Massachusetts Association MALSCE of Land Surveyors & Civil Engineers

2019 MALSCE & North East Surveying Societies Convention

Elevating Our Profession

DoubleTree by Hilton Hotel Leominster

99 Erdman Way, Leominster, MA 01453

Friday and Saturday, March 15 & 16, 2019

7:00 AM - 10:00 PM Friday

7:00 AM – 1:30 PM Saturday

Session Attendee Handouts

Supported by 2019 MALSCE Sustaining Members:

AIRWORKS | Carlson ...For the Total Project | CIVILVIEW | CEI Col-East | DGT Associates Surveying & Engineering

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The 2019 MALSCE Convention is brought to you by the Berkshire and Connecticut Valley Chapters

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Massachusetts Association of Land Surveyors & Civil Engineers

2019 MALSCE & NESS Convention

March 15 & 16, 2019, DoubleTree by Hilton Hotel Leominster

Schedule of Events

Friday, March 15

7:00 AM – 4:30 PM
Registration Desk Open
Concourse

8:00 AM – 4:30 PM
Convention Exhibit
Concourse

8:00 AM - 3:15 PM
MALSCE Plan Contest
Beethoven/Brahms/Mozart

7:55 AM - 8:00 AM
Opening Remarks
Beethoven/Brahms/Mozart

8:00 AM - 9:00 AM
Session 1A: A Short Journey to the Moving Center of the Earth – The Evolution of the National Spatial Reference System*
Junior Ballroom

8:00 AM - 9:00 AM
Session 1B: MALSCE Guidelines for 3D Surveying Services Updates*
Strauss/Schubert

9:00 AM - 10:15 AM
Session 2: Board of Registration Panel – The Future Licensure and the Land Surveying Profession
Beethoven/Brahms/Mozart

10:15 AM - 10:45 AM
Break
Concourse

10:45 AM – 12:00 PM
General Session 3: MALSCE Proprietors' Council – Pulse of Business
Beethoven/Brahms/Mozart

12:00 PM – 1:00 PM
Lunch with Exhibitors & MALSCE Awards Presentations
Beethoven/Brahms/Mozart

1:00 PM - 1:30 PM
Session 4: Vendor Quick Fire Session
Beethoven/Brahms/Mozart

1:30 PM – 2:45 PM
Session 5: Educators Panel – A Collaborative Discussion of the Future of Land Surveying Education
Beethoven/Brahms/Mozart

2:45 PM - 3:00 PM
Break
Concourse

2:45 PM - 4:00 PM
Session 6A: New Survey Tools and LiDar Limitations for Projects
Strauss/Schubert

***indicates the sessions that have handouts**

3:00 PM - 4:15 PM
Session 6B: Fun with Drones for Surveyors*
Junior Ballroom

4:15 PM - 5:15 PM
Session 7A: Drone Use, Accuracy, and Tips from the Field
Junior Ballroom

4:15 PM - 5:15 PM
Session 7B: North East Surveying Societies Panel Discussion
Strauss/Schubert

5:15 PM - 6:15 PM
MALSCE Education Trust Benefit Auction/Reception
Nectar Restaurant & Bar

6:15 PM - 6:45 PM
Break

6:45 PM - 8:00 PM
Dinner
Beethoven/Brahms/Mozart

8:00 PM - 10:00 PM
Entertainment
Beethoven/Brahms/Mozart

Saturday, March 16

7:00 AM - 3:00 PM
Registration Desk Open
Concourse

7:00 AM - 8:00 AM
Breakfast & MALSCE Board of Directors Meeting
Mozart

8:00 AM - 10:00 AM
Leadership: "Anyone Could Lead Perfect People"*
Strauss/Schubert

8:00 AM - 10:00 AM
Surveyor-in-Training Refresher Course
Gershwin
Professional Land Surveyor Refresher Courses
Cole Porter

10:00 AM - 10:15 AM
Break
Concourse

10:15 AM - 12:15 PM
Leadership: "Anyone Could Lead Perfect People" (continued)
Strauss/Schubert

10:15 AM - 12:15 PM
SIT & PLS Refresher Courses (continued)
Gershwin & Cole Porter

12:15 PM - 1:15 PM
Lunch/Closing Remarks
Mozart

12:15 AM - 5:00 PM
SIT & PLS Refresher Courses (continued)
Gershwin & Cole Porter

A short Journey to the Moving Center of the Earth

Massachusetts Association of Land Surveyors and Civil Engineers

March 15, 2019

Dan Martin
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Session description and objectives

- In 2022, the National Geodetic Survey will be replacing the U.S. horizontal and vertical datums (NAD 83 and NAVD 88). We will discuss the history of these datums, their relationship to other reference frames, the reasons for the change, and how it affects surveyors and their access to these datums.
- Objective…gain a fundamental understanding of:
  - How and why our datums/reference frames have changed over time
  - The need to further modernize the US reference frames
  - What Progress has been made?
  - New State Plane

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Geodetic Survey

Mission: To define, maintain & provide access to the
National Spatial Reference System (NSRS)
to meet our Nation's economic, social & environmental needs

National Spatial Reference System

- Latitude
- Longitude
- Height
- Scale
- Gravity
- Orientation

& their time variations

GEODETIC DATUMS

HORIZONTAL

2 D (Latitude and Longitude) (e.g. NAD 27, NAD 83 (1986))

VERTICAL

1 D (Orthometric Height) (e.g. NGVD 29, NAVD 88, Local Tidal)

GEOMETRIC

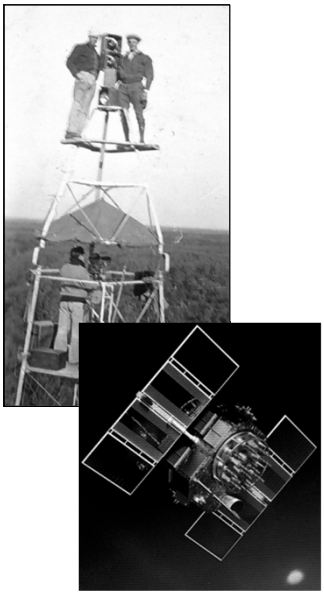
3 D (Latitude, Longitude and Ellipsoid Height)
Fixed and Stable - Coordinates seldom change
(e.g. NAD 83 (1996), NAD 83 (2007), NAD 83 (CORS96) NAD 83 (2011))

also

4 D (Latitude, Longitude, Ellipsoid Height, Velocities) Coordinates change with time
(e.g. ITRF00, ITRF08)

A (very) brief history of NAD 83

- Original realization completed in 1986
  - Consisted (almost) entirely of classical (optical) observations
- "High Precision Geodetic Network" (HPGN) and "High Accuracy Reference Network" (HARN) realizations
  - Most done in 1990s, essentially state-by-state
  - Based on GNSS but classical stations included in adjustments
- National Re-Adjustment of 2007
  - NAD 83(CORS96) and (NSRS2007)
  - Simultaneous nationwide adjustment (GNSS only)
- ***New realization: NAD 83(2011) epoch 2010.00***



Why change datums/Realizations

- NAD27 based on old observations and old system
- NAD83(86) based on old observations and new system
- NAD83(96) based on new and old observations and same system (HARN)
- NAD83(NSRS2007) based on new observations and same system. Removed regional distortions and made consistent with CORS
- NAD83(2011) based on new observations and same system. Kept consistent with CORS

Horizontal Datums/Coordinates…What do you use in MA?

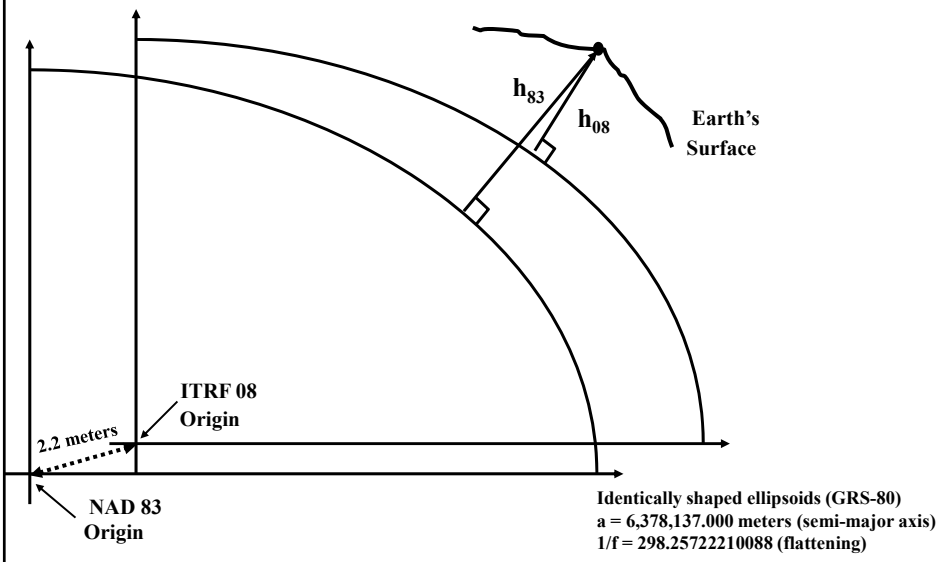
- NAD 27
- NAD 83 (Lat-Lon) SPC
  - Which one???
    - NAD 83 (1986)
    - NAD 83 (1992)
    - NAD 83 (1996)
    - NAD 83 CORS96(2002)
    - NAD 83 (NSRS2007)
    - NAD 83 (2011)
- WGS 84
  - Which one???
    - WGS 84 (1987)
    - WGS 84 (G730)
    - WGS 84 (G873)
    - WGS 84 (G1150)
    - WGS 84 (G1674)
    - WGS 84 (G1762)
- ITRF00 (epoch 97)
- IGS08 (epoch 2005)
- IGS14 (epoch 2010)

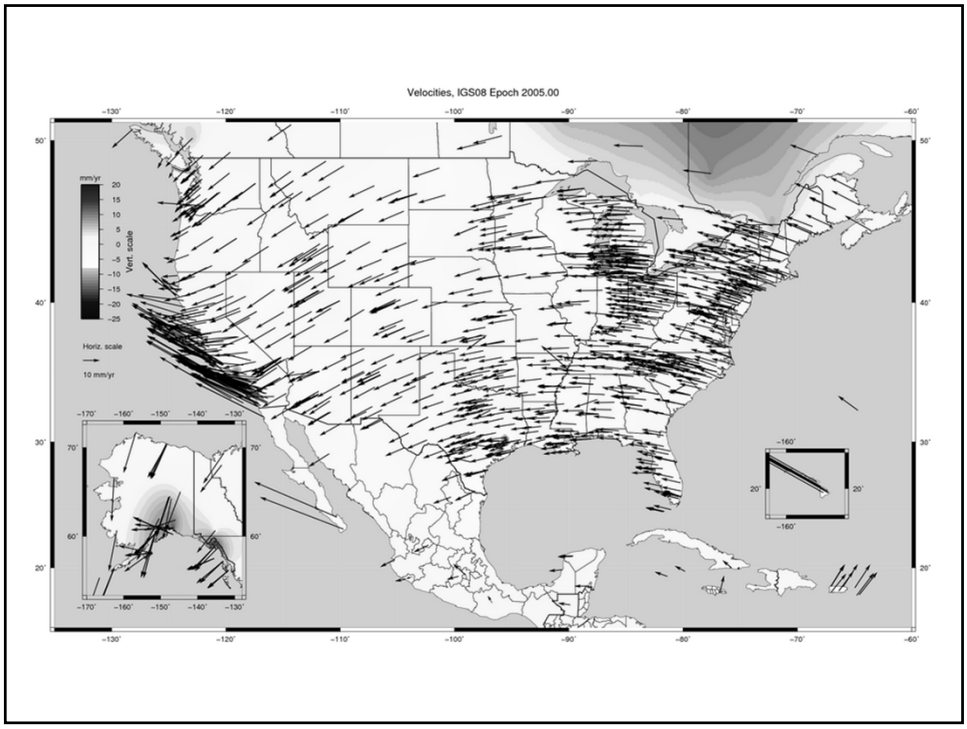
National Spatial Reference System (NSRS) Improvements over time

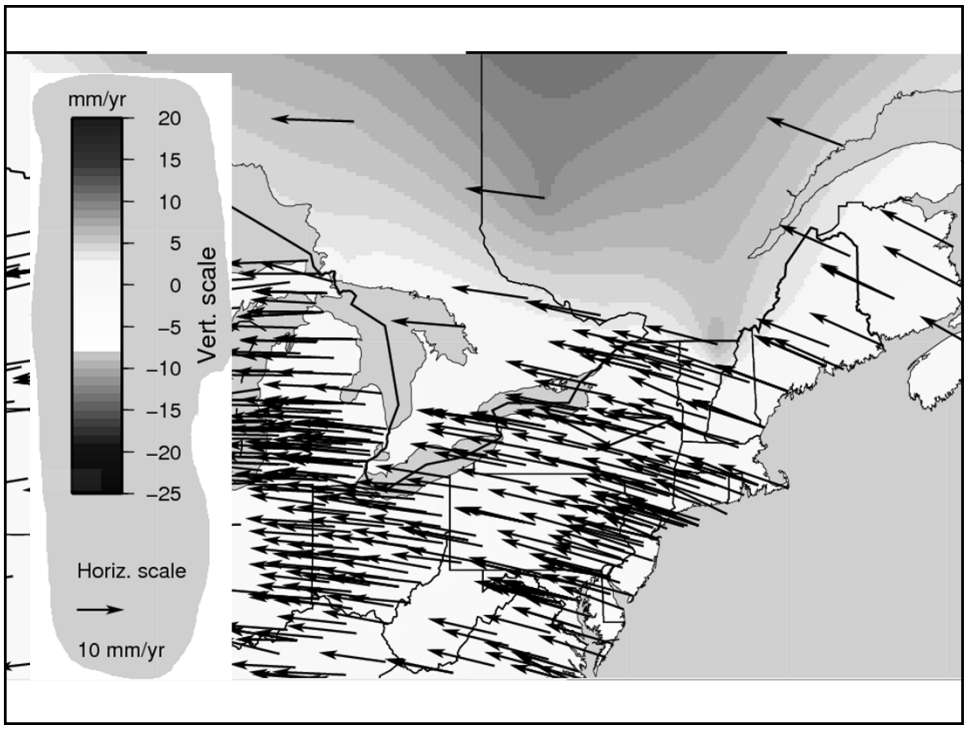
NETWORK	TIME SPAN	NETWORK ACCURACY	LOCAL ACCURACY	SHIFT
NAD 27	1927-1986	10 meters	(1:100,000)	10-200 m
NAD83(86)	1986-1990	1 meter	(1:100,000)	0.3-1.0 m
NAD83(199x)* "HARN", "FBN"	1990-2007	0.1 meter	(1:1 million) (1:10 million)	0.05 m
NAD83(NSRS2007)	2007-2011	0.01 meter	0.01 meter	0.03 m
NAD83(2011)	2011-	0.01 meter	0.01 meter	0.01 m

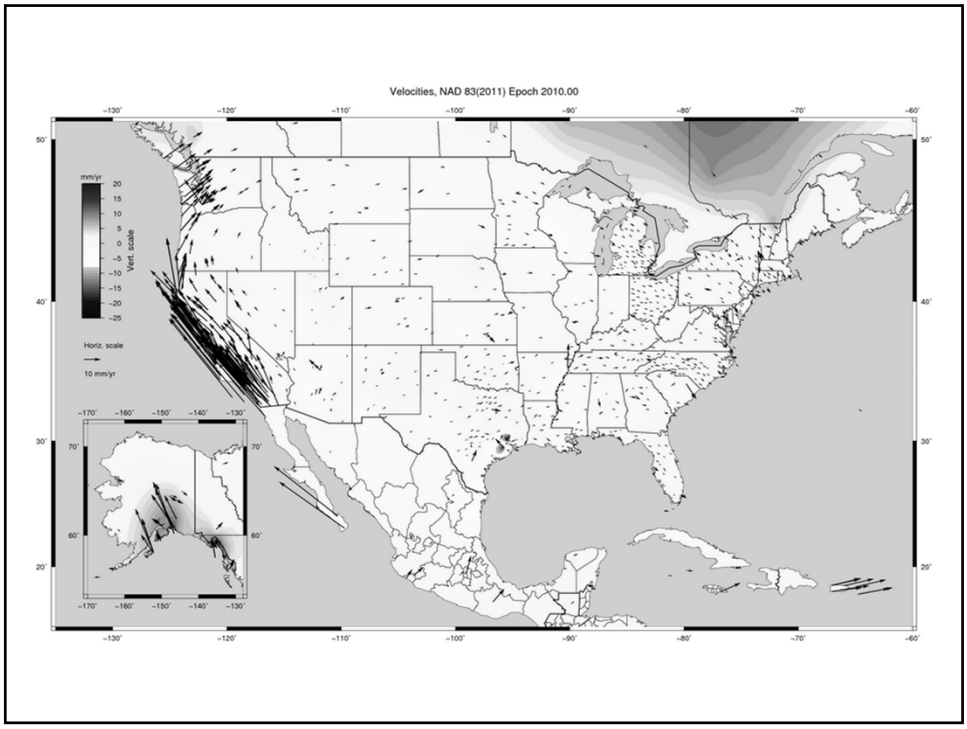
ITRF2008, IGS08 AND NAD 83(2011)

