Oregon DOT: Moving towards Engineering Automation

CGSIC States and Local Government
Tampa Bay, Florida
14 September 2015

Ken Bays, PLS
Lead Geodetic Surveyor, Oregon Dept. of Transportation
Technical Manager, Oregon Real-time GPS Network

Overview

- Engineering Automation: Key Concepts
- Steps taken at Oregon DOT Geometronics Unit
  - Digital Signatures
  - Oregon Low Distortion Mapping Projections:
    - the Oregon Coordinate Reference System
  - Oregon Real-time GPS Network
    - Height Modernization
  - Major Events & Projects
    - Design to Dozer
    - Design to Paver
    - Intelligent Compaction Projects
  - New Remote Sensing Tools at Oregon DOT
    - LiDAR Terrestrial Scanning: Stationary and Mobile
    - Unmanned Aerial Systems: Drones
- ODOT Reorganization to Support Engineering Automation

http://www.oregon.gov/ODOT/HWY/GEOMETRONICS/docs/engautokeyconcepts.pdf

OREGON DEPARTMENT OF TRANSPORTATION

Highway Division

Authored and Presented by

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Geometronics Manager
Chief of Surveys
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Reviewed and Endorsed by

The Engineering Automation Steering Committee

Engineering Automation

Key Concepts for a 25 Year Time Horizon

8 March, 2009

Revision History

Authored by
Ron Singh, Geometronics Manager /Chief of Surveys

First Draft – 10 March, 2008
For review by the Engineering Automation Steering Committee

First Release – 21 April, 2008
Based on comments from the Engineering Automation Steering Committee
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Second Release – 3 November, 2008
Added Executive Summary and made minor edits

Third Release – 8 March, 2009
Updated the status of Digital Signatures relating to new Oregon Administrative Rules.

Digitally Signed:

Ranvir Singh

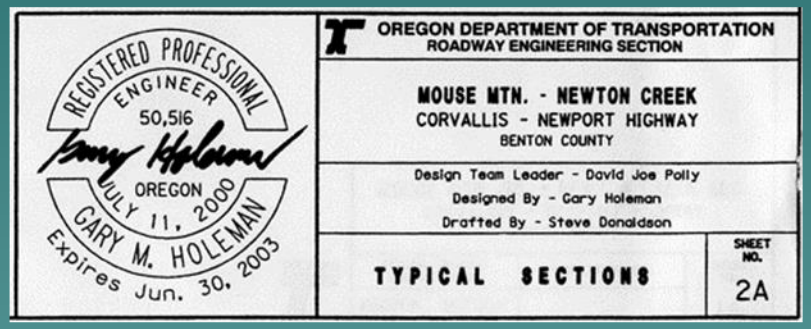
KEY CONCEPTS FOR THE FUTURE

DIGITAL DATA – CREATION, STORAGE, RETRIEVAL, AND FORWARD MIGRATION
MANAGING INFRASTRUCTURE LIFE CYCLE DATA
STRUCTURED DATA EXCHANGE - LANDXML
DIGITAL SIGNATURES
DATA SILOS
ENGINEERING DATA MANAGEMENT SYSTEM
ENGINEERING DATA AND ASSET MANAGEMENT
POST CONSTRUCTION SURVEYS
UNDERGROUND UTILITY LOCATION
DYNAMIC DOCUMENTS
ENGINEERING DATA AND THE GIS CONNECTION
IT INFRASTRUCTURE
WIRELESS COMMUNICATION
NEW STATEWIDE COORDINATE SYSTEM
THE OREGON REAL-TIME GPS NETWORK
HEIGHT MODERNIZATION
REMOTE SENSING
HIGH RESOLUTION IMAGERY/POINT CLOUDS FOR DESIGN
3D AND 4D DESIGN
VISUALIZATION
CONSTRUCTION AUTOMATION
MAINTENANCE AUTOMATION
ENGINEERING DATA AND INTELLIGENT TRANSPORTATION
DESIGN DATA AS PRIMARY AND CONSTRUCTION PLANS AS SECONDARY

Digital Signatures for Surveying and Engineering Documents

- How do you sign a point cloud or digital document?

Engineering Documents



Oregon law requires that a specific seal is affixed to the document with the signature of the registered professional

Oregon Department of Transportation

Automated Machine Guidance & Engineering Automation

Wet Signatures

THE PROBLEM

Problems with Wet Signatures

- The signature itself may not bind the signer to the document, unless the signer's identity was authenticated during the placement of a signature.
- The signature itself does not certify the integrity of the document.
- Today, most seals are simply CAD cells stored in a library open to anyone to copy, alter, and affix to any drawing.
- The requirement for wet signatures significantly hinders a company's or agency's abilities to fully integrate the development, transmittal, execution, archival, and retrieval of digital engineering documents.

Problems with Wet Signatures

- Wet signatures on physical documents worked well in the era of hand written/drawn documents
- The use of computers has progressed into an era where electronic documents are transmitted; reviewed and approved; utilized during bidding; utilized for stake-less construction; and archived for future retrieval

Problems with Wet Signatures

- To apply a hand written signature to electronic files requires printing, signing the paper document, and then scanning it back into an electronic file
- Loses the original files native format and any imbedded intelligence, is time consuming, and in today's world… unnecessary.

Digital Signatures

THE SOLUTION

Digital Signatures

The term *Digital Signature* is used to describe a signature system applied to an electronic document that utilizes specific technical processes to provide significant added security, authentication, and/or encryption.

What is a Digital Signature?

- A digital signature is to an electronic document as a handwritten signature is to a paper one and much more.
- A digital signature provides signer authentication, document authentication, possible document encryption, and efficiency.

