Trimble

Surveying and Data Management to Support 3D Design *(for Construction)*

Florida DOT CIM Workshop

15 June 2012

Requested Learning Points

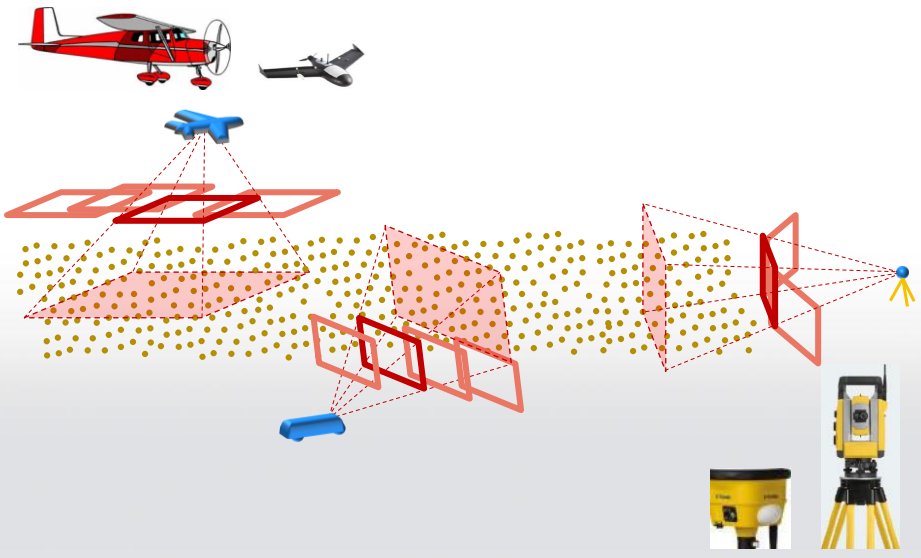
- **Owners / DOT:**
  - Minimize quantity disputes ✔
  - Minimize rework ✔
- **Contractors:**
  - CIM – help understand how it can help us contractors bid better, win more, be profitable ✔
  - Early error detection – avoid delays, rework ✔
  - Safety – people vs machines *(MC presentation)*
  - Pass reduction – fuel and wear *(IC presentation)*

Agenda

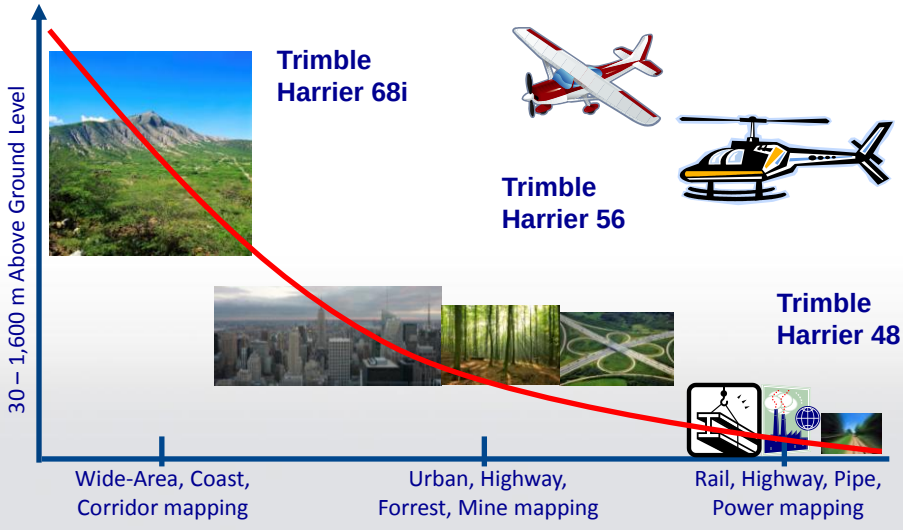
- Data Collection and Processing
- The Complete Design Workflow
- Opportunities for CIM Benefits at the Design Level
- Financial Returns