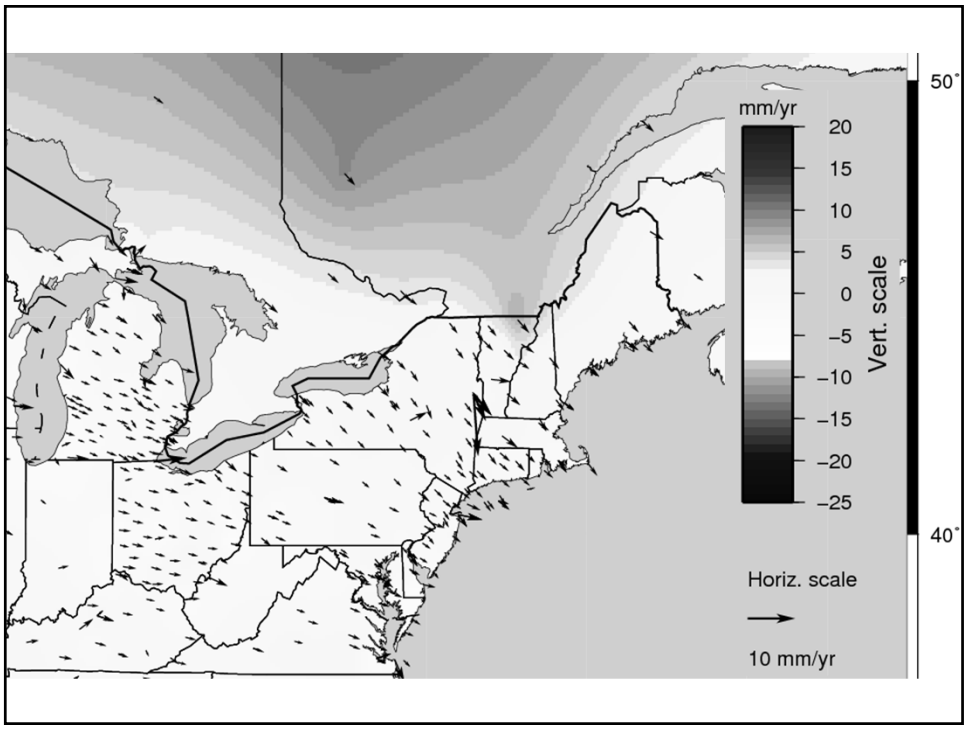
Simplified Concept of NAD 83 vs. ITRF08




Velocities, IGS08 Epoch 2005.00
mm/yr
20
15
10
5
0
−5
−10
−15
−20
−25
Vert. scale
Horiz. scale
10 mm/yr

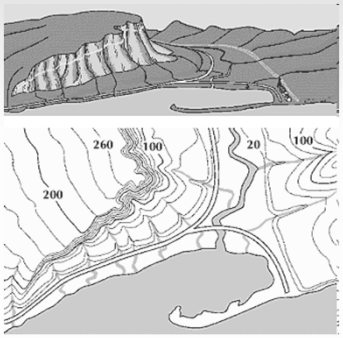

mm/yr
20
15
10
5
0
−5
−10
−15
−20
−25
Vert. scale
Horiz. scale
10 mm/yr


Velocities, NAD 83(2011) Epoch 2010.00
mm/yr
20
15
10
5
0
−5
−10
−15
−20
−25
Vert. scale
Horiz. scale
10 mm/yr
−130°
−120°
−110°
−100°
−90°
−80°
−70°
−60°
50°
40°
30°
20°
−170°
−160°
−150°
−140°
−130°
70°
60°

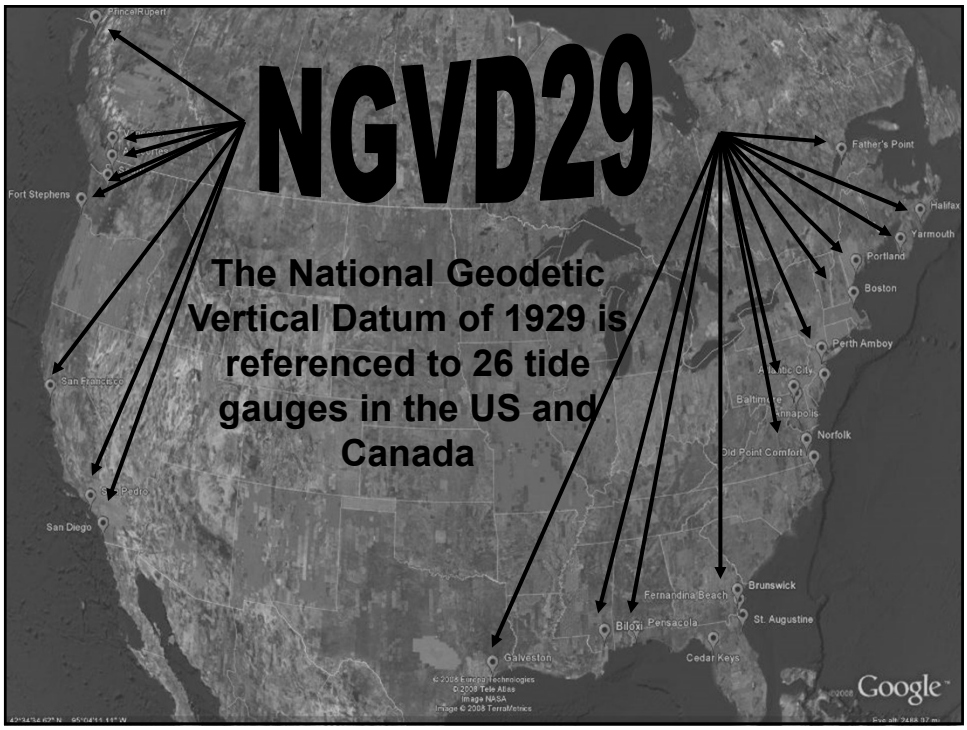

mm/yr
20
15
10
5
0
−5
−10
−15
−20
−25
Vert. scale
50°
40°
Horiz. scale
10 mm/yr

What is a Vertical Datum?

- Strictly speaking, a vertical datum is a ***surface*** representing zero elevation
- Traditionally, a vertical datum is a ***system*** for the determination of heights above a zero elevation surface
- Vertical datum comprised of:
  - Its ***definition:*** Parameters and other descriptors
  - Its ***realization:*** Its physical method of accessibility



"*topographic map*." Online Art. Britannica Student Encyclopædia. 17 Dec. 2008 <http://student.britannica.com/ebi/art-53199>



History of vertical datums in the USA

- **NGVD 29**
  - National Geodetic Vertical Datum of 1929
  - Original name: "Sea Level Datum of 1929"
  - "Zero height" held fixed at 26 tide gauges
    - Not all on the same tidal datum epoch (~ 19 yrs)
  - Did not account for Local Mean Sea Level variations from the geoid
    - Thus, not truly a "geoid based" datum

Current Vertical Datum in the USA

Father Point Lighthouse, Quebec

- **NAVD 88**: North American Vertical Datum of 1988
- ***Definition:*** The surface of equal gravity potential to which orthometric heights shall refer in North America*, and which is 6.271 meters (along the plumb line) below the geodetic mark at "Father Point/Rimouski" (NGSIDB PID TY5255).
- ***Realization:*** Over 500,000 geodetic marks across North America with published Helmert orthometric heights, most of which were originally computed from a minimally constrained adjustment of leveling and gravity data, holding the geopotential value at "Father Point/Rimouski" fixed.

**Not adopted in Canada*

History of vertical datums in the USA

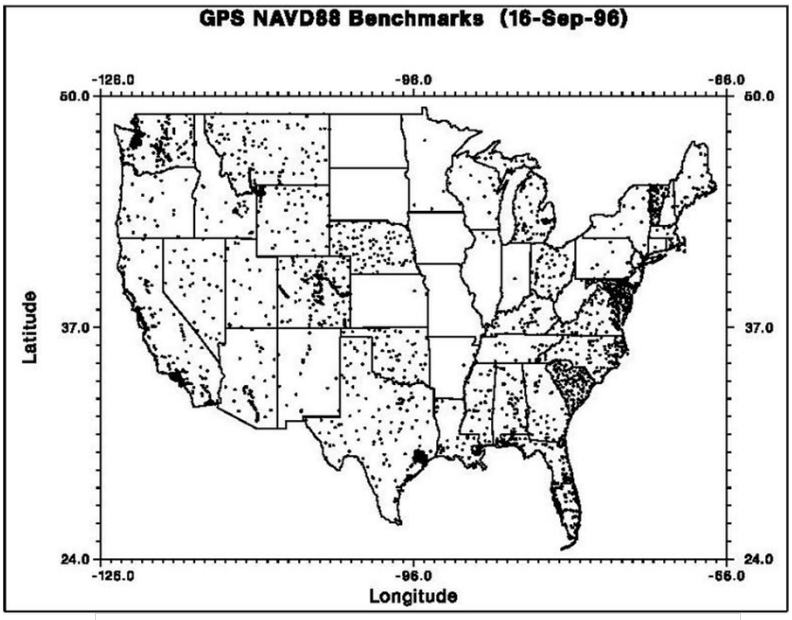
- **NAVD 88**
  - North American Vertical Datum of 1988
  - One height held fixed at "Father Point" (Rimouski, Canada)
  - …height chosen was to minimize 1929/1988 differences on USGS topo maps in the eastern U.S.
  - Thus, the "zero height surface" of NAVD 88 wasn't chosen for its closeness to the geoid (but it was close…few decimeters)

History of vertical datums in the USA

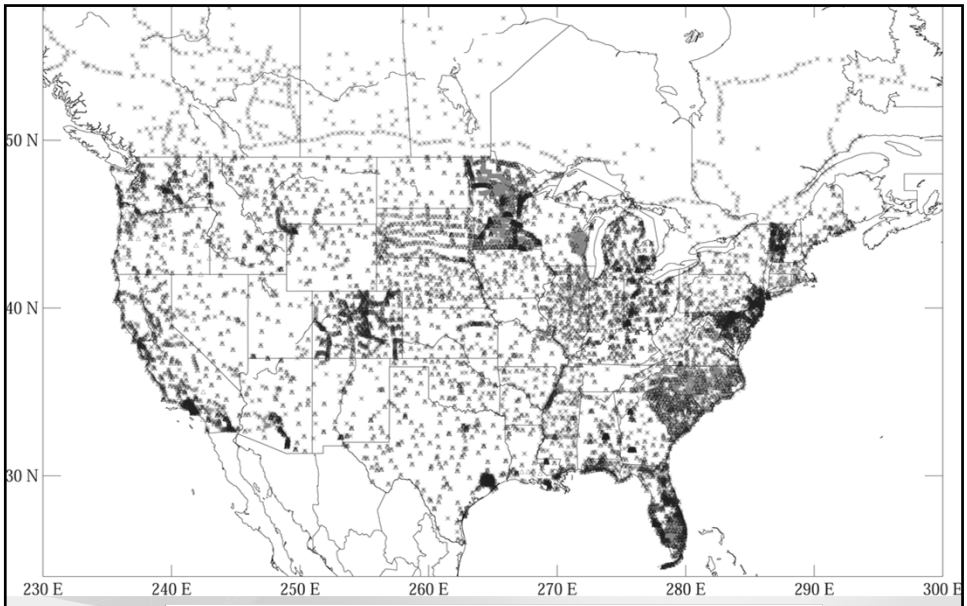
- **NAVD 88** (continued)
  - Use of one fixed height removed local sea level variation problem of NGVD 29
  - Use of one fixed height did open the possibility of unconstrained cross-continent error build up
  - H=0 surface of NAVD 88 was supposed to be parallel to the geoid…(close again)

Types Uses and History of Geoid Height Models

- Gravimetric (or Gravity) Geoid Height Models
  - Defined by gravity data crossing the geoid
  - Refined by terrain models (DEM's)
  - Scientific and engineering applications
- Composite (or Hybrid) Geoid Height Models
  - Gravimetric geoid defines most regions
  - Warped to fit available GPSBM control data
  - Defined by legislated ellipsoid (NAD 83) and local vertical datum (NAVD 88, PRVD02, etc.)
  - May be statutory for some surveying & mapping applications

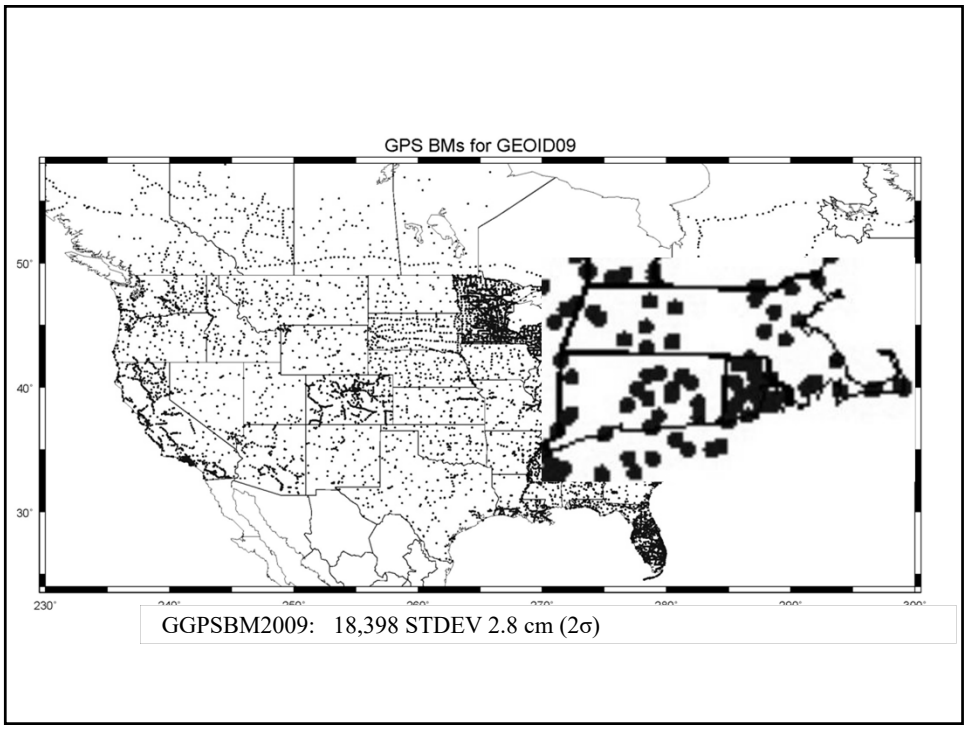


GPSBM1996: 2,951total 0 Canada STDEV ≈ 5 cm (2σ)

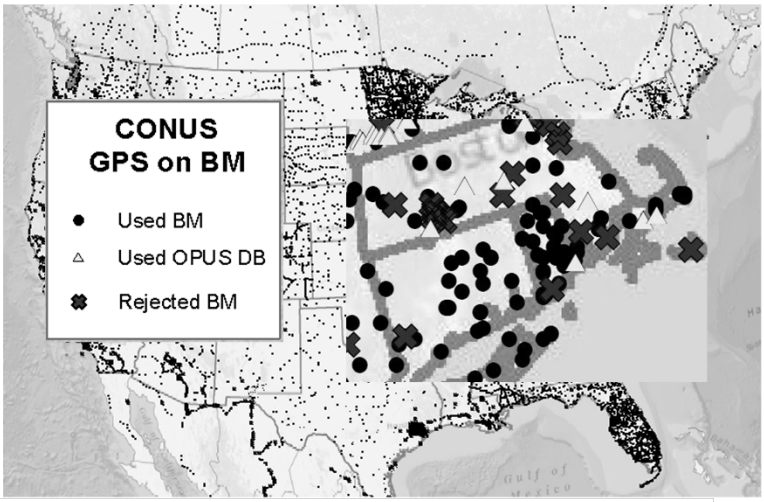


GPSBM1999: 6,169 total 0 Canada STDEV 9.2 cm (2σ)

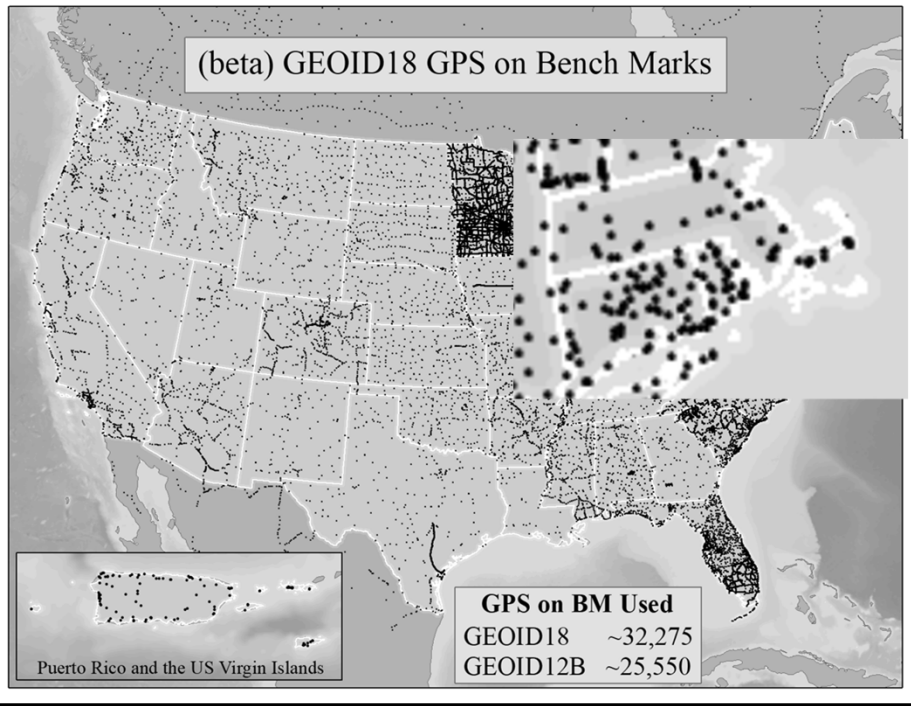
GPSBM2003: 14,185 total 579 Canada STDEV 4.8 cm (2 σ)



GGPSBM2009: 18,398 STDEV 2.8 cm (2σ)



GGPSBM2012A: 23,961 (CONUS)
499 (OPUS on BM)
574 (Canada)
177 (Mexico)

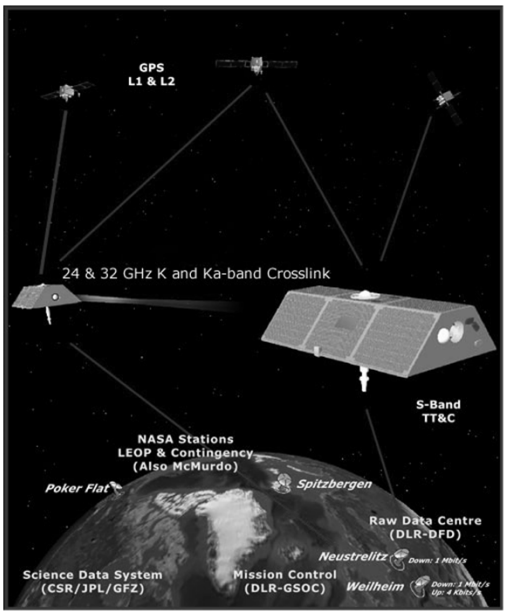


Which Geoid for Which NAD 83?