Legal Policy in Oregon

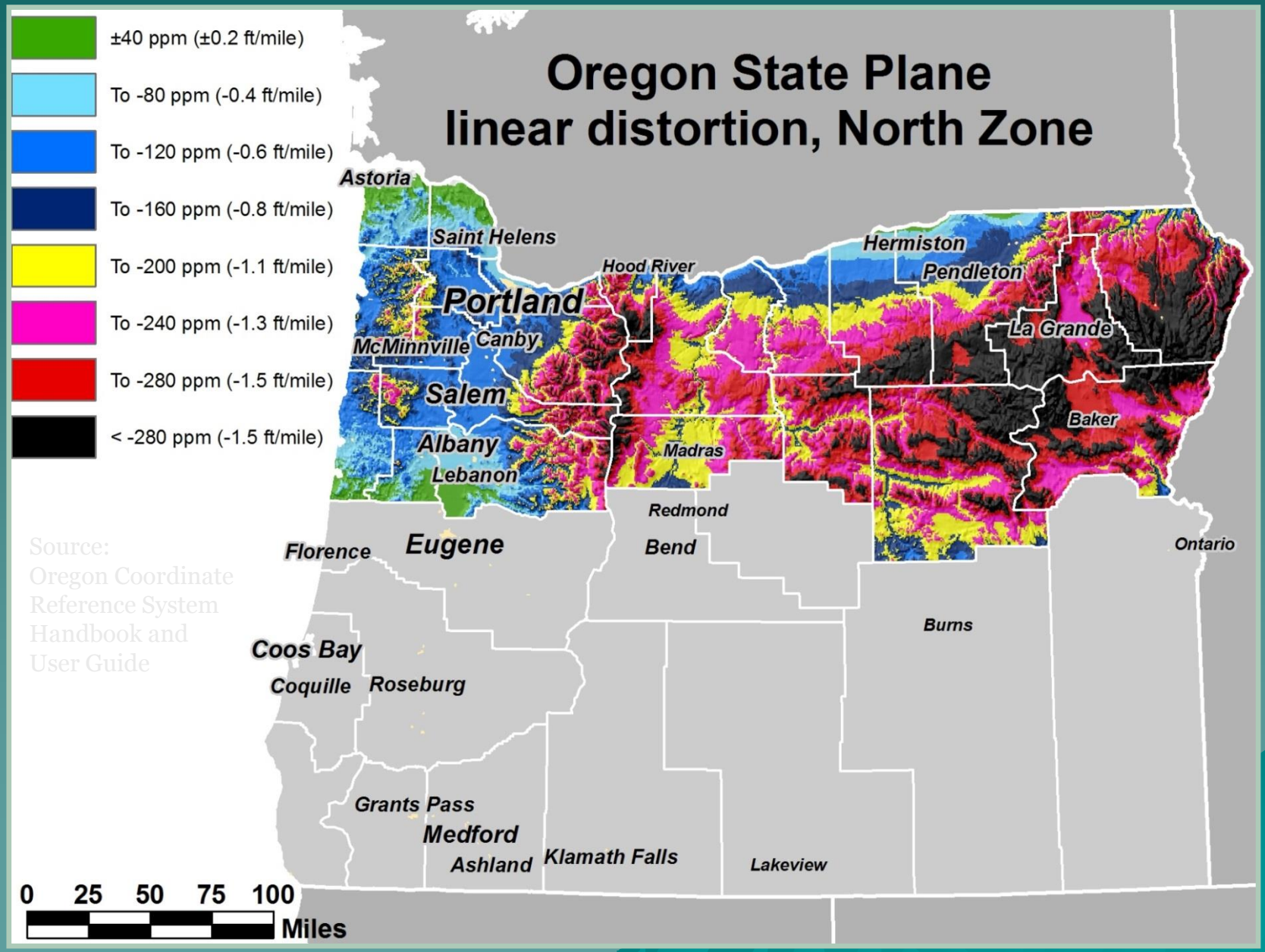
- Oregon State Board of Examiners for Engineering and Land Surveying (OSBEELS) approval: 8 July 2008
- New administrative rules were filed with the Oregon Secretary of State's office allowing the use of digital signatures for engineers and land surveyors.

