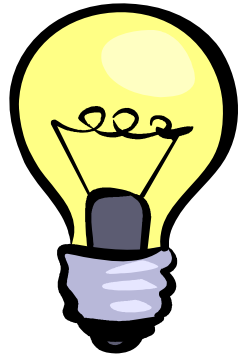
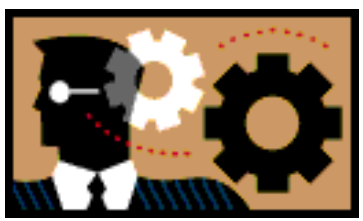


New Methods in Asphalt QA/QC Testing



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Common QC/QA tests

- Gradation of Individual Stockpiles
- Moisture Content of Aggregates
- Viscosity Testing of the Asphalt Binder
- Moisture Content of Mix
- Asphalt Content: Ignition test or Nuclear AC Gauge
- Gradation of Recovered Aggregate
- Maximum Theoretical Specific Gravity of the Mix
- Laboratory Density using the Gyratory Compactor
- Temperature of the Mix
- In-place (Roadway) Density of Compacted Mat
- Joint Density
- Smoothness of Mat

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QC/QA State of Practice

- Over the past 20 years, many changes have been made in quality control and acceptance of HMA.
- More responsibility for testing has shifted to the Contractor.
- Specifications have become more complex.
- Additional tests are required being for product Acceptance.
- HMA production rates have increased. QC focus is on testing the end product and not **controlling the process**.

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And those dang researchers…

- Are constantly coming up with new tests, such as:
  - Permeability testing
  - Thermal imaging for identifying temperature and/or mix segregation
  - Bond strength testing
  - So called simple performance tests
- If we are demanding higher quality, is the answer more tests?

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Fundamental Questions to Ponder?

- What should the owner agency test/measure to assure that it has received quality materials and construction?
- What should the contractor test/measure to assure that it has produced quality materials and construction?
- Are the tests necessarily the same?
- Do the tests ensure good performance?

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The Answer is…

- I don't know
- It depends
- It begins with NO

So how can we make the situation better?

- I don't know
- Let's use new technology

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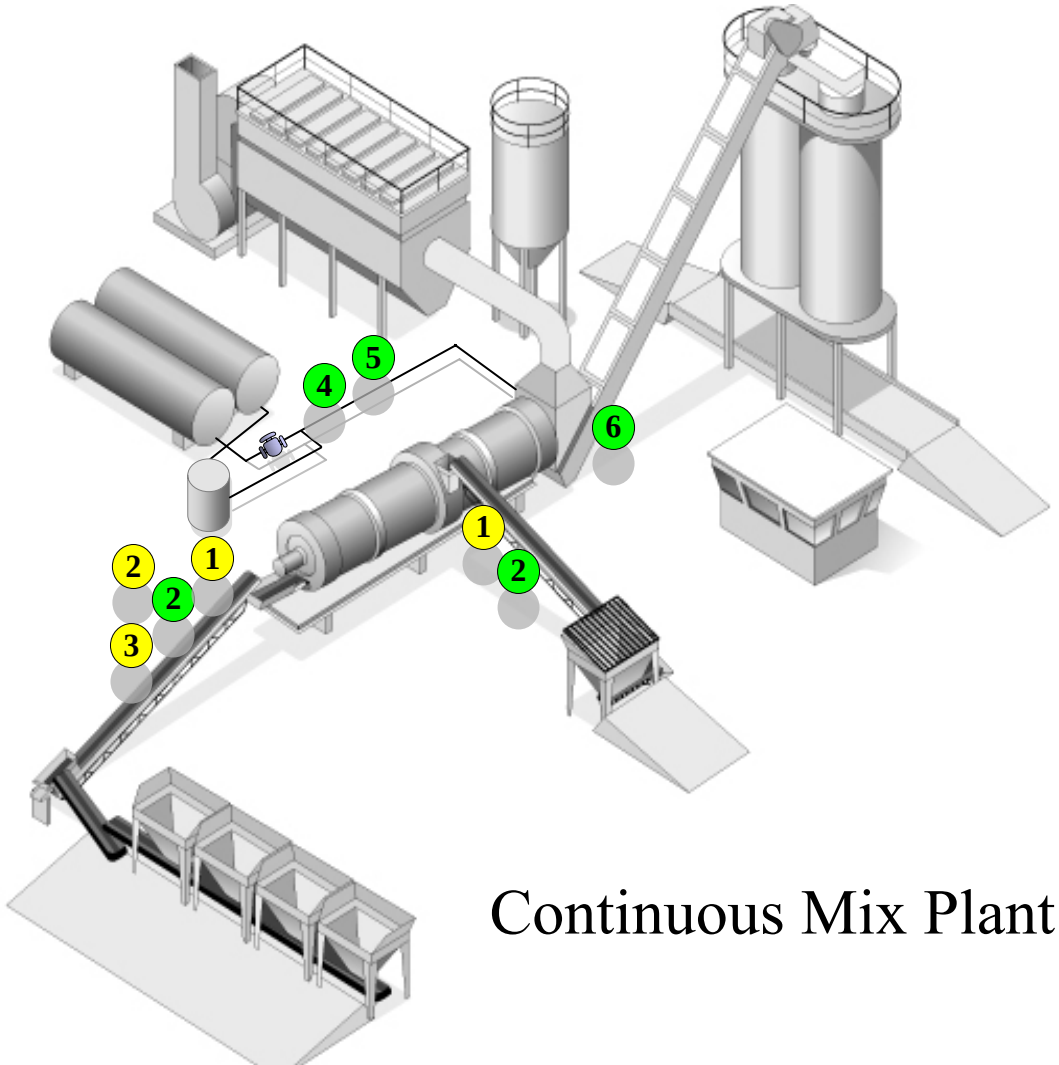
Automated QC Technologies

