Survey Aspects of Automated Machine Control

Mapping and Design Issues Facing the AMC Contractor

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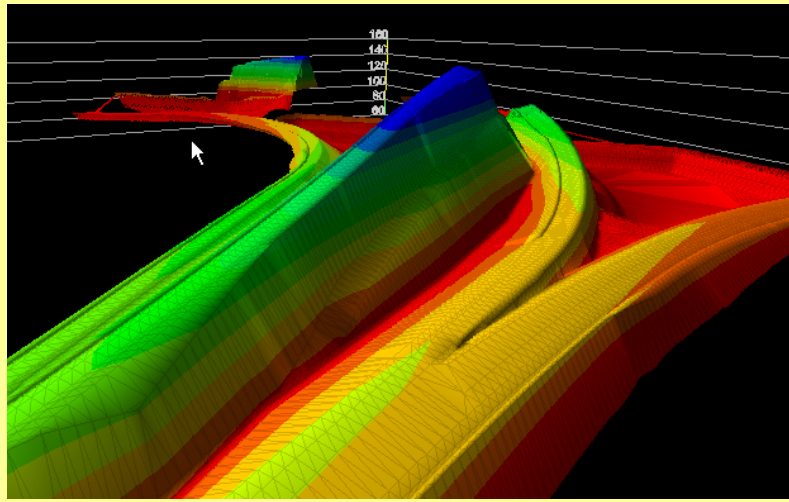

Benefits of AMC:

- Cost Reductions
  - Surveys
  - Backfill/Earthwork Errors
- Schedules
  - No waiting on surveyors
  - 24/7 Operations
- More Accurate Construction
  - Better Product

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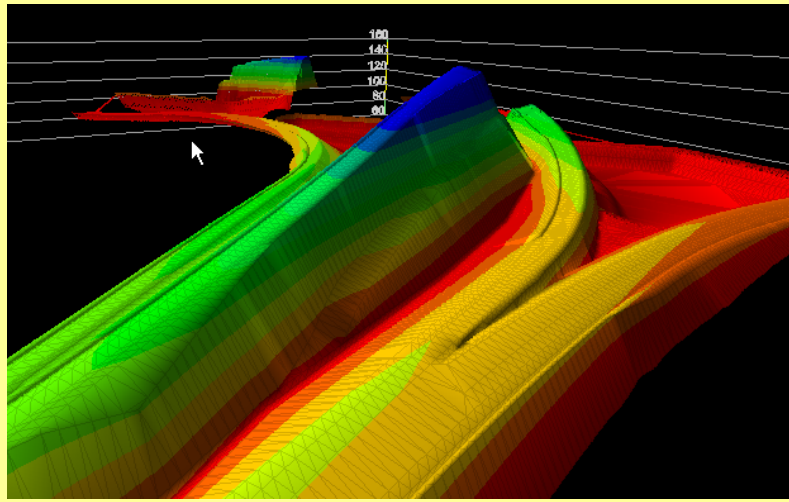


Problems:

The Survey

The Design Data

Construction Preparation

The Survey
Updates and Revisions

How old is the data?

Has there been new construction, widening or resurfacing of pavement, etc.?

How thorough was the survey?

The Survey

Updates and Revisions

- How old is the data?
  - Has there been new construction, widening or resurfacing of pavement, etc.?
- How thorough was the survey?

