



ORTHO'S LIDAR REMOTE SENSING ELEVATION MODELS CONTOURS INFRARED DATA CONVERSION ANALOG & DIGITAL MAPPING 3D MODELS GROUND BASED LASER MAPPING TRAINING

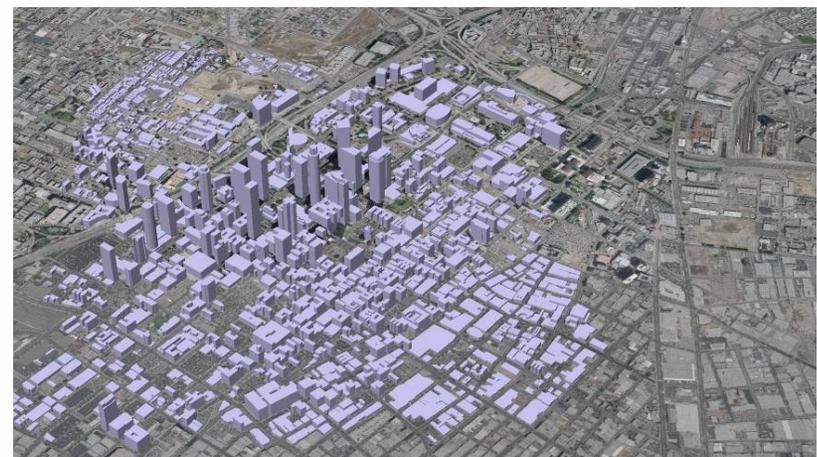


# Presentation for Building Outline Extraction - GIS Steering Committee

**Date:** July 15, 2008

**Location:** LA County-DPW

*Presented by: Milan Svitek, AICP*



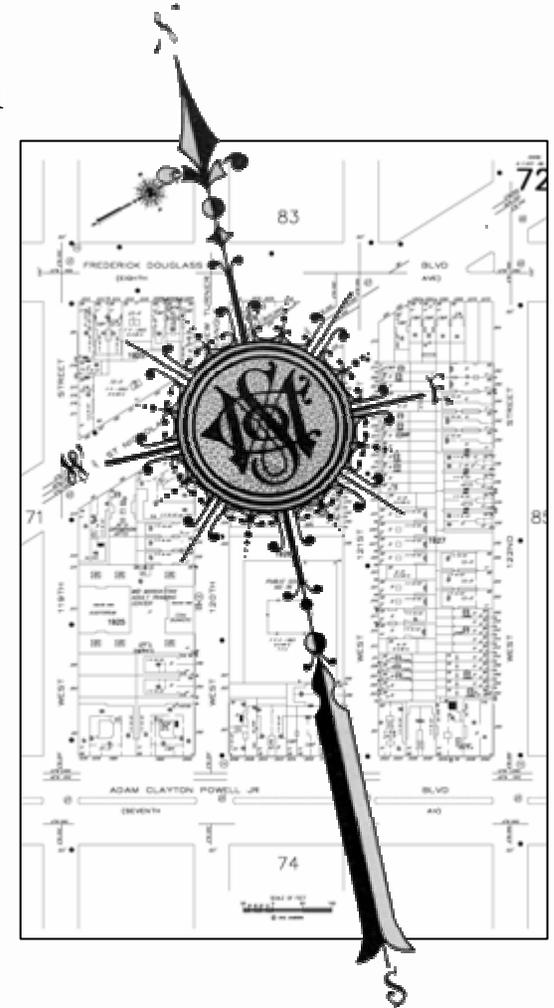
# Agenda

- Sanborn Overview
- Sanborn Qualifications
- Planimetric Data Possibilities
- Building Outline Products
- LA Base Map Sources
- Base Map Characteristics
- Building Outline Creation Methods
- Quality Assurance and Control
- Building Classification and Attribution
- Visualization
- Justification and Recommendations
- Preliminary Budget Estimate
- Questions