Data Collection and Processing

Data Collection Technologies



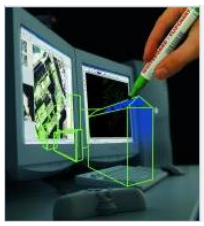
Airborne Systems Applications

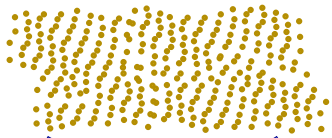


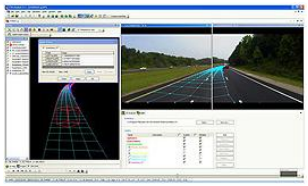
Land Mobile Systems

Accuracy Requirement (open sky)	Common Project Types	Trimble Mobile Data Capture Hardware	Trajectory Correction Source	Target Detection and Registration	Trimble Information Extraction
100 cm	Asset Inventory	**MX1 MX3 MX8**	DGPS	Not Required	**Trident Analyst** for GIS, Roadway Signs, Spatial Imaging
10 cm	Asset Inventory, DTM Mapping, and Engineering	**MX3 MX8**	Post Processing (Longer baseline)	Not Required	**Trident Analyst** for Roadway Signs for Spatial Imaging
5 cm	DTM Mapping, and Engineering	**MX8**	Post Processing (short baseline)	Not Required	**Trident Analyst** for Spatial Imaging
1 cm	Survey and Engineering	**MX8**	Post Processing (local)	Required	**Trident Ana** for Spatial Ima

From Cloud to …







Feature Extraction

- OBIA
- Objects, vectors

MGIS

Design Extraction

- DTM/TIN
- Break-lines
- Cross sections

CAD

Starting Point

Standard Cloud-to-Design Workflow

Collection	GPS Trajectory Smoothing	Precision Target Referencing	Design Extraction	Design Workflow
- LAS Laser file - AVI Image file - GPS Location file 600K points/sec → **Tons of data!** 10cm accuracy	**Post process the GPS trajectory** for loss of signal and other errors, using inertial sensors input. Smooth trajectory is fed back into the LAS file to **correct the point cloud**. 4-5cm vertical accuracy.	Post process to **tightly reference point cloud** to precision-placed targets along corridor. 9mm vertical accuracy.	**Semi-automated / interactive** process to extract edge of pavement, crown, breaklines, etc. **Output XML or other formats**. Other outputs, e.g.: - Clearances for bridges/tunnels - Exact location of GIS features	**Archive** the massive point cloud file for future reference. Downstream **work with the design file** (or the GIS file)