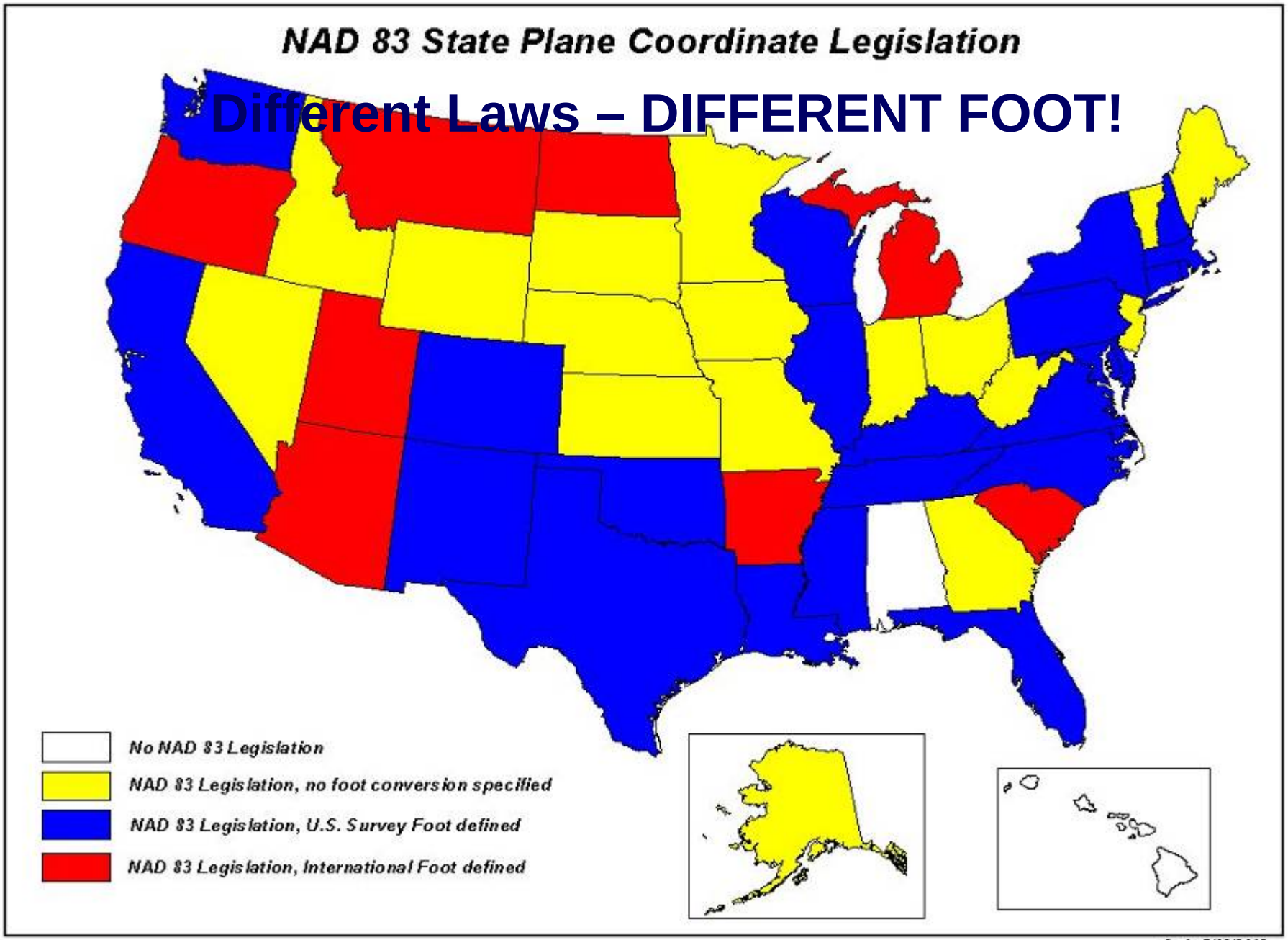
Accuracy – Then and Now

- Equipment Accuracy may influence Survey Accuracy
  - Procedures
  - Total stations vs GPS
  - Photogrammetry

What State? What Datum?

Different States

- Different Laws
- Different Zones


NAD 83 State Plane Coordinate Legislation
Different Laws – DIFFERENT FOOT!
No NAD 83 Legislation
NAD 83 Legislation, no foot conversion specified
NAD 83 Legislation, U.S. Survey Foot defined
NAD 83 Legislation, International Foot defined
Craig 5/02/2003

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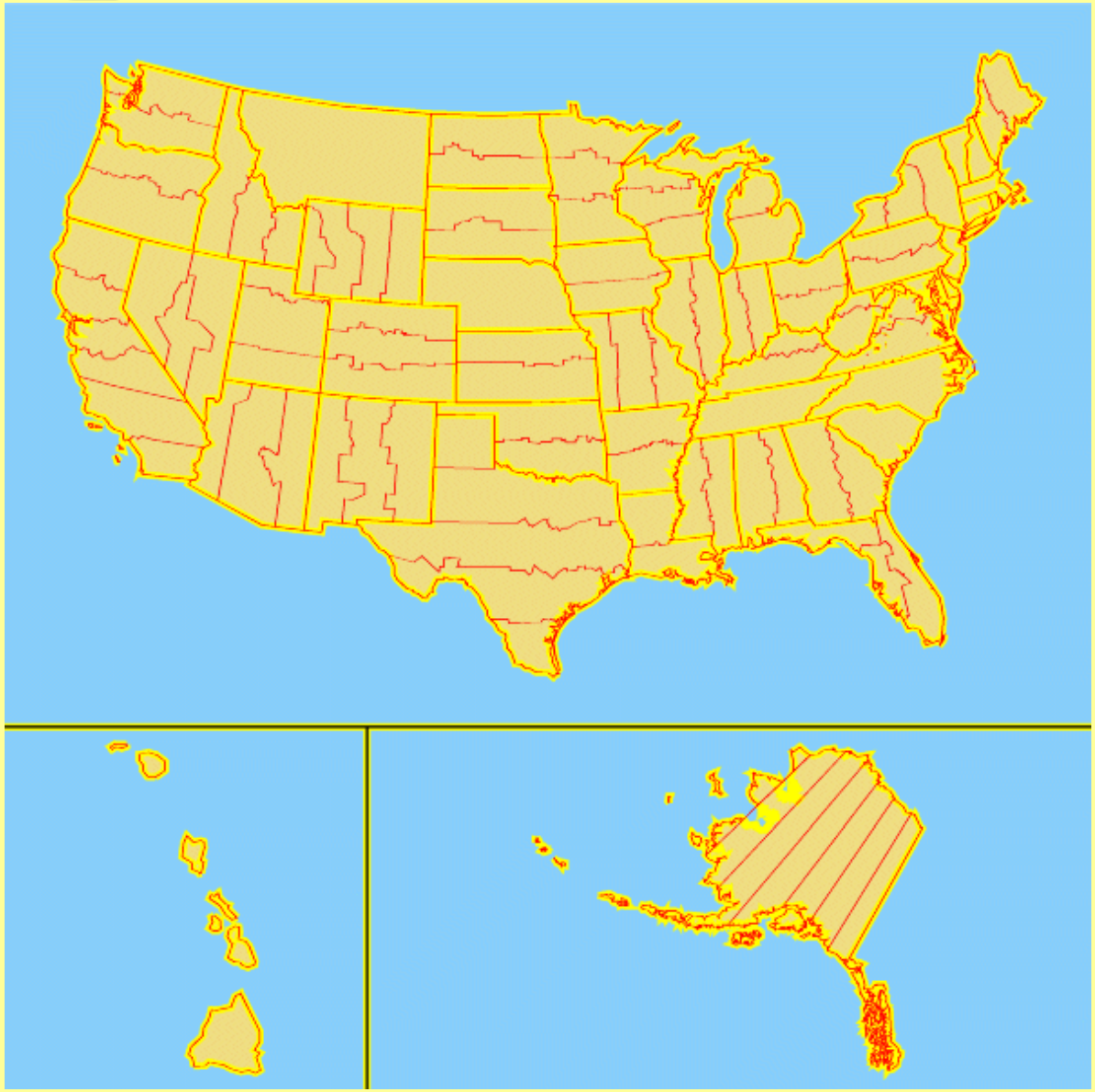


Different Zones

Which Zone Are We In Today?

What State? What Datum?

Different States

- Different Laws
- Different Zones

Different Datums – Coordinate Shifts

- NAD 27 to NAD 83 – Horizontal
- HARN
- NGVD 29 to NAVD 88
- Local or assumed coordinates for the project

