Presentation Outline...

1. Flores Automation & Machine Control Introduction
2. 3D Stringless Paving Overview
3. Achieving Bonus Ride Numbers with Stringless Paving
   - Infrastructure of your 3D team
   - Work-flow has changed!
   - Adjustments while paving
4. Time permitting questions and answers
5. Introduction to Hawkins Construction
Frank Flores (CEO) started Flores Automation in 2007
- Specializing in industrial/mobile automation contracts.
  - Numerous long-term contracts for controls with machine OEMs
- Currently performing paving machine retrofits for FAMC
- Built engineering and management staff of 14 employees
- OEM engineering that compliments FAMC’s 3D controls

Started Flores Automation & Machine Control in 2012
- Started providing 3D Machine Control Services
  - Project consultation, onsite trainings, remote support, data preparation
- Obtained Leica Geosystems relationship in 2013
- Current Authorized Leica distributor for paving applications in the US
We are the US resource to assist contractors in their transition to stringless paving. We provide services that are accountable, accurate, and accommodating of your contracts demands…
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Stringless Paving Overview

- General Overview
- Differences between the technologies
- What machines are currently offered control systems for in the paving market?
- Contractors using the technology
Stringless Paving Overview

The technology of monitoring your paving machine’s position with surveying instruments, and comparing to a digital model to control the movements of steering and elevation.

No Wire Onsite!
Stringless Paving Overview

Cost Savings Benefit

Removes wire lines and conventional survey pins from the jobsite
- Eliminates the drilling, pounding, & surveying in pins to base the wire elevation
- Eliminates material costs and transport for posts, wire arms, and wire
- Eliminates “bumps” to the wire during operation
- The instruments give ability to measure before and after your paving for exact quality control

The stringline is virtually created, and put right on the machine computer
- No waiting for surveying before production
- Significantly reduces over-milling, over-pouring
- Increases productivity, quality and performance bonuses
Stringless Paving Overview

Logistical Benefits

Roadway is now open
- Trucks no longer need to back up so far
- No “Gates” in wireline needed
- Better versatility moving through site

Wireline Clearance
- Track grade is now the width of the actual machine
Stringless Paving Overview

Safety Benefits

Site Hazards

Walking hazard eliminated for workers near stringline
Vehicle hazard eliminated for driving near stringline
Stringless Paving Overview
Difference between 2D and 3D controls and sensors

2D control is controlling the steering and elevation of the paving machine with the use of 5 volt based wand sensors

For Steering: $0 \text{ v} - 2.5 \text{ v} = \text{Steer Left}$

$2.5 \text{ v} - 5 \text{ v} = \text{Steer right}$

For Elevation: $0 \text{ v} - 2.5 \text{ v} = \text{Move Down}$

$2.5 \text{ v} - 5 \text{ v} = \text{Move Up}$

These sensors require a physical reference on the site to “follow” along. (Wire Line set to grade)

The wire line is set for steering and elevation reference by a surveyor
Stringless Paving Overview

Difference between 2D and 3D controls and sensors

3D control is controlling the steering and elevation of the paving machine with the use of CAN Network data. This data is derived from surveying instruments monitoring the machine, and comparing to a digital model for deviations.

Like the range of the wand sensors the onboard computer software creates an arbitrary range of numbers for the movements of the machine

For Steering: 265 to 465 = Steer Left

465 to 665 = Steer Right

For Elevation: 265 to 465 = Move Down

465 to 665 = Move Up
Stringless Paving Overview

Three major changes in the technology will change the workflow of conventional paving

1. No longer have to setup wirelines to guide the machines
2. Must have Survey Control Point Information to setup total stations
3. They must have a specifically prepared design “MODEL”

When multiple contractors are on the same project, or you are using 2 different brands of equipment: utilizing the same control point information, and design model will prevent many unforeseen issues.
Stringless Paving Overview

**What technology is currently in the market?**

Overview of the different manufacturers for the paving industry
Overview of the instrument technology types offered and their applications
Overview of the support system for each
Overview of the different manufacturers for the paving industry

- Leica Geosystems
- TOPCON
- Trimble

Preparation to Bonus Ride Results
What technology is currently in the market?