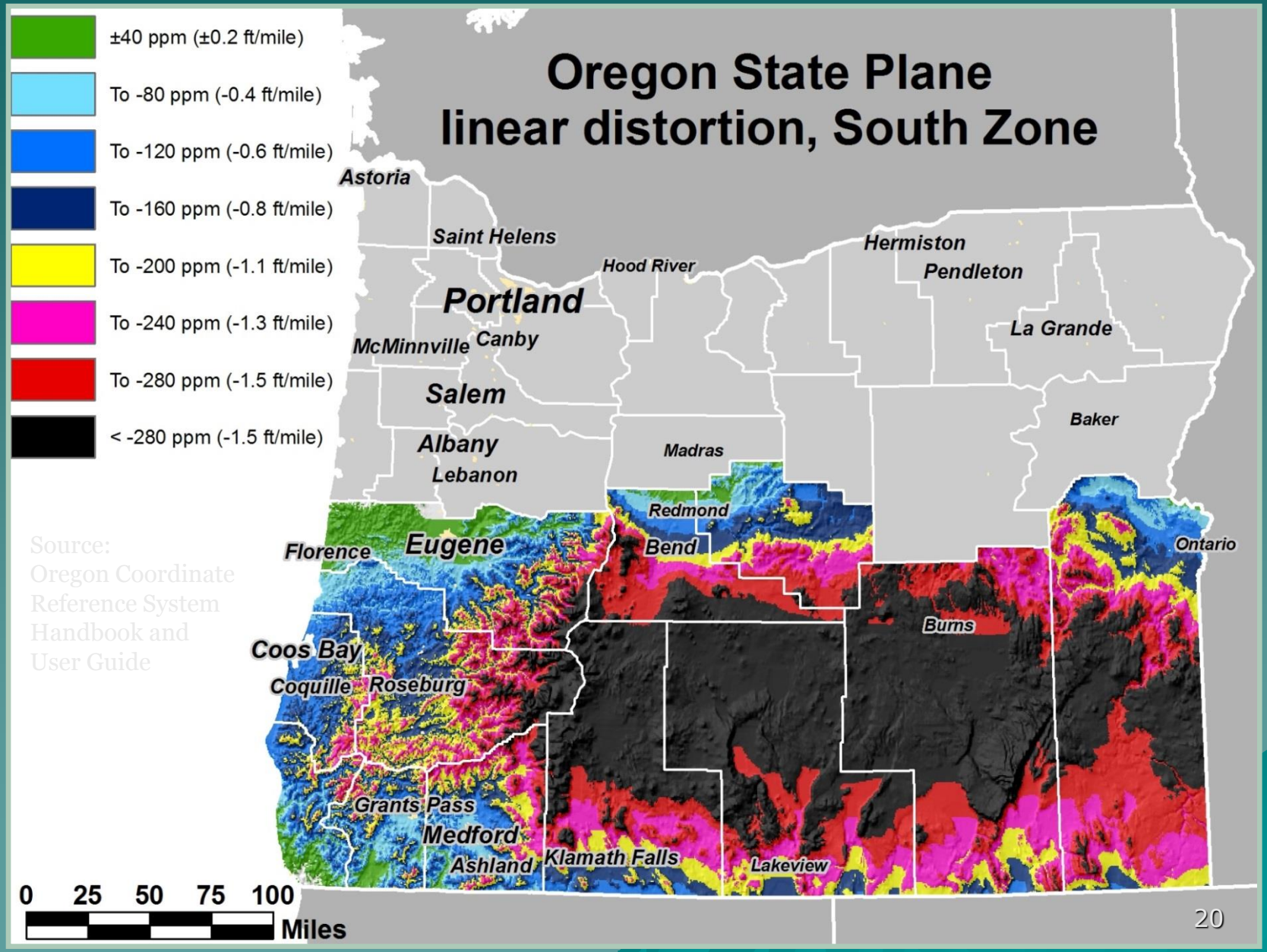
What's Next

- Deploy Digital Signatures Across All Engineering Disciplines
- Complete the Deployment of an Engineering Data Management System
- Digitally Sign DATA for Machine Guidance Systems

Low Distortion Mapping Projections

- The problem with State Plane Coordinates
- The new Oregon Coordinate Reference System
  - Low distortion mapping projections.


Oregon State Plane
linear distortion, North Zone
±40 ppm (±0.2 ft/mile)
To -80 ppm (-0.4 ft/mile)
To -120 ppm (-0.6 ft/mile)
To -160 ppm (-0.8 ft/mile)
To -200 ppm (-1.1 ft/mile)
To -240 ppm (-1.3 ft/mile)
To -280 ppm (-1.5 ft/mile)
< -280 ppm (-1.5 ft/mile)
Source:
Oregon Coordinate
Reference System
Handbook and
User Guide
Astoria
Saint Helens
Portland
McMinnville
Canby
Salem
Albany
Lebanon
Florence
Eugene
Coos Bay
Coquille
Roseburg
Grants Pass
Medford
Ashland
Klamath Falls
Lakeview
Hood River
Hermiston
Pendleton
La Grande
Baker
Madras
Redmond
Bend
Burns
Ontario
0 25 50 75 100
Miles


Oregon State Plane
linear distortion, South Zone
±40 ppm (±0.2 ft/mile)
To -80 ppm (-0.4 ft/mile)
To -120 ppm (-0.6 ft/mile)
To -160 ppm (-0.8 ft/mile)
To -200 ppm (-1.1 ft/mile)
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Lebanon
Madras
Baker
Redmond
Bend
Florence
Eugene
Ontario
Burns
Coos Bay
Coquille
Roseburg
Grants Pass
Medford
Ashland
Klamath Falls
Lakeview
0 25 50 75 100
Miles