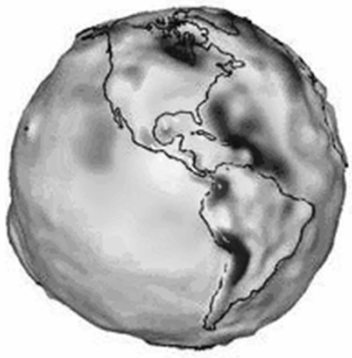
- NAD 83(2011)
  - Geoid12A/12B
  - Geoid18
- NAD 83(2007)
  - Geoid09
  - Geoid06 (AK only)
- NAD 83(1996) & CORS96
  - Geoid03
  - Geoid99
  - Geoid96

Problems with NAD 83 and NAVD 88

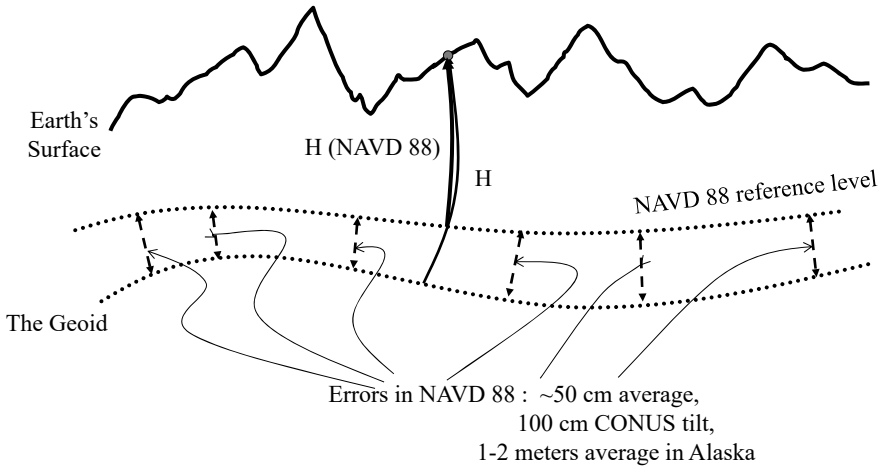
- **NAD 83** is not as geocentric as it could be (approx. 2 m)
  - Positioning Professionals don't see this - **Yet**
- **NAD 83** is not well defined with positional velocities
- **NAVD 88** is realized by passive control (bench marks) most of which have not been re-leveled in at least 40 years.
- **NAVD 88** does not account for local vertical velocities (subsidence and uplift)
  - Post glacial isostatic readjustment (uplift)
  - Subsurface fluid withdrawal (subsidence)
  - Sediment loading (subsidence)
  - Sea level rise (0.92 ft – 1.17 ft per 100 years)
    - **Boston, MA 2.81 mm/yr (0.009 ft/yr) 1921-2016**
    - **Nantucket Island, MA 3.57 mm/yr (0.011 ft/yr) 1965-2016**
    - **Woods Hole, MA 2.83 mm/yr (0.009 ft/yr) 1932-2016**



GRACE – Gravity Recovery and Climate Experiment



Why isn't NAVD 88 good enough anymore?

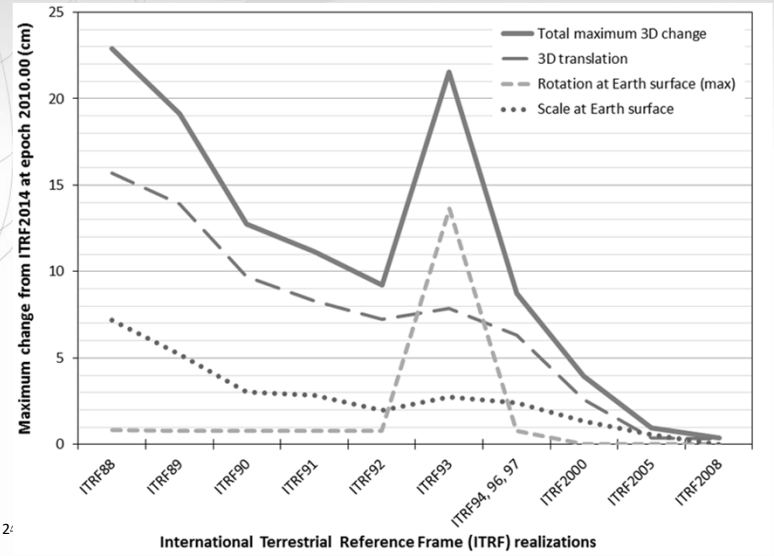


Why replace NAVD 88 and NAD 83?

- **ACCESS!**
  - easier to find the sky than a 60-year-old bench mark
  - GNSS equipment is cheap and fast
- **ACCURACY!**
  - easier to trust the sky than a 60-year old bench mark
  - immune to passive mark instability
- **GLOBAL STANDARDS!**
  - systematic errors of many meters across the US
  - aligns with GPS, international efforts
  - aligns with Canada, Mexico

31

ITRF is now mature

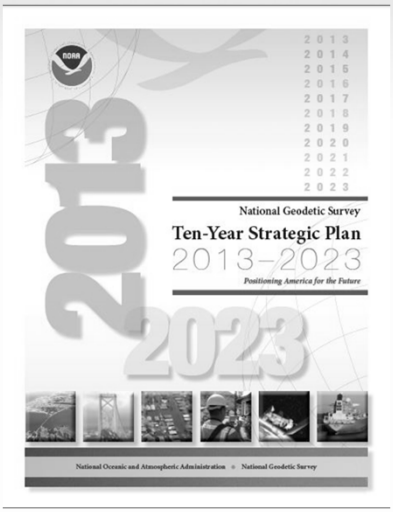


April 2

The National Geodetic Survey 10 year plan Mission, Vision and Strategy 2008 – 2018, 2013-2023

http://www.ngs.noaa.gov/INFO/NGS10yearplan.pdf

- *Official NGS policy as of Jan 9, 2008*
  - *Modernized agency*
  - *Attention to accuracy*
  - *Attention to time-changes*
  - *Improved products and services*
  - *Integration with other fed missions*
- *2022 Targets:*
  - *NAD 83 and NAVD 88 re-defined*
  - *Cm-accuracy access to all coordinates*
  - *Customer-focused agency*
  - *Global scientific leadership*



Scientific Decisions

- Blueprint for 2022, Part 1: Geometric
  - ✓Four plate-fixed Terrestrial Reference Frames
    - ✓And what "plate fixed" means
  - ✓Mathematical equation between IGS and TRFs
    - ✓Plate Rotation Model for each plate
    - ✓Coordinates at survey epoch
  - ✓Intra-frame velocity model
    - ✓To compare coordinates surveyed at different epochs

Replacing the NAD 83's

- Three plate-(*pseudo*)fixed frames will be replaced with four *plate-fixed* reference frames
  - N. Amer., Pacific, Mariana, Caribbean(new!)
- Remove long-standing non-geocentricity of NAD 83 frames
- All four : identical to IGSxx at a TBD epoch
  - 2020.00?
- All four : differ from IGSxx by plate rotation only
  - Updated Euler Pole determination for rigid plate only

Names

The Old:

NAD 83(2011)

NAD 83(PA11)

NAD 83(MA11)

The New:

The North American Terrestrial Reference Frame of 2022 (NATRF2022)

The Caribbean Terrestrial Reference Frame of 2022 (CTRF2022)

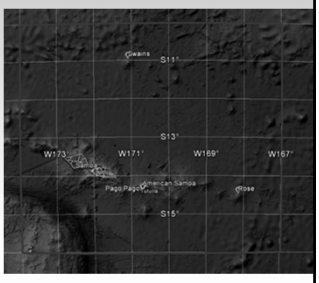
The Pacific Terrestrial Reference Frame of 2022 (PTRF2022)

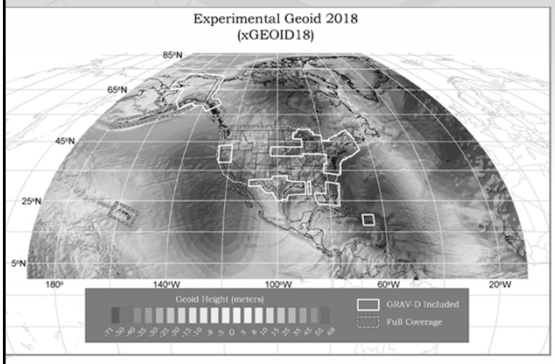
The Mariana Terrestrial Reference Frame of 2022 (MTRF2022)

Scientific Decisions!!

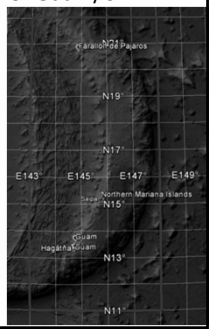
- Blueprint for 2022, Part 2: Geopotential
  - ✓Global 3-D Geopotential Model (GGM)
    - ✓Will contain all GRAV-D data
    - ✓Able to yield any physical value on/above surface
  - ✓Special high-resolution geoid, DoV and surface gravity products consistent with GGM
    - ✓Not global: NA/Pacific, American Samoa, Guam/CNMI
  - ✓Time-Dependencies
    - ✓Geoid monitoring service
      - ✓Impacts of deglaciation, sea level rise, earthquakes, etc

GEOID2022 (et al) over American Samoa:
-16 to -10, 186-193





GEOID2022 (et al) over Guam/CNMI:
11-22, 143-148



GEOID2022 (et al) over the North America/Pacific/Caribbean/Central America/Greenland region will range from 0 to 90 latitude and from 170 to 350 longitude.

Names

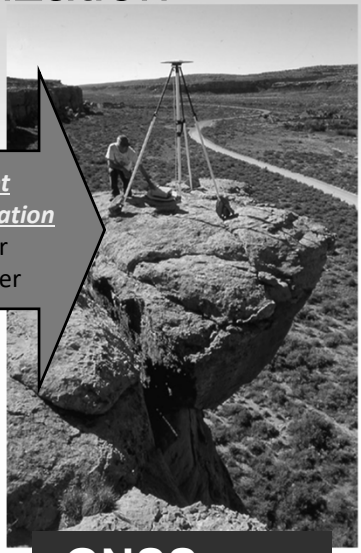
	The Old:
Orthometric Heights	NAVD 88
Normal Orthometric Heights	PRVD 02
	VIVD09
	ASVD02
	NMVD03
	GUVD04
Dynamic Heights	IGLD 85
Gravity	IGSN71
Geoid Undulations	GEOID12B
Deflections of the Vertical	DEFLEC12B

The New:

The North American-Pacific Geopotential Datum of 2022 (NAPGD2022)

- Will include GEOID2022

Height Modernization



Height Modernization
-faster
-cheaper

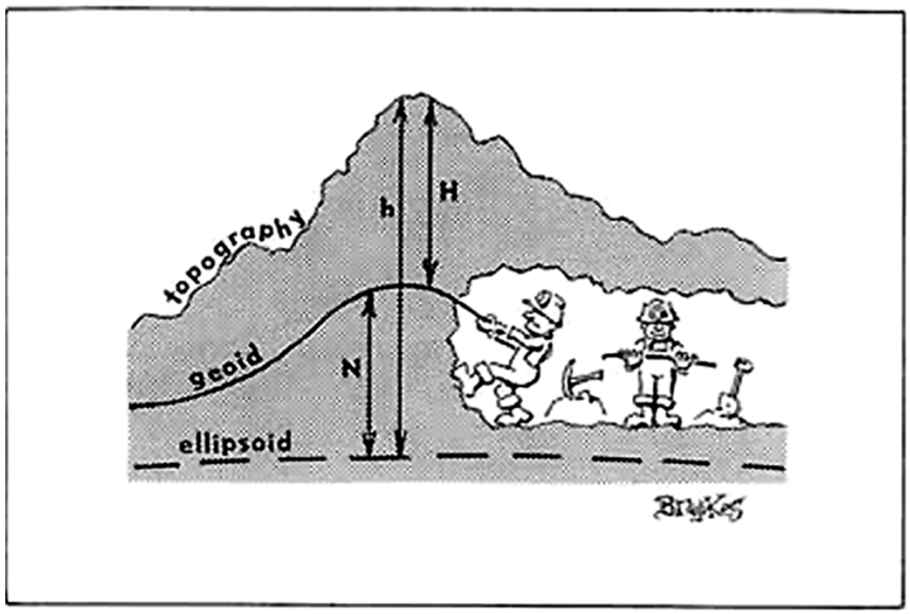
Differential Leveling

GNSS + …

Height Modernization Bottom line

1. Using GNSS is cheaper, easier than leveling

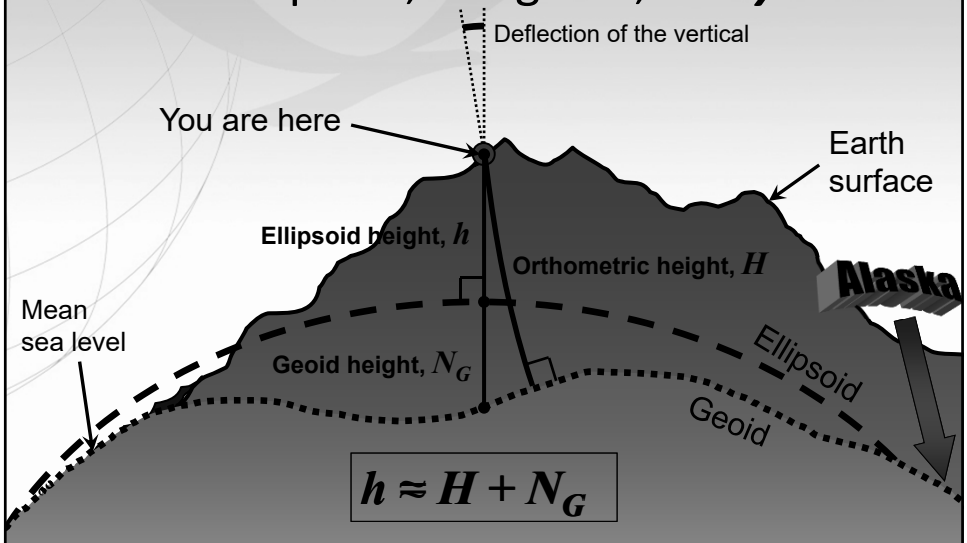
2. To use GNSS we need a good geoid model



In Search of the Geoid

NOAA's National Geodetic Survey Positioning America for the Future www.ngs.noaa.gov

The ellipsoid, the geoid, and *you*

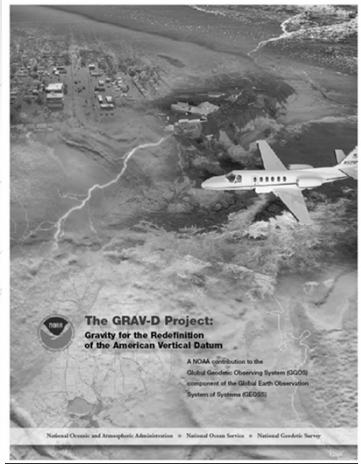


$$h \approx H + N_G$$

Note: Geoid height is **negative** everywhere in the coterminous US (but it is **positive** in most of Alaska)

NOAA's National Geodetic Survey Positioning America for the Future www.ngs.noaa.gov

Gravity for the Redefinition of the American Vertical Datum (GRAV-D)