Overview of the instrument technology types offered and their applications

<table>
<thead>
<tr>
<th>Total Station</th>
<th>Millimeter GPS</th>
<th>GPS RTK</th>
</tr>
</thead>
<tbody>
<tr>
<td>accuracy +/-.01’</td>
<td>accuracy +/-.01’</td>
<td>accuracy +/-.1’</td>
</tr>
<tr>
<td>*line of sight</td>
<td>*with good satellite signal</td>
<td>*with good satellite signal</td>
</tr>
</tbody>
</table>

- Slipform pavers
- Trimmers
- Milling Machines
- Curb & Gutter
- Asphalt paving

- Slipform pavers
- Trimmers
- Milling Machines
- Curb & Gutter
- Asphalt paving

- Placer/Spreaders
- Follow-up Machines
- Curb & Gutter Steering
- Asphalt Paving Steering
What technology is currently in the market?

Overview of the support system for each

Direct Paving Dealers
Same support personnel for all paving applications in the US
Leica support for FAMC, FAMC then supports the end user

Local Machine Control Dealer Network (Sitech)
Trimble support for the Sitech dealer, Sitech then supports the end user

Local Machine Control Dealer Network
Topcon support for the dealer, then dealer supports end user
Stringless Paving Overview

Who is using stringless paving technology in US?

ACME – Spokane, Wa
Acura Inc. – Bensenville, IL
Anthony Allega – Valley View, OH
Archer Western – Fort Lauderdale, FL
CC Myers – Rancho Cordova, CA
Cemex – Mexico
Cold Spring Construction – Akron, NY
Concrete Placing Company – Boise, ID
Emery Sapp – Springfield, IL
ET Simonds – Carbondale, IL
Flat Iron – Canada
Flynn Company – Dubuque, IA
Fred Weber – Maryland Heights, MO
Golden Triangle – Imperial, PA

Granite Construction Co – Texas
Hawkins Construction – Omaha, NE
Head Inc. – Louisiana
IHC – Nebraska
K-Five – Chicago, IL
Kiewit – Dallas, TX
Knife River – Iowa and South Dakota
Lindahl Brothers – Chicago, IL
McCarthy Improvement – Dubuque, IA
MCM – Dallas, TX
Millstone Weber – Indianapolis, IN
Toebe Construction – Wixom, MI
WK Construction – Waterloo, IA
Zachry – North Carolina and Texas
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What roles need to be filled?

- Open-minded crew, adapt to change
- Survey/Grade Checker resources
- Ground-man, adjustments to machine
- Data prep resource
Open-minded crew, adapt to change

- Market as a whole is still new and changing often
- Software/Hardware updates are provided frequently
- Many procedures in the field are new until learning curve is complete
Survey/Grade Checker resources

• Many layout abilities are possible with the instruments

  Any surveying experience is a benefit

• Accurate checks and adjustments need to be communicated to ground man

• Bridging the gap between data prep and field work benefits the crew as a whole, it is good for the Surveyor/Grade Checker to have this experience to help the communication between office and field.
Achieving Bonus Ride Numbers with Stringless Paving

Infrastructure of your 3D team

Ground-man, adjustments to machine

• One man will usually monitor the corrections needed to keep quality of the paving

• This will usually be someone with paving experience of what to look for

• Good communication on what he is adjusting within the pave crew is ideal
Achieving Bonus Ride Numbers with Stringless Paving
Infrastructure of your 3D team

Data preparation resource

• The model now becomes as important to the spread as the wire would be.

• The quality of these models is dependent on success of paving accurately.

• Without this in-house ability, it is highly recommended to use a professional service to provide accountability.