Horizontal Datums

Adindan/Afgooye/Ain el Abd/American Samoa/Anna 1 Astro/Antigua Island Astro /Arc 1950 / Arc 1960 / Ascension Island/Astro Beacon/Astro DOS Astro Tern Island /Astronomical Station /Australian Geodetic / Ayabelle / Bellevue (IGN)/Bermuda/Bissau/Bogota Observatory/Bukit Rimpah /Camp Area Astro / Campo Inchauspe / Canton Astro/Cape/Carthage/Chatham Island Astro/Chua Astro/Corrego Alegre//CORS/Dabola / Deception Island /Djakarta (Batavia/DOS /Easter Island 1967/Estonia /European 1950 /European 197/Fort /Gan 1970/Geodetic Datum 1949/Graciosa Base SW 1948 /Guam/Gunung Segara /GUX 1 Astro / HARN/ Herat / Hermannskogel Datum/Hjorsey/Hong Kong 1963/Hu-Tzu-Shan/Indian/Indian 1954/Indian 1960 / Indian 1975/Indonesian 1974/Ireland 196 /ISTS 061 Astr /ISTS 073 Astr /Johnston Island /Kandawala / Kerguelen Island/Kertau 1948/Kusaie Astro 1951/Korean Geodetic/L. C. 5 Astro 1961/ Liberia M'Poraloko /Mahe 1971/Midway Astro/Montserrat Island Astro 1958 /Nahrwan/Naparima BWI /North American 1927 / North American 1983/North Sahara/Observatorio Meteorologico/Egyptian 1907/Old Hawaiian/Ordnance Survey Great Britain 1936/Pico de las Nieves/Pitcairn Astro 1967/Point 58/Pointe Noire 1948/Porto Santo 1936/Provisional South American 1956 /Provisional South Chilean/Puerto Ric /Pulkovo 1942/Qatar National / Qornoq/ Reunion /Rome 1940 /S-42 (Pulkovo 1942/S-JTSK /Santo (DOS) 1965/Sao Braz/Sapper Hill 1943 / elvagem Grande/Sierra Leone 1960/South American 1969 /South Asia /Tananarive Observatory/ Timbalai 1948/Tokyo/Tristan Astro 1968 /Viti Levu 191 /Voirol 1960/Wake Island Astro 1952 /Wake-Eniwetok 1960 / WGS 72/ WGS 84 /Zanderij International

Horizontal Datums

North American Datum of 1927 (NAD 27)

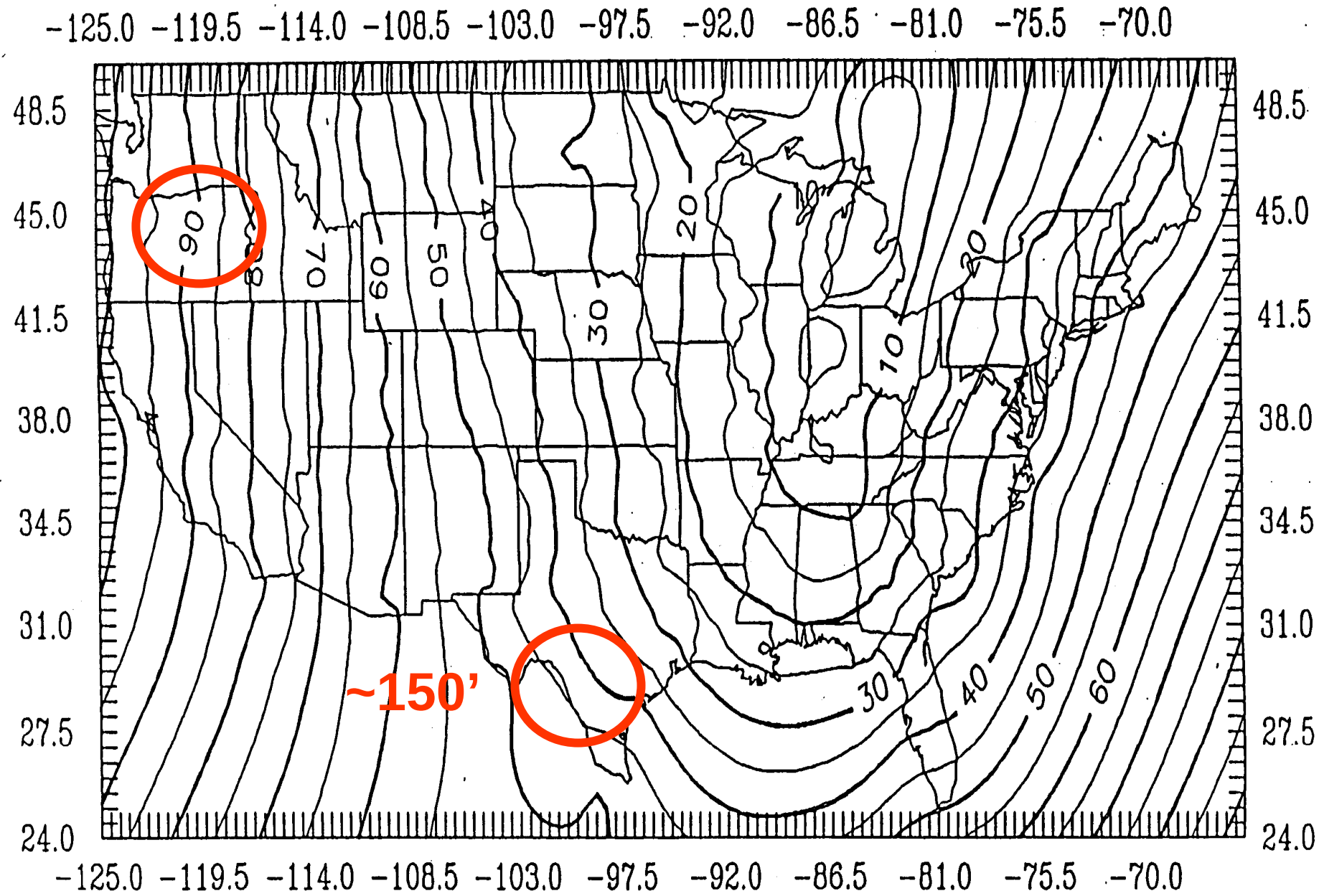
North American Datum of 1983 (NAD 83)

International Terrestrial Reference Frame

High Accuracy Reference Network (HARN)

HARN 1995,2001, 2007 Adjustments

MAGNITUDE OF DATUM SHIFT (METERS)



HARN Adjustments 1995, 2001, 2007

Station: SMITHPORT (EZ5525)					
Difference Northing (m)					
Adjustment		83/86	83/95	83/2001	83/(NSRS2007)
	Northing (m)	199354.569	199354.397	199354.384	199354.377
83/86	199354.569	0.000			
83/95	199354.397	0.172	0.000		
83/2001	199354.384	0.185	0.013	0.000	
83 (NSRS2007)	199354.377	**0.192**	0.020	0.007	0.000
Difference Easting (m)					
Adjustment		83/86	83/95	83/2001	83/(NSRS2007)
	Easting (m)	665067.183	665067.513	665067.503	
83/86	665067.183	0.000			
83/95	665067.513	-0.330	0.000		
83/2001	665067.503	-0.320	0.010	0.000	
83 (NSRS2007)	665067.499	**-0.316**	0.014	0.004	0.000