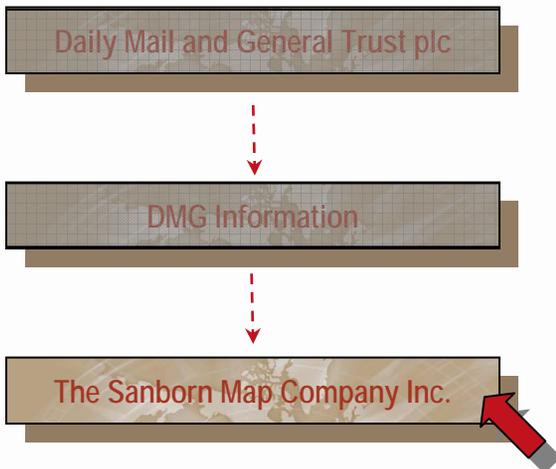
# Sanborn – Since 1866

## Sanborn Maps™

- Extensive mapping & GIS collection with over 12,000 municipalities nationwide
- Extensive Attribute Information
  - Building and Land Use
  - Building Specific Address
  - Building Construction
  - Internal and Subterranean Building Detail
  - Year Built...
- Special Surveys
  - Land Use
  - Vacancy Studies
  - Building Condition



# Sanborn Locations



## The Sanborn Map Company Inc.

Over 300 employees

- Ann Arbor, Michigan
- Charlotte, North Carolina
- Colorado Springs, Colorado**
- Fort Collins, Colorado
- Pelham, New York
- Portland, Oregon
- St. Louis, Missouri
- Mumbai, India

# Sanborn Overview

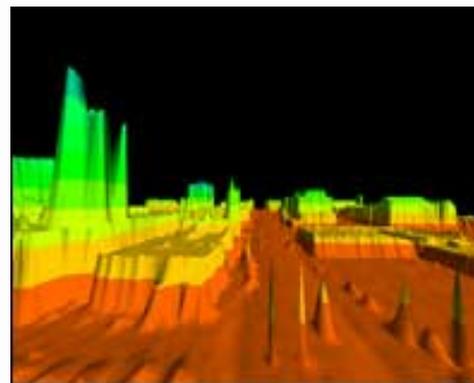
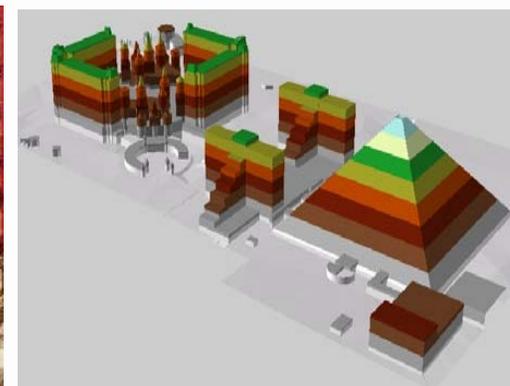
## Locations



# Geospatial Solutions

## List of Services and Products

- Mapping
- Remote sensing and analysis
- GIS software development
- Decision support tools
- Data analysis
- Geospatial products
  - CitySets®
  - 3D Buildings
  - GEOBOOK®
  - Sanborn LiDAR
  - Sanborn Orthos
  - CityViz™



# Data Acquisition Resources

*Sanborn owned and operated*

- Fixed wing aircraft (8)
- UltraCam Digital (2)
- Z/I DMC (4)
- Leica Analogue RC30/20 (3)
- Optech LiDAR-50 Hz (1)
- Leica LiDAR ALS 50 II (2)
- Trimble Ground-Based LiDAR (1)
- Airborne GPS systems (7)
- Inertial Navigation Systems (6)
- Trimble GPS survey equipment
- Storage (200 TB per facility)
- 350 Employees / 4 primary production facilities