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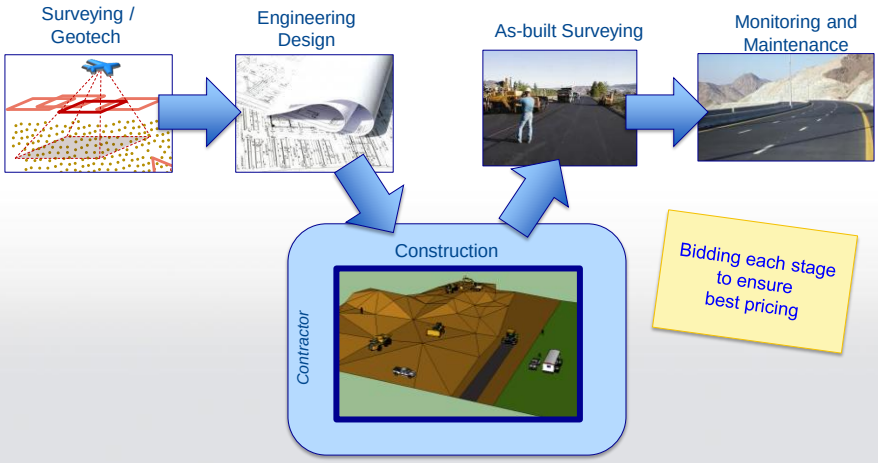
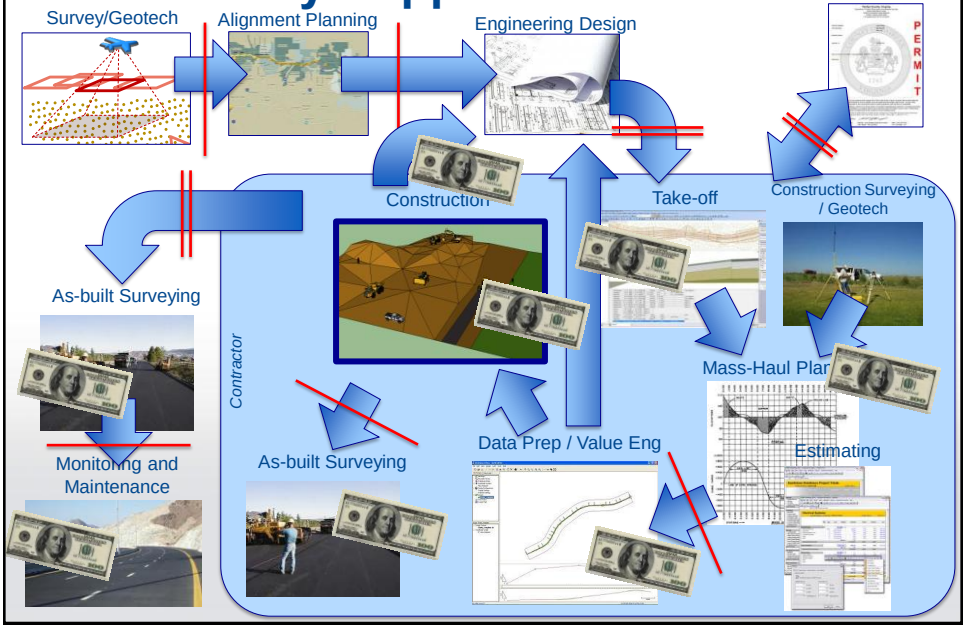
Opportunities for CIM Benefits at the Design Level