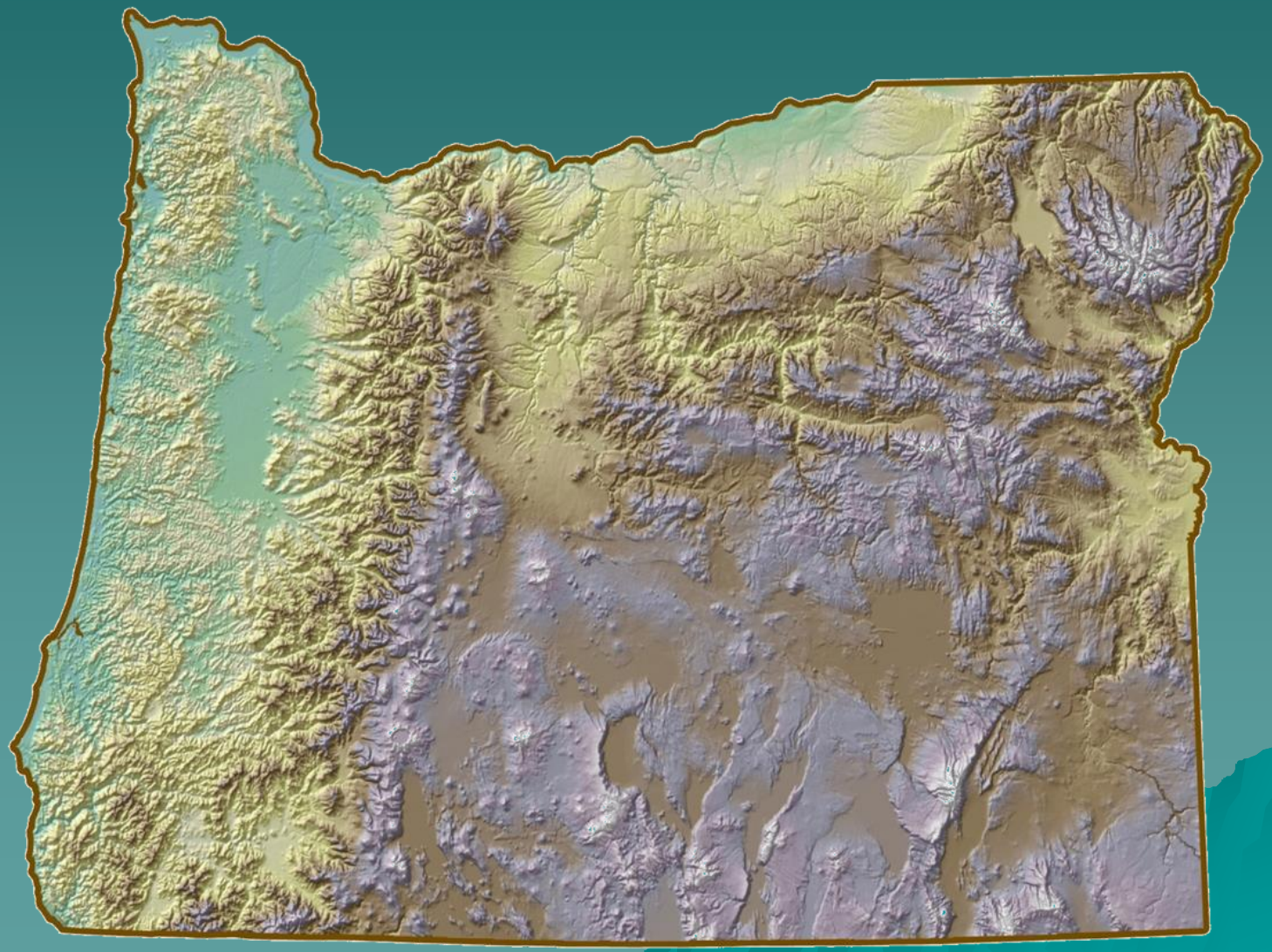
Problems with State Plane Coordinate Projections

- Do not represent ground distances
- Do not minimize distortion over large areas
- Do not reduce convergence angle
- Do not support modern surveying accuracy requirements

Low Distortion Projections

- Minimizes difference between "Grid" and "Ground"
- Central Meridian and Latitude near site, reducing distortion and Convergence Angle
- Well documented – easy to transform between LDP and National Spatial Reference System
  - Easily used in geospatial software to share data