• Good support within the software products you use is crucial.
Proper training – Creating Company Documentation

• Thorough understanding of operation and troubleshooting instruments

• Proper understanding of maintenance of instruments (calibrations)

• Initial training away from production

• Follow through training while in production

• Understanding of how to measure and report production

• Create Standard Operating Procedures for your company’s specific operation
Reasonable expectations of crew workload

• Understand what your investment leaves you capable to handle

• One mainline system will not always be feasible to move between sites

• Production rates of stringless need to be established by how well the crew has accomplished the learning curve of the new workflow

• Management of the survey, modeling, and capable crew members must be taken into account
Achieving Bonus Ride Numbers with Stringless Paving

Workflow of Stringless Paving

Stringless Paving will change your Work-Flow!

1. Prepare 3D Model
2. Request/Set Survey Control
3. Machine Setup
4. Sub-Grade/Model verification
5. Plan Total Station locations and hopping patterns
6. Paving adjustments needed while paving
Prepare your 3D Model

If plans are available, you can start the modeling without any site information.
Understand if your engineer can provide any of these digital formats to save data prep time.
There are 3 general digital formats of a “Model” that machine control utilizes.

- Linework Models
- Surface Models
- Alignment/Profile Models
3D Linework Models

Cad based format of elevated lines (polylines)

All lines are selectable for reference to that line’s position and elevation

All alignments are tangent based, true curves not supported for alignments

Based on Northing, Easting, Elevation
3D Surface Models

Full site coverage using Triangulation between known elevations

Usually not “seen” by the operator, but calculates corrections anywhere on the site in the background of your software

Used in combination with a 3D Line-work File for visibility

Based on Northing, Easting, Elevation
3D Alignment PROFILE Models

Built from Alignment Data, Profile Data, and Template Data

Supports True Horizontal and Vertical Curves!

Can be exploded to be line-work/surface formats previously mentioned or bundled in XML for true road curves

Based on Station, Offset, and Elevation
Alignment

- Understands where horizontal curves begin and end
- Understands true curve information
- Understands the stationing
Profile

- Understands where vertical curves begin and end
- Understands true curve information
- Understands stationing
Templates

- Build other elevated lines based upon the profile line
- Base these other lines on slope and distance
- Outputs of these elements results in having a 3D Line-work or Surface File
95% of the US market is currently using Polyline models in paving, most manufacturers do support alignment/profile data, this is a fairly new innovation within the paving market that we have had recent success using.

**Linework VS Alignment/Profile Models**

True Vertical Curves → Improved Thickness/Smoothness, no “pin bumps”

True Horizontal Curves improves “Chording”
Is the model Smooth? new procedures...

Convert an edge of paving to a TXT file of points, then import to PROVAL

Simulate ride scores of your model, a good model will be under 10 on IRI

Check for frequencies of breaks in your profile (Power Spectral Density)
Achieving Bonus Ride Numbers with Stringless Paving

Workflow of Stringless Paving

www.roadprofile.com
Achieving Bonus Ride Numbers with Stringless Paving

Workflow of Stringless Paving
Achieving Bonus Ride Numbers with Stringless Paving

Workflow of Stringless Paving

Simulate IRI Score
Achieving Bonus Ride Numbers with Stringless Paving

Workflow of Stringless Paving

### Ride Quality

<table>
<thead>
<tr>
<th>Analysis Type</th>
<th>Overall</th>
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<tr>
<td>Right Edge</td>
<td>Center</td>
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</tr>
<tr>
<td>Sawcut Edge</td>
<td>Center</td>
<td>Full</td>
<td></td>
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</table>

<table>
<thead>
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<th>File</th>
<th>Profile</th>
<th>IRI (in/mi)</th>
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<tr>
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<td>Sawcut Edge</td>
<td>Center</td>
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</table>
Achieving Bonus Ride Numbers with Stringless Paving

Workflow of Stringless Paving

[Image: A screenshot of a software interface showing a chart with ride quality analysis. The chart displays ride indices and a profile graph indicating ride quality metrics.]
Achieving Bonus Ride Numbers with Stringless Paving

Workflow of Stringless Paving

Request/Set Survey Control

Need to have a control point file to setup the total stations. This is a CSV file that contains:

- Point Number
- Northing
- Easting
- Elevation

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<td>4094.373</td>
</tr>
</tbody>
</table>

Machine control is only as good as the site control!
Achieving Bonus Ride Numbers with Stringless Paving

Workflow of Stringless Paving

Request \ Set Survey Control

With this information, we can setup total stations anywhere we want based on the survey information provided.
Achieving Bonus Ride Numbers with Stringless Paving

Workflow of Stringless Paving

Machine Setup\Calibration

✓ Check machine frame “square” in the front of the main frame, and the back of the main frame that connects to the bolsters

✓ Check paving pan sections for level with total station before measuring your 3D Calibration

✓ Perform track alignment routine for your specific paver

✓ Set initial sensitivities

✓ Calibrate your 3D System

✓ Dry Run machine... check, check, check!

Dry run the machine to tune steering, elevation and ensuring model is correct. This ensures an added level of insurance to a good day of paving.
Sub-Grade \ Model verification

- Measure 3 points across every 25’ on the subgrade
- Measure existing headers for Tie-in, adjust model to taper as preferred
- Process topo points, surface, run quantities/maps
- Through this process is where you are able to verify onsite control
Achieving Bonus Ride Numbers with Stringless Paving

Workflow of Stringless Paving

Sub-Grade \ Model verification
Achieving Bonus Ride Numbers with Stringless Paving

Workflow of Stringless Paving

Sub-Grade \ Model verification

Volumes Report

Cut Volume: 190.4 C.Y.
Fill volume: 8,565.2 C.Y.
Import Volume: 8,374.9 C.Y.

Max Cut: 0.391 at 1231699.816,291618.053
Max Fill: 3.210 at 1232166.054,291620.814

Area in Cut: 116,896.9 S.F., 2.69 Acres
Area in Fill: 297,199.5 S.F., 6.82 Acres
Total Inclusion hertz area: 414,462.2 S.F., 9.51 Acres
Total Inclusion slope area: 414,702.2 S.F., 9.52 Acres

Average Cut Depth: 0.04 feet
Average Fill Depth: 0.78 feet
Cut to Fill ratio: 0.02
Elevation Change To Reach Balance: -0.546
Volume Change Per .1%: 1,638.0 C.Y.

Cut (C.Y.) / Area (acres): 20.0
Fill (C.Y.) / Area (acres): 900.2
Achieving Bonus Ride Numbers with Stringless Paving

Workflow of Stringless Paving

Total station hopping patterns

- Dry runs are a good time to envision total station layouts
- Depending on truck routes, line-of-site objects (trees, signs, etc.), and curves in the alignment
- Different jobs have limited options and distances between total stations
Achieving Bonus Ride Numbers with Stringless Paving

Workflow of Stringless Paving

Adjustments while paving

- Create a grade check discipline
  - Cut/Fill check on Left, Right and Center of paving every 50’
  - Alignment check every 100’

- Understand how your total stations are tracking, spread more? Closer? Elevation holding well at your furthest distance?

- If an adjustment is to be made, you need to see some redundancy in this check. If outside of tolerance check a couple more spots with a closer interval before making adjustments.

- This is the biggest source of error in ride results, too many adjustments!
Adjustments while paving – Real-Time adjustments

- Highly recommended to get to consistent ride numbers
- Calculates dynamic IRI score of your pavement
- Identifies inconsistent loads very well
- Bump detection helps the finishers understand what may need to be fixed before final ride evaluation.
- The utility is a great tool to fine tune sensitivities in a trial and error manner.
Achieving Bonus Ride Numbers with Stringless Paving

Workflow of Stringless Paving

Adjustments while paving – Real-Time adjustments
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Thank you for your attention...

FAMC

We provide 3D automation solutions and services that are accountable, accurate and accommodating of construction project demands.

Anthony Cerisano
Vice President

S84 W18693 Enterprise Drive
Muskego, WI 53150
Office Phone (262) 682-4229 x123
Cell (949) 923-8966
Office Fax (262) 682-4661
acerisano@floresautomation-mc.com
www.floresautomation-mc.com

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