Height Differences Between NAVD 88 and NGVD 29

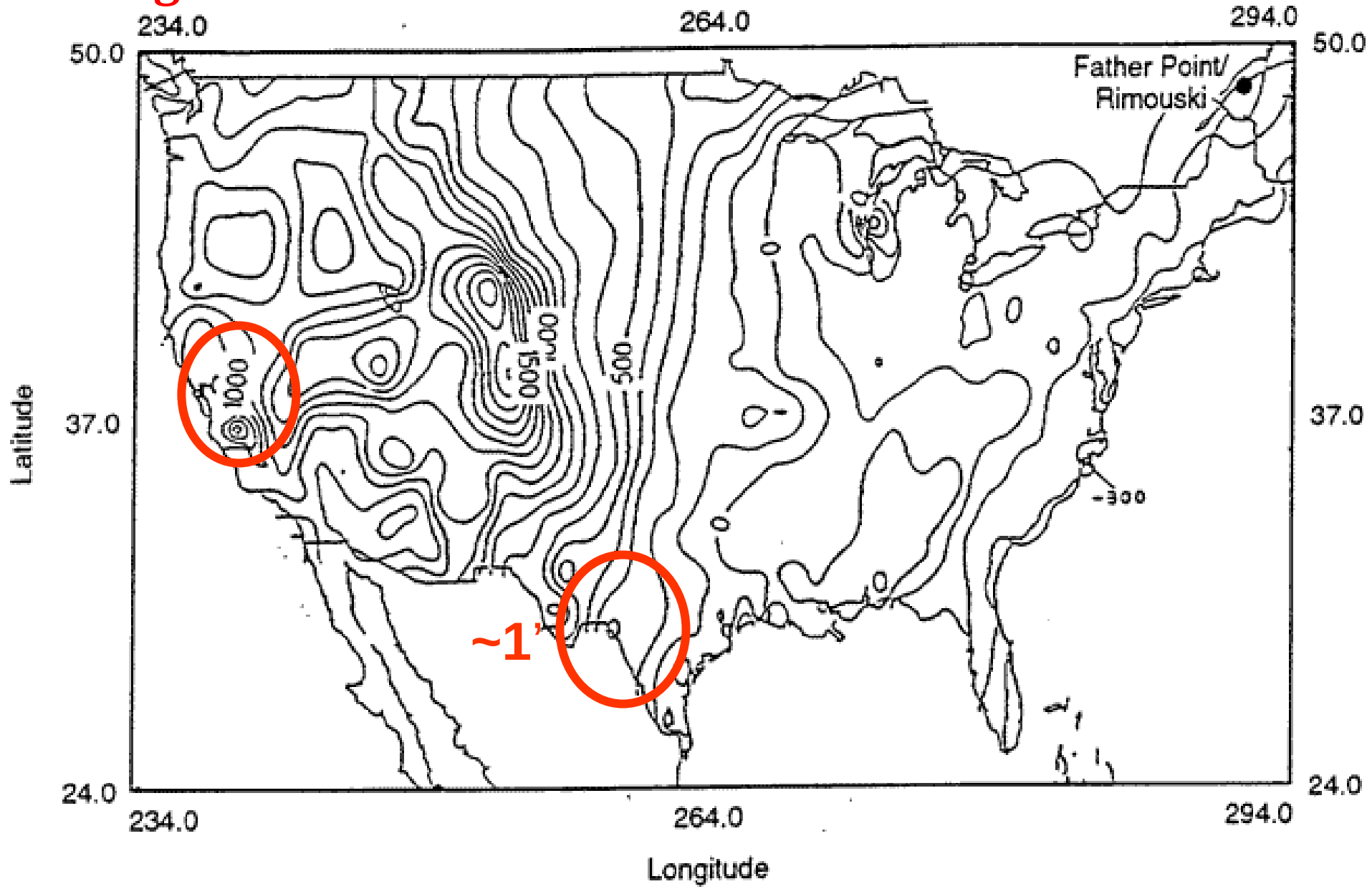


Figure 4. Contour map depicting height differences between NAVD 88 and NGVD 29 (units = mm).

Local or assumed coordinates for the project –

N 10,000
E 10,000

N 10,000
E 10,000

N 10,000
E 10,000

N 10,000
E 10,000

N 10,000
E 10,000

N 10,000
E 10,000

Who Knows Where We Are?

The Design Data - How Good?

How was it developed?

3D Modeling?

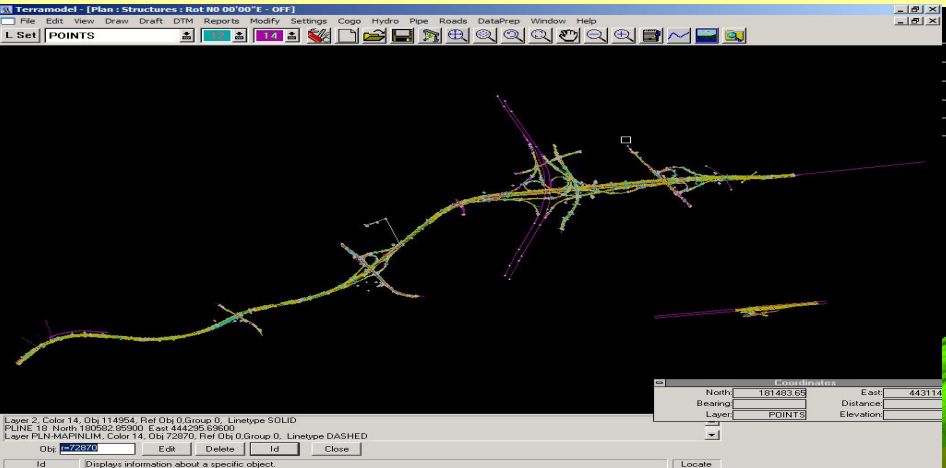
Are there Spikes or Holes?

