ▪ Densities ▪ Operations

Construction Phase: 1

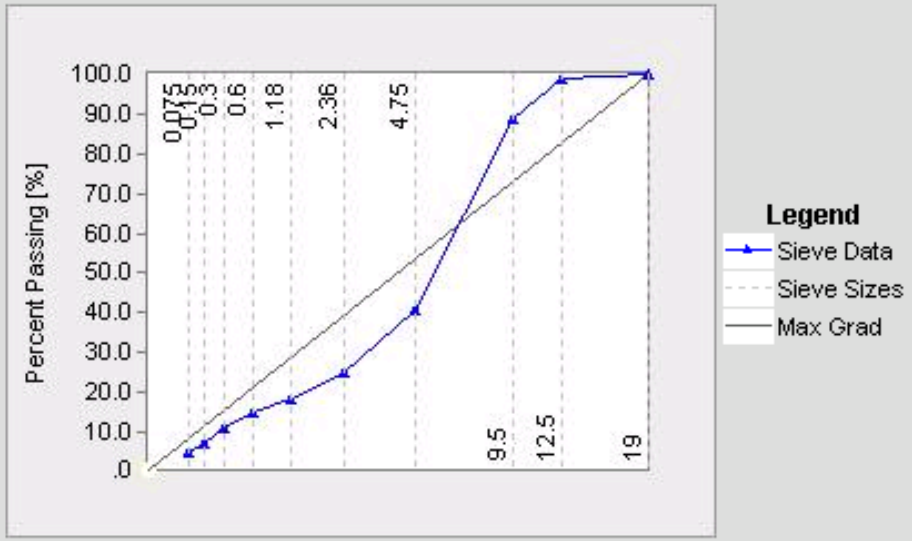
Lot-Sublot **21-10** » Goto:

QC Data:

Lot:	21	
Sublot:	10	
Lot Date:	11/1/1999	
AC:	4.74	[%]
VMA:	14.5	
VFA:	69.2	
Gmb:	n/a	
Gmm:	2.565	
Core Density:	n/a	

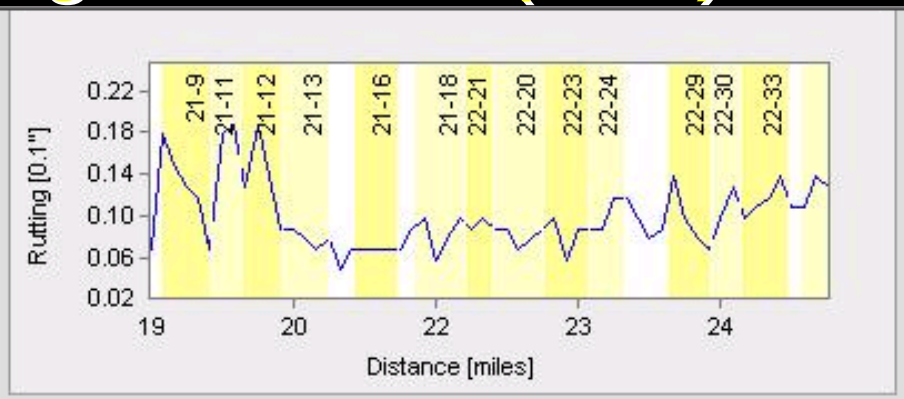
Gradation:

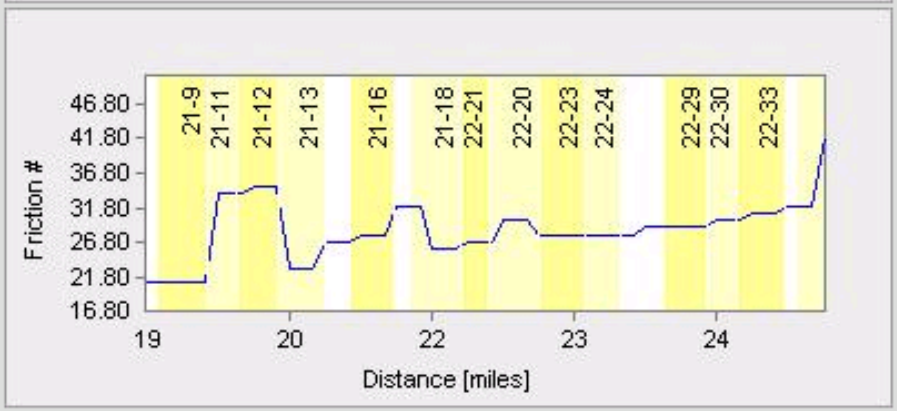
Sieve Sizes:	0.075	0.15	0.3	0.6	1.18	2.36	4.75	9.5	12.5	19	[mm]
Passing:	4.7	7	11	15	18	25	41	89	99	100	[%]



Typical Example
IRI & Rutting for each (Sub) Lot

19.9	20	N	96.06	0.19	34
20	20.1	N	70.01	0.13	n/a
20.1	20.2	N	51.18	0.19	35
20.2	20.3	N	61.02	0.14	35
20.3	20.4	N	100.46	0.09	n/a
20.4	20.5	N	107.65	0.09	23
20.5	20.6	N	90.33	0.08	23
20.6	20.7	N	112.73	0.07	n/a
20.7	20.8	N	75.16	0.08	27
20.8	20.9	N	68.55	0.05	27
20.9	21	N	57.75	0.07	n/a
21	21.1	N	86.22	0.07	28
21.1	21.2	N	112.09	0.07	28
21.2	21.3	N	90.89	0.07	n/a
21.3	21.4	N	122.28	0.07	32
21.4	21.5	N	129.71	0.09	32
21.5	21.6	N	123.18	0.10	n/a
21.6	21.7	N	65.37	0.06	26
21.7	21.8	N	56.93	0.08	26
21.8	21.9	N	105.31	0.10	n/a
21.9	22	N	140.78	0.09	27
22	22.1	N	135.58	0.10	27
22.1	22.2	N	114.05	0.09	n/a
22.2	22.3	N	94.17	0.09	30





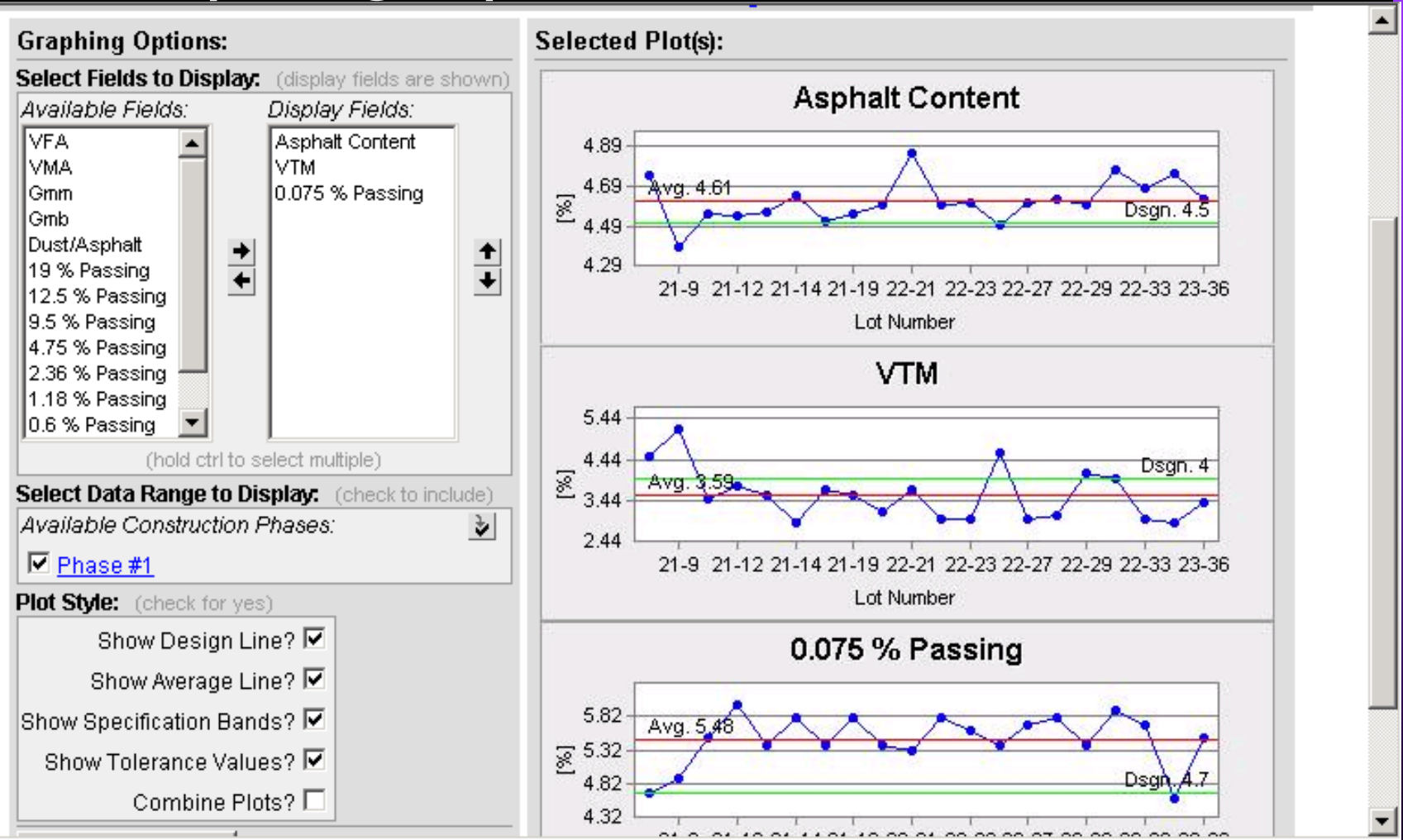
Plot Style: (check for yes)

Show Paving Lot Locations? ☑

Consider Lot w/ Tonnage > 600

Refresh Plot

Typical Example
Graphing Options for Volumetrics



Possible Evaluations At Network Level

- Binder content vs rutting,
- Fines (passing P200) vs rutting,
- IRI of several projects by year,
- Rutting of several projects by year,
- IRI vs use of Material Transfer Vehicle,
- IRI vs night/day paving,
- IRI vs surface preparation.

Possible Evaluations At Project Level

- IRI by year,
- Rutting by year,
- IRI vs distance/lots,
- Rutting vs distance/lots,
- IRI vs use of Material Transfer Vehicle,
- IRI vs night or day paving,
- IRI vs surface preparation.

Advantages of Concept for a DOT

- Existing pavement network can be used as road test:
  - Evaluate different materials, techniques, design concepts, etc
  - Produce more accurate pavement prediction models
- Pavement preservation can be done more accurately
- Data are entered only once, and data warehouse allows easy storage, retrieval, linking, analysis and reporting.

Organizational Hurdles to be taken

- Resistance to change
- Fear for loss of control at group levels in DOTs
- Lack of funds
- Problems to standardize performance indices
- Fear that data are misused or that confidential data show up outside the DOT
- Information Technology Dept. might resist the shift from Mainframes to Servers.

Technical Hurdles to be taken

- Linking performance data to materials & construction data can be difficult because:
  - Performance data are often averaged over a mile,
  - Distress is often sampled over a short distance only at each mile point,
  - Normally only one lane is measured.
- Maintenance activities, if not properly recorded and referenced, could distort the analysis

Specific Actions -Superpave

- States need help to implement this concept,
- Needed: a champion for the multi-state project, i.e. AASHTO Committee, FHWA representative, State representative,
- A State willing to actively be the lead state in a Superpave Multi-state Project,
- Funding,
- Support by FHWA and AASHTO.

Specific Actions – AASHTO 2002

- Recognizing the need to evaluate the 2002 AASHTO Pavement Design Guide – New concept, not implemented or proven,
- Needed: early planning to set up outline of monitoring study before large usage develops – get ahead of the game,
- A State willing to actively be the lead state to promote the Project,
- Funding,
- Support by FHWA and AASHTO.

CONCLUSION

Good PMS Data Can Be Used to Evaluate Materials, Techniques and Design Concepts