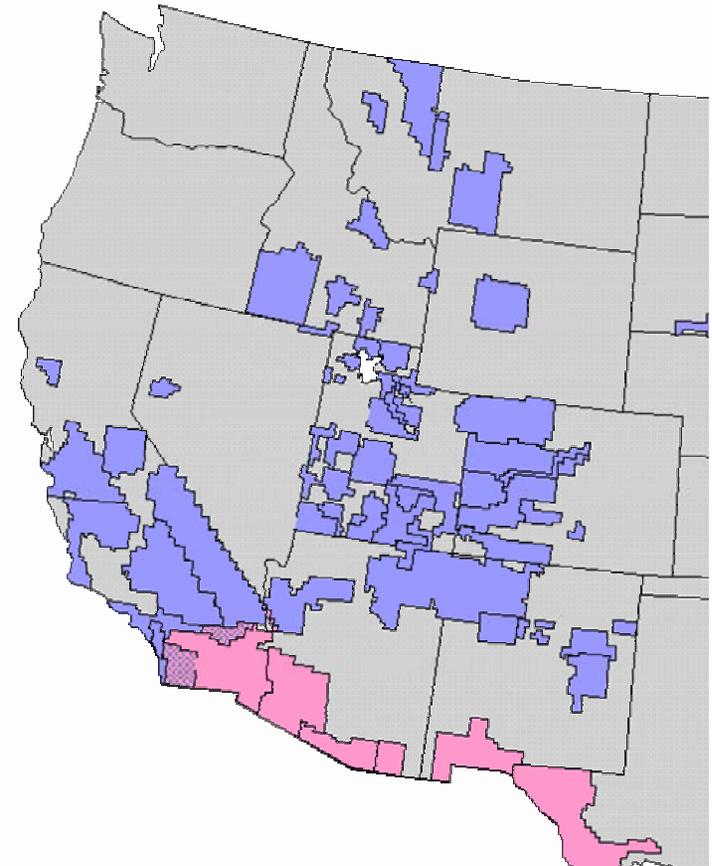
# Sanborn Qualifications



- California Mapping Experience
  - City of Riverside
  - Calaveras County
  - San Louis Obispo
  - USGS
  - Tuolumne Watershed
  - Alameda County

**Over 75,000 square miles of photogrammetric mapping experience in the State of California**

- Major Planimetric Mapping Experience
  - City and County of Denver
  - New York City
  - City of Omaha
  - City of Philadelphia
  - Dekalb County, GA (Atlanta)

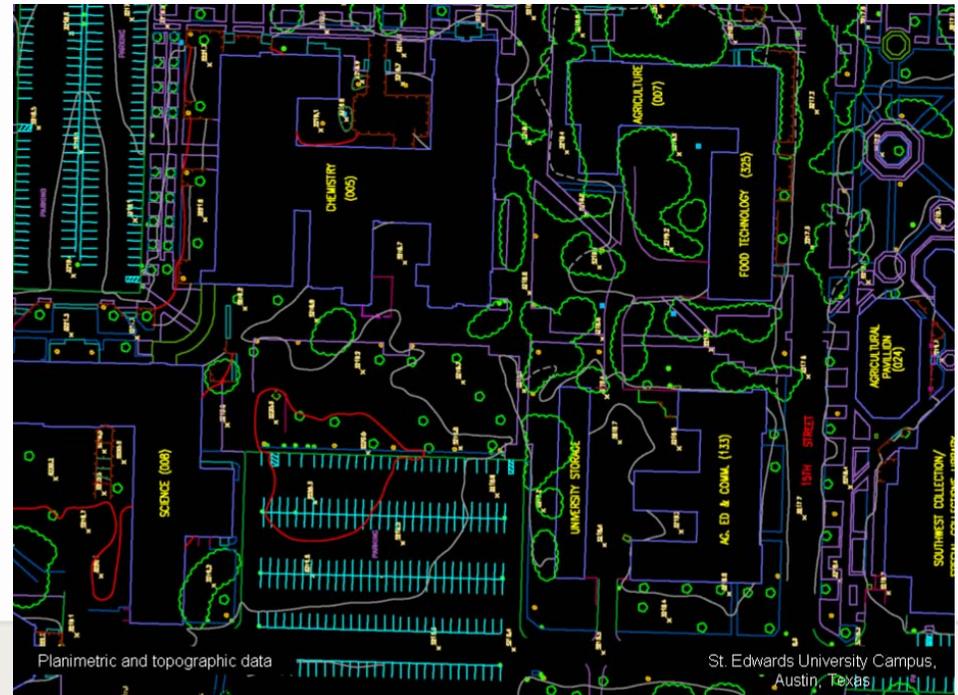


**Several million building outlines developed to date**

# Planimetric Features:

For 1"=100' and 1"=200' Map Scales

- Permanent Structures
  - 10' x 10' for 1"=100' map scale
  - 20' x 20' for 1"=200' map scale
- Paved and Unpaved Surfaces
- Land Marks (Parks, Golf Courses)
- Rail Roads
- Barriers
- Disturbed Areas
- Water Feature
- Water Structures
- Water Utilities (Man holes)
- Electrical Utilities



