Equipment and Operator 101
Equipment Automated Grade Controls
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Contents
- Industry trends driving technology in Heavy & Highway Construction
- Traditional Grade Control and New 3D Control Methods
  - 3D Technology for Pavers
  - 3D Technology for Milling Machines
  - Intelligent Compaction for Asphalt Compactors

Industry trends driving technology in Heavy & Highway Construction
- Transfer of responsibility from the owner to the contractor for the survey, design and construction
- Result: Use of survey and design data in the construction stage
  
  Most projects currently
  Design and Build projects becoming more common
Industry trends driving technology in Heavy & Highway Construction

- Building quality and long lasting pavements
- Result:
  - Increased adoption of 3D controls on machines (e.g. GPS)
    - Lays to a design
    - Quality control tool
  - Result:

- A stronger end-user focus for the construction process
  - Projects on time and budget
  - Reduced lane closures
- Results:
  - Increased adoption of 3D control with the benefit of doing the job faster:
    - No rework
    - No stakes and wire to be set
    - Reduced third party dependence

Traditional Grade Control

Control Box

CS200 Contact Sensor

Slope Sensor
Traditional Grade Control

- **Upside**
  - Easy to set-up and operate
  - Lower upfront cost
  - Crew is familiar with it

- **Downside**
  - No millimeter accurate thickness control
  - More manual intervention, risk to consistency
  - Stringline required for accurate variable depth control
  - No log of grade laid afterwards for Qc

3D Control is moving through the Construction Cycle

- Measure
- Design
- Bulk Earthworks
- Compact
- Pave
- Fine/Base Grading

New roads
From initial survey to finish surface

3D Control is however new to resurfacing jobs

- Measure
- Design
- Mill
- Compact
- Pave

Resurfacing
From initial survey to finish surface
3D Paving – What is it?

3D Designs

- The design is critical
- If the design is wrong the surface is wrong
  - Less important in grading “Because the paver can smooth it out”
  - You are the paver
  - The last chance to get it right

- Less important in grading “Because the paver can smooth it out”
3D Paving - What issue does it solve?

- **Project Issue:** Lay material where there is **no reference surface**
- **Benefit 3D Paving:** Eliminate the stringlines!

What issue do we solve?

- **Project Issue:** Lay complex designs
  - E.g. Transitions, super-elevated curves, variable drainage angles, ...
- **Benefit 3D Paving:** Screed grade and slope automatically adjusted to design

What issue do we solve?

- **Customer Issue:** Take out **long longitudinal roadwaves**
- **Benefit 3D Paving:**
  - Ability to improve smoothness without stakes
Why can 3D smooth long longitudinal roadwaves better than traditional 30 feet averaging beam systems?

Original Surface with longitudinal roadwaves

Surface after paving with a traditional averaging beam system

Surface after rolling: roadwaves not entirely gone yet

Why can 3D smooth long longitudinal roadwaves better than traditional 30 feet averaging beam systems?

Original Surface with longitudinal roadwaves

3D Paved surface before compaction

3D Paved surface after compaction

New road design with compaction factor (e.g. 1.25)

3D Paving - Applications

- Variable depth and slope paving for airports, roads and commercial surfaces
  - Both base material and asphalt
3D Paving - Other Applications

- Tunnels

3D Paving – Other Applications

- Sports surfaces
  - Running tracks
  - Tennis courts

3D Paving – Other Applications

- Concrete Treated Base – Advantages 3D Paving
  - Normally no grade references
  - Maximizing thickness can save more expensive asphalt material
3D Paving – Other Applications

- Roller Compacted Concrete- Advantages 3D Paving
  - Final surface for industrial terrains
  - Same advantages as for Concrete Treated Base

3D Paving Benefits Summary

- Stringless
- Higher accuracy, improves your yield
- Handles complex designs

3D for Milling Machines
3D Milling Specifications - Components

- Total Station for grade check and leapfrogging
- Cross Slope Sensor
- Control Box
- Radio
- 3D Target

Advantages of 3D Milling #1:
Increased Production: Only mill where required

Target application 3D Milling

- Application: Variable depth and slope milling for renewing deteriorated road or runways
Advantages of 3D Milling #1:
Increased Production and less Milling Cost

Advantages of 3D Milling #2:
Increased Smoothness
- Take out longitudinal road waves and longitudinal high and low spots
- No stakes required!

