GPS APPLICATIONS IN CONSTRUCTION

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GPS APPLICATIONS IN CONSTRUCTION

• GPS Components
  - Base Stations
  - 3D-GPS – Rover Pack
  - 3D-GPS – Machine Control
  - 3D-millimeter GPS
  - Truck Mounted GPS

• Using GPS Data
  - Quantity Documentation
  - Change of Work Verification
  - Utility Conflict Resolution
  - Complete Project As-Built
GPS COMPONENTS

• Base Stations
• 3D-GPS – Rover Pack
• 3D-GPS – Machine Control
• 3D-millimeter GPS
• Truck Mounted GPS
Base Stations

• Purpose of the Base Station
• Placement of the Base Station
• InCORS Network
Even though GPS receivers have the ability to calculate a position every second (some even faster). Given what the signals have to travel through and the precision of the clock used to calculate a solution, those positions could vary as much as 30 feet.
The Base receiver is told to assume one calculated position to be the “true” position. From there it can determine the relationship between the “true” position and every other calculated position. It then passes this relationship to the Rover and the Rover then corrects itself.

Now all of the Rover’s positions are highly precise relative to the Base’s “true” position.
Placement of the Base Station

Keep it Simple:
• Easy to get to for simple daily setup
• Non-production area to minimize relocation

Keep it Safe:
• Safe from theft
  • Away from roads and easy access locations
  • Near people, equipment yard, jobsite office, etc.
• Safe from getting hit by machinery & vehicles

Keep it Stable:
• The mounting platform must be stable
• Keep clear of equipment, parking areas, and work areas where it might get bumped or subject to vibration.
Placement of the Base Station

Permanent Tripod Building
Placement of the Base Station

Primary factors determining the best location for the Base Station

1. GPS Friendly Location
2. Radio Friendly Location
3. Simple, Safe, Stable Location
InCORS Network
(Indiana Continuously Operating Reference Station Network)

- Network of 45 geodetic quality GPS (GNSS) receivers and antennas, permanently installed, located across the state – INDOT & ISP sites
- Continuously collects GPS data
- Transmits through internet to central servers
- Data archived for future use, available for download by users
- Data processed by server software to generate network corrections – available via internet in real-time
- The InCORS Network takes the place of needing a Base Station setup on a project
Components
- GPS Receiver
- Data Collector

Capabilities
- Cut and fill information
- Layout items
- Measure and record points
Rover Pack - Components

GPS Receiver

• Communicates with satellites
• Receives data from base station
Rover Pack - Components
Data Collector

- Communicates with the GPS Receiver via Bluetooth
- Touch screen interface
- Contains all project data
  - Surface Models
  - Linework Files
  - Alignment Lines
  - Control Points
  - Data Points
The individual Data files are contained in a *Project File*

- Multiple Project files can be stored in the controller.
A CAD Surface Model is created and imported into the Data Collector.
This Surface Model is the surface with which the existing grade is related to, providing the cut and fill numbers.
Managing Layers

- Layers can be created (New), edited, or deleted
- Layers can be selected to be ON or OFF

Layer is ON

- Linework/Points will be displayed on the working screen.
- Linework or Points will be displayed when Linework/Points Listing is selected.

Layer is OFF
Rover Pack - Capabilities

Cut and Fill

See continuous Cut/Fill and Elevations anywhere on the project
Rover Pack - Capabilities
Cut and Fill

• Ability to check grade anywhere on the project, at any time
• Eliminates the need to set lathe for INDOT to pull stringline to check grade
Lines and points can be manually placed into the data collector or imported directly from an AutoCAD drawing.

- Alignment Lines
- Construction Phase Lines
- Permanent ROW
- Construction ROW
- Radius Locations
- Temp Widening
- Temp Striping Lines
- Signal Post Locations
- Extents of Sheeting
- Pavement Removal
- Box Culvert Layout
Points, lines and curves can be recorded by placing the rover over the point and pushing the measure button. This supplies both a location as well as an elevation of the point.

- Volume of Common Excavation
- Measure Stockpile Volumes
- Complete Project As-Builts
- Calculate Quantities
- Provide Quantity Documentation
- Change of Work Quantities
- Utility Locations
## 3D-GPS – Rover Pack

### Summary

**Components**
- GPS Base
- GPS Rover

**Capabilities**
- Layout
- Grade Checking
- Collect Points
- Quantities
- Stake Tool

*Offers control over every single square inch of your job!*
3D-GPS – Machine Control

- Overview
- Components
- Benefits
Machine Control - Overview

• Placed on several different types of machines
  • Graders
  • Dozers
  • Excavators
  • Concrete and Asphalt Pavers
  • Milling Machines
• Sensors are installed on the machinery and are infused with the valves
• The automated process then controls the blades and moves them according to the proposed surface model grades
• Uses the same Control, Surface and Linework files as the Rover Pack
Machine Control - Components

3D-MC uses System Five’s Cross Slope Components

Main Slope Sensor
Rotation Sensor
Blade Slope Sensor
Machine Control - Components

Blade
Slope
Sensor

The BLADE SENSOR measures the slope of the cutting edge...
Machine Control - Components

Rotation Sensor

The ROTATION SENSOR measures the rotation of the moldboard...
Machine Control - Components

Main Fall Sensor

The MAINFALL SENSOR measures slope of the machine going up or down...
Machine Control - Components

- GPS Antenna
- Radio Antenna
- GPS Receiver & Radio
- 3D-MC Control Box
Machine Control - Components

- **Radio Antenna**
  - Communicates with the Base Station

- **GPS Antenna**
  - Collects signals from the satellites

- **GPS Receiver and Radio**
  - The “heart” of the 3D GPS System
  - Contains GPS receivers, radios, and controllers

- **3D-MC Control Box**
  - Provides the operator with real-time grade information and control
  - Similar to the Rover Pack Data Collector as it contains the files for the system
Machine Control - Components

Control Box sample screen shots
(Plan View)
Machine Control - Components

Control Box sample screen shots
(Profile View)
Machine Control - Components

Control Box sample screen shots
(3D View)
Machine Control - Benefits

- Significantly increase grading productivity
- Reduce staking on jobsite almost entirely
- Control materials
- Keep up with fast paced construction schedules
- All jobs becoming easier to grade
3D-millimeter GPS

• Overview
• Components
• Benefits
3D-millimeter GPS - Overview

• Combines the advantages of laser (multi-user and high vertical accuracy) with GPS (multi-user and 3D) into one versatile and easy to use system

• Large working range: up to 8000’ horizontal and 120’ vertical

• Works with existing GPS systems

• Control multiple machines and rovers at the same time
3D-millimeter GPS - Overview
3D-millimeter GPS - Overview

mmGPS Vertical Working Window

1000' × ±33' × ±10°
3D-millimeter GPS - Overview

Operate up to 4 PZL-1 Transmitters at the same time for a total working range of 8000’.
Operate up to 4 PZL-1 Transmitters at the same time for a total working height of 120’.
3D-millimeter GPS - Components

PZL-1 Transmitter
- Tripod (2 meter fixed height tripod)
- Calibration download cable

PZS-1 Sensor
- Cable to connect PZS-1 to GPS receiver - Rover

PZS-MC GPS+ Receiver
- mm receiver w/ built in GPS antenna - Grader
3D-millimeter GPS - Components

PZL-1 Transmitter

- Setup on a Control Point with a known height (2 meters)
- The Rover Receiver sends the GPS info through the mmGPS Sensor to the Transmitter
- The Transmitter corrects the data and transmits it back to the sensor with laser accuracy
3D-millimeter GPS - Components

PZS-1 Sensor

- Receives & Decodes the Laser Zone Signal
- Works with up to 4 PZL-1s
3D-millimeter GPS - Components

PZS-MC

- Receives & Decodes the Laser Zone Signal
- 360° beam Detection
- Portable – easy to move between machines
- GPS works without PZL-1 transmitter
3D-millimeter GPS - Components

PZS-MC
Machine Sensor
3D-millimeter GPS - Benefits

• Up to 300% more accurate than standard GPS
• Increased Productivity – fewer passes to reach final grade
• Grade to tighter tolerances and eliminate high-cost material overruns
• Finish grade even with minimal satellite coverage
Truck Mounted GPS Systems
3D Mobile Mapping

• Expedient
  • Collect current, up-to-date location information

• Efficient
  • Collect data at normal roadway speeds
  • Collect complete information in one pass
  • Eliminate return trips to the field

• Safe
  • Map from the security of a vehicle

• Used by INDOT, designers, and contractors to record existing project data.
Truck Mounted GPS Systems
3D Mobile Mapping

- GNSS Antenna
- IMU
- 360° Camera
- Laser Scanners
- IP-S2
- Cube Mount
Truck Mounted GPS Systems
3D Mobile Mapping
Truck Mounted GPS Systems
3D Mobile Mapping
Truck Mounted GPS Systems
3D Mobile Mapping

360° Spherical Images
User-adjustable time or distance capture intervals
Truck Mounted GPS Systems
3D Mobile Mapping

- Colorized 3D Point Cloud
- View from Camera Center

- Image provides instant visual recognition of objects
- Point cloud provides precise geospatial position of objects

360° Image + Point Cloud
USING GPS DATA

• Quantity Documentation
• Change of Work Verification
• Complete Project As-Builts
• Utility Conflict Resolution
Quantity Documentation

- With Rover Pack, measure the extents of each pay item on the project
  - Use different layers for each item
  - Can use points, lines and polylines

- Calculate the area or length using either the data collector software or a CAD program

- Print drawing of the areas of each pay item for records

- Print out the length or area calculation page
Change of Work Verification

• With Rover Pack, shoot location and elevations of items with any change in work
  • Soft Unsuitable Subgrade
    • Volume of undercut
  • Removal items
  • Temporary pavements

• Especially important when the items will be covered up and not able to be quantified later.

• Will be able to print out a drawing showing actual quantities.
Complete Project As-Builts

- Use the same shots taken for the Quantity Documentation

- Will then have accurate locations of all items on project.
Complete Project As-Builts
Complete Project As-Builts
Utility Conflict Resolution

• As the underground line has been uncovered, can shoot the location and elevation of said line.

• Can then simply email the CAD file of actual locations to INDOT/Engineers to be able to quickly create a resolution to the conflict.
Questions?