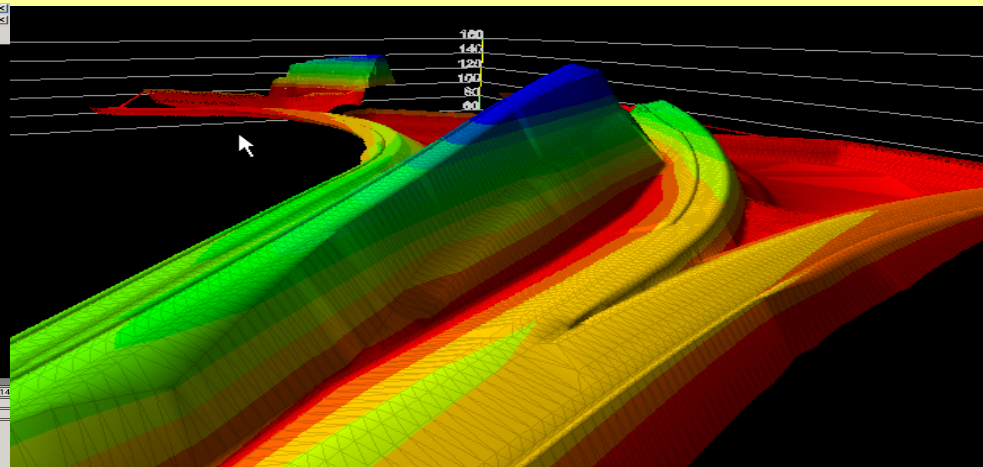
Cross-Sections ?

What Interval?

Are there CADD conflicts

(Crossing Breaklines)?

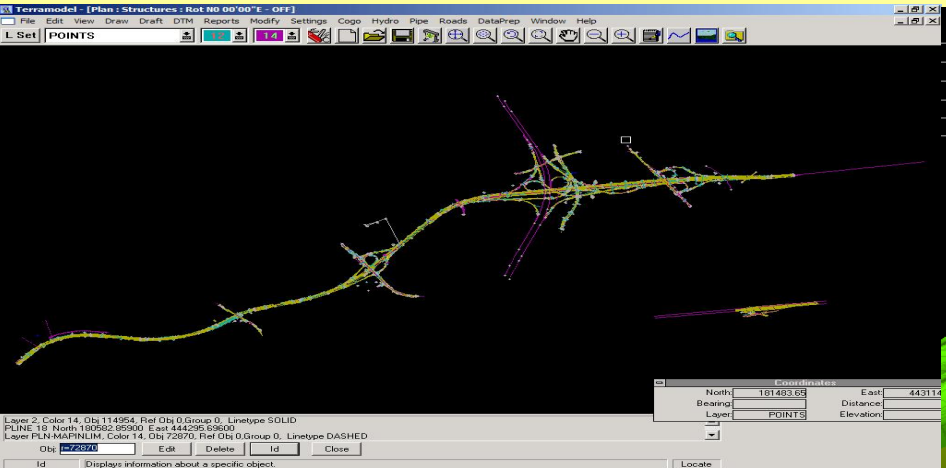


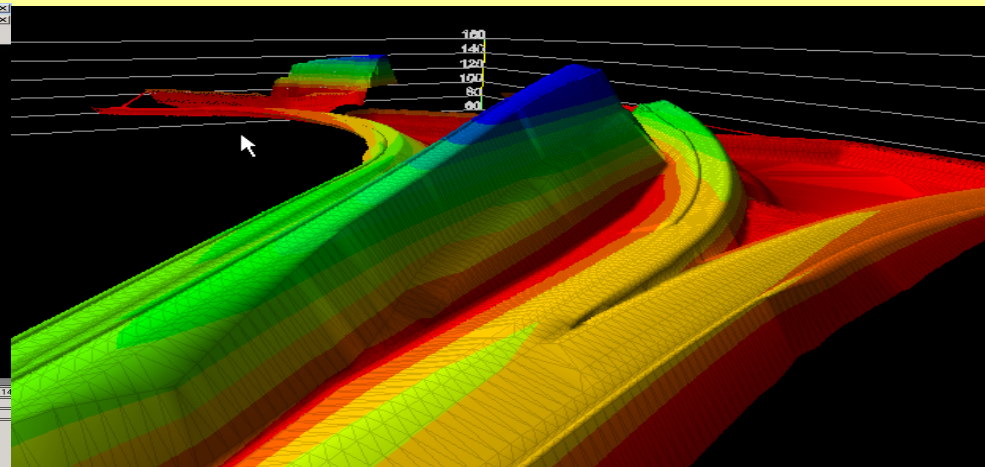


The Design Data – Experience & Liability?

Who developed the data?

- The DOT
- The Contractor
- 3rd Party
  - Professional Certification?
  - Does it match DOT model?





Construction Preparation

Clarify Points 1 and 2 (Survey and Design)
How good is that GPS?
How good is that surface model?
Where's the control?



Construction Preparation

How good is that GPS?

Is Survey Grade Accuracy really millimeter?

What happens to the blade on that Dozer?

Construction Preparation

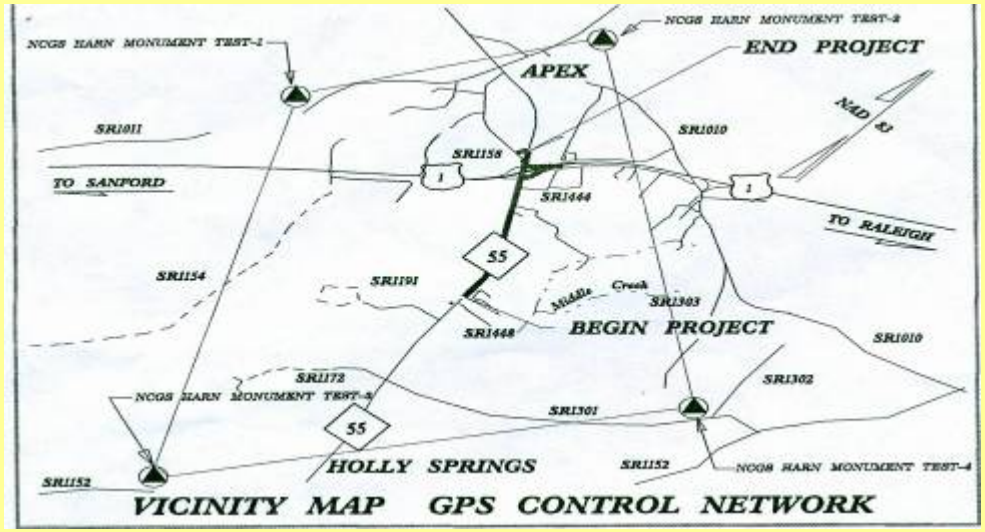
How good is that surface model?