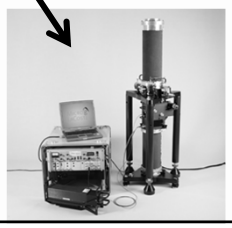


Gravity *and* ***Heights*** *are inseparably connected*

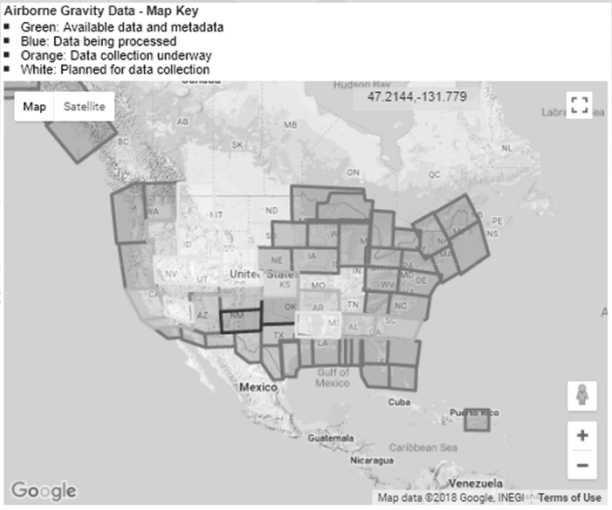
- Replace the Vertical Datum of the USA by 2022 (at today's funding) with a **gravimetric geoid accurate to 1 cm**
- Orthometric heights accessed via GNSS accurate to 2 cm
- Three thrusts of project:
  - Airborne gravity survey of entire country and its holdings
  - Long-term monitoring of geoid change
  - Partnership surveys
- Working to launch a collaborative effort with the USGS for simultaneous magnetic measurement

Gravity Survey Plan

- National Scale Part 1
  - Predominantly through airborne gravity
  - With Absolute Gravity for ties and checks
  - Relative Gravity for expanding local regions where airborne shows significant mismatch with existing terrestrial

Airborne Gravity Current Coverage



Data Block Status

Complete
Processing
Collecting
Planned

As of Oct 2018

http://www.ngs.noaa.gov/GRAV-D/data_products.shtml

Accessing the New Vertical Datum

- **Primary access** (NGS mission)
  - Users with geodetic quality GNSS receivers will continue to use OPUS suite of tools
  - Ellipsoid heights computed, and then a gravimetric geoid removed to provide orthometric heights in the new datum
  - No passive marks needed
  - But, could be used to position a passive mark
- **Secondary access** (Use at own risk)
  - Passive marks that have been tied to the new vertical datum
  - NGS will provide a "data sharing" service for these points, but their accuracy (due to either the quality of the survey or the age of the data) will not be a responsibility of NGS

Continuously Operating Reference Station

Accessing the New Vertical Datum

- **NAVD 88 conversion to new datum**
  - A conversion will be provided between NAVD 88 and the new datum
    - Only where recent GNSS ellipsoid heights exist to provide modern heights in the new datum

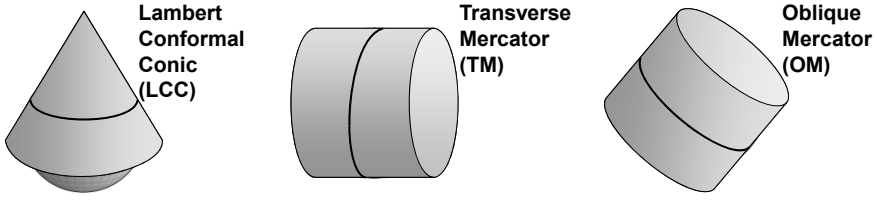
Predicted Orthometric Changes in 2022
Vicinity of Boston, MA

```
Note: The GRS80 ellipsoid is used for both NAD83 and IGS08.


Your input in NAD83 (2011) epoch 2010.00:
Latitude         Longitude         Ellipsoid Height        Station
42 22 25.09735   071 03 12.76587   -24.992                  TRI STA

Your Result in IGS08 epoch 2022.00:
Latitude         Longitude         Ellipsoid Height
42 22 25.13385   71 03 12.78549    -26.207

The geoid height of GEOID12B (with respect to NAD83):           -27.688 m
The orthometric height in NAVD88 (based on GEOID12B):             2.696 m

Estimated orthometric height in North American-Pacific Geopotential Datum of 2022 (NAPGD2022)
based on different geoid models (all heights in meters):

Geoid Model         Geoid Height          Ortho Height          Ortho(model)-NAVD88(GEOID12B)
USGG2012                -28.549                2.342                  -0.354
xGEOID17A               -28.586                2.379                  -0.317
xGEOID17B               -28.573                2.366                  -0.330
-------------------------------------------------------------------------------------------
```

-0.33m (-1.08ft)

A New State Plane Coordinate System

- **State Plane Coordinate System of 2022 (SPCS2022)**
  - Referenced to 2022 Terrestrial Reference Frames (TRFs)
  - Based on same reference ellipsoid as SPCS 83 (GRS 80)
  - Same 3 ***conformal*** projection types as SPCS 83 and 27:



50

Deadlines for SPCS2022 input

NGS.Feedback@noaa.gov
by **August 31, 2018**

Anyone can comment!

Federal Register Notice (FRN)

- Announcement and public comments
  - On draft **SPCS2022 policy & procedures**
  - On **"special purpose"** zones

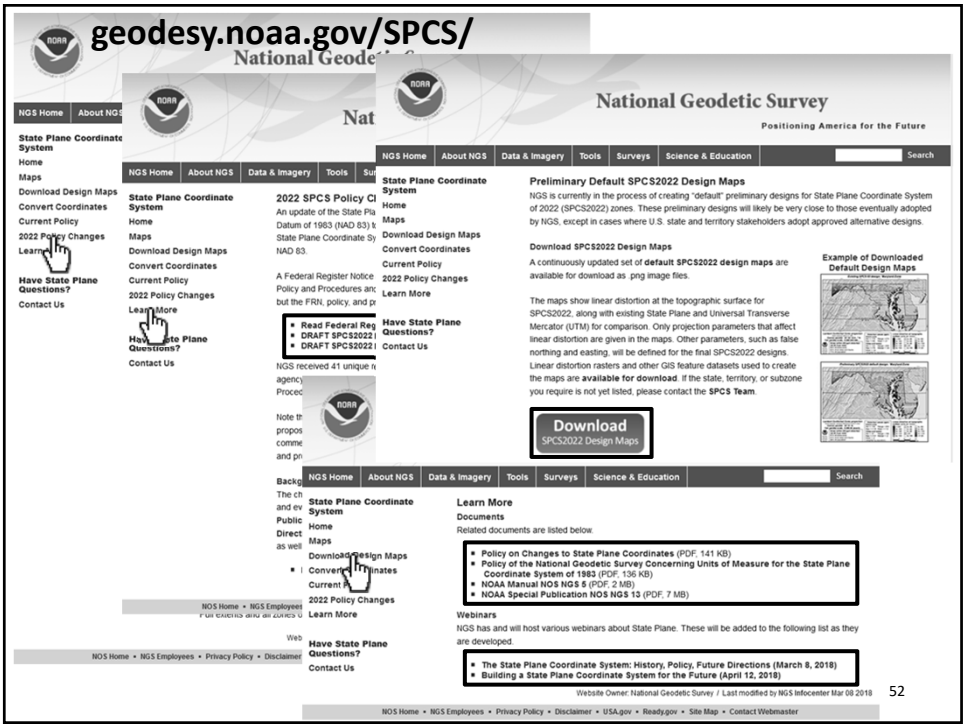
NGS.SPCS@noaa.gov
by **March 31, 2020** for ***requests*** and ***proposals***

by **March 31, 2021** for ***submittal*** of ***approved*** designs

State stakeholders only!

SPCS2022 Procedures (draft)

- **Consensus** input per SPCS2022 procedures
  - ***Requests*** for designs done by NGS
  - ***Proposals*** for designs by contributing partners
- Submittal of **approved** designs
  - Proposal must first be approved by NGS
  - Designs must be complete for NGS to review
- Later requests will be for ***changes*** *to* SPCS2022



SPCS2022 Policy & Procedures

Summary of main things that did* NOT *change

- **Policy**
  - Limited to LCC, TM, and OM projections
  - Zones designed to reduce distortion at ground
  - Default zones designed by NGS if no consensus input
  - Parameters in meters, but feet allowed for output
- **Procedures**
  - Stakeholders must submit requests/proposals
  - 1-parallel LCC and local OM projection definitions
  - Specified a linear distortion design criterion
  - Limit NGS designs to minimum of ±50 ppm
  - 50 km min zone size for height range of 250 m or less

53

Changes to SPCS2022 Policies

Summary of main changes

- Allow "special use" zones
  - But only for zone areas in more than 1 state
- NGS will design statewide zone for every state
  - Also will design default zones if no consensus request for something different from state stakeholders
- Allow max of 3 layers (1 statewide + 2 multi-zone)
  - But most states will have 1 or 2 layers
- Added requirement that all zones be unique
- Require positive east longitudes

54

Changes to SPCS2022 Procedures

Summary of main changes

- Delayed deadlines by 3 months
- Removed "contributing partner" category
- Moved submittal details to fillable forms
- Added section on zones numbers and names
- Added details on ***linear distortion design criterion***
- Removed minimum distortion limit
- Added 10 km min zone size for height range >250 m

55

SPCS2022 stakeholders

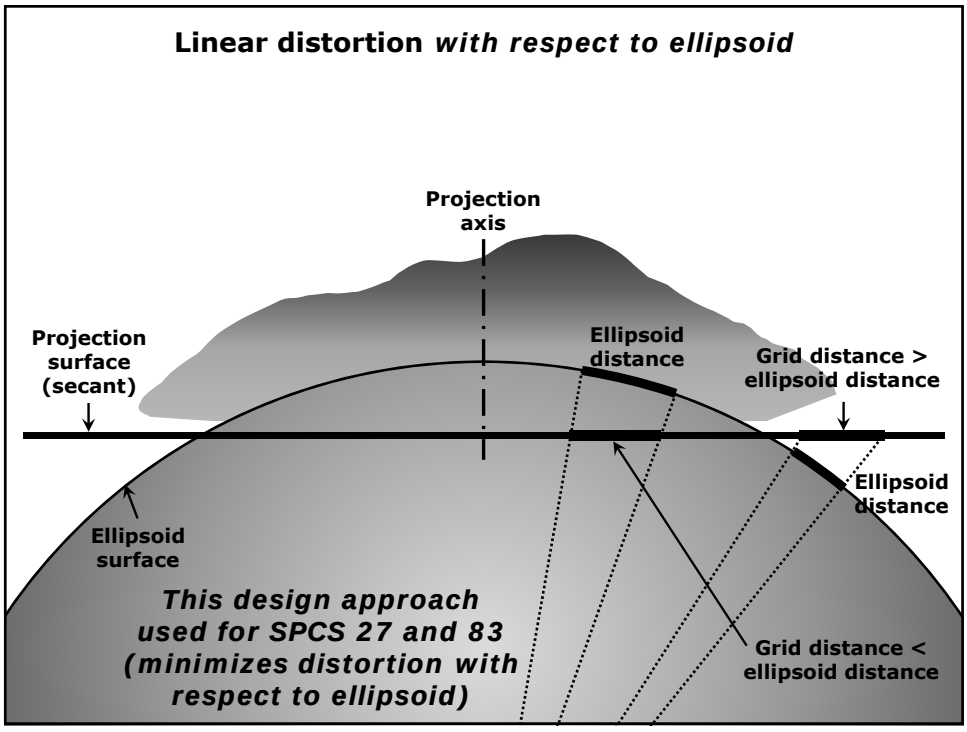
- **State *groups*** that formally interface with NGS
  - Departments of transportation
  - Cartographer/GIS office
  - Professional surveying, engineering, GIS societies
  - Colleges/universities with geospatial curriculum
- Can submit ***requests*** and ***proposals*** for designs
  - ***Requests*** are for designs by NGS
  - ***Proposals*** are designs by stakeholders
- Stakeholder input must be ***unanimous***

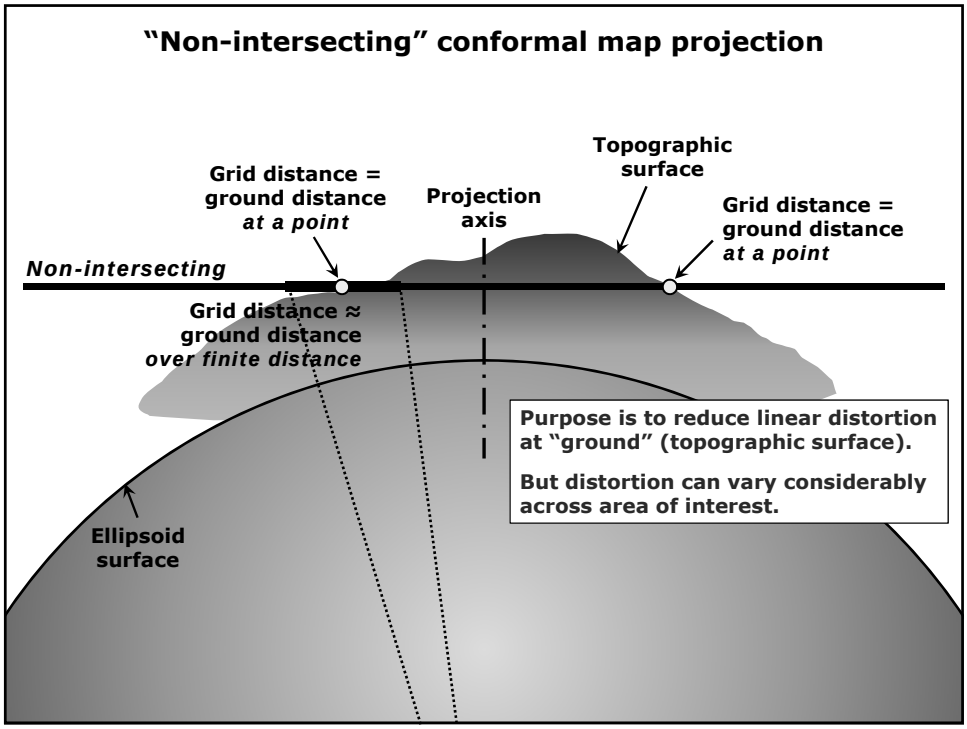
56

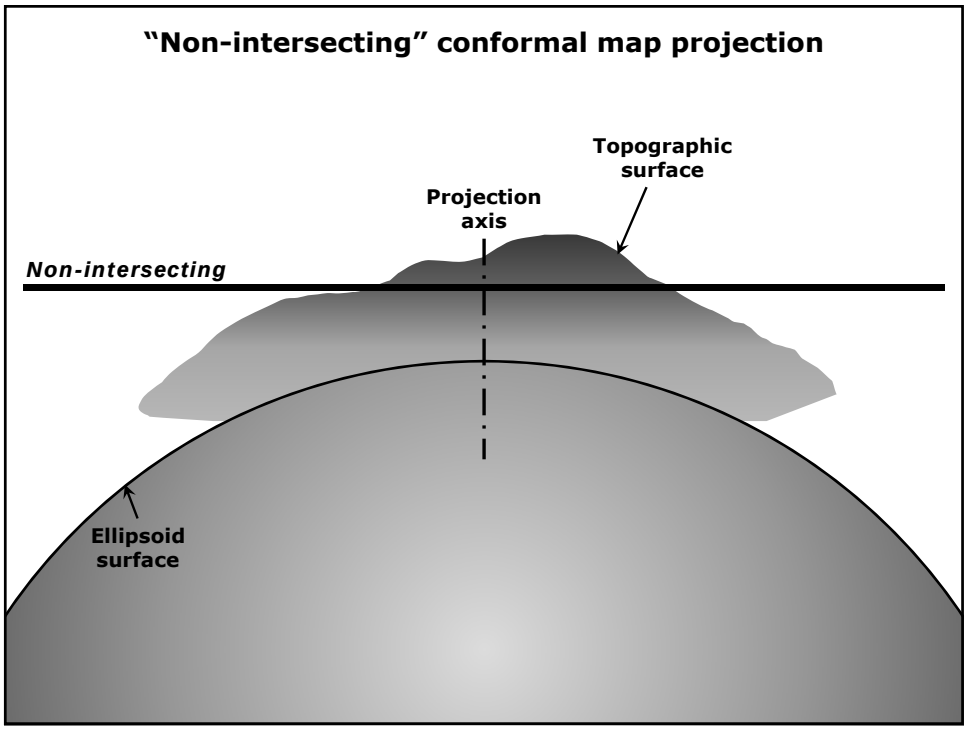
General SPCS2022 characteristics

- Based on final adopted policy & procedures
- Distortion design requirements
  - ***Linear distortion*** minimized at topographic surface (***not*** at ellipsoid surface)
  - ***Purpose:*** to reduce difference between and projected "grid" and actual "ground" distances
- Other characteristics
  - Default designs (if no consensus stakeholder input)
  - Statewide and "layered" zones
  - "Special use" zones
  - Positive east longitudes
  - Low-distortion projections (LDPs)

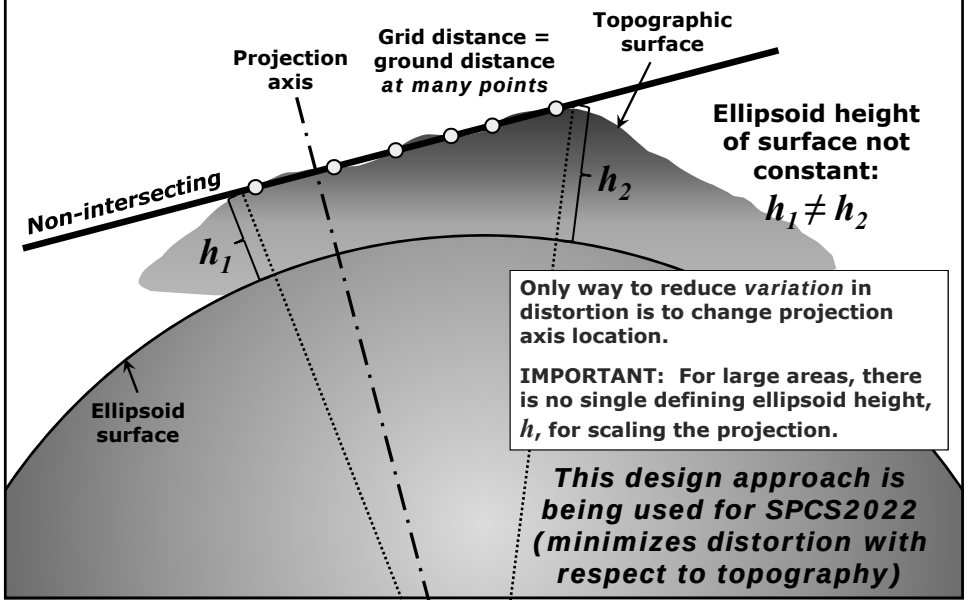
57




"Non-intersecting" conformal map projection
Topographic surface
Grid distance = ground distance at a point
Projection axis
Grid distance = ground distance at a point
Non-intersecting
Grid distance ≈ ground distance over finite distance
Purpose is to reduce linear distortion at "ground" (topographic surface).
But distortion can vary considerably across area of interest.
Ellipsoid surface


"Non-intersecting" conformal map projection
Topographic surface
Projection axis
Non-intersecting
Ellipsoid surface

Changing projection axis to reduce distortion variation



GOOD COORDINATION BEGINS WITH
GOOD COORDINATES

GEOGRAPHY WITHOUT GEODESY IS A FELONY

Point Cloud Scoping and Acquisition

Best Practice Guidelines

v1.9

Contents

Statement of Intent

Every year the Geospatial Industry is having to adapt to the continuous advances in survey technology. Professional Land Surveyors are being asked to perform surveys using equipment and data that clients may be unfamiliar with. At the same time clients are looking to integrate and maximize the utility of survey data like never before. The technology driving this work is rapidly developing, faster than best practice standards can be communicated.