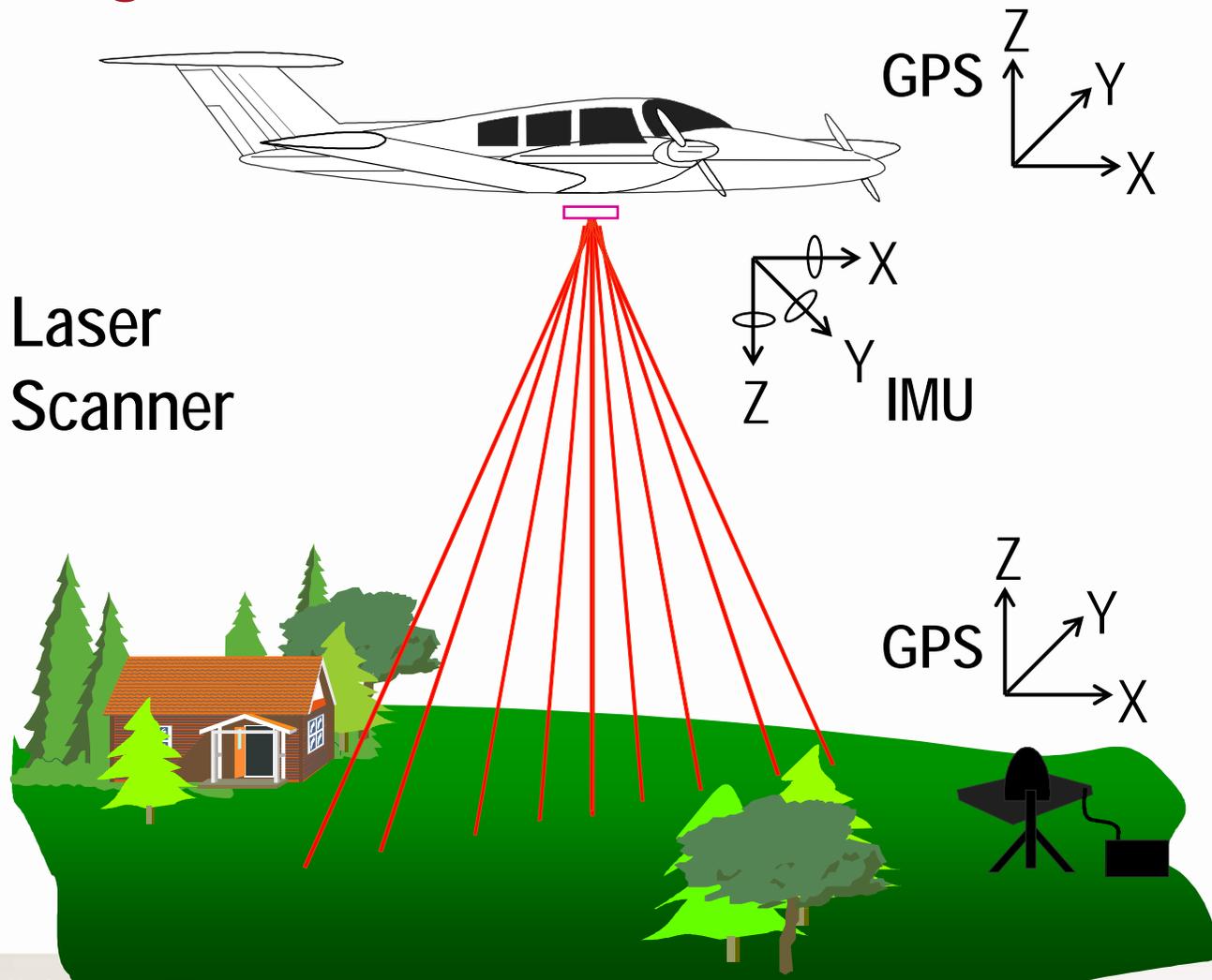


# LA County Existing Source Data

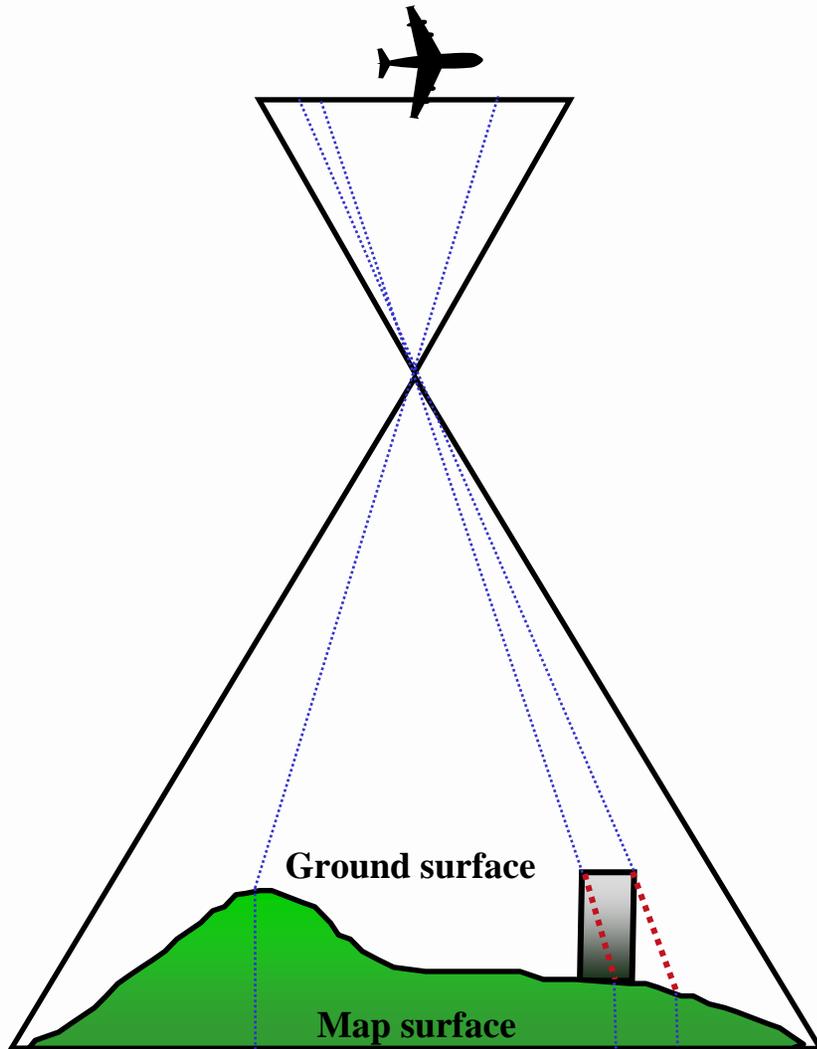
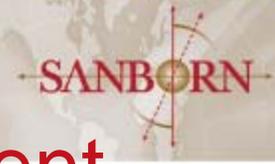
*LA County has invested significant monies in the development of base map data that can be used for planimetric extraction.*

- 2006 LiDAR and Ortho
  - Allows for the automated extraction of features
  - Data can be represented in 2D or 3D format
  - Partially Obsolete
- 2008 Ortho Imagery
  - Allows for “heads up” digitizing or automated extraction of features
  - Data can only be represented as a 2D product
- 2008 Stereo Pairs
  - Allows for the compilation of features in a stereo environment using two overlapping images.
  - Data can be represented as a 2D or 3D product