- Resurvey the bare earth for new tie points?
- Adjust the model?

Construction Preparation

Where's the control?

- No Centerline staked any more
- Calibration Points surround project
- Tied to original surveys
- RTK Network or local base station?



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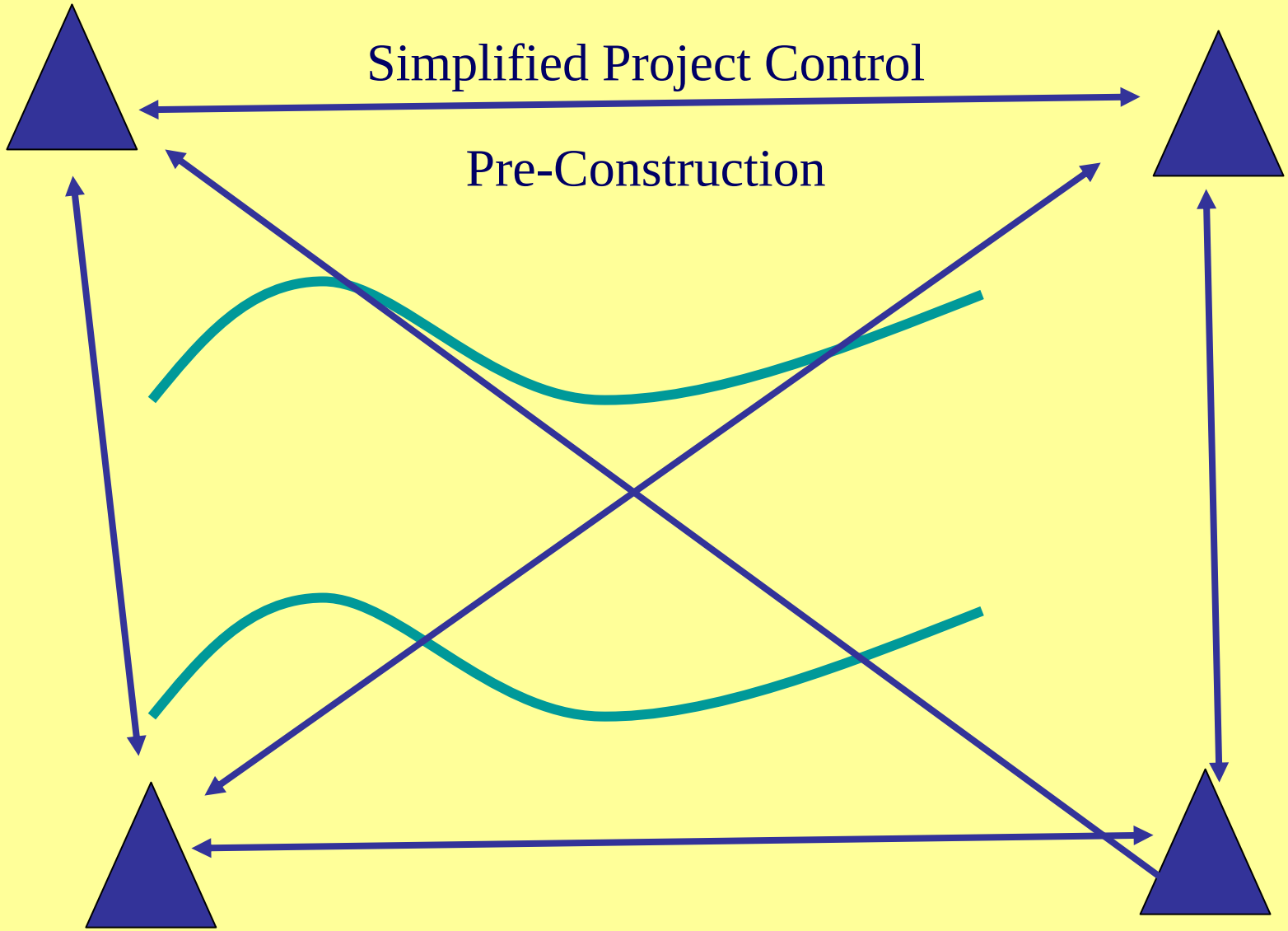

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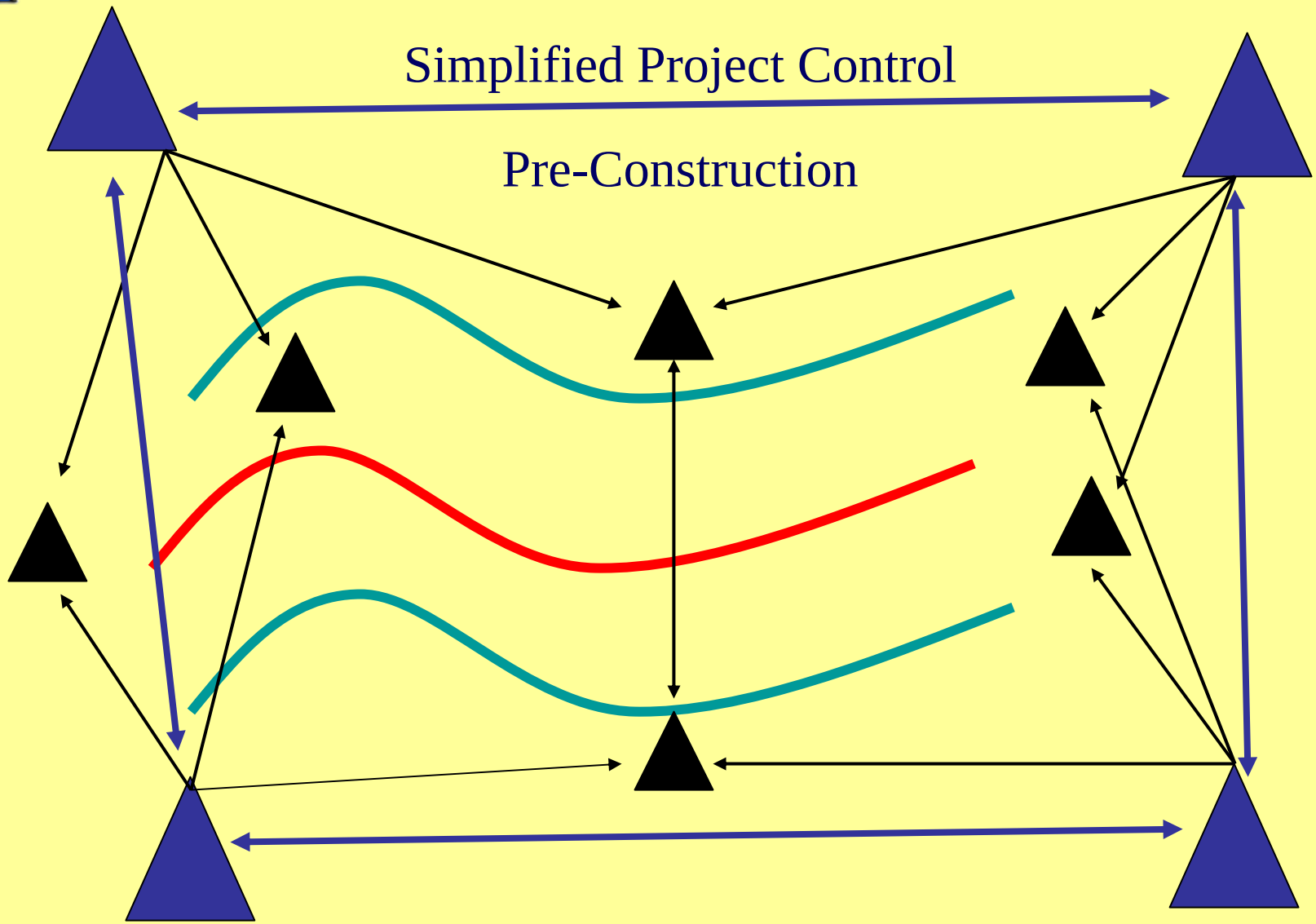