The standards below are focused on remote sensing point cloud data production. The intent is to both inform and protect the owner, service provider surveyors, and end user, when procuring and using point cloud data.

These standards aim to facilitate the process of asking for a scope and fee to conduct a survey to deliver a point cloud or derived model, such that all parties understand the steps and procedures they must take to assure the data being collected, processed, and then provided to the client, will meet the standards and accuracies being requested.

When requesting a survey involving a point cloud or derived deliverable, MALSCE recommends using a Registered Massachusetts Professional Land Surveyor, Professional Engineer, and / or ASPRS Certified Photogrammetrist to perform the required work. The final deliverable should be accompanied by a stamped certified statement for the end use intent based on these standards.

These guidelines are seen as a living document which shall be informed and revised with continuing outreach, technology changes, and industry developments.

Table 1: Point Cloud Project Scoping Guide

Point Cloud Project Scoping Guide					
Class	**Focus**	**Example Uses**	**Point cloud accuracy**	**Example Minimum Feature of Interest**	**Considerations**
A	**Architectural, MEP and Civil Engineering design, construction documents**	Engineering level existing conditions, construction documents, model development Vertical coordination Deformation analysis and monitoring Property relation and site plan coordination	1/4" Level 1 Control Minimum	Small MEP components Structrual releaving joints Verfied positional locations Architectrual detailing	Maximum potential for reuse across project lifecycle Full discipline coordination Least likely for required returns if scope developes Full registration to site control or grid reporting
B	**Design**	All of the below plus: Design development Initial coordination planning Volume Quantity	1/2" Level 2 Control Minimum	Masonary openings Large MEP systems Site positioning Coordination	Lower accuray & spatial relation, vertical stacking Likely to require additional survey Limited alternate usage
C	**Project Planning, Schematic design**	Limited accuracy planning tools Demolition phasing Elevation Markups Notation Volume estimates Condition assessments	3" Level 3 Control Minimum	Initial design concept coordination Mass modeling	Floors may not stacked Will require considerable additional survey for higher end usage. Restricted alternate usage
D	**Feasibility / Visualization**	Site visualization, Animations, fly through, imagery	Accuracy not verified	General area context capture	Lowest costs for data accuracy. Global accuracy not verifiable Limited value to modeled elements
Notes			Point cloud accuracy: reliability of final point cloud from end to end across multiple scanning locations		

Table 2: Required Quality Control

Survey Quality Control				
Level	**Survey Method**	**Project Control Positional Tolerance**	**Target Based Registration**	**Review**
1	Closed traverse survey control with total station (differential levels recommended).	For 1/4" point cloud relative to control (survey network minimum accuracy 0.04' + 50 ppm)	Yes	PLS / PE*
2	Survey control via total station and/or Survey Grade Geodetic GPS	For 1/2" point cloud relative to control (survey network minimum accuracy 0.10' + 75 ppm)	Yes	PLS / PE*
3	Basic survey points only for geolocation or QA/QC	For 3" point cloud relative to control (survey network minimum accuracy 0.25' + 200 ppm)	Minimal (Overlap Dependent)	PLS/PE, ASPRS Photgrammetrist
4	No survey control checks		None (Overlap Only)	PLS/PE, ASPRS Photgrammetrist
Notes		To ensure point cloud data longevity, Level 1 or 2 control is recommended. See glossary for implications		*Statement of accuracy from PLS/PE recommended

Recommended Certification Statement

INSERT COMPANY LETTER HEAD HERE

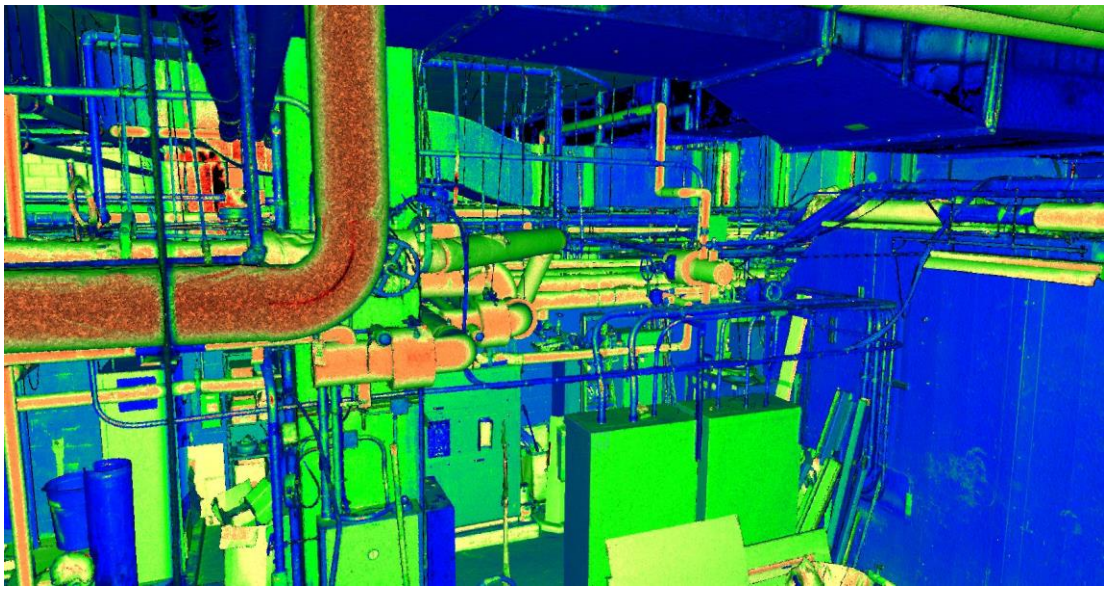
INSERT DATE

I hereby certify that the data provided meets or exceeds the accuracies specified in the MALSCE recommended guideline Class *X* Level *X*

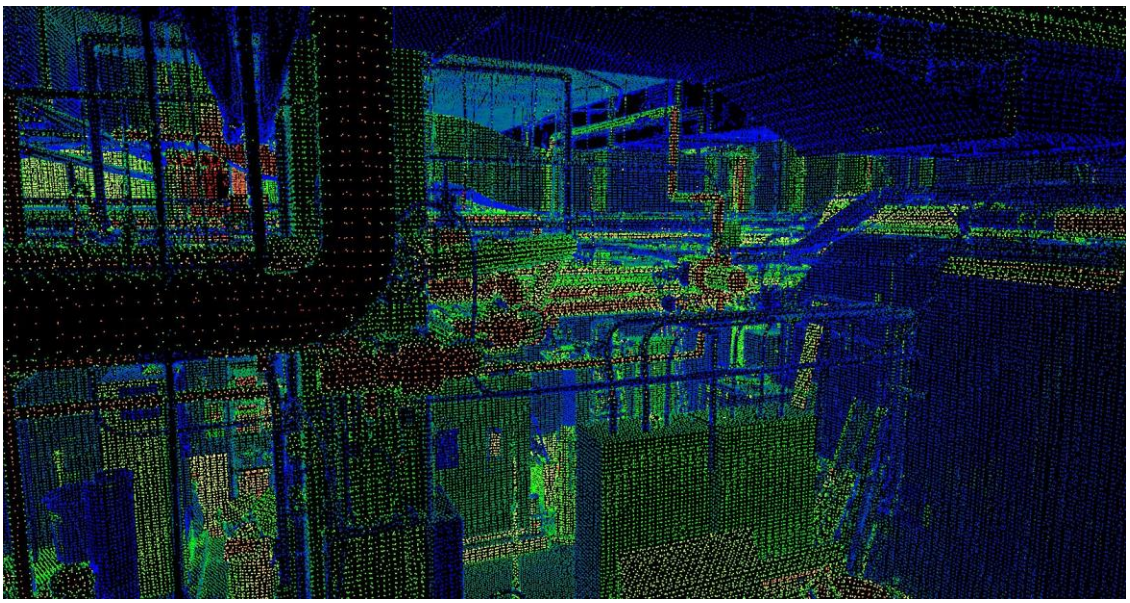
INSERT STAMP AND SIGNATURE

Point Cloud Data Examples

MEP Interior high resolution survey (1/4”+)

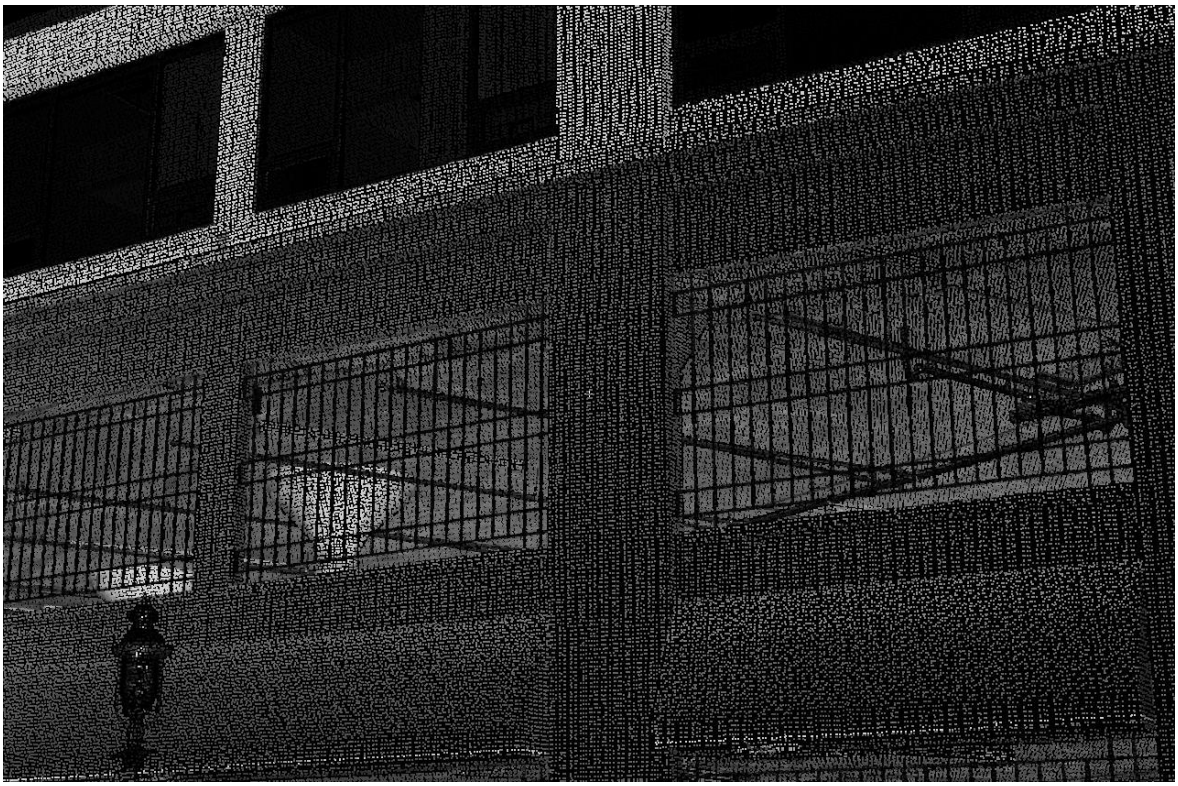


MEP interior lower resolution survey (3”)



Exterior façade high resolution survey (1/4”+)

Exterior façade lower resolution survey (3”)

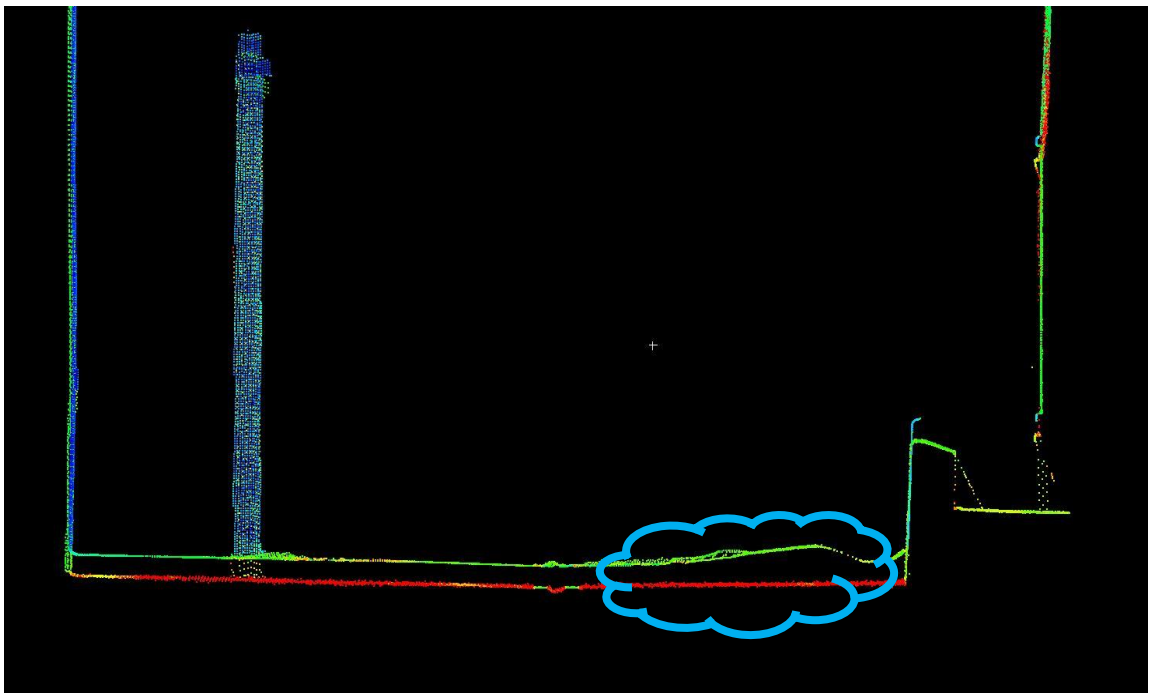


UAV Topography, high resolution survey (3”)