1. Belt Sampling
2. Moisture Content
3. Gradation
4. Binder Viscosity
5. Asphalt Content
6. HMA Temperature



Continuous Mix Plant

Possible Advantages of Automated QC Tests

- Faster results
- More frequent data
- More consistent data

- All should lead to better decision making and higher quality HMA

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Belt Sampling Devices

- a.k.a. – Belt Sweeper
- Removes a sample of aggregate while the plant is running.
- Belt sampler on the aggregate incline conveyor and the RAP conveyor.
- Sized for belt capacity (production rate) and desired sample mass.

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Belt Sampler

- A mature technology.
- Appears to do a good job of sampling aggregate and RAP.
- Sampling material at drop off from head pulley may be better.

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Automated Moisture Contents

- Accurate moisture content of aggregate and RAP are needed to adjust belt scale readings for continuous mix plants.
- Accurate moisture contents are also needed to evaluate the efficiency of the plant's drying system.
- Current practice of measuring moisture contents of aggregates is labor and time intensive.

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Moisture Content of Materials

1. Microwave Moisture Probes
   - Continuous or discrete measurements
2. Automated sample Drying Unit (ADU)
   - Discrete sample measurements
   - Used in conjunction with automated sample gradation device

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Moisture Content Probes

- Measure moisture content of aggregate on belt using microwave technology.
- Requires calibration for each mix.
- Data can be used to adjust weight reading of the belt scale.

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Moisture Content Probes

- Retractable system to minimize probe wear - gives only discrete measurements.
- Funnel device added to crowd RAP onto probe face.

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Aggregate Sample Drier

- Receives sample from belt sampler and dries it.
- Programmable sample size
  - Usually 8 to 14 Kg
  - if sample mass is below the limit, then another belt sweep is made.
- Electrically heated chamber with air blown through sample.
- When constant weight is reached, test ends and sample drops to automatic gradation unit

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Automated Moisture Content

- Using microwave probes mounted on aggregate incline belt requires time consuming calibration for each mix.
- Alternate microwave probe locations should be evaluated.
- The prototype automated drying unit is slow, needs additional development.

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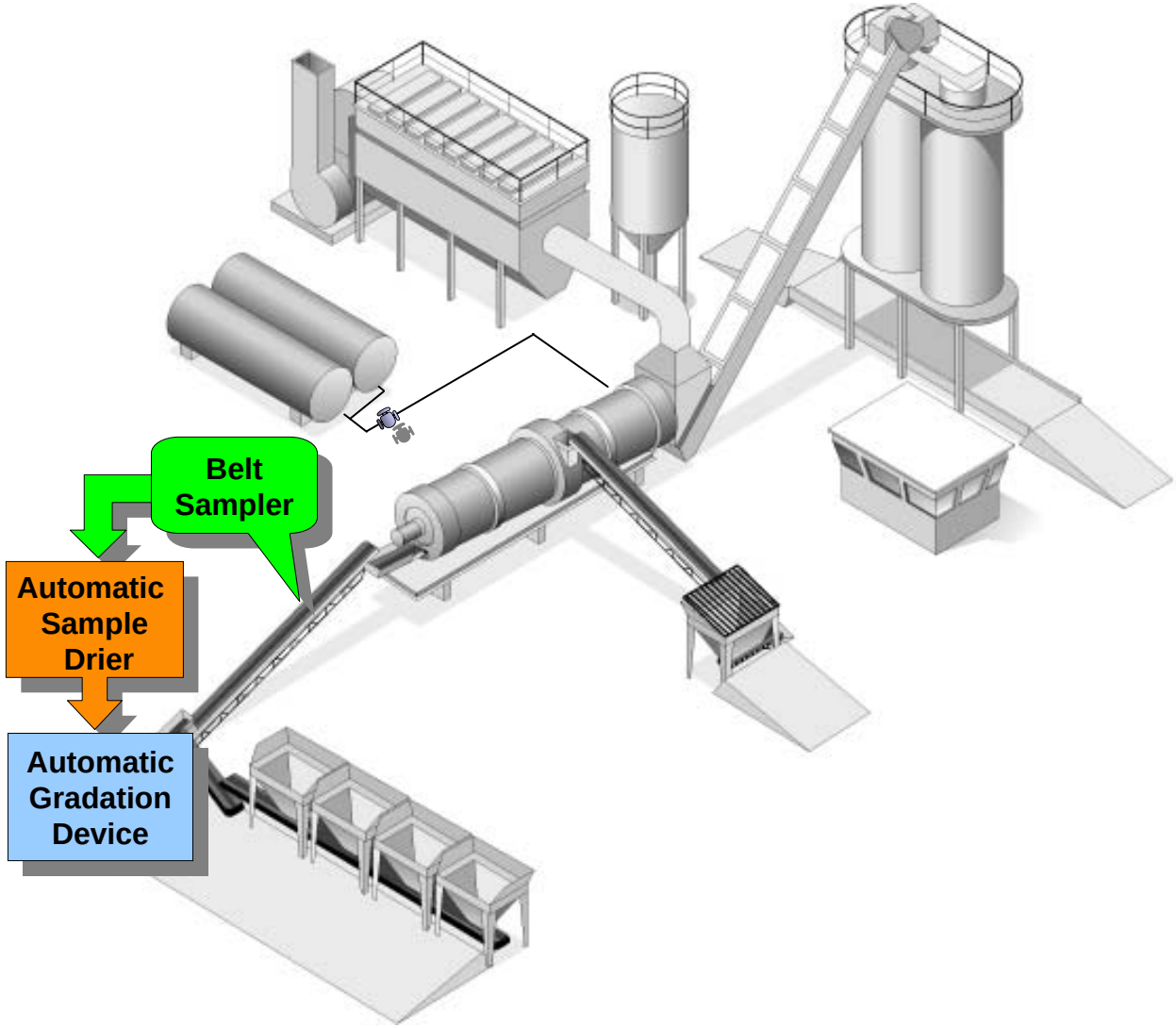

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Automatic Gradation Unit

Sieves

12.5 mm

9.5 mm

4.75 mm

2.36 mm

0.60 mm

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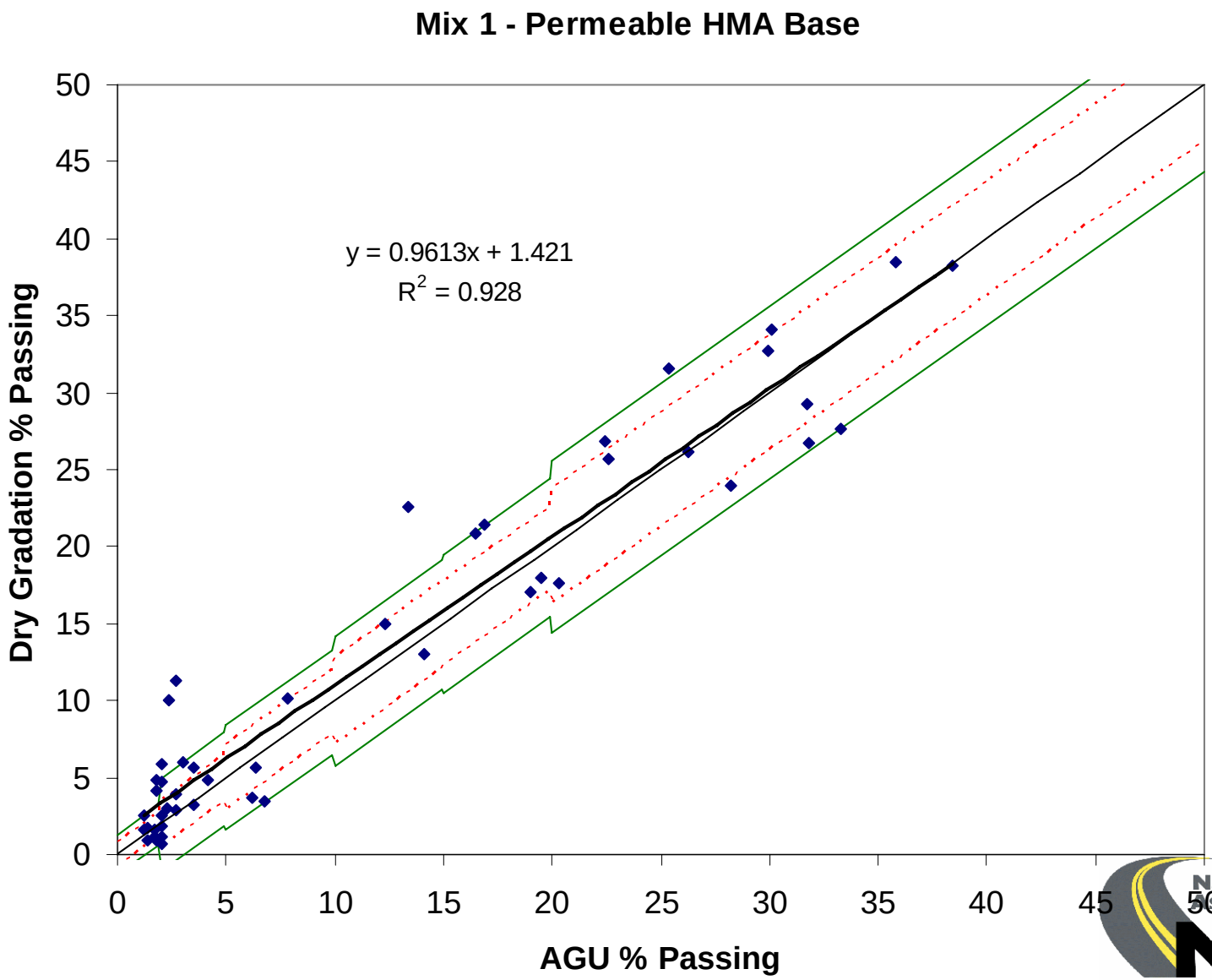
AGU versus Lab Gradation