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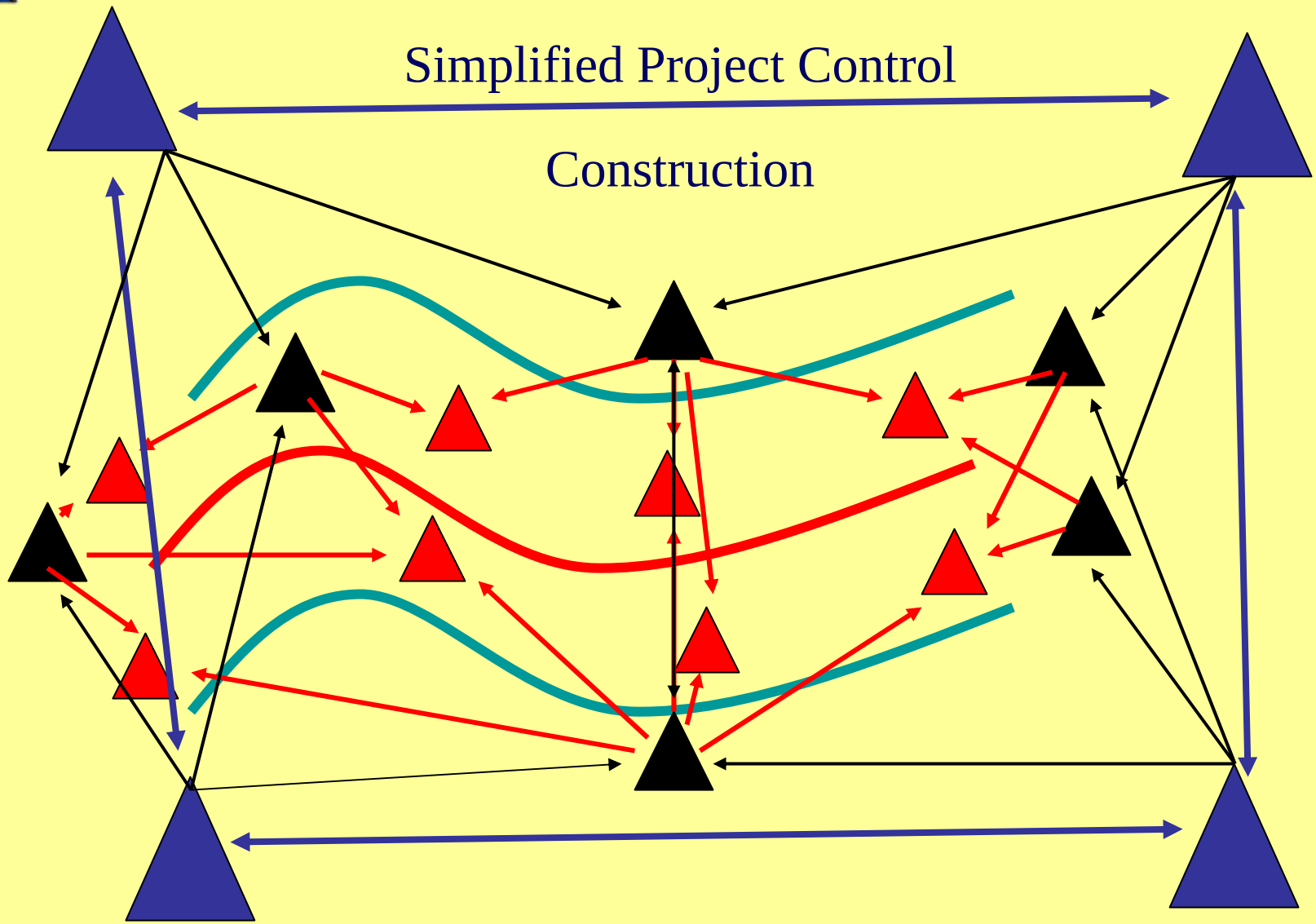
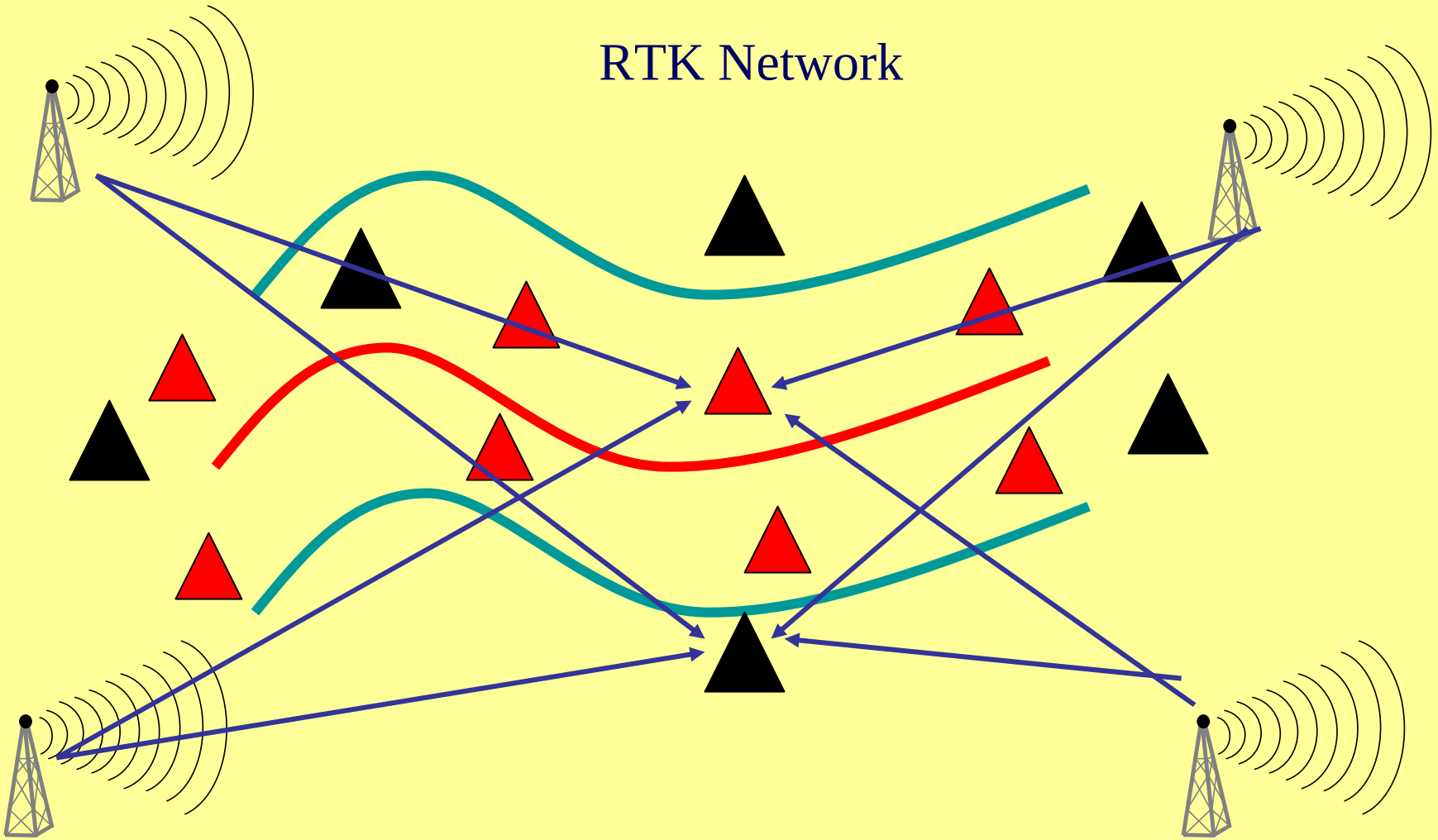