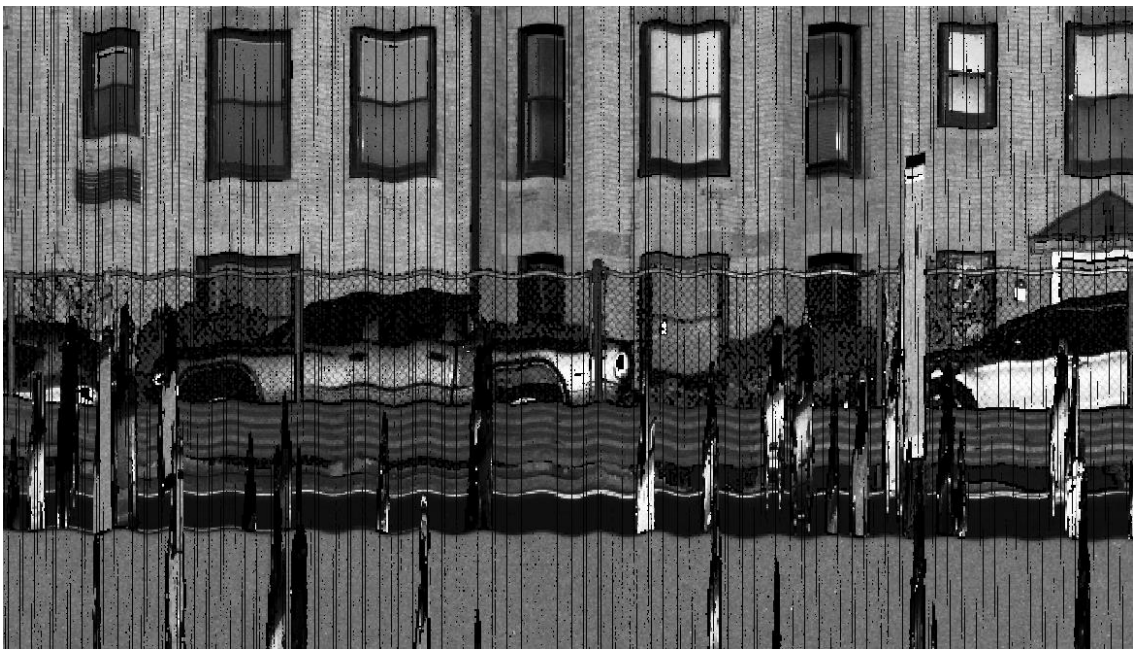
UAV Topography, lower resolution survey (6”)

Examples of errors and issues with point cloud data

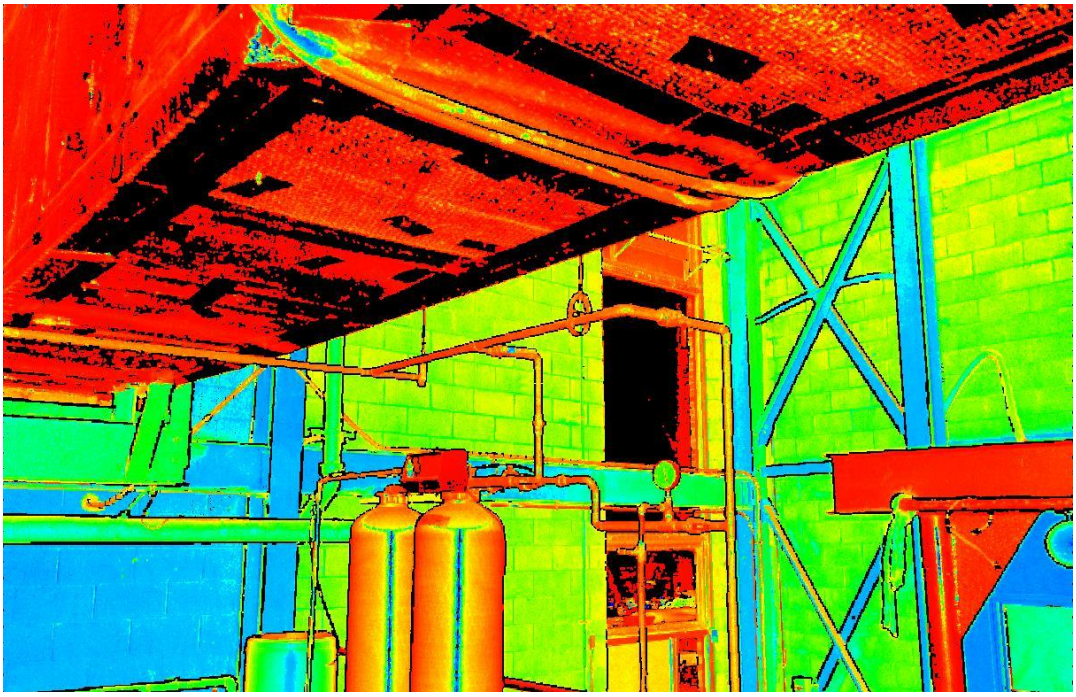
Point cloud separation issues due to insufficient survey control or scan target checks



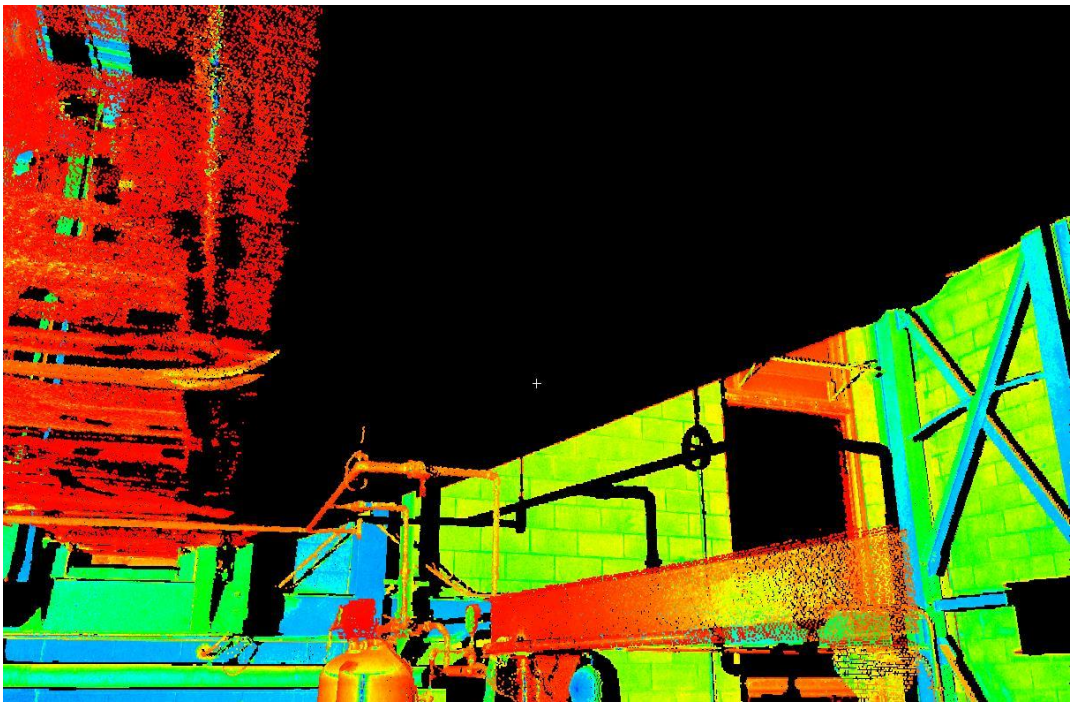
Poor quality data possibly caused by vibration at time of scanning, wind buffeting, or sensor errors



Shadow areas or blind spots caused by blocking objects. Particularly important for above ceiling MEP. Often obscured from just floor level scanning



Scanning location view



Shadow/blind spot area

Glossary

MALSCE: Massachusetts Association of Land Surveyors and Civil Engineers

PLS: Professional Land Surveyor

PE: Professional Engineer

ASPRS: American Society for Photogrammetry and Remote Sensing

PPM: Parts per million

Minimum feature of interest: smallest element of target survey area that needs to be clearly defined in the point cloud

MEP: Mechanical, Electrical, and Plumbing (also referred to as MEP/FP for Fire Protection)

UAS: Unmanned Aircraft System or drone

AEC: Architecture, Engineering, and Construction industry

Bibliography:

U.S. Institute of Building Documentation

Level of Accuracy Specifications

BIM Forum (U.S. Chapter of buildingSMART International)

Level of Development Specifications

ASPRS

Accuracy Standards for Digital Geospatial Data 2014

Code of Massachusetts Regulations Title 250 CMR

250 CMR

Caltrans Office of Land Surveys Manual

Laser Scanning

Fun with Drones

Raymond J. Hintz, PLS, PhD
University of Maine
Ray.hintz@maine.edu

1

2 types

(1)Fixed wing (airplane)

-can be cheaper

-can be faster and last longer on a battery

-Need a take-off and landing area

-turns between flight lines take space

(2) Rotary (helicopter-ish)

- **Can be more expensive**
- **Less space required**
- **More non-survey applications (inspection)**

2

http://www.uavinsider.com/rotary-wing-vs-fixed-wing-uavs/

http://www.questuav.com/news/fixed-wing-versus-rotary-wing-for-uav-mapping-applications

http://www.ua-sp.com/rotary.html

Non-Ray assessments of fixed wing vs. rotary drones

3

Can a hybrid fixed wing/rotary drone be created? Of course!

http://rotordronemag.com/fixed-wing-vtol-uav-combination-designs/

The California company Arcturus UAV have developed a drone that combines the best of both fixed wing and multi-rotor aircraft. The vertical takeoff and landing system of their T-20 and T-16 fixed wing UAVs allows the plane to make vertical takeoff using A multi-rotor design built into the aircraft wings. Once the plane is high enough in the air the front motor of the aircraft takes over and converts the plane from hover to forward flight. Really, when you think about it, a very logical design. All flight control is fully autonomous.

4

But battery life stinks!!!!

http://www.digitaltrends.com/cool-tech/yeair-gas-powered-drone-kickstarter/

So German inventor Holger Willeke took a different approach with his Yeair drone, unveiled on Kickstarter today. Instead of relying solely on batteries and electric motors, it uses a mixture of battery power and good old-fashioned combustion engines. The result? A quadcopter that can do 60 mph, carry nearly 12 pounds, and stay airborne for 60 minutes straight.

5

In a lot of ways, drone's hybrid gas-electric approach gives it the best of both worlds, like a Prius. Combustion engines allow it to harness the incredible energy density of hydrocarbon fuel, while electric components help keep the craft light and responsive. And when you do run out of power, you don't have to twiddle your thumbs for two hours while you wait for a battery to recharge — you can just refuel and start flying again right away.

6

http://www.digitaltrends.com/cool-tech/hycopter-hydrogen-powered-drone/

4.2 oz of hydrogen at 5076 psi gives up to 4 hours of flight time

7

Drones usually have

(1) Camera (small and light)

(2) GPS – could be real time or post processed RTK but that adds to cost

(3) IMU – measure 3 angles of camera – actually an accelerometer and gyroscope with a stabilizer

(4) wind speed monitor

(5) Ground sensing device

(6) Radio communication to lap top

Etc.

8

Could have

(1) Gimball mount – allows camera to be easily pointed non-vertical (building, bridge, or dam face)

(2) Different camera sensors (thermal)

(3) Lidar (heavy, expensive)

9

Terminology (from eBee)

AMSL Above Mean Sea Level

Your *eBee*'s altitude can be shown and set in *eMotion* using ATO or AMSL.

Your drone uses the EGM96 mean sea level standard for navigation.

ATO Above the Take-off Altitude

Your *eBee*'s altitude can be shown and set in *eMotion* using ATO or AMSL.

Altitudes in ATO are relative to the place your *eBee* started its motor just

before take-off.

DSM Digital Surface Model

A 3D digital representation of a surface.

10

Terminology (from eBee)

geo-reference A data point associated with a specific location on the earth's surface.

GSD Ground Sampling Distance

The distance measured on the ground between pixel centres in an image or DSM. The smaller the GSD, the higher the spatial resolution of the image. For example, a GSD of 5 cm means that one pixel in the image represents 5 cm on the ground.

mosaic A single map or terrain model created from several map sections that have been placed side-by-side and merged together.

orthomosaic A single, corrected image constructed either from several images taken from different angles, or from several orthophotos. Distortions due to different camera positions, ground curvature and relief are corrected for so that the image displays accurately in the given map projection.

11

Terminology (from eBee)

photogrammetry A technique in which measurements taken from photographs are used to reconstruct a 3D surface or a series of points in space.

point cloud A set of data points within a coordinate system.

rayCloud A feature unique to *Postflight Terra 3D* that combines the 3D point cloud with the original images. Multi ray matching with the rayCloud extends the stereo view triangulation and increases the accuracy of 3D point estimates while providing a full understanding of 3D results.

triangle model An approximate representation of a surface, constructed from connected triangles.

12

In a perfect world see

https://www.sensefly.com/drones/postflight-terra-3d.html

(1) Check image quality in the field – quality report with low resolution ortho mosaic preview

(2) Generate orthomosaics, 3-D models, and point clouds

(3) Assess and edit (or import to GIS, CAD, photogrammetry softwares

(4) Compute – break lines, contours, profiles, earthwork/volumes, etc.

13

Need examples

https://www.sensefly.com/drones/example-datasets.html

You can download a wide variety of different types of information for a wide variety of projects.

14

Planning a flight

- **Software accesses "all" available photography such as Google, Mapquest, etc.**
- **You have a visual interface that first allows you to enter a location by lat./long or by city/state/country**
- **You then use graphics to zoom in on your desired flight area**

15

Planning a flight

Mission planning

(1) Flight area is selected graphically by moving, scaling and rotating a flight area rectangle (note complex areas can use a polygon)

(2) Correct camera is selected along with desired flying height or desired pixel resolution (the two are directly related)

(3) Overlap along flight lines (>=60%)and between flight (>=20%)lines is selected

16

Planning a flight

Overlap – since no film exists higher overlaps simply increase redundancy and thus can enhance accuracy – but obviously the processing time increase as overlaps increase

(4) Upload (store) – flight parameters are ready to go when you reach the job site

(5) Review flight plan (usually in Google Earth) to make sure no obstructions will limit your intended flight (ha-ha I am sure this will always work)

17

Planning a flight

(6) Select a takeoff location (perhaps may need to be changed in field)

In the field

(1) Weather check – small drones do not like big winds!!

(2) Inspect the unit based on vendor recommendations

(3) Put in fully charged batteries and make sure camera is ready per vendor recommendations

18

In the field

(4) Your drone goes through a series of pre-flight checks and any problems will be relayed to your lap top connected by radio to the drone

19

Federal Aviation Administration

Small UAS Certificate of Registration

CERTIFICATE HOLDER: **Raymond Hintz**

UAS CERTIFICATE NUMBER: **FA3LE4TCFA**

ISSUED:**02/02/2016** EXPIRES:**02/02/2019**

20

For U.S. citizens, permanent residents, and certain non-citizen U.S. corporations, this document constitutes a Certificate of Registration. For all others, this document represents a recognition of ownership.

For all holders, for all operations other than as a model aircraft under sec. 336 of Pub. L. 112-95, additional safety authority from FAA and economic authority from DOT may be required.

Safety guidelines for flying your unmanned aircraft:

Fly below 400 feet

Never fly near other aircraft

Keep your UAS within visual line of sight

Keep away from emergency responders

Never fly over stadiums, sports events or groups of people

Never fly under the influence of drugs or alcohol

Never fly within 5 miles of an airport without first contacting air traffic control and airport authorities

21

Remember these simple safety guidelines when flying your unmanned aircraft:

- Don't be careless or reckless with your UAS
- Fly below 400 feet and remain clear of obstacles
- Stay away from other aircraft at all times
- Keep your UAS within your sight
- Don't fly near airports, stadiums, or other people
- Don't fly under the influence of drugs or alcohol
- Keep away from emergency responders

For more information, visit: www.faa.gov/uas/model_aircraft

22

23

24

Previous photos are from approximately 120.1 m. above ground with a Sony DSC WX-220 camera which is 3.4 cm./ pixel

Camera image has 18.2 megapixels/image

Effective pixels are 4896 x 3672 = 17,978,112

Frame size is 6.17 x 4.55 mm

Which produces pixel size of 6.17/4896 = .00126 mm

Focal length is 4.55 mm. when flying

Ground dist = photo dist * flying hgt./focal length

Scale equation .00126 mm * (120.1 m / 4.55 mm) = .034 m = 3.4 cm!! Yeah!!!

25

Frame size is 6.17 x 4.55 mm

Focal length is 4.55 mm. when flying

Flying hgt is approximately 120 meters.

How much ground is covered?

By scale (flying hgt/focal length)

6.17 mm (120 m/4.55 mm) = 163 m

4.55 mm (120 m/4.55 mm) = 120 m

On an eBee the shorter distance is in the direction of flight

26

Old school photogrammetry

Along flight line

60% endlap (longitudinal in eBee default 70%)

Across flight lines

20% sidelap (latitudinal in eBee default 60%)

Old school thought was to minimize # of photos but keep some points on 3 photos along flight lines and make sure between flight lines no gaps exist

27

Photogrammetry old school

(1) Flying time (airplane) is expensive

(2) Film (especially from a 9 in. format metric camera) is expensive and also expensive to process

Drone Photogrammetry

(1) Flying time is cheap – battery life is your limit

(2) No film!! Storing jpegs is no big deal thanks to big harddrives

28

Evolution to Multi_ray Photogrammetry

(1) More photos add little expense

(2) If an image is on lots of photos it can be positioned more precisely than if only on 2-3 photos

(3) If an image is on a lot of photos, but in a couple photos the image is not clear (shadow, reflectance, etc.) it can still be positioned from the photos where it is clear

(4) Only issue is can processing time of many photos become a concern

29

Evolution to multi-ray Photogrammetry

(1) Higher overlaps between flight lines and photos along a line

(2) Possible cross flights (right angle to original flight lines)

(3) possible flight lines at angled line of sight – extremely useful to obtain sides of buildings

30

The fundamental least square routine that brings all exposures and all image points into one common coordinate system is called the bundle adjustment or aerotriangulation. It uses the principle of collinearity:

"A ground point, the nodal point of the lens, and its image location lie on a straight line"

31

Old school aerotriangulation

(1) Unknown exposure stations (duh!)

(2) Manual measurement of image points

(3) Limited image points due to the slowness of manual measurement

(4) Ground control allows one to solve for all exposure (coordinates and 3 rotation angles) and unknown image station positions)

32

Modern bundle adjustment

(1) Measured exposure station positions (by GPS) and angles (by IMU)

(2) Automated image matching of same point (pixel) on multiple photos – no human involved!!!