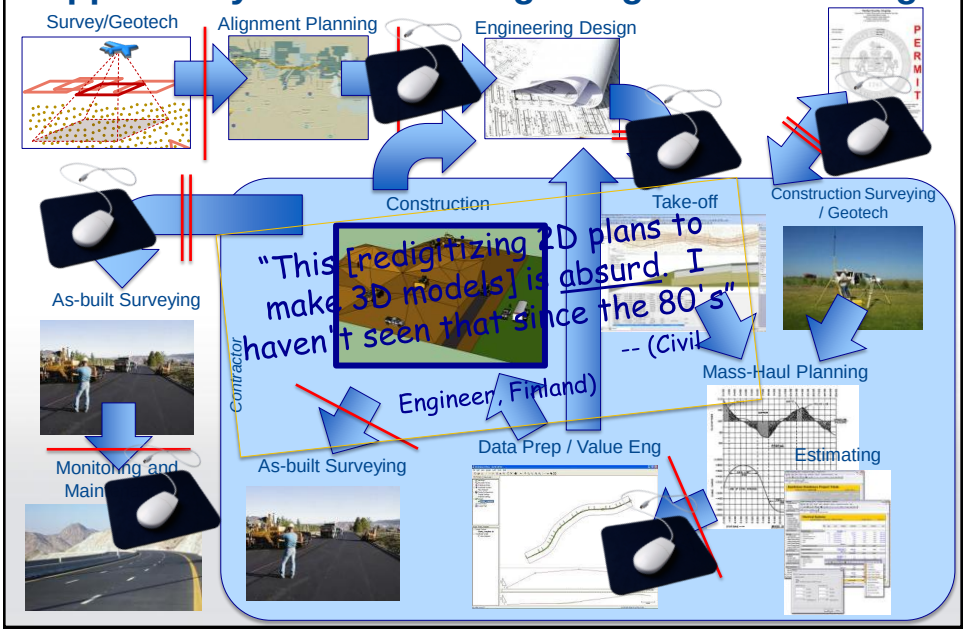
Conceptual Model / Data Flow



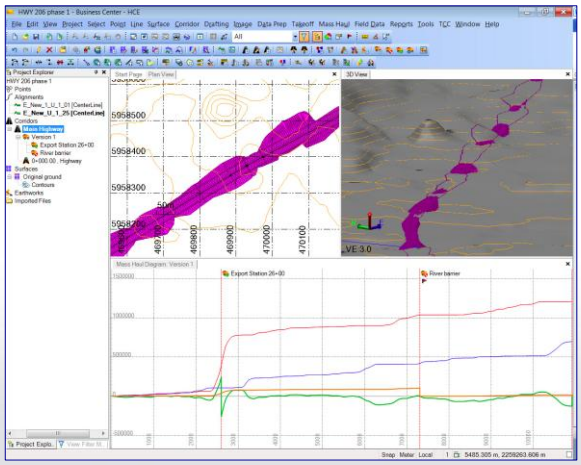
What Really Happens …



Opportunity 1: Avoid Re-digitizing and Measuring

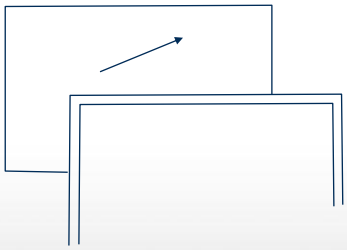


Opportunity 2: Value Engineering



From "*a*" design → "*the*" design

Opportunity 3: 3D vs 2D Design



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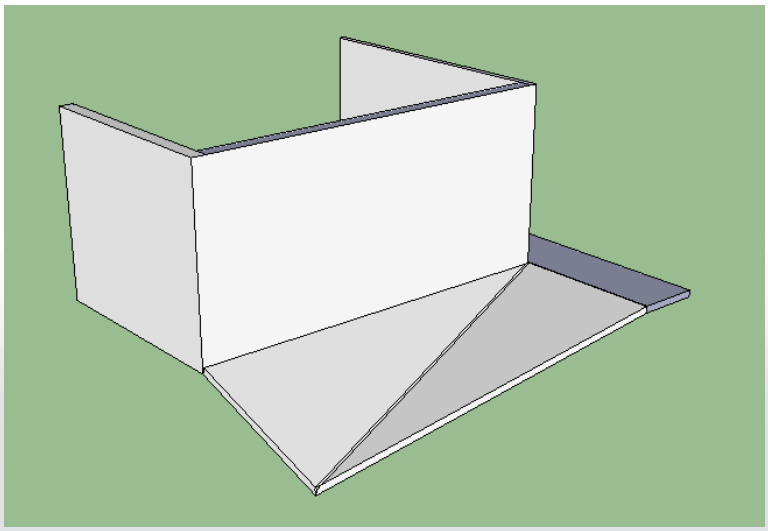

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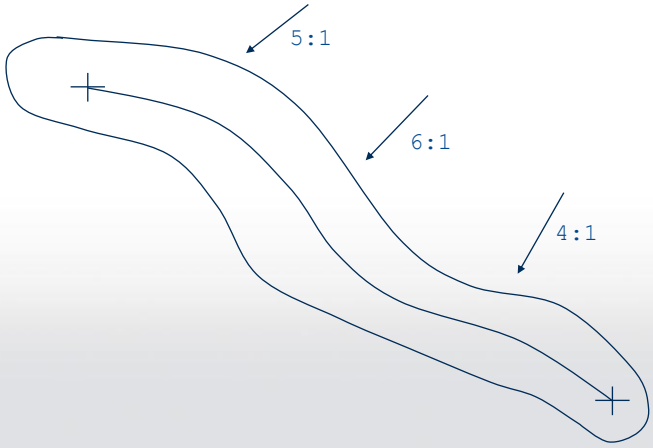

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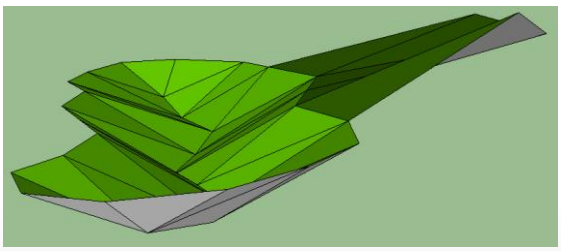
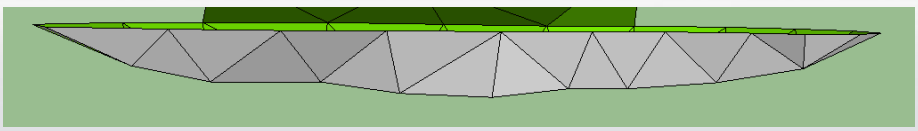
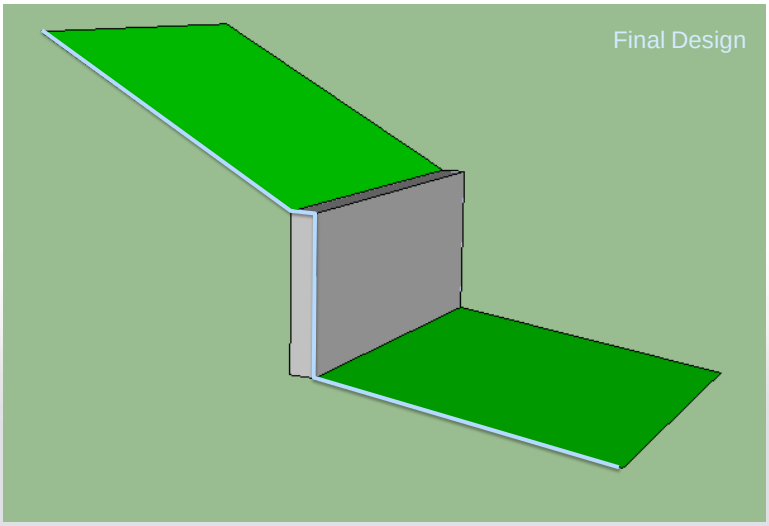