Oregon Coordinate Reference System

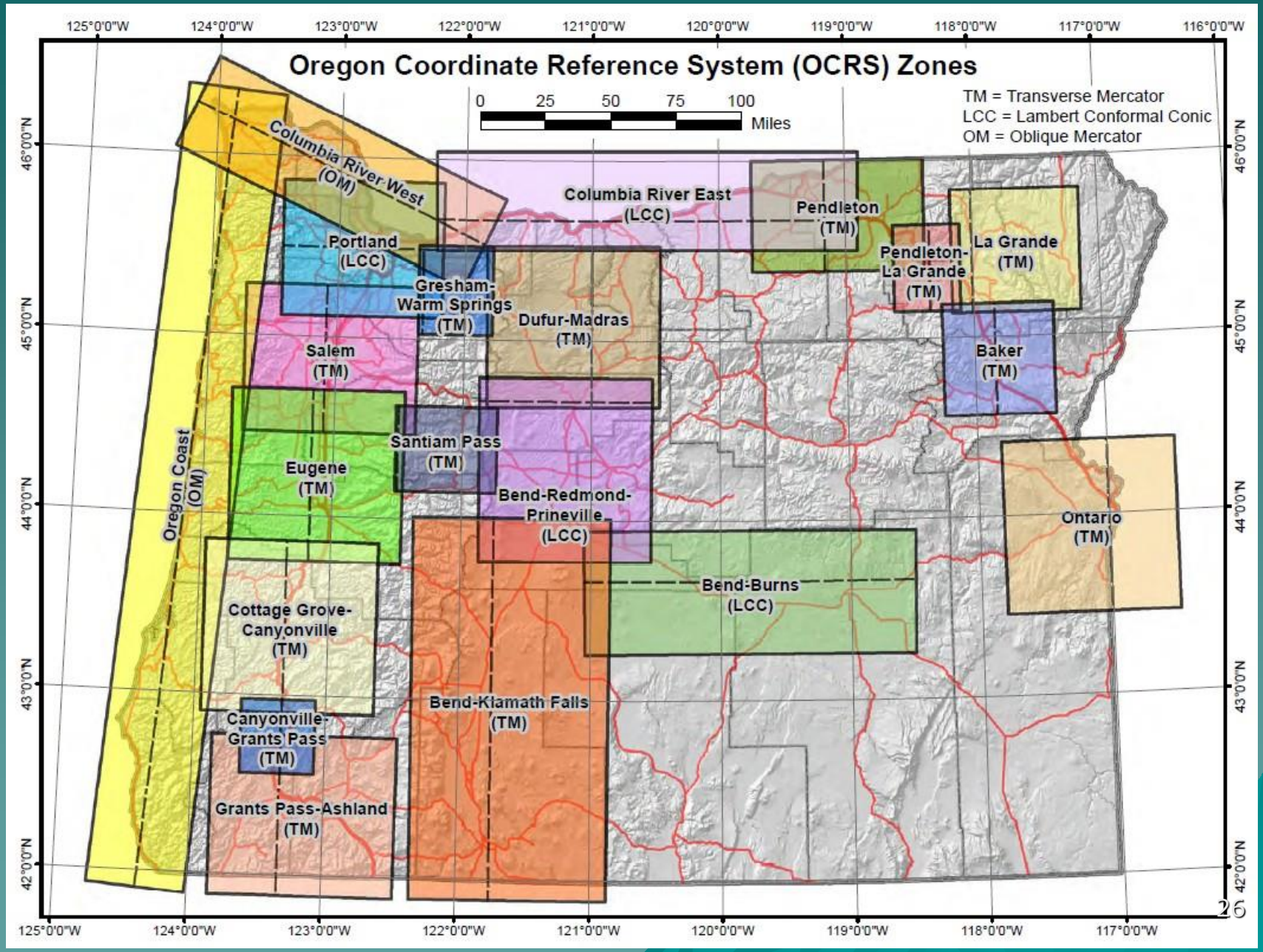


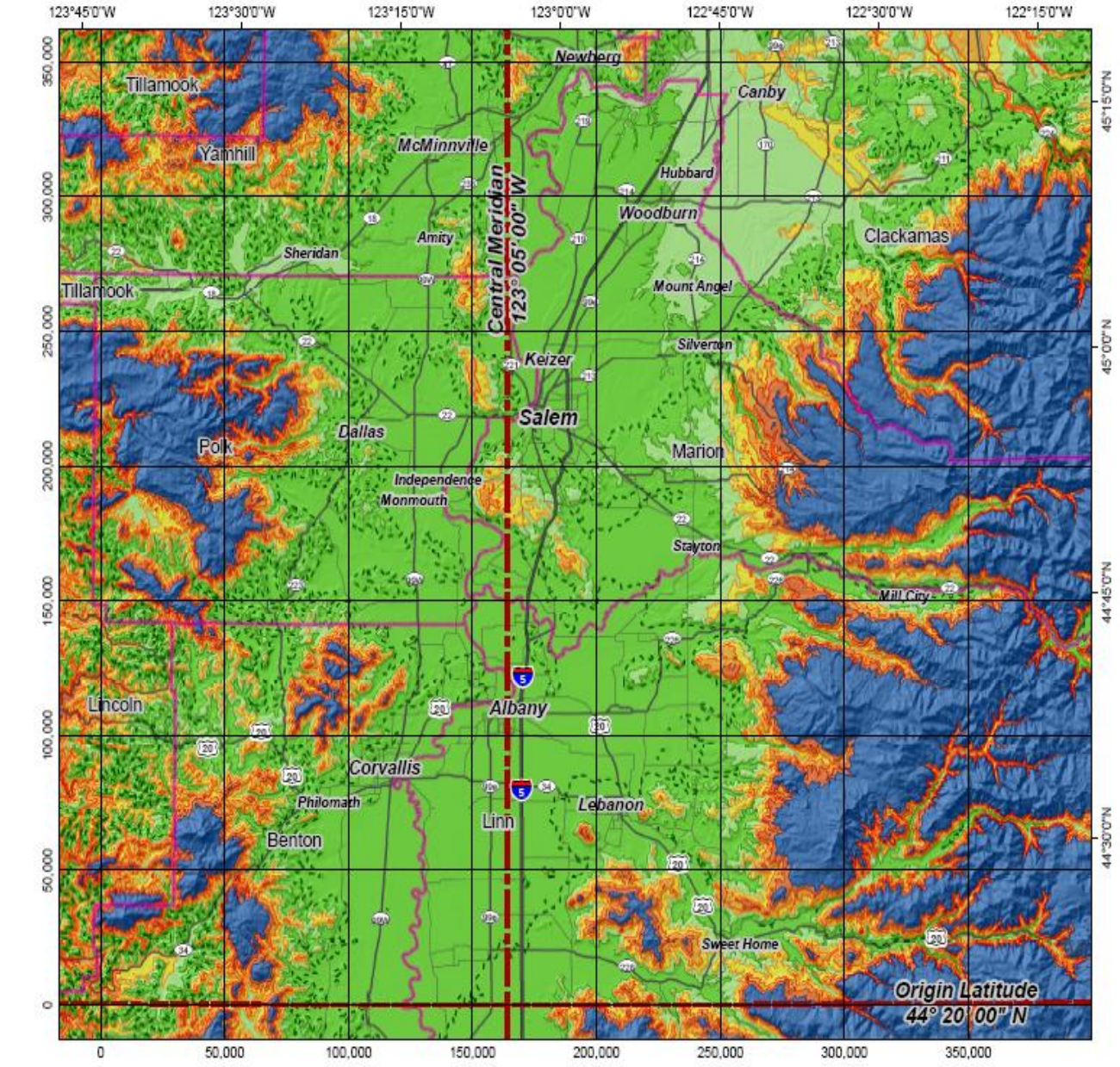
OCRS Design Team

- Michael Dennis, PE, PLS, (GIS)
  - Private consultant: Geodetic Analysis
- Geospatial professionals from Oregon
  - ODOT
  - Private Surveyors
  - GIS professionals
  - Academia