(3) Limited ground control (due to (1)) that is manually measured

33

Modern bundle adjustment

Why does automated image matching work?

(1) Due to known camera positions and orientations, and known focal length and image frame size, software can predict where image match points should be

(2) These pixel's "ROY G. BIV" integer image returns are attempted to be matched. If initial guess does not match neighboring pixels are examined for a better match.

34

Modern bundle adjustment

Why does automated image matching work?

(3) Only excellent matches are used

(4) A preliminary bundle adjustment "refines" the initial GPS IMU positions of exposures – they get better

(5) With better exposure positions the matching algorithm works better

(6) Once matches are found, they are no longer match candidates so the search algorithm has fewer candidates to match on later examinations

35

When the bundle adjustment is complete all exposure stations and image points have been "best fit" by least squares to fit into one common coordinate system (UTM or state plane normally)

Lets look at some results from a 2 flight line job of 45 photos over a large field at the University of Maine under fairly lousy flying conditions (a little foggy as it was 50 degrees in February!!) From arriving at job site to leaving job site the exercise took 20 minutes!!!!!!

36

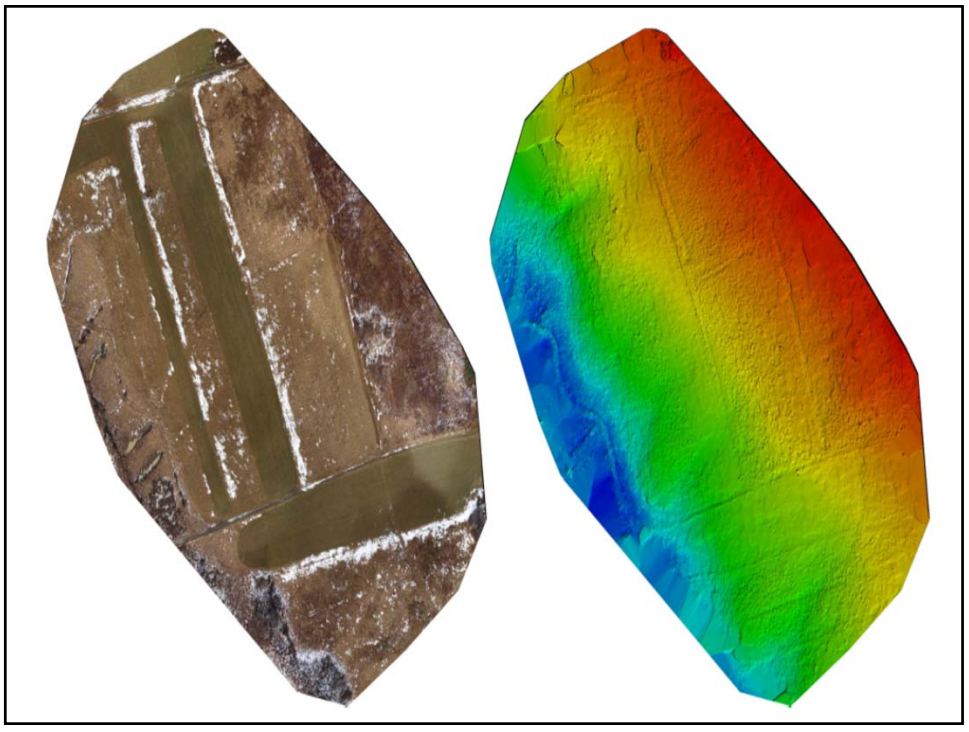
Summary

Project	farm
Processed	2016-02-04 14:03:04
Average Ground Sampling Distance (GSD)	3.42 cm / 1.34 in
Area Covered	0.174 km^2 / 17.4008 ha / 0.0672 sq. mi. / 43.0207 acres
Time for Initial Processing (without report)	06m:13s

Quality Check

Images	median of 68833 keypoints per image
Dataset	45 out of 45 images calibrated (100%), all images enabled
Camera Optimization	0.38% relative difference between initial and optimized internal camera parameters
Matching	median of 22490.8 matches per calibrated image
Georeferencing	yes, no 3D GCP

37



38

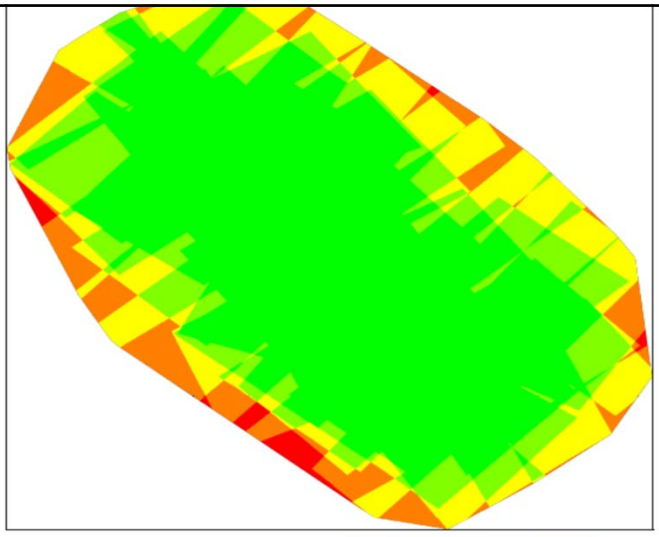


Figure 4: Number of overlapping images computed for each pixel of the orthomosaic.
indicate low overlap for which poor results may be generated. Green areas indicate an overlap of over 5 images for ever
ill be generated as long as the number of keypoint matches is also sufficient for these areas (see Figure 5 for keypoint ma

39

Bundle Block Adjustment Details

Number of 2D Keypoint Observations for Bundle Block Adjustment
Number of 3D Points for Bundle Block Adjustment
Mean Reprojection Error [pixels]

Internal Camera Parameters

DSC-WX220_4.4_4896x3672 (RGB). Sensor Dimensions: 6.170 [mm] x 4.627 [mm]

EXIF ID: DSC-WX220_4.4_4896x3672

	Focal Length	Principal Point x	Principal Point y	R1	R2
Initial Values	3628.284 [pixel] 4.572 [mm]	2447.997 [pixel] 3.085 [mm]	1836.004 [pixel] 2.314 [mm]	0.012	-0.045
Optimized Values	3614.317 [pixel] 4.555 [mm]	2430.646 [pixel] 3.063 [mm]	1861.280 [pixel] 2.346 [mm]	-0.008	-0.003

40

3D Points from 2D Keypoint Matches

	Number of 3D Points Observed
In 2 Images	311844
In 3 Images	64721
In 4 Images	19867
In 5 Images	8852
In 6 Images	4294
In 7 Images	2322
In 8 Images	564
In 9 Images	115

41

Min Error [m]	Max Error [m]	Geolocation Error X [%]	Geolocation Error Y [%]	Geolocation Error Z [%
-	-3.68	0.00	0.00	0.00
-3.68	-2.94	0.00	0.00	0.00
-2.94	-2.21	0.00	0.00	0.00
-2.21	-1.47	0.00	0.00	0.00
-1.47	-0.74	0.00	4.44	0.00
-0.74	-0.00	53.33	48.89	51.11
-0.00	0.74	46.67	40.00	48.89
0.74	1.47	0.00	6.67	0.00
1.47	2.21	0.00	0.00	0.00
2.21	2.94	0.00	0.00	0.00
2.94	3.68	0.00	0.00	0.00
3.68	-	0.00	0.00	0.00
Mean [m]		0.002984	0.006374	-0.002818
Sigma [m]		0.261153	0.453457	0.255087
RMS Error [m]		0.261170	0.453501	0.255102

Min Error and Max Error represent geolocation error intervals between -1.5 and 1.5 times the maximum accuracy of all the images. Columns X, Y, Z percentage of images with geolocation errors within the predefined error intervals. The geolocation error is the difference between the intial and com positions. Note that the image geolocation errors do not correspond to the accuracy of the observed 3D points.

42

Now that you have fallen asleep looking at bundle adjustment statistics:

We have mathematical product that is the "control survey" of photogrammetry – now we can create products

(1) Point cloud densification – very detailed x,y,z on every unique image

(2) Orthophotomosaic – what a one photo of the entire area would look like except you are looking down at all points, not from a perspective of each individual exposure

43

Point Cloud – just a couple of point like more than 6 million!

Results

Number of Generated Tiles	1
Number of 3D Densified Points	6020544
Average Density (per m^3)	87.38

44

Point cloud – also contains the image information for each pixel/each xyz

Standard format in industry for point clouds (can be from Lidar, too is binary .las or a .laz which is .las which has been zipped)

Note it is so huge it has to be binary as text files take up huge space.

Note it contains the image of each x,y,z too!

45

Orthophoto

Based on initial flying height each 3.43 cm

Square is an image with a projection x,y that has been corrected for elevation (relief distortion)

Example – Two football fields at different elevations on one photo will have different lengths. They will be the same length (300 ft. goal to goal if a ground not grid coor. System) because they have been projected to a common elevation (usually the projection plane through the ellipsoid)

46

What follows

(1)Exposures in Map type look

(2) Exposures in 3D type look

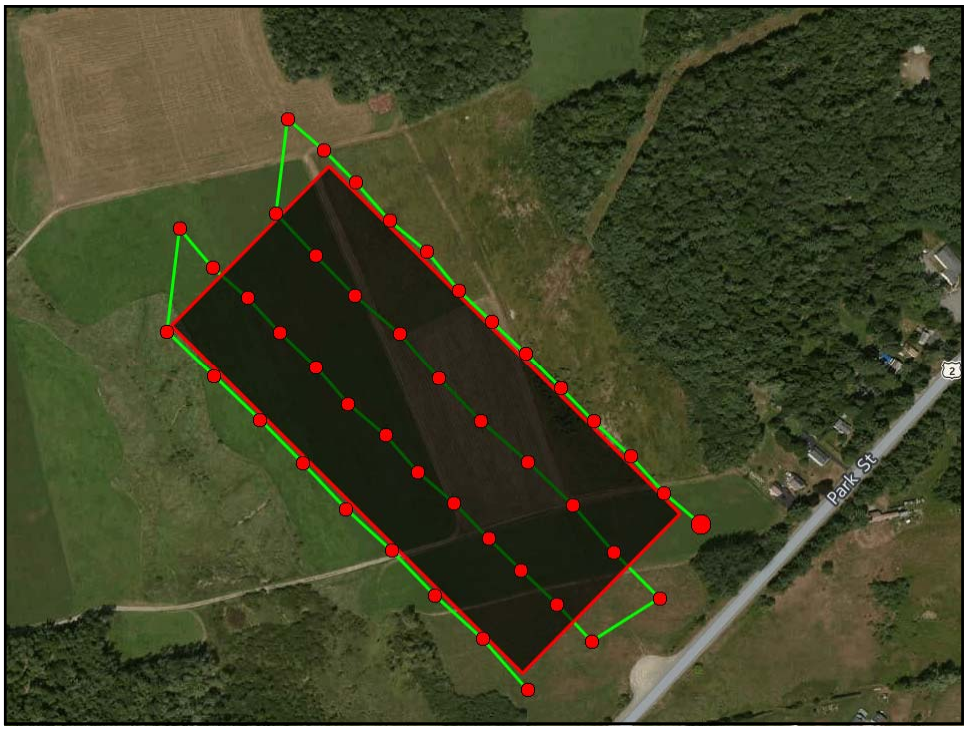
(3)Elevation model (DSM) color coded

(4)Job on conventional map

(5).las brought into other software (Fugroviewer) and 0.5 m. contours drawn

(note the contours need smoothing for production)

47



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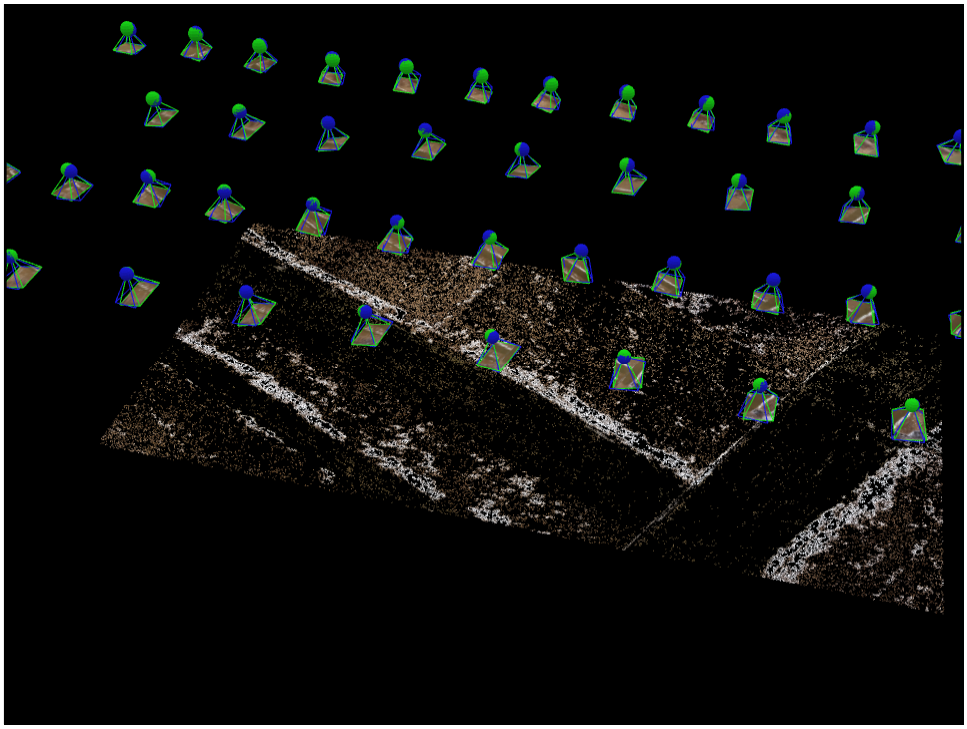

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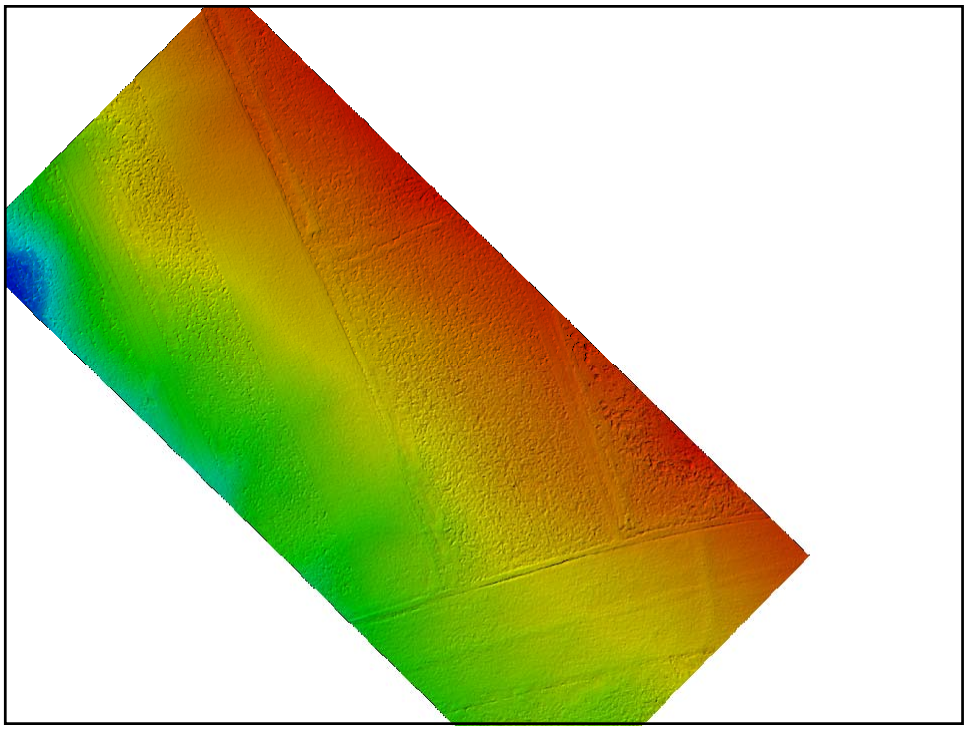