Opport 4: Construction Design



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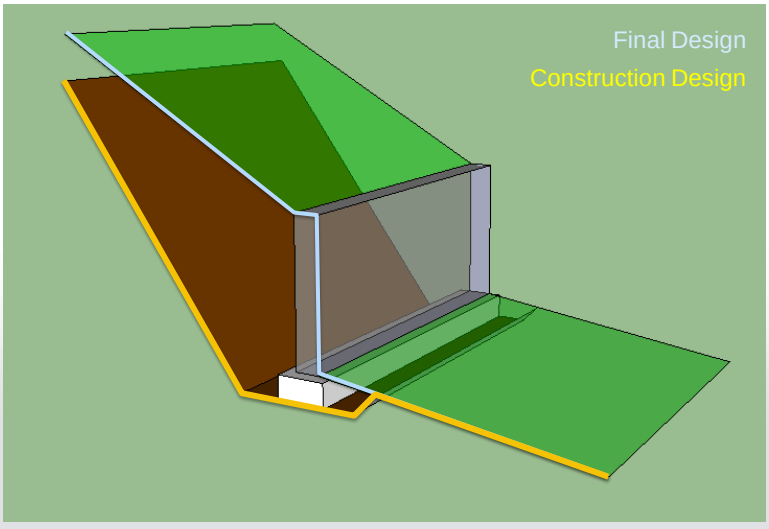
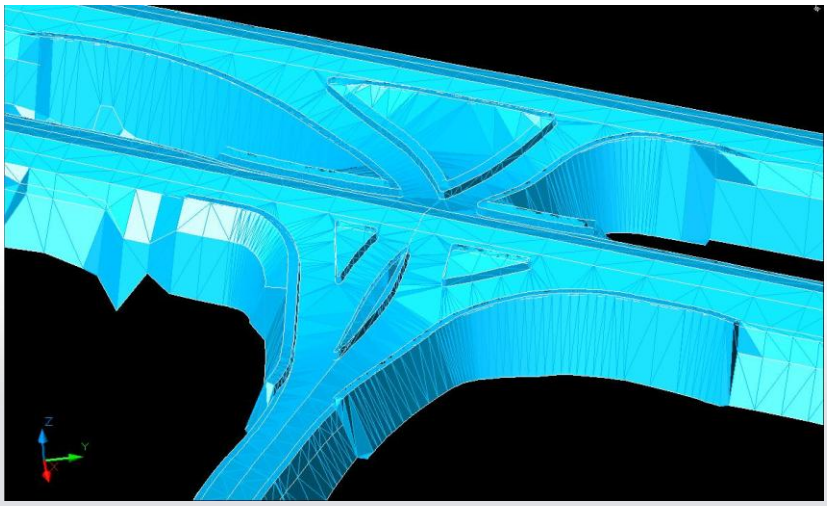
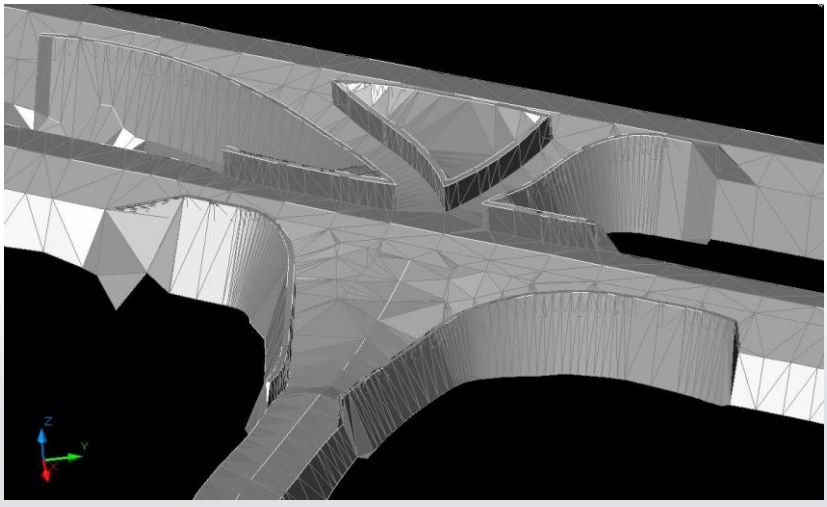