# LiDAR: Data Extraction with "Angle of View"



# Characteristics of Ortho Imagery: Data Extraction with Radial Displacement

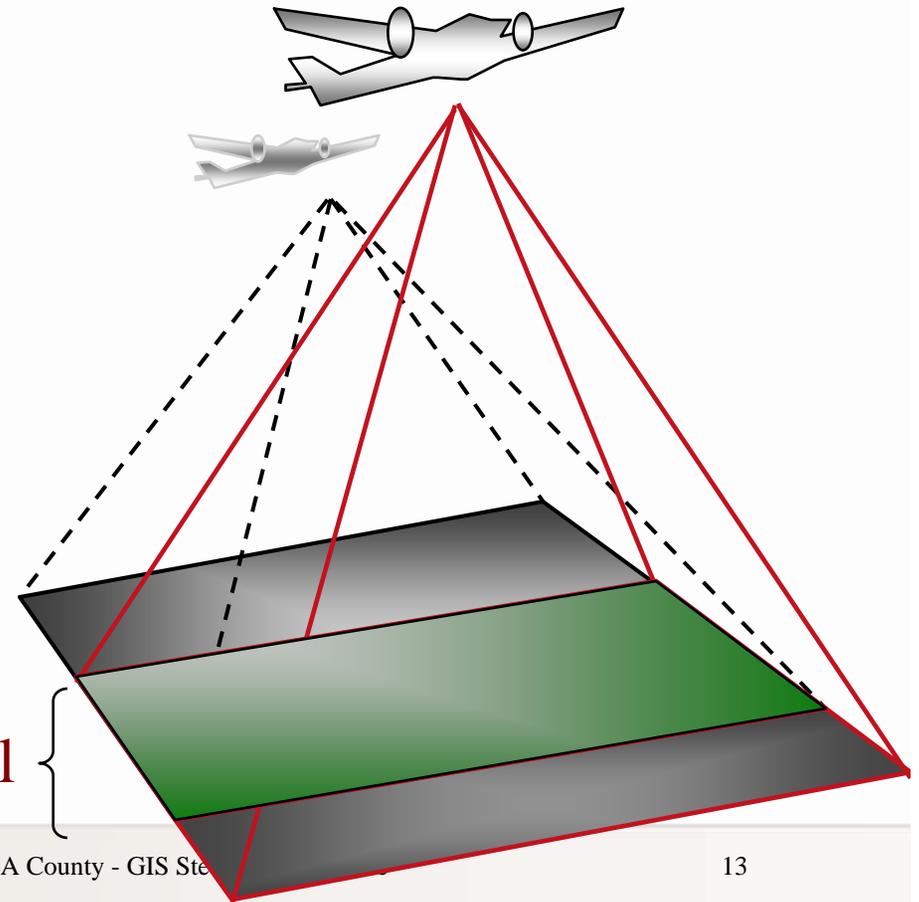


# Characteristics of Stereo Imagery: Data Extraction without Radial Displacement

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- Adjacent images having overlapping coverage of the ground are known as stereo pairs, with the overlapping area known as a stereo model
- Stereo models are viewed in 3D using a photogrammetric stereo plotter
- This method allows for data collection void of radio displacement in elevated features (building lean)
- This method also allows for delineation of feature which may be obstructed by building lean