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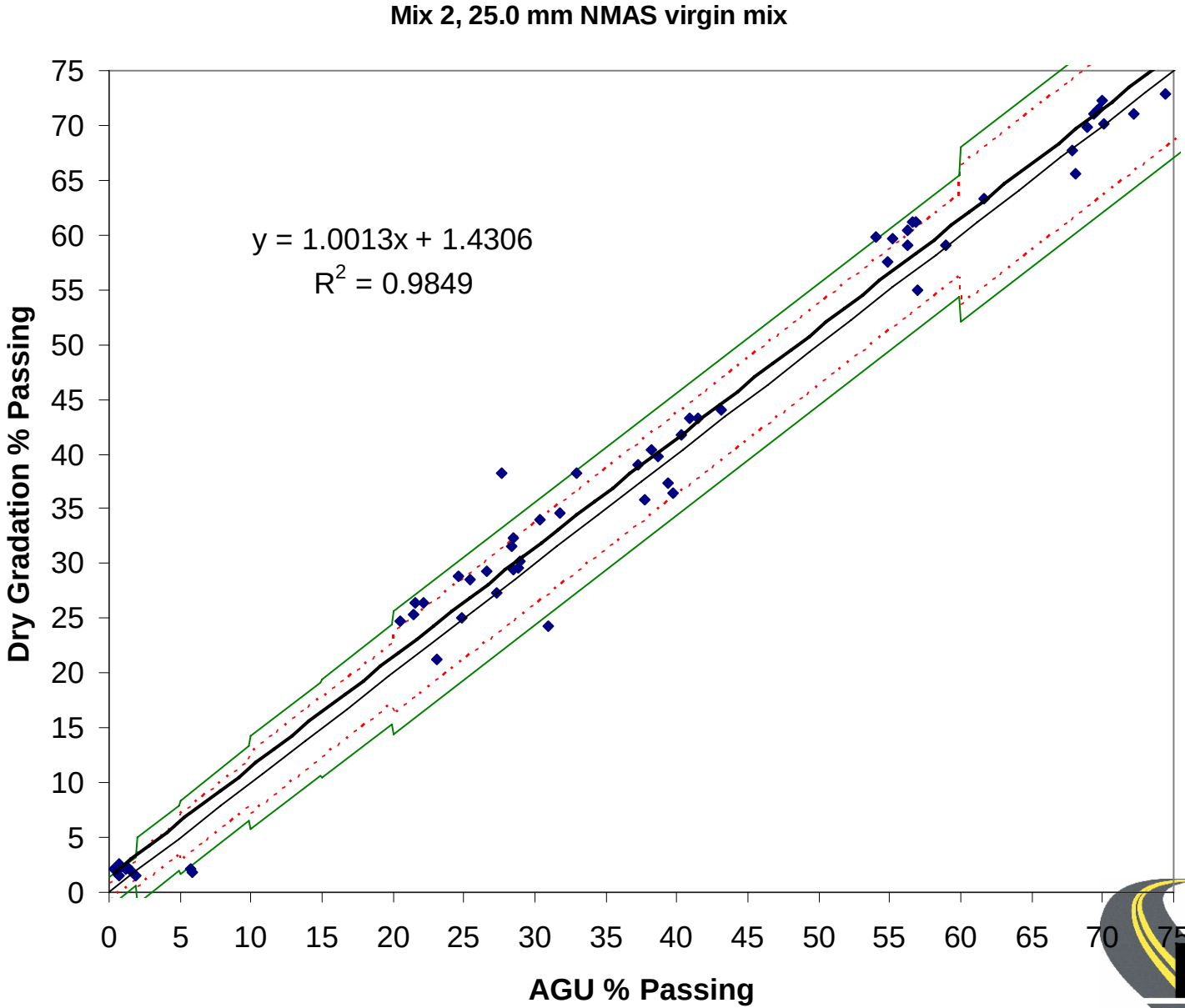
AGU versus Lab Gradation