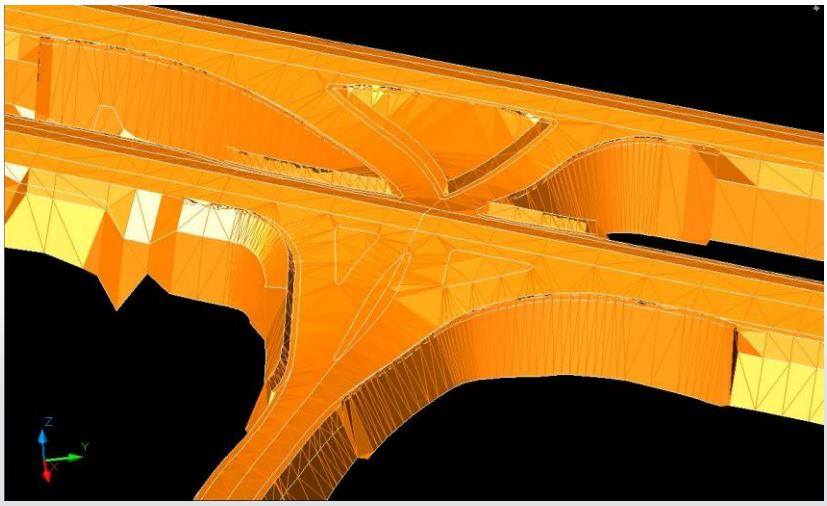
Finished Surface



Sub Grade Surface



Sub Base Surface



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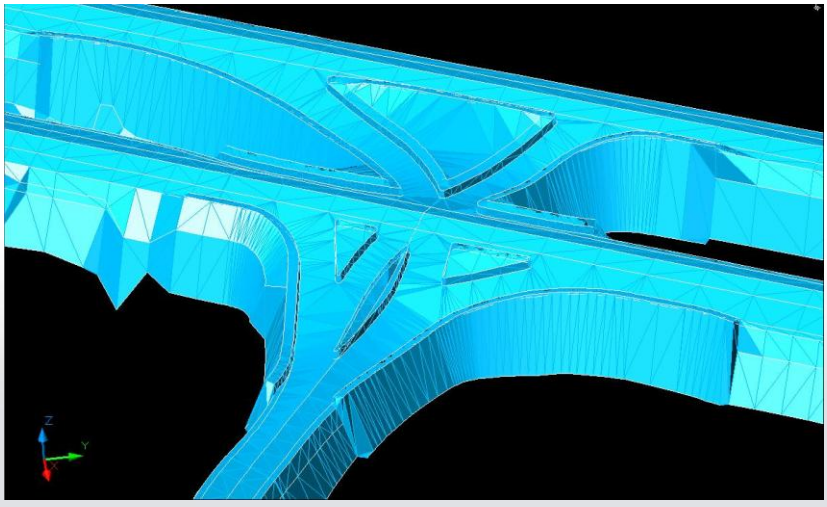
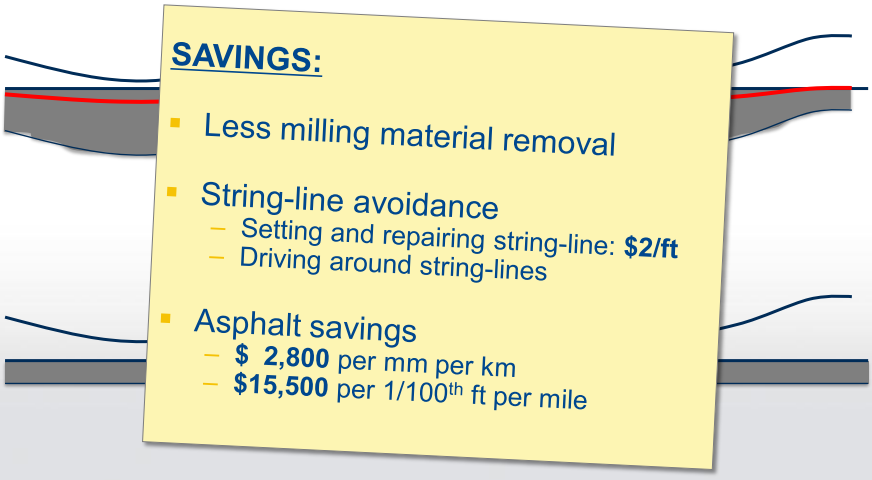


Opportunity 5: 3D vs 2D Resurfacing



SAVINGS:

- Less milling material removal
- String-line avoidance
  - Setting and repairing string-line: **$2/ft**
  - Driving around string-lines
- Asphalt savings
  - **$ 2,800** per mm per km
  - **$15,500** per 1/100th ft per mile

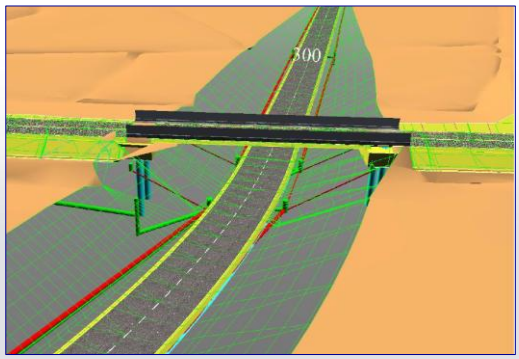
CIM Opportunities in Design

1. **Re-digitization and Re-measurement Cycles**
2. **"a" Design → "the" Design**
3. **2D Design → 3D (4D, 5D) Design**
4. **Final Design → Construction Design**
5. **2D milling → 3D re-surfacing**

Virtuous Feedback Loop

- Error Detection
- Value Engineering
- Improved planning

3D Model Design



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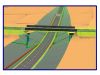


- Less Rework
- No stakes, stringlines
- Faster execution

Site Technology

Virtuous Feedback Loop

- Error Detection
- Value Engineering
- Improved planning

- Less Rework
- No stakes, stringlines
- Faster execution

3D Model Design

Site Technology

~Real-time Feedback

- More frequent volumes
- 100% QA/QC
- Faster decision making
- Rich as-builts
- Detailed records
- Data security