**Stereo-Model**

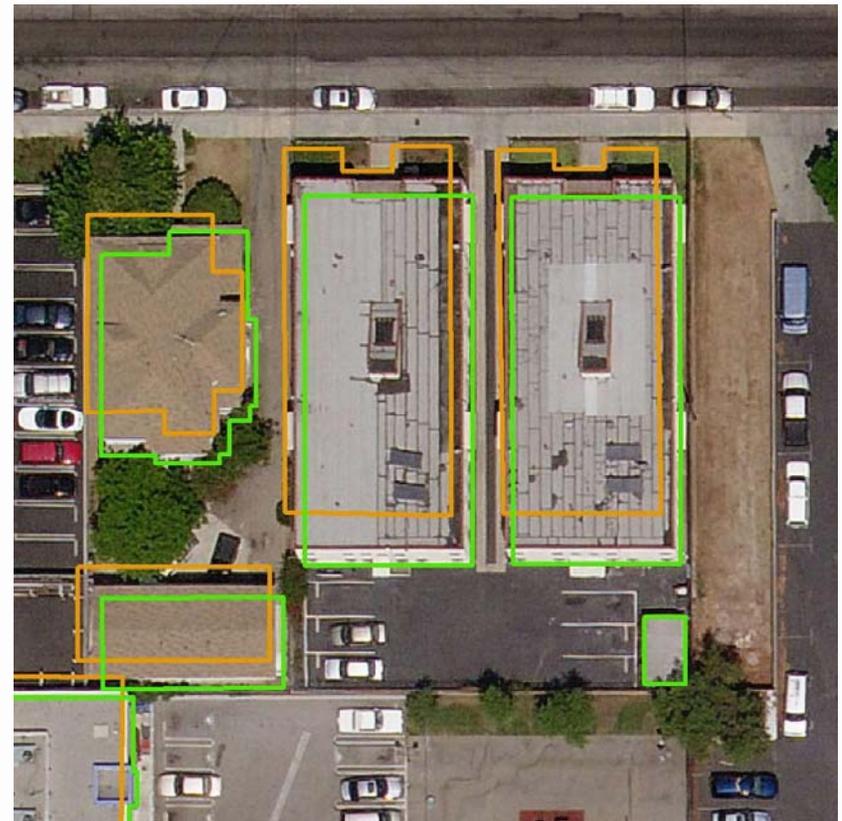


# Data Sample: Stereo Digitizing vs. Ortho Digitizing

- Orange:** Building outline was digitized from 2006 ortho imagery
- Green:** Building outline was digitized from 2007 stereo imagery



2006 Ortho Imagery



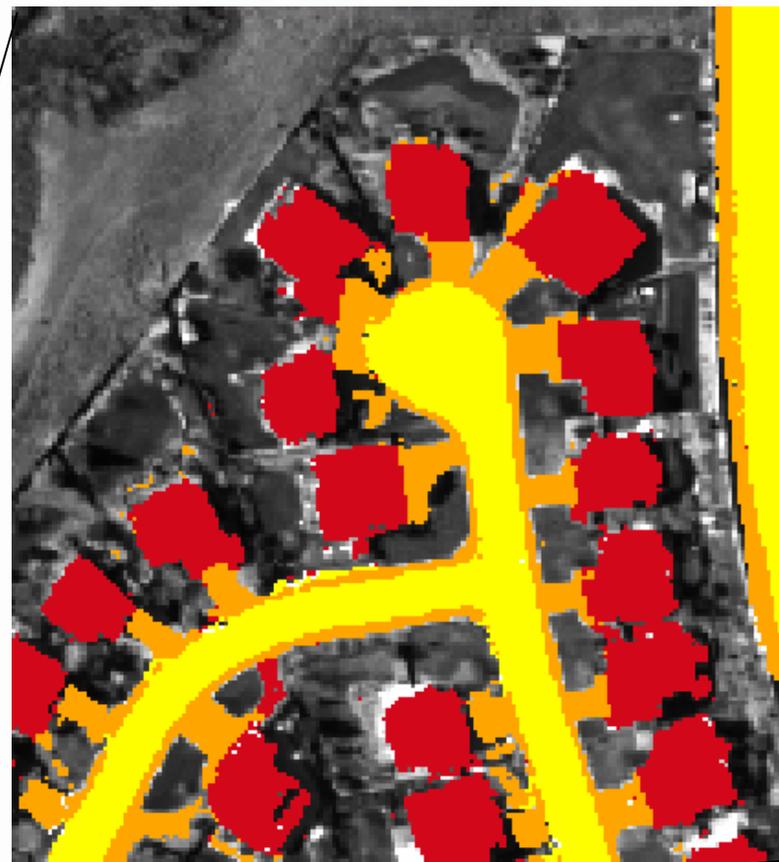
2007 Ortho Imagery  
(LAR-IAC2 Pilot)

# Building Outline Products

## – Products

1. Simple building – raster product
2. Simplified building outline – 2D polygon with no elevation attribution
3. 3D buildings
  - A. Simplified building outline – 2D polygon with elevation attribute
  - B. block style – multiple 2D polygons with elevation attributes
  - C. 3D building architecturally correct – Provided in TIN format and includes slope, dome and other rooftop information
    - i. 3D building with generic textures
    - ii. 3D building with attribute based textures
    - iii. 3D building with photorealistic textures

# Simple Building: Raster



## Method:

# Raster Based Automated Extraction

- Methodology: Using automated feature extraction software, buildings can be collected through the analