Moving Dirt 1905

Rose Creek Road, Hopkins County, Kentucky (outside Madisonville)
Eula Tapp became Eula Tapp Townes and is the grandmother of Douglas Townes.

Eula Tapp (1897 – 1982)

Calvin Tapp

Moving Dirt 1905
Rose Creek Road, Hopkins County Kentucky (outside Madisonville)
GPS in Construction

Photo courtesy of McAninch Corporation

By: Douglas Townes, P.E.
FHWA Resource Center
During this session

• You will:
  – Hear about the history of GPS in Construction
  – Hear from the Construction Industry about the advantages of GPS
  – Hear about the impediments that block implementation of GPS technology
  – Here how members of AASHTO SOC can become a part of the solution
History of GPS in Construction

- 1982 Trimble bought technology and began incorporating into surveying instruments
- 1988 first GPS survey instruments sold
- 1993 first strip mining machines began using GPS for “location”
- 1998 first product to have GPS and cellular on a single board for fleet management
History of GPS in Construction (Continued)

- 1999 first GPS grade control system for the construction market
- 2000 Contractors begin using “Stakeless” grading
- 2002 GPS machine controls are installed on Caterpillar excavators and motor graders
Show Caterpillar Video
(1 minutes, 30 seconds)
Introduction of 3D Technology & Machine Control Systems

Bret Alsobrooks
<table>
<thead>
<tr>
<th>PROJECT</th>
<th>D.O.T.</th>
<th>COUNTY</th>
<th>CITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERSTATE 840</td>
<td>Tennessee</td>
<td>Williamson</td>
<td>Franklin</td>
</tr>
<tr>
<td>7 miles 4-lane rock subgrade / I-65 Interchange</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>I-4 MEMORIAL BLVD.</td>
<td>Florida</td>
<td>Polk</td>
<td>Lakeland</td>
</tr>
<tr>
<td>6 miles new construction (6 lane)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIGHWAY 153</td>
<td>Tennessee</td>
<td>Hamilton</td>
<td>Chattanooga</td>
</tr>
<tr>
<td>A. 4-Lane, 5 miles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Lack of radio signal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Poor plans elevation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Poor JBI training</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JOE B. JACKSON PARKWAY</td>
<td>Tennessee</td>
<td>Rutherford</td>
<td>Murfreesboro</td>
</tr>
<tr>
<td>4 mile subgrade / I-24 Interchange</td>
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</tr>
<tr>
<td>US HWY 79</td>
<td>Tennessee</td>
<td>Stewart</td>
<td>Dover</td>
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<tr>
<td>3.5 mile new construction (4 lane)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRIMARY 29</td>
<td>Virginia</td>
<td>Amherst</td>
<td>Amherst</td>
</tr>
<tr>
<td>A. 14 miles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Soil cement subgrade</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Base cement in rock cuts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FM 1187</td>
<td>Texas</td>
<td></td>
<td>Fort Worth</td>
</tr>
<tr>
<td>4-lane, 7 miles subgrade; lime treated subgrade</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US 71 / 59 INTERCHANGE</td>
<td>Texas</td>
<td></td>
<td>Texarkana</td>
</tr>
<tr>
<td>6 miles subgrade, select fills</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTERSTATE 4 / MEMORIAL BLVD.</td>
<td>Florida</td>
<td></td>
<td>Lakeland</td>
</tr>
<tr>
<td>CORRIDOR H (Two Projects)</td>
<td>West Virginia</td>
<td></td>
<td>Hardy</td>
</tr>
<tr>
<td>10 miles; 200 ft cuts and fills; boxed cuts; select fills</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
Introduction

• **Good Practice Survey**
• De-mystify 3D Machine Control
• How to analyze which tool will help you meet or exceed project specifications
• A look at some new, high tech grade control tools that are changing the way grading is being done.
Introduction

- 3D Systems require a set “Process” to be followed
- 3D Machine Control Systems are not “Plug and Play” products
“Stakeless” Grade Control

SiteVision GPS

BladePro 3D-ATS
What is “Stakeless” Grade Control? How does the ‘process’ work?
Projects are being surveyed and designed in 3-D for the DOT’s but the Contractors are not allowed to get a copy of those same electronic files when the project is awarded.
Applications of 3D Machine Control and GPS Survey Systems

• BladePro 3D (BP3D)- Total Station Based
  ▪ Finishing Subgrade
  ▪ Knockdown and placing of materials in various zones
  ▪ Finish Grading
  ▪ Phased Construction
  ▪ Erosion Control
  ▪ Bridge Structures
  ▪ Drainage
  ▪ Signs, Guardrail
  ▪ Location of test results
The Global Positioning System (GPS) is used to...

- Accurately position the grading machine **BLADE**, on the 3D digital model of the project
  - Within 1cm in X and Y
  - Within 1-3 cm in Z = 1.18 of an inch
  - Old school one tenth = 1.2 of an inch

- This puts the blade on the design, precisely located in 3D
Four screens available to the operator

Cut Left (FT) ▼ 0.1
Cut Right (FT) 0.0
Design Elev (FT) 975.0
Tilt (%) -32.8
Satellites 7

Northing (FT) 10381.8
Easting (FT) 9937.8
Elevation (FT) 645.4
GPS Status High Accuracy
Satellites 9

Blade: Left
V. Offset: 0.000FT
Design: Good Surf
Dozers D3-D11 manual and automatic
Two Antennas

Gives You:

• Most Accurate Solution!
• Cuts/Fills calculated along the entire blade cutting edge, from the right tip all the way to the left tip (no matter how the blade is tilted or rotated)
• Always know which way the machine is facing and moving. (operator must tell the system which direction with single antenna)
• No need for rotation or tilt sensors that are affected by vibration (especially on dozers)
• No daily/weekly/monthly calibration of sensors
Scaleable Lightbars

Lightbar Scales

<table>
<thead>
<tr>
<th>Vertical Tolerance</th>
<th>0.100 FT</th>
<th>0.050 FT</th>
<th>0.100 FT</th>
<th>0.150 FT</th>
<th>0.200 FT</th>
<th>0.400 FT</th>
<th>0.800 FT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal</td>
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<tr>
<td>Half Set 0.050</td>
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<td></td>
</tr>
<tr>
<td>Double Set 0.200</td>
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</tr>
<tr>
<td>Default Set 0.200</td>
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</tbody>
</table>
Blades-manual and automatic
Considerations when using GPS Technology

**Advantages**
- Places the design in front of the operator.
- Unlimited machines possible on one base
- Line of sight not required
- Dramatically increases production
- Dramatically reduces labor costs-layout, stakes
- Not effected by fog, dust etc.
- Operators love to use it!

**Disadvantages**
- You need a clear view of the sky
  - Tree canopy
  - Tall buildings
  - Blocking terrain
- Requires a local “champion” to manage-
  - Data and site Cal
  - Radio coverage
  - Proper application requiring attention
  - PDOP issues
I-4 Lakeland Florida
SiteVision GPS
GPS Technology

<table>
<thead>
<tr>
<th>GPS technology</th>
<th>Compared with</th>
<th>Estimated savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade Checking</td>
<td>Manual method</td>
<td>Up to 66%</td>
</tr>
<tr>
<td>Reduction or Elimination of Stakes</td>
<td>Using stakes</td>
<td>Up to 85%</td>
</tr>
<tr>
<td>Improved material yields/select fills/undercutting</td>
<td>Overruns using manual methods</td>
<td>3% to 6% in volume</td>
</tr>
<tr>
<td>Un-interrupted earth moving production under any weather conditions (24/7)</td>
<td>Daytime / fine weather operation only/night work</td>
<td>30% to 50%</td>
</tr>
<tr>
<td>RTK, robotics stakeout</td>
<td>Traditional survey stakeout</td>
<td>More than 100% in speed and 66% in staffing</td>
</tr>
</tbody>
</table>

Other savings from:
- Improved utilization of equipment/30%
- Lower skill level required realize over 100%
- Erosion control as you go
- Accurate location of testing for QAQC
How to get up and running faster

- Fully committed to the process
- Draw upon experienced resources
- Stay the course and be willing to follow through the learning curve
- Job planning
- Do not panic!
Help Needed With GPS Machine Control

• Provide 3-D electronic data along with 2-D paper plans during bid process and at contract award
• Revise standard specifications tolerances to allow stakeless machine grading
• Quality control guidelines for stakeless construction need to be implemented by DOT’s
• DOT’s need to add Machine control as an option in their Bid packages
• Provide training of the entire Team involved with the project (certification by Level of Training)
• Have Contractor return paper and electronic “asbuilt” files when Project is complete
QUESTIONS?

Email: bret@jonesbrosinc.com

Good Practice Survey
The use of GPS Technology in Construction provides:

- More accuracy in setting grades and control points
- Reduces construction time for the Contractor
- Provides higher quality grading with GPS controlled machinery
What is happening in DOT Construction Today?

• According to this subcommittee’s Technology Implementation Group’s (TIG) 2002 survey:
  – Only 9 of 36 States reported contractors were using GPS controlled machinery

• 6 of 17 reported GPS use in Construction in the SOC “Technologies Used in Construction” 2004 survey
So why isn’t GPS Technology being used in more State transportation construction projects?

- State DOTs are reluctant to give electronic survey data with contract documents
  - Fear of misuse or misapplication
  - Procedure for QC does not exist for stakeless grading
  - Current plans are 2 dimensional and leave a paper trail
  - Due to the initial high cost of the equipment, smaller contractors will be at a disadvantage
We are surveying a DOT project in 3 dimensions and Contractors are building projects in 3 dimensions. Designers produce plans for construction in 2 dimensions (on paper) because this has been the standard since roads were first designed.
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We need to find a way to embrace latest technology and begin producing 3-D electronic plans along with paper plans that facilitate the production of transportation construction projects of highest quality by the most economical means.
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We need to find a way to embrace latest technology and begin producing 3-D electronic plans along with paper plans that facilitate the production of transportation construction projects of highest quality by the most economical means.
Where do we go from here?

• Appoint a joint committee to come up with a standard format to give electronic plans to a contractor
  – This committee should be multidisciplinary with representation from Survey, Design, CAD and Construction
Many thanks go to the following:

- Bret Alsobrooks for traveling and making his presentation to the group
- McAninch Corporation for preparing the white paper for distribution
- Caterpillar for providing the video and the brochures in the back of the room
Questions?