Combined Distortion Goals (OCRS Design Criteria)

PPM	Feet/Mile	Ratio
+/- 10	+/- 0.05	1:100,000
+/- 20	+/- 0.10	1:50,000


Oregon Coordinate Reference System (OCRS) Zones
0 25 50 75 100
Miles
TM = Transverse Mercator
LCC = Lambert Conformal Conic
OM = Oblique Mercator
Columbia River West (OM)
Columbia River East (LCC)
Pendleton (TM)
Pendleton-La Grande (TM)
La Grande (TM)
Portland (LCC)
Gresham-Warm Springs (TM)
Dufur-Madras (TM)
Salem (TM)
Baker (TM)
Santiam Pass (TM)
Eugene (TM)
Oregon Coast (OM)
Bend-Redmond-Prineville (LCC)
Ontario (TM)
Bend-Burns (LCC)
Cottage Grove-Canyonville (TM)
Bend-Klamath Falls (TM)
Canyonville-Grants Pass (TM)
Grants Pass-Ashland (TM)
125°0'0"W
124°0'0"W
123°0'0"W
122°0'0"W
121°0'0"W
120°0'0"W
119°0'0"W
118°0'0"W
117°0'0"W
116°0'0"W
46°0'0"N
45°0'0"N
44°0'0"N
43°0'0"N
42°0'0"N



Oregon Coordinate Reference System
Salem Zone

Transverse Mercator projection
North American Datum of 1983

Latitude of grid origin:	44° 20' 00" N
Central meridian:	123° 05' 00" W
False northing:	0.000 m
False easting:	50 000.000 m
Central meridian scale:	1.000 010 (exact)

Grid North

0 5 10 15 20 25 Miles

Linear distortion

- Zero distortion
- < -50 ppm (< -0.25 ft/mi)
- ±10 ppm (±0.05 ft/mi)
- 10 - 20 ppm (0.05 - 0.1 ft/mi)
- 20 - 30 ppm (0.1 - 0.15 ft/mi)
- 30 - 40 ppm (0.15 - 0.2 ft/mi)
- 40 - 50 ppm (0.2 - 0.25 ft/mi)
- > +50 ppm (> +0.25 ft/mi)

NOTE: Map grid is shown in units of international feet.

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O.C.R.S. History/Timeline

Mar. 2008 - Presentation to ODOT
July 2008 - Presentation to OGUG
Nov. 2008 - ODOT/OGUG Workshop
Jan. 2009 - Presentation to PLSO
Apr. 2009 - Created Technical Development Team
July 2009 - Developed Test Projections
Jan. 2010 - Developed 15 Projections
Jan. 2010 - Presentation to PLSO
April 2010 - Roll out and Workshop
Jan. 2012 - Made official and legal: Revised ORS 93 & 209; Place State Plane and OCRS definitions into a new OAR

Legal Status of OCRS

- The Oregon Transportation Commission adopted new Oregon Administrative Rules (OARs) defining the Oregon Coordinate Systems (734-005-0005, 734-005-0010, 734-005-0015) on December 21, 2011, and the rule was filed with the Secretary of State on December 22, 2011. The rule became effective January 1, 2012.

- These rules implement **Senate Bill 877** by moving all definitions of the existing Oregon State Plane Coordinate System from ORS Chapter 93 to ODOT's administrative rules and placing all definitions for the new Oregon Coordinate Reference System in the new OAR.


GEODETIC LETTER
STATE PLANE COORDINATES
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UNITED · STATES · COAST · AND · GEODETIC · SURVEY ·
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M-115

Oregon Real-time GPS Network

www.theorgn.net

- Operational since 1st quarter 2006
- Provides consistent datum/coordinate system for projects
  - referenced to the National Spatial Reference System
- Part of ODOT Height Modernization program
  - move towards GPS-derived orthometric heights
- Provide real-time correctors for surveying, engineering and automated machine guidance.
- GLONASS
- User overview
  - Surveyors & Engineers
  - Academia
  - Automated Machine Guidance
  - Mobile LiDAR Scanning
  - Precision Agriculture

Engineering Automation Events & Projects

- Design to Dozer: August 2010
- Design to Paver: July 2014
  - www.designtopaver.org
- Intelligent Compaction Projects: Summer 23015

Oregon Department of Transportation

Design to Dozer
17 & 18 August 2010, Eugene, OR

Computer Controlled Heavy Equipment Demonstration

Presented by the Oregon Department of Transportation in collaboration with Wildish Construction, Pacific Excavation, K&E Excavating, PPI Group, Pacific Survey Supply, Bentley Systems, and others

ODOT is poised to make a significant change to it's automation of surveying, design, and construction administration. You are invited to learn about these changes as your leadership and support is vital to the success of this undertaking.

Although the focal point of this event will be demonstrating the Automated Guidance and Control of Road Construction Heavy Equipment, many related topics such as 3D Design; Digital Signatures on Contract Plans; the new Oregon Coordinate Reference System; the Oregon Real-Time GPS Network; and Construction Inspection Tools will be presented.