Virtuous Feedback Loop

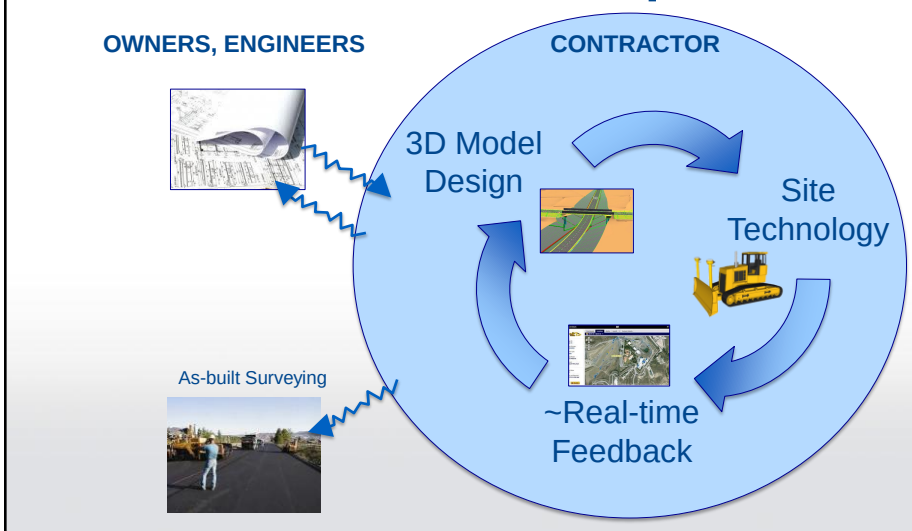
CONTRACTOR

3D Model Design

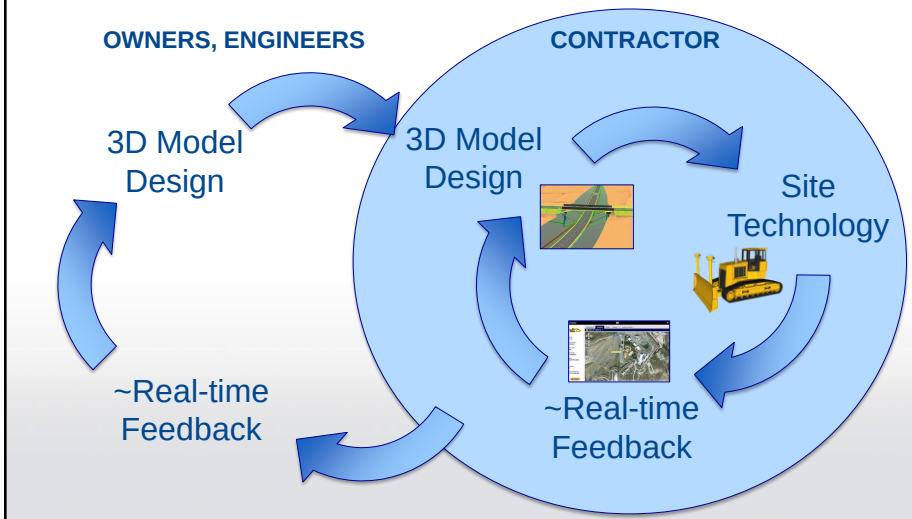
Site Technology

~Real-time Feedback

Virtuous Feedback Loop



Virtuous Feedback Loop



Why not? Challenges…

- **Workload/cost for doing 3D vs 2D design**
  - Modern dynamic tools make 3D simpler
  - The 3D work is being done *somewhere*, often more than once
  - What is the *total* cost of all the RFIs and change orders?
  - As-built verification is much simpler
- **Liability**
  - 3D design allows for earlier error detection
  - "Minimalist" approach encourages RFI's and change orders, more exposure
  - Less clarity = more potential disputes
  - Electronic models can be authenticated and time-stamped as well
- **Skill and Certification**
  - The more the Licensed Engineer does, the less the contractor needs to do
  - Modern technology allows for continuous verification and accurate final QA