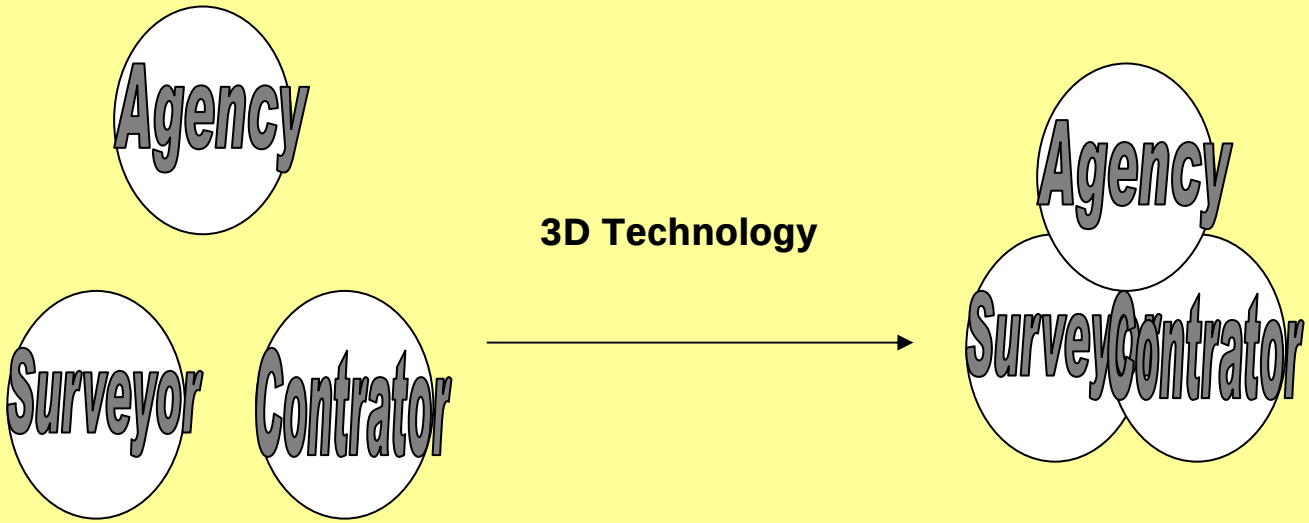
Simplified Project Control

RTK Network



The Biggest Issue – Good Communication!

We're not 3 Independent Kingdoms anymore



The Biggest Issue – Good Communication!

- Agencies can encourage (or force) various groups to adopt workable standards (i.e. reduce conflict)
  - *Verify* consistent positioning of the project
  - Adopt 3D technology in verification process
  - Insist on a standard electronic model

The Biggest Issue – Good Communication!

- Surveyors can help educate and ensure professional standards are being met
  - Manage project *position* (control)
  - Ensure technology being utilized meets professional standards (manage consistency between agency, contractor, and surveyor)
  - Arbitrate grade discrepancies

The Biggest Issue – Good Communication!

- Contractors can visualize grade and sometimes “see” 3D model problems not obvious to agency/surveyor
  - Work within standards agreed to by surveyor
  - Always “check-in” to surveyor established points
  - Ask all the dumb questions, especially when the 3D model seems unusual

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Questions?

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Thank You!