Presenter

- Kevin Ackley
- Sitech Michigan
Why use 3D Milling and 3D Paving?
To build better pavement Structures!!!
Sample Engineering Specifications
2D and 3D Milling-Paving Terminology

- 2D Milling-Paving – guidance to grade [elevation-thickness] and/or slope
  - 2D is **Ground-up**
  - 2D Systems typically place a constant thickness over the base

- 3D Milling-Paving – guidance to grade and slope at a known position using a design/model
  - 3D is **Design-down** and does not use the existing surface for guidance
“Traditional” 2D Milling Method: Non-Graded Surfaces
3D Milling Method: Graded Surfaces
PCS900 3D Milling – Making Grade
Why 3D Mill?

- Increased production, lower cost
  - Only mill where needed
- Increased smoothness
  - Remove longitudinal waves
- Decreased asphalt usage
  - No need to fill in low spots [leveling course]
- Change/Fix Cross-Slopes
  - New State/Federal Specs
- Mill complex designs
  - Transitions, supers, drainage, etc.
- No Stringline or wire required
  - Reduce costs
  - Better truck/traffic management
  - Safer
Why 3D Mill? – Con’t

- Variable depth and slope milling:
  - Remove more or less material as per project specifications
  - Provides uniform surface for pavement
Other Advantages of 3D Milling

- Increased Smoothness

The issue of differential compaction when paving:

3D milling takes away the issue:
Other Advantages of 3D Milling – Con’t

- Decreased asphalt usage
  
  Asphalt filling of low spots [Levelling Course]

- 3D Milling minimizes asphalt usage
Results of better Pavement Structures using 3D

- Smoother
  - Easier to control vehicles at higher speeds
  - Less impact, especially with heavier loads

- Safer
  - Better drainage, reduce ponding/hydroplaning
  - Better traffic control
    - Quebec Ministry of Transportation increased off-ramp +10km/h [+6mph]

- Longer lasting
  - Lower maintenance costs
  - Better snow removal hence
    - reducing additional wear
    - premature failures from undulating surfaces

- Taxpayers enjoy driving on smooth roads 😊
PCS900 On –Machine Components
Control System Overview

PCS900
- 3D Position Sensor
- Relative to design
- Top Down

Up/Down
Left/Right
Corrections

2D OEM Control System

Machine Hydraulics
[Leg Control]

Contact Sensors
Sonic Sensors
Wire Rope Sensors
- 2D Position only
- Ground up
2D System Compatibility

- Wirtgen LevelPro
  - DLS-1 v6.072 or v6.074
- MOBAmatic
  - CAN / PWM
- ROADTEC ACE Grade and Slope
- CAT Grade and Slope
Trimble PCS900 3D Mills – In the Field
PCS900 3D Paving – Making Grade
Why 3D Pave?

- Achieve the highest accuracy and smoothness levels
  - Better material management
  - Better material yields
- Eliminate the stringlines:
  - Reduce staking labor, downtime and errors
  - Reduce costly rework
  - Finish the project faster
- Pave variable depth and slope including complex designs
- Use an “Uncompacted Design” to help differential compaction issues
  - For most applications, includes “levelling course” in the same pass
PCS900 3D Paving Applications

- Any project where a contractor uses Stringline, wire or “grade marks” for elevation grade
- Variable depth and slope paving applications
  - Roadways, Airports and commercial surfaces
  - Base material [P209, gravel, etc...]
  - Asphalt
  - Roller Compacted Concrete [RCC]
  - Concrete Treated Base [CTB]
PCS900 3D Paving

** 3D Paving to fill 3D milled areas and set road grade surface!

QUEEN KA’AHUMANU HWY NB LANE – KONA HAWAI’I
JANUARY 2018
PCS900 3D Paving

QUEEN KA‘AHUMANU HWY NB LANE – KONA HAWAI‘I
JANUARY 2018
PCS900 3D Paving

QUEEN KA'AHUMANU HWY NB LANE – KONA HAWAI’I
JANUARY 2018
PCS900 3D Paving

QUEEN KA’AHUMANU HWY NB LANE - KONA HAWAII
JANUARY 2018
PCS900 3D Paving

QUEEN KA'AHUMANU HWY NB LANE – KONA HAWAI’I
JANUARY 2018
PCS900 3D Paving

QUEEN KA'AHUMANU HWY NB LANE - KONA HAWAI'I
JANUARY 2018
PCS900 3D Paving – UTS Tracking [typ for Corridors]