DESIGN to PAVER

Intelligent Construction Systems and Technologies Demonstration

Oregon Department of Transportation

U.S. Department of Transportation Federal Highway Administration

Every Day Counts

www.designtopaver.org

Introduction

- This event is an 'Every Day Counts' activity highlighted in the Federal Highway Administration's national implementation plan for 3D Engineered Models for Construction.
- Hosted by the Oregon Department of Transportation's Geometronics Unit
- Classroom presentations and field demonstrations

DESIGN to PAVER

Intelligent Construction Systems and Technologies Demonstration

Purpose

- To promote the use of Intelligent Construction Systems and Technologies (ICST) by providing information and training relating to 3D Design, Automated Machine Guidance (AMG) and related technologies for highway construction.
- This goal will be achieved through classroom presentations, field demonstrations of AMG for road construction, and an implementation guidebook.

The Team

- Federal Highway Administration – Provide supplemental funding
- Oregon DOT – Donate resources to plan, organize, and conduct event
- Contractors – Donate equipment and operators to construct road
- Equipment Manufacturers – Donate equipment for event
- Oregon National Guard – Donate use of land
- Oregon DOT also collaborates with the Oregon State University – School of Civil and Construction Engineering to share information and knowledge relating to ICST for educational purposes.

DESIGN to PAVER

Intelligent Construction Systems and Technologies Demonstration

Oregon Department of Transportation

U.S. Department of Transportation Federal Highway Administration

Every Day Counts

also thanks to sponsors

- On-site Dinner on July 9th sponsored by
  - Bentley Systems, Inc
  - Trimble Navigation
- Social hour on July 9th sponsored by
  - Leica Geosystems

Target Audience

- Survey, design, and construction staff from the 18 WASHTO State DOTS, local agencies and engineering consultants.
- There were 200 attendees at the event.

Location: Indoor Lectures

LaSells Stewart Center, Oregon State University, Corvallis, OR

Beavers

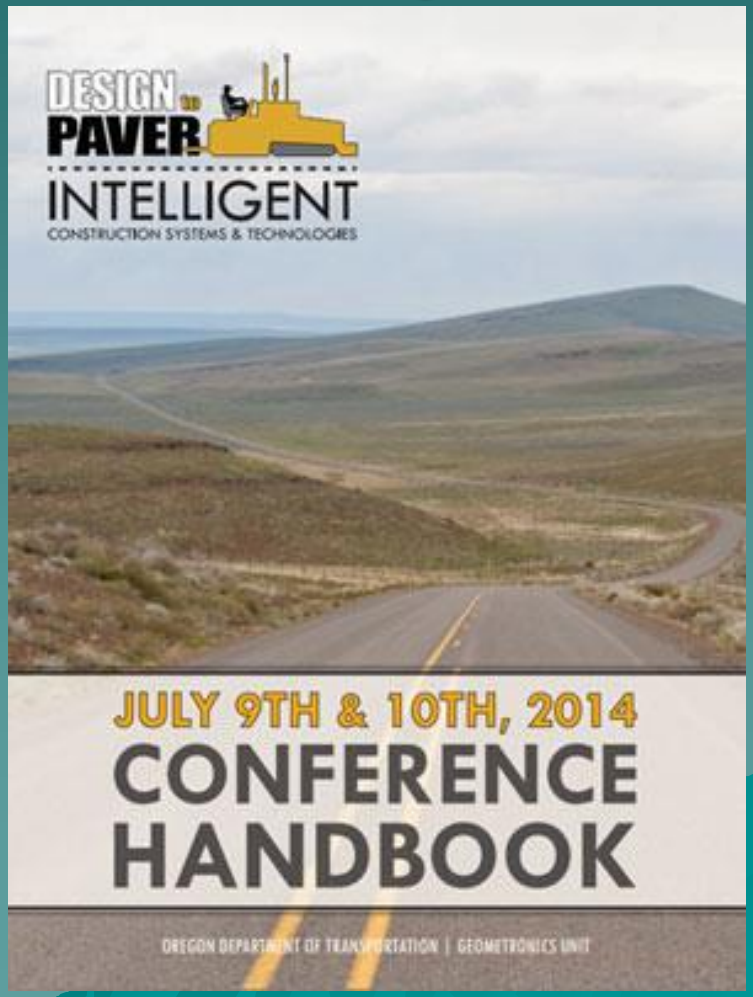
OSU
Oregon State
UNIVERSITY

Location: Field Demonstrations

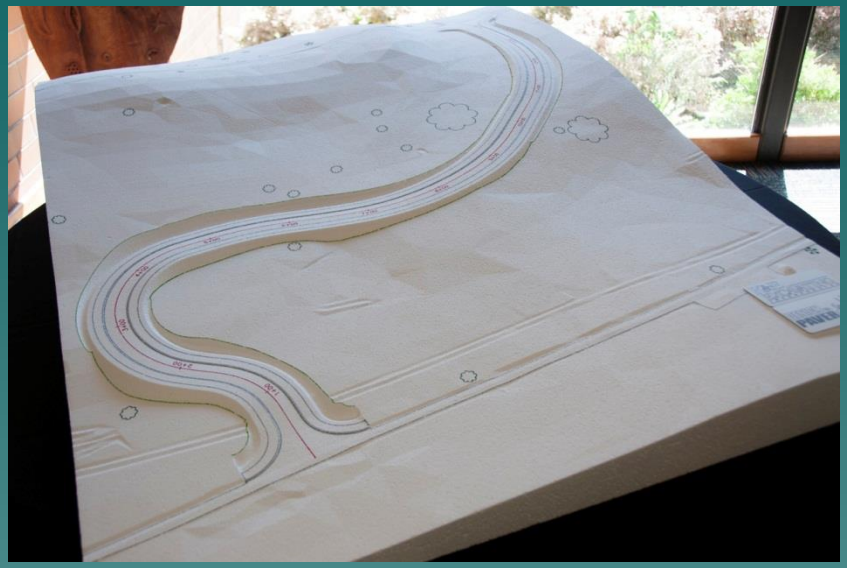
Camp Najaf, Oregon National Guard Training Center, Adair, Oregon