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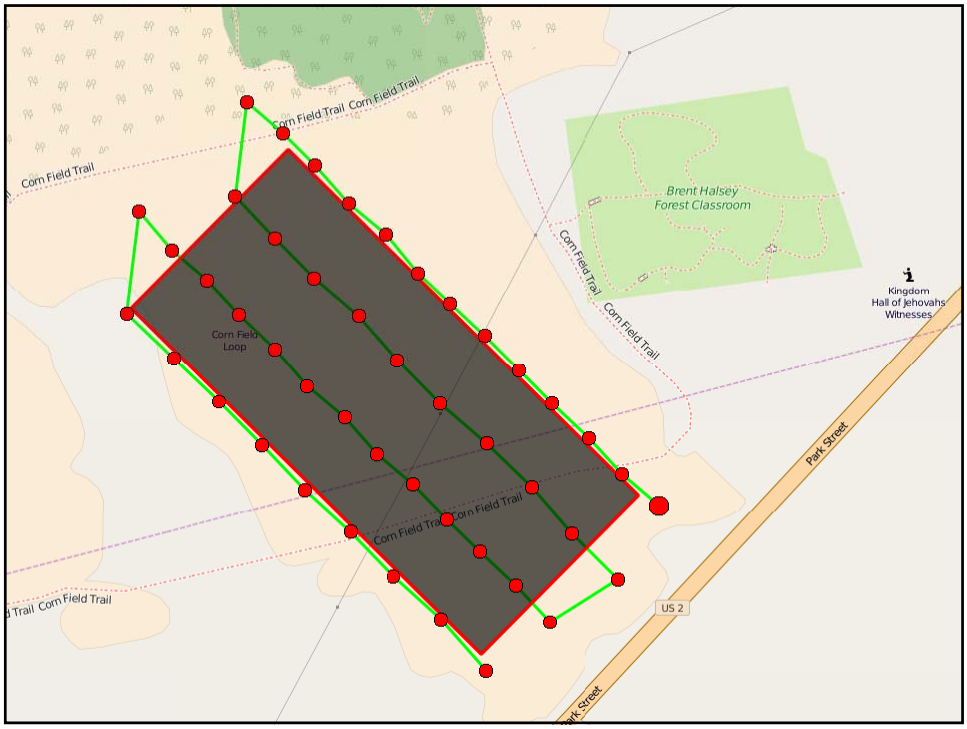
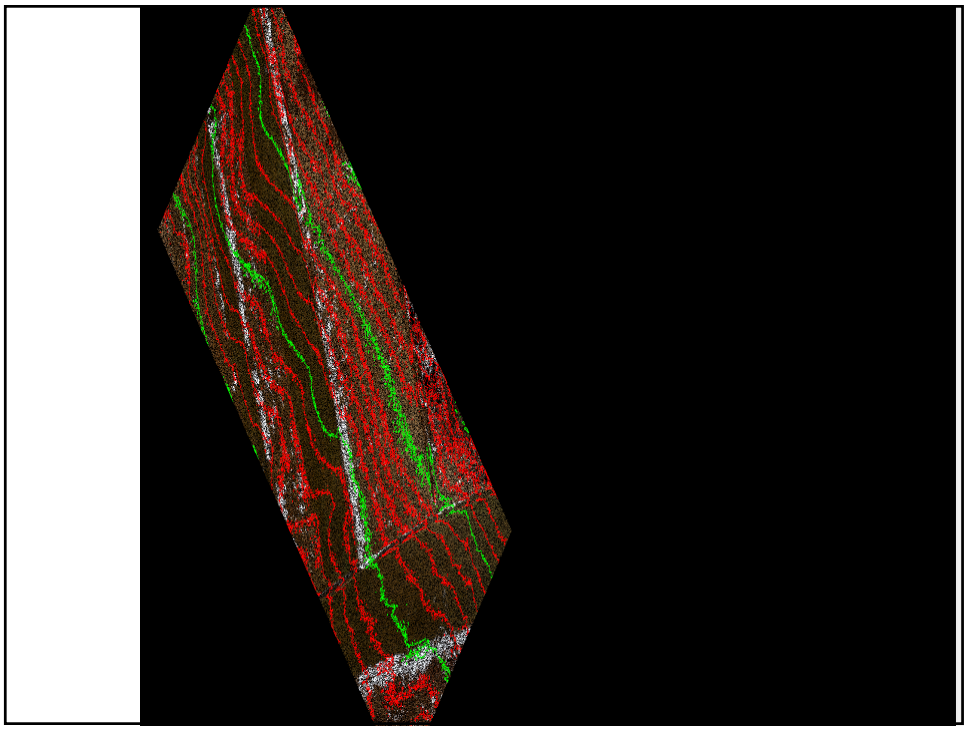

Corn Field Trail
Corn Field Trail
Corn Field Trail
Brent Halsey
Forest Classroom
Corn Field Trail
Corn Field Trail
Kingdom
Hall of Jehovahs
Witnesses
Corn Field
Loop
Corn Field Trail
Corn Field Trail
Park Street
US 2
Corn Field Trail
Corn Field Trail

51



52

Does this controversial in a licensure sense?

Check out

Here is an interesting article from a drone owner who is providing volume calculations but doesn't feel a survey license is necessary. I think this is a very slippery slope. I don't think our profession is based on our ability to accurately measure alone, but licensure dues help to ensure the public is protected in this area. Here is a case where a user thinks he knows better than the state board because he's a software developer and had done a lot of "quality control." He may be correct and his results may be accurate, but there is little doubt he is probably breaking a surveying law in some states.

I think we are going to all be battling this a lot more as the technology becomes more widely available and software easier to use. A joe-schmoe citizen with no education or training in photogrammetry or even ground control, has a $500 drone a whiz-bang software package starts providing a volume calculation (and eventually mapping) to the public.

I have very strong opinions about this automated photogrammetry software and its potential for misuse by uninformed drone owners who may over state it's capabilities. I think it poses a legitimate threat to public welfare.

http://www.lidarmag.com/content/view/11676/198/

Thoughts?

53

FAA things on 10-13-18 (could change quickly)

http://www.faa.gov/uas/ (general info)

https://registermyuas.faa.gov/ (register a UAV)

http://www.faa.gov/uas/getting_started/fly_for_work_business/becoming_a_pilot/

(become a UAS pilot)

http://www.faa.gov/training_testing/testing/acs/media/uas_acs.pdf (remote pilot standards)

54

FAA things on 10-13-18 (could change quickly)

http://www.faa.gov/training_testing/testing/test_guides/media/remote_pilot_ktg.pdf

(test guide)

http://www.faa.gov/regulations_policies/handbooks_manuals/aviation/media/remote_pilot_study_guide.pdf **(study guide)**

http://www.faa.gov/training_testing/testing/test_questions/media/uag_sample_exam.pdf

(sample test questions)

55

Do I need a regular airplane pilot's license?

No, but it is a faster process to become a licensed commercial UAS operator if you do.

https://www.faa.gov/uas/request_waiver/

(request waivers to the rules)

https://www.faa.gov/uas/getting_started/

(shows why a hobby UAS or an educator is easier to fly than a commercial operation)

56

Pilot Requirements:
•Must be at least 16 years old
•Must pass an initial aeronautical knowledge test at an
•FAA-approved knowledge testing center+
•Must be vetted by the Transportation Safety Administration (TSA)
+A person who already holds a pilot certificate issued under 14 CFR part 61 and has successfully completed a flight review within the previous 24 months can complete a part 107 online training course at www.faasafety.gov to satisfy this requirement.

57

Questions?

Maybe no answers!!

58

Anyone Could Lead Perfect People

Massachusetts Association
~ of ~
Land Surveyors and Civil Engineers

Leominster, Massachusetts
March 16, 2019

Presented by
Gary R. Kent, PS
The Schneider Corporation
Indianapolis, Indiana

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The Schneider Corporation
Indianapolis, Indiana

Biography of Gary R. Kent

Gary Kent is Integrated Services Director for Schneider Geomatics, a land surveying and consulting engineering firm based in Indianapolis and with an office in North Carolina. He is in his 36th year with the firm and his responsibilities include account and project management, safety, corporate culture, and training, coaching and mentoring members of the surveying staff.

Gary has served on the Indiana State Board of Registration for Professional Surveyors since 2004 and is currently chairman. He is frequently sought as an expert witness in cases involving boundaries, riparian rights, easements and surveying practice. He regularly presents programs across the country on surveying, leadership and title topics, and he also writes a column for *The American Surveyor* magazine.

Gary is a graduate of Purdue University with a BS in Land Surveying; he is registered to practice as a professional surveyor in Indiana and Michigan. He has been chair of the committee on ALTA/NSPS Standards for NSPS since 1995 and is the liaison to NSPS for the American Land Title Association. He is also past-president of the American Congress on Surveying and Mapping and a twice past president the Indiana Society of Professional Land Surveyors.

A member of the adjunct faculty for Purdue University from 1999-2006, Gary taught Boundary Law, Legal Descriptions, Property Surveying and Land Survey Systems and was awarded "*Outstanding Associate Faculty*" and "*Excellence in Teaching*" awards for his efforts. Gary is on the faculty of GeoLearn (www.geo-learn.com), an online provider of continuing education and training for surveyors and other geospatial professionals. He is also an instructor for the International Right of Way Association.

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"Anyone could lead perfect people - if there were any ... Many otherwise able people are disqualified to lead because they cannot work with and through the [imperfect] people, who are all there are." From The Servant as Leader by Robert K. Greenleaf

What makes a Business Successful?

- Appropriate Leadership
- A Sense of Community

The Power Model of Leadership

- The problem with this model is not power itself, but how it is exercised
- Is it taken and exercised on behalf of those being led, or merely to retain and get more of it?

Machiavelli's The Prince

- "A wise prince ought, while he has the chance, to foment some enmity so that by suppressing it, he will augment his greatness."

Servant Leadership Model

- 'Leading with a servant's heart'
- Companies that practice it…
    - The Men's Wearhouse
    - The Container Store
    - United Telecom
    - The Toro Corporation
    - Starbucks
    - Southwest Airlines

- *The goal of many leaders is to get people to think more highly of the leader. The goal of a great leader is to help people to think more highly of themselves.* The Reverend Dr. J. Carla Northcutt

The Schneider Corporation – Servant Leadership Defined

We believe that Servant-Leadership is a journey, not a destination.

A Servant Leader's position as a leader is founded on being a servant first. Servant Leaders are responsible for helping grow every person with whom they interact along their journey. This is accomplished by:

- *Setting the example for others to follow*
- *Listening first, to understand - then acting decisively*
- *Accepting the imperfect nature of people and respecting their diversity*
- *Holding people accountable, starting with one's self*
- *Having foresight - planning for the future*

Servant-Leadership is the result of the collective deeds and works of solitary individuals who care about others. It is not the work of the organization, yet the organization values and nurtures it. When the opportunity arises, every individual has the ability, and responsibility, to lead.

- *We must be silent before we can listen. We must listen before we can learn. We must learn before we can prepare. We must prepare before we can serve. We must serve before we can lead.* From Leadership …with a Human Touch by William Arthur Ward

- *"…to the worldly, servant-leaders may seem naïve … Servant-Leaders may stand alone, largely without the support of their culture, as a saving remnant of those who care for both persons and institutions, and who are determined to make their caring count – wherever they are involved."* From The Servant as Leader by Robert K. Greenleaf

- *"Southwest has learned that when employees are trusted to apply a little common sense and ingenuity to a problem, several things happen. First, they come up with far better solutions than the company could have dreamed of mandating. Second, they can quickly respond to customers' demands. Finally, they can direct their energies toward seizing unique market opportunities when time is critical."* From Nuts – Southwest Airlines' Crazy Receipt for Business and Personal Success by Herb Kelleher

- It is almost a foregone conclusion that somebody inside the organization already has a solution – and in many cases, they are already using it! But if the culture of the organization is such that employees are expected to toe the line and follow exacting rules, you'll never know it ... they will not feel empowered enough and safe enough and trusted enough and valued enough to offer up their solutions on their own. From Finding our Way – Leadership in Uncertain Times by Margaret J. Wheatley

- The measure of a great leader - *"Do those served grow as persons; do they, while being served, become healthier, wiser, freer, more autonomous, more likely themselves to become servants?"* From The Servant as Leader by Robert K. Greenleaf

- *Employees are number one. The way you treat your employees is the way they will treat your customers.* From Nuts – Southwest Airlines' Crazy Receipt for Business and Personal Success by Herb Kelleher

- Leaders…
    - Should see leadership as a call to service
    - Will frequently be called upon to make decisions without all of the necessary information
    - Must often make decisions that are in conflict with some peoples' interests, but with the larger benefit of the group in mind

- **Accountability** means choosing to answer for what one commits to accomplish. Accountability differs from responsibility. Responsibility encompasses roles and job descriptions. Leaders usually delegate some of their responsibilities to others… [But] both the delegator and delegatee need to mutually commit to accountability… Integrity is essential to true accountability. From The Four Powers of Leadership by David Kyle

- "The forces for good and evil in the world are propelled by the thoughts, attitudes, and actions of individuals… Some individuals are born of inspiration and shape our values that affect the quality of our civilization in the future… Perhaps only a few receive this inspiration and the rest will learn from them…" "Great ideas go to waste unless someone is inspired to lead and accept the risk of failure as well as the chance of success ... Leading by providing ideas and structure, for all to follow, for he trusts those who go with him on the path of uncertainty and danger." From The Servant as Leader by Robert K. Greenleaf

- *In organizations, you get to know people, you learn to respect them, you become friends with them, in some cases you even learn to love them. And one of the harshest realities of business is that sometimes you have to fire those same people. How that is done; however, is the key.* From Love and Profit by James Autrey

- *The failure or refusal of leaders to exercise **foresight** is an ethical failure.* Robert K. Greenleaf

- *"Deal with difficulties while they are still easy; handle the great while it is still small."* From The Tao Te Ching by Lao Tzu

- *How far you go in life depends on your being tender with the young, compassionate with the aged, sympathetic with the striving, and tolerant of the weak and the strong. Because some day, you will have been all of these.* George Washington Carver

- *Not much happens without a dream. And for something great to happen, there must be a great dream. Behind every great achievement is a dreamer of great dreams. Much more than a dreamer is required to bring it to reality; but the dream must be there first.* Robert K. Greenleaf

- *The culture is responsible for the results. Not the rules and policies – the culture that the leadership promotes and demonstrates.* Colleen Barrett, retired President Southwest Airlines

- *Make the vision the boss.* Herb Kelleher, founder, Southwest Airlines

- *It is better to conquer yourself, than to win a thousand battles.* Buddhist proverb

- The importance of self-awareness – The Four Agreements by Don Miguel Ruiz

  - Be impeccable in your word
  - Don't take anything personally
  - Don't make assumptions
  - Always do your best

- *When the best leader's work is done the people say, "We did it ourselves."* From The Tao Te Ching by Lao Tzu

- *"Quality is about the human spirit."* W. Edwards Deming

- *"In human communities, the conditions of freedom and connectedness are kept vibrant by focusing on what's going on in the heart of the community rather than being fixated on the … rules of the community."* Margaret Wheatley

- *Today, so many communities and the institutions that serve them are lost because they lack clarity about why they are together. Few schools know what the community wants of them – to prepare kids for college? To give them life skills? To teach them a trade? To help them appreciate and cope with life? Which is it? All of them? That's a challenge.* From Margaret Wheatley

- *The primary task of being a leader is to make sure that the organization knows itself.* Mort Meyerson, former chairman, Perot Systems

- *If conformity is the goal, it will kill initiative. The price we pay for obedience is that we forfeit vitality and creativity.* Margaret Wheatley

- Change. Two simply truths…
  - We cannot force anybody to change, and
  - No two people see the world the same way.

- *"We're under so much stress that all we do is look around the organization to find somebody we can shoot."* Health care executive commenting on when things go wrong

- Old Organizational Change Strategy
  1. Assign a manager
  2. Set a goal that is bigger and better
  3. Define the direct outcomes
  4. Determine the measures
  5. Dissect the problem
  6. Redesign the machine
  7. Implement the adaptation
  8. Test the results
  9. Assign the blame

- The Four Core Principles of Change, from Margaret Wheatley
  1. Participation is not a choice
  2. People react to directives, they do not 'obey' them
  3. No one really sees reality; we each create our own interpretation of what's real
  4. To create better health in a living system, connect it to more of itself [create community]

Conclusion

People willingly share if they feel committed to an organization. If they believe their leaders are worth supporting, and if they feel encouraged to participate and learn, and value their colleagues. Knowledge sharing is going on all of the time in most organizations.

Every organization is filled with self-organizing "communities of practice," relationships that people spontaneously create among colleagues to help them work more effectively or to help them survive the current turbulence.

These communities of practice are evidence of people's willingness to learn and to share what they know. But the organization must provide the right conditions to support people's willingness. Some of these necessary, non-negotiable conditions are:

- People must understand and value the objective or strategy
- People must understand how their work adds value to the common objective
- People must feel respected and trusted
- People must know and care about their colleagues
- People must value and trust their leaders

Technology does not connect us. Our relationships connect us.

We must relearn to have a tolerance from (1) messy, non-linear processes, and (2) time.

Core Principles from today…

- Establish a Culture of Servant Leadership in your organization
  - Leading by example, listening, having foresight … all of those things
  - Recognizing that a critical part element of good leadership is the leader developing a higher sense of self-awareness by:
    - Being impeccable in your word
    - Not taking things personally
    - Not making assumptions and
    - Always doing your best.
- Build a sense of Community in your organization
  - Which involves:
    - Understanding the importance of a shared sense of purpose
    - Respecting the need for and nurturing connectiveness
    - Recognizing the paradoxical human needs for both individuality and connectiveness
    - Respecting the power of diversity
    - Successfully mastering change by enlisting employees and their connections and communication networks

Some Resources

The Servant as Leader by Robert K. Greenleaf

The Case for Servant Leadership by Kent Keith

Servant Institutions in Business by Jerry Glashagel

Life and Work by James Autrey

The Servant Leader by James Autrey

Finding our Way – Leadership in Uncertain Times by Margaret J. Wheatley

The Fifth Discipline and *The Fifth Discipline Fieldbook* by Peter Senge

Good to Great by James Collins

The Seven Habits of Highly Effective People by Stephen Covey

Leadership is an Art by Max Depree

Beyond Reengineering by Michael Hammer

The Soul of a Business by Tom Chappell

Time Management for Unmanageable People by Ann McGee Cooper

The Empowered Manager by Peter Block

The Leadership Engine by Noel Tichy