QUEEN KA’AHUMANU HWY NB LANE – KONA HAWAI’I
JANUARY 2019

N.T.S. +40°
PCS900 3D Paving – Managing Differential Compaction
Managing Differential Compaction

- 3D Designs describe the final finished surface
- 3D AMG systems use vertical offsets to build up to this surface
- Final asphalt lift is designed to finish at this design surface
- If existing paving surface is not to grade or not level, low areas will compact more
  - Paved surface will have longitudinal waves affecting smoothness
- Traditional practices are to place multiple lifts hoping the waves are reduced and/or eliminated by final lift
  - ~60% to +80% of waves reduced per lift
Managing Differential Compaction

- PCS900 can help manage differential compaction
  - Using a PCS Uncompacted Design
- PCS Uncompacted Designs require 3 key components:
  - Existing Surface
  - Design Surface [e.g.: first lift of compacted asphalt]
  - Compaction Factor
    - E.g.: 2” compacted, placed at 2.5”
    - Compaction Factor = 2/2.5 = 0.80
- 3D Paving goal is to place “levelling course” at the same time as design grade
  - Compacted material is placed at grade
Using an Uncompacted Design

Original surface with longitudinal road waves

New road design with compaction factor [e.g. 0.80]

3D paved surface before compaction

3D paved surface after compaction
Managing Differential Compaction

Paving & Rolling on a smooth or 3D AMG graded surface
Managing Differential Compaction

This surface represents long longitudinal roadwaves. This is N.T.S and is extremely exaggerated.

- If you lay a thicker lift you get more compaction.
Managing Differential Compaction

This surface represents long longitudinal roadwaves
This is N.T.S and is extremely exaggerated

- Place the asphalt to the “Uncompacted” Design
  - A little thicker over the low areas

- Rolling will leave a smooth level surface
- **Consider using a 3D mill prior to paving!!!**
PCS900 3D Paving – Components
3D Paving Components with UTS

- Universal Total Station [UTS]
- MT900 [1x]
- Adj Mast & Angle Riser [2x]
- AS450 [2x]
- Display
- Radio
Dual Mast Setup

- Allows measure-up of left and right masts
  - Still only using one side for machine guidance
  - Makes switching over from one side to another fast
  - Same feature that exists on Mills
Control System Overview

PCS900
- 3D Position Sensor
- Relative to design
- Top Down

Up/Down Left/Right Corrections

2D OEM Control System

Machine Hydraulics [Screed Control]

Contact Sensors
- Sonic Sensors
  - Averaging Beams
    - 2D Position only
    - Ground up
2D System Compatibility

- Trimble PCS400 2D – V1.22
- MOBAmatic – CAN / PWM
- Vogele NiveltronicPlus3D Interface
- CAT Grade and Slope
Trimble PCS900 3D Pavers – In the Field
PCS900 3D – Key Features
Design Support

- Supports SVL / SVD
- Supports alignments
  - Not required
UTS – Transition Strategy

- Elevation/Horizontal differences are absorbed
- No movement during transition; no “bump”
Key Ingredients for a Successful 3D Automated Machine Guidance [AMG] Project
Key Ingredients for a Successful 3D AMG Project

- Consult with a qualified manufacturer and supplier prior to the project
- Training and Support from a qualified distributor
  - Plan and prepare for training prior to production on the project
- Contractor is committed in using technology
  - Should have a person on staff to be responsible
  - Product Solutions Investment and an Investment to change how you work
- Contractor follows all machine manufacturer recommendations for operating the machines equipped with Machine Guidance
  - E.g.: Paving By The Numbers, etc... for pavers
  - There is no “magic” button when technology is install, you still need to know how to pave
Key Ingredients for a Successful 3D AMG Project

- Use the correct technology for the project application [s]
  - Is there line of sight for the total stations?
  - Are there any obstructions?
Key Ingredients for a Successful 3D AMG Project

- Use the correct technology for the project accuracy requirements
- How does the 3D technology work with the existing milling or paving 2D technology?
- Machine is in optimum working condition
  - Any wear or “slack” on the machine will affect results
- Consider other machines for machine guidance and not limit to just one. Look at the whole spread.
  - One machine is productive, multiple machines are MORE productive!
Key Ingredients for a Successful 3D AMG Project

- All Instruments need to be checked, cleaned, adjusted, updated with a Certified Service Center
- All Technology [e.g.: Instruments, Sensors, etc...] on the project need to be field calibrated as per the manufacturer’s recommendations
- Always check and double check equipment and technology on the project
Key Ingredients for a Successful 3D AMG Project

- Project **Survey Control Points** must be accurate
- Must be less than ½ the project specifications
  - Example: Project Spec of ½” [0.012m], Survey Control less than ¼” [0.006m], etc...
  - Contractors may choose to be more accurate than project spec to help manage material yields
- Use a **Digital Level** system to reduce or eliminate human errors!
- If you are 3D milling or 3D paving, mm accuracy is a must
  - There is no reason or excuse for poor survey control accuracy
- Should be no more than 500’ [150m] apart for Total Station Machine Guidance
  - You need to know the technology ranges and/or limitations
- Surround the project
Key Ingredients for a Successful 3D AMG Project

- Use Digital Level [Vertical]
- Total Station [Horizontal]
3D Data/Designs – Built for AMG

- Must be Accurate
- Built for Machine Guidance applications
- If building a road/corridor, runway/taxiways, use the design as it was built
  - HAL, VAL, X-Section Templates, Stationing, Superelevations & Widening, etc...
- Build the design as the project will be constructed
  - Subgrade, Finish Grade, etc...
Key Ingredients for a Successful 3D AMG Project

- Optimized and densified for Machine Guidance

- Must meet or exceed IRI/Smoothness Spec!
  - Check design in BC-HCE/ProVal prior to sending to machine

- If the design is wrong the surface is wrong
  - If you are milling or paving, this is your last chance to get it right!
Undensified Corridor Surface Curves and Vertical Curve surfaces are more segmented, not smooth.
Densified Corridor Surface Curves and Vertical Curve surfaces are more uniform and SMOOTH.
Key Ingredients for a Successful 3D AMG Project

- As-built or existing surface data accuracy should be equal or better than the technology being used
  - If the AMG technology can achieve 3mm to 5mm [0.01’ to 0.02’], as-built data accurate at 10mm to +20mm [0.03’ to +0.07’] is not ideal
  - The data can be used for a 3D design and/or to verify was has been milled or placed
Questions?
Notable/Award Winning Projects

- Telluride CO Airport Project with Kiewit
- New St-George UT Airport Project with Western Rock [Staker Parson/Oldcastle Group]
  - https://www.youtube.com/watch?v=35uxS4BE4ag
- Provo River Constructors [PRC] I-15 Project in Provo UT
- Port Mann-Hwy 1 Project in Vancouver BC with Kiewit
- Circuit Of The Americas [COTA] F1 Track in Austin TX with Austin Bridge & Road
  - https://www.youtube.com/watch?v=ygC-vbVVv7oc
- Western Wake Expressway Raleigh NC with Lane
- Colorado Springs CO Peterson AFB Runway Project with Kiewit
- Honolulu HI Reef Runway Project with JAS W Glover
  - https://www.youtube.com/watch?v=DKKjUXrIQLU
- Bowling Green KY National Corvette Museum Motorsports Park [Corvette Test Track] with Scotty’s Contracting
  - https://www.youtube.com/watch?v=napiTkJT2os
- Quebec Ministry of Transportation
- Bogota El Dorado International Airport
- US Bank Vikings Stadium in Minneapolis MN with Park Construction
  - https://www.youtube.com/watch?v=UUbkFCW2-NY
- Numerous FHWA/State DOT Intelligent Compaction Projects