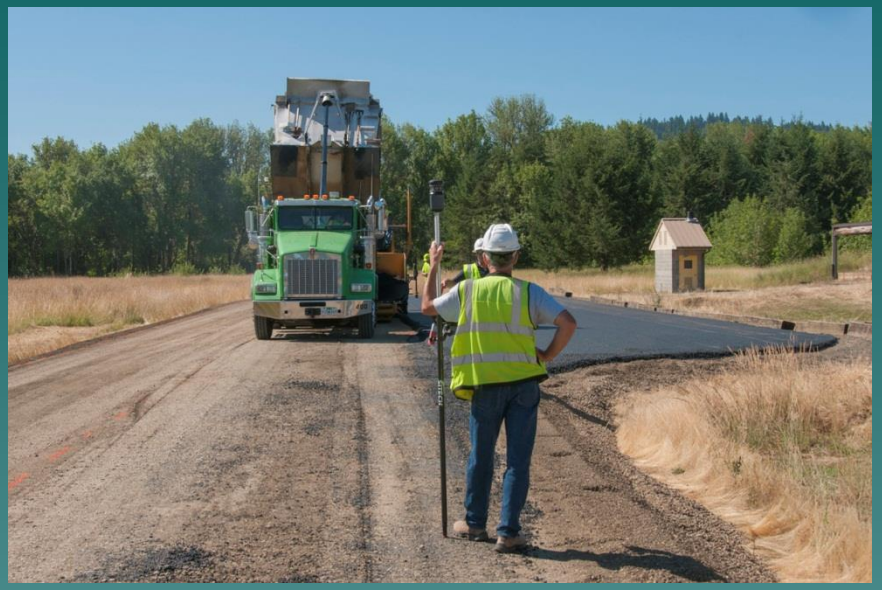
Post Event Information
www.designtopaver.org

- Classroom presentations
- Field Demonstrations
- Work Zone Camera
- Event Photos
- Other Material
  - Conference Handbook
  - Time Lapse Photography of Road Construction



Established ORGN Reference Station NAJF
to support survey, design, and machine guidance.





Oregon Department of Transportation

DESIGN to PAVER

Intelligent Construction Systems and Technologies Demonstration

Oregon Department of Transportation

U.S. Department of Transportation Federal Highway Administration

DESIGN to PAVER

Intelligent Construction Systems and Technologies Demonstration

Intelligent Compaction Projects

Stationary LiDAR

Leica C10

Leica P40

Mobile Scanners

Topcon IP-S2-HD
Mapping Accuracy

Leica Pegasus
Survey Accuracy

Mobile Oregon Real-time Network Reference Station

- Surplus Variable Sign Trailer
  - Solar Power
  - Battery Bank
  - Cellular Modem
  - GPS Reference Sensor
  - Antenna must be ground mount
- Support Mobile Scanning
- Support Automated Machine Guidance Projects

ODOT Mobile Scanners

Drones at Oregon DOT

- COA's
  - Ron Singh: designated agency lead for drones by Director of ODOT
    - Private pilot
    - Builder of experimental airplanes
  - Design to Paver: COA for Trimble UX5
  - Interstate 5 "Solar Highway" PV panel inspection
  - ODOT applying for state-wide COA for ODOT projects
- Oregon Legislature holding hearings on possibility of regulating drone air space in Oregon

ODOT Leica Aibot X6 Hexacopter

KEY CONCEPTS FOR THE FUTURE

DIGITAL DATA – CREATION, STORAGE, RETRIEVAL, AND FORWARD MIGRATION
MANAGING INFRASTRUCTURE LIFE CYCLE DATA
STRUCTURED DATA EXCHANGE - LANDXML
DIGITAL SIGNATURES
DATA SILOS
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Reorganization at ODOT to Support Engineering Automation

- Engineering Automation Section:
  - Manager: Ron Singh: Chief of Surveys for ODOT
  - New organization chart
  - Key components of two units
    - Engineering Automation Unit
    - Geometronics Unit
- Connected and Automated Vehicles Group (CAV)

Oregon DOT Geometronics Unit

(formerly a Unit in the Traffic Roadway Section of ODOT)

Ron Singh, ODOT Chief of Surveys
& Manager, Geometronics **Unit**

Geometronics

- **Photogrammetry**
- **Survey Operations**
- **Right-of-Way Engineering**
- **Geodetic Control**
  - Ken Bays
  - Randy Oberg
  - Clint Ward

Mark Armstrong, NGS State Advisor

New Engineering Automation Section

(created Summer 2015)

Ron Singh, ODOT Chief of Surveys
& Manager of the new Engineering Automation Section

- **Geometronics Unit**
- **Engineering Automation Unit**

New Engineering Automation Unit

(created Summer 2015)

- Construction Automation Surveyor
- Construction Automation Engineer
- Construction Automation Tech
- Construction Automation Inspector
- Design & Automation Engineer
- Business Strategist
- Eng Data Management Specialist
- Senior Design and Automation Engineer

ODOT Connected and Automated Vehicles Group

- A team of high level managers from various disciplines
- Possible Oregon Real-time GPS Network support:
  - Connected Vehicles: Vehicle to Infrastructure
    - Accuracy
    - Dependability
    - Other

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    - LiDAR Terrestrial Scanning: Stationary and Mobile
    - Unmanned Aerial Systems: Drones
- ODOT Reorganization to Support Engineering Automation

Grant County, Oregon

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