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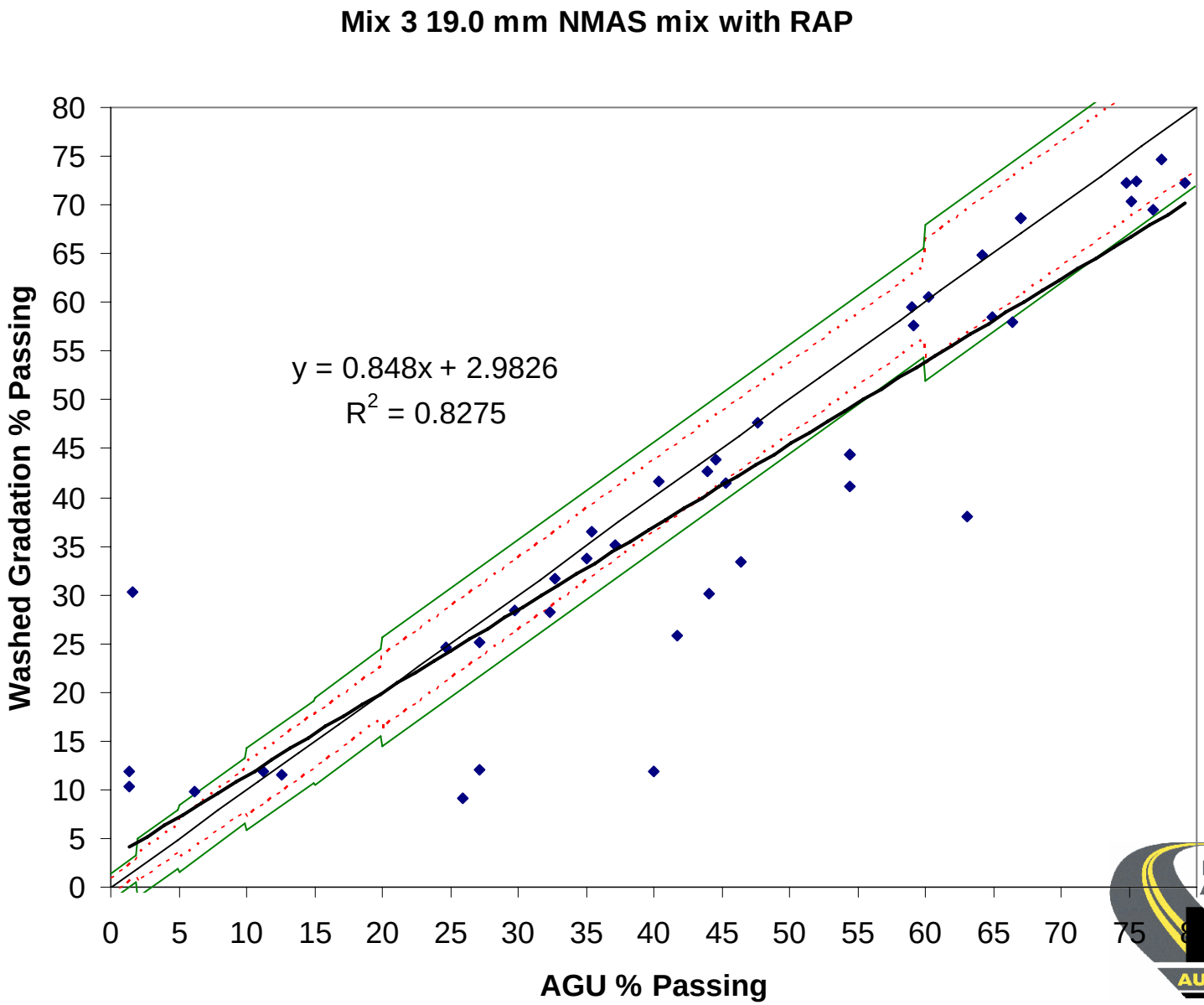

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Automated Gradation of Aggregates

- Prototype AGU works reasonably well, some improvements are needed.
- Technician-free results
- Current limitations:
  - Only six sieves
  - Dry gradation only
  - Unable to determine RAP aggregate gradation

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Other Automated Gradation Technologies

- Video (vision) based gradation devices
  - Gradation
  - Particle shape and texture
  - e.g. J.M. Canty Inc., used by Rinker quarry near Miami
- New automated washed gradation system
  - Plant scale system is being designed from a laboratory device
  - Moisture content of aggregate part of process
  - Agg Master from Castonis & Assoc.

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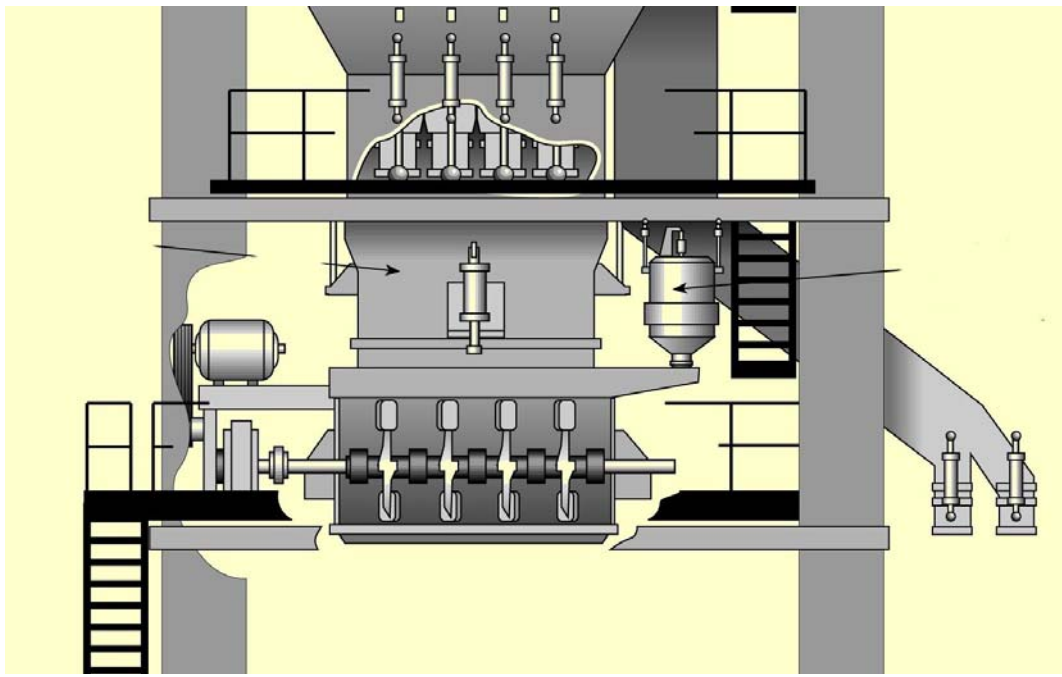
Automated Asphalt Content

Batch Plants

$$\%AC = \frac{\text{Asphalt Mass in Batch (tons)}}{(\text{Asphalt Mass} + \text{Dry Aggregate Batch Mass (tons)})}$$



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Automated Asphalt Content

Continuous Mix Plants

$$\%AC = \frac{\text{Binder flow rate (tons/hr)}}{(\text{Binder flow rate} + \text{Dry aggregate flow rate (tons/hr)})}$$

- Dry aggregate flow rate is determined from belt scale and moisture content measurements
- Assume that fine aggregate removed by dryer exhaust system is returned at the same rate to the mixing point

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Asphalt Content Using the Plant's Automated Controls

Binder flow rate (gal./min. → tons/hr) is continuously measured with a meter or a non-powered, positive-displacement pump.

Aggregate and RAP feed rates (tons/hr) are measured with belt scales, tachometers and a computer integrator.

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Belt Scale Calibration

- Proper calibration of belt scales using material over the weigh bridge and diverted to a tared truck.
- Better standards are needed on plant calibration
  - Methods
  - Training
  - Frequency
  - Documentation

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Asphalt Meter Calibration

- Calibration tanks can be used to verify the asphalt meter
- Hands-free, therefore safer, faster, and more accurate

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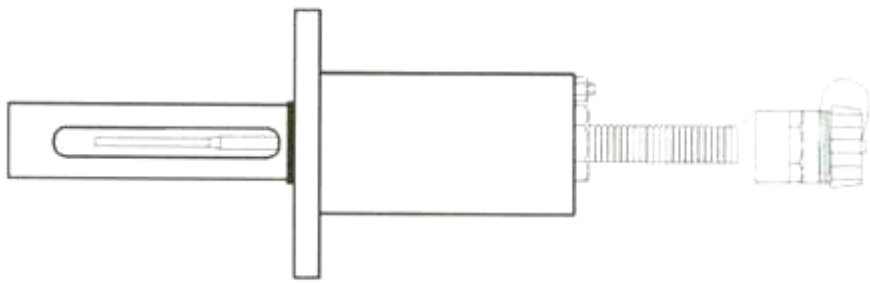
In-Line Viscometer & Temperature System

- Measures the viscosity & temperature of the binder.
- Mounts in line from AC tank to injection point.



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Automated Binder Viscosity

- Viscosity appears to be a simple indicator of binder grade.
- Variability of some in-line measurements need to be further investigated.
- Other binder modification systems need to be evaluated.

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Mix Temperature Gauge

- Mix temperature is often monitored by the plant operator, usually at the point of discharge from the mixer.

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Mix Temperature

- Automated measurement of mix temperature is important and it works.
- We should make better use of this information.
- Future work should consider locating IR temperature sensor at loadout point and print mix temperature on ticket.

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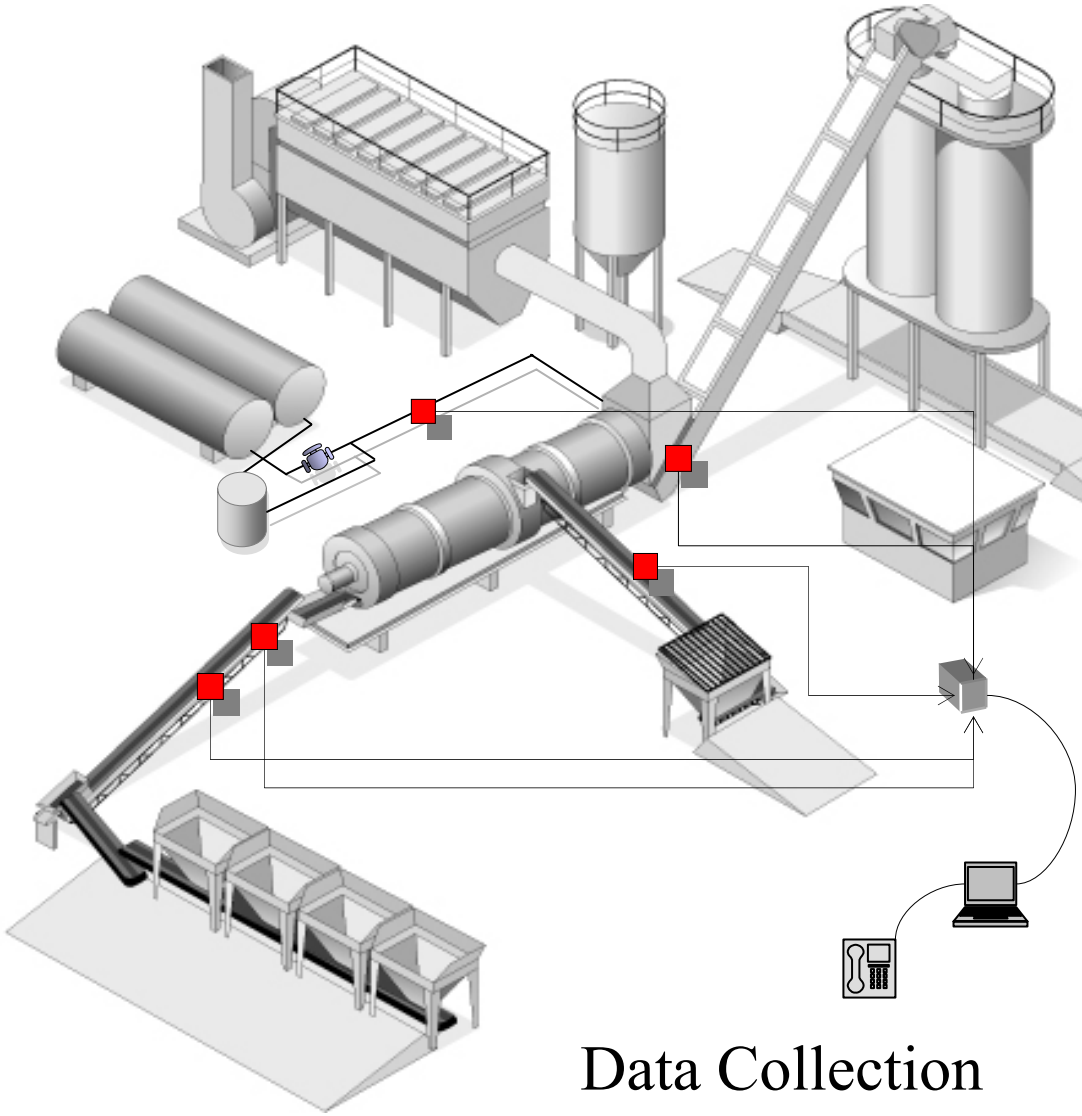

Data Collection
Data Management

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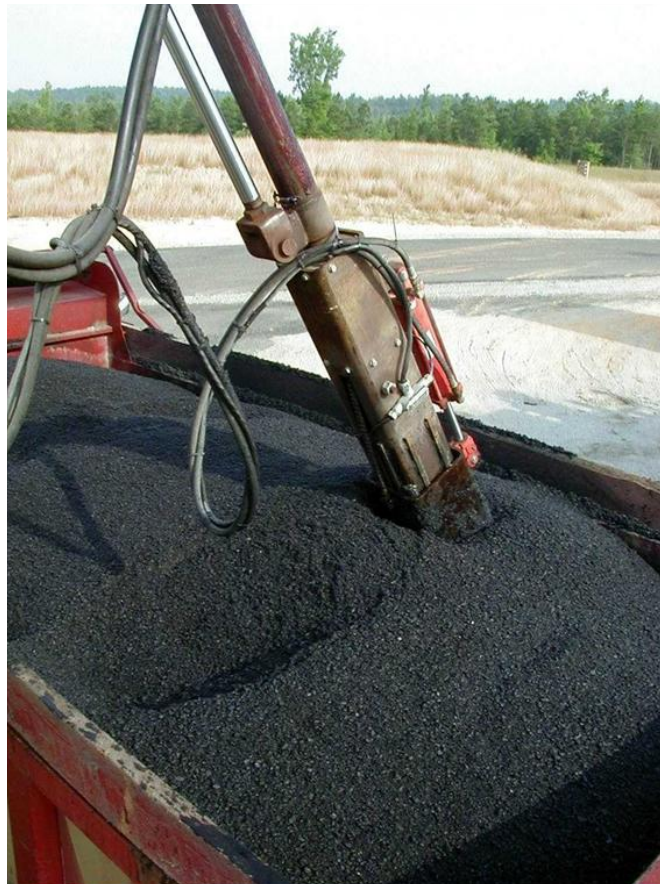
Robotic Truck Sampling



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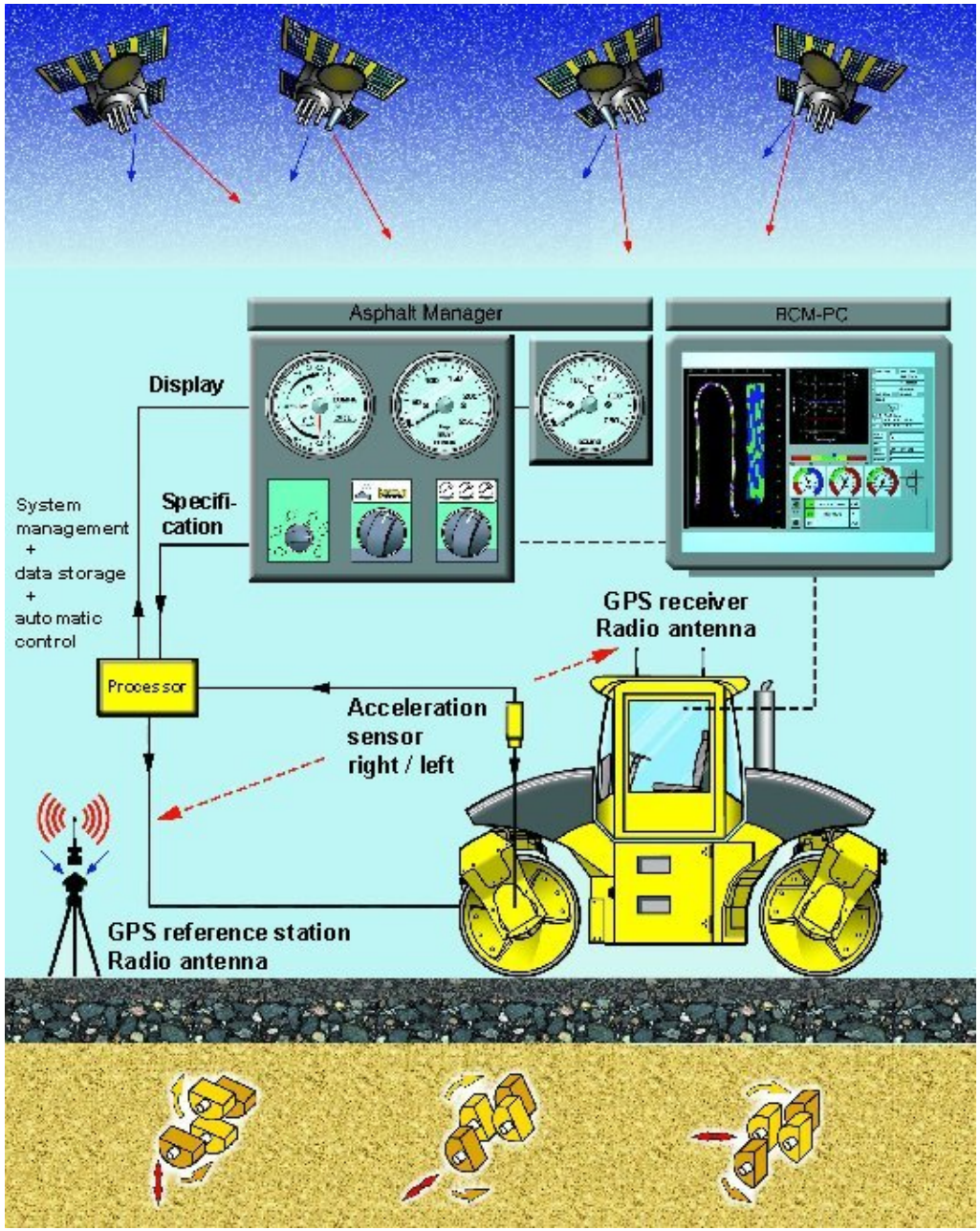
Intelligent Compaction



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Down the Road

- This is the 1st Step
- Improvements can be made with modifications
- Other automated technologies are being developed
- Information gaps need to be filled by new technologies
- Looking for ideas from other industries

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Thank You