The issue of differential compaction when paving:

Previous 3D milling takes away the issue:
Advantages of 3D Milling #3: Decreased asphalt usage

- Asphalt filling of low spots
- 3D Milling minimizes asphalt usage

Advantages of 3D Milling #4: Mill complex designs

- Variable depth and slope milling enables milling of:
  - Transitions
  - Super-elevated curves
  - Variable drainage slopes
  - Longitudinal waves in the road
  - ...

Guide Policy for Geometric Design of Freeways and Expressways - NAASRA 1976

Intelligent Compaction
Goals for Asphalt Compactors

- Goal of asphalt contractors = achieve the target mat density as efficiently as possible

- What does that mean:
  - Minimize number of rollers by running most efficient rolling pattern
  - Minimize fuel usage
  - Avoid over-compaction
  - Avoid under-compaction
  - Avoid re-work

Issues with asphalt compaction: Passcount Tracking

- To reach desired compaction, the compactor operator needs to achieve a certain pass count target.
- However:
  - The operator easily loses track and the job becomes guesswork
  - The contractor cannot monitor compaction performance

Issues with asphalt compaction: Passcount Tracking

- Tracking the pass count shows the huge inconsistency in pass count
- Typical example:

  ![Passcount Tracking Graph](Source: T wente University, 2008)
Issues with asphalt compaction: Asphalt Temperature

- It's an art for the operator to correctly judge the optimal time window for compaction

Example limited time window (Matrix Metals, Anthony Jones, GPRC)

Adding Science to the Art of Paving

- Better Info to the Operator = Better Surface

- A Compaction Control System can provide:
  - Pass count maps to avoid over/undercompaction
  - Real-time temperature maps for the operator to find the optimal window for compaction
  - Documentation of compaction effort
  - As-built information

Pass Count Mapping

- Takes the guesswork out of asphalt compaction
  - More consistent compaction effort to target pass count
  - Increased productivity to taking the most efficient rolling pattern
Temperature Mapping

- Provide temperature maps for a user definable min and max value
- User defined high/low temp warnings are displayed over the machine icon

Reporting

- On the machine
  - On-machine validation of final compaction runs
  - Print in-field with thermal printer for sign-off and approval
- In the office
  - For further analysis and documentation

IC System: Possible Set-Up

Other options:
- GPS accuracy
- As-built mapping
- Wireless connection to web
Pass Count Mapping Test
Productivity and quality effects of using the technology

E470 and 120th Project Overview
- Compactor: Cat CB534D breakdown roller.
- Single lift of Stone Mastic Asphalt, target pass count was 6.
- Paver outran the compactors, production limited by compactors

Test Results without using Pass Count Mapping
- Target Pass Count 6
- 20 hours of operation
- 310,000 SF compacted surface area
- 23% over target pass count
- 40% under target pass count
- 37% around target pass count (5-7)
Test Results using Pass Count Mapping

- Consistent roll pattern
- Meets target pass count

- Target Pass Count 6 (Provided by Lafarge)
- 18 hours of operation
- 380,000 SF compacted surface area
- 19% over target pass count
- 30% under target pass count
- 51% around target pass count (5-7)

Combined Results: Pass Count

Combined Results: Productivity

Using the Trimble pass count technology?

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<th>No</th>
<th>Yes</th>
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<tr>
<td>Area compacted sqft</td>
<td>316,000</td>
<td>380,000</td>
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<tr>
<td>Time required (hours)</td>
<td>20</td>
<td>18</td>
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<td>Production sqft/hour</td>
<td>15,800</td>
<td>21,111</td>
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Observed Productivity Increase*: 34%

*: Observed productivity increase may include some effects not related to compactor operation.
Final words

- Moving to 3D Technology is an investment in terms of
  - Initial system purchase cost
  - Changing the way you work
- But it has benefits in terms of ROI:
  - Making your smoothness bonus
  - Reducing your grinding cost
  - Reducing asphalt usage
  - Making your deadline
  - Achieve the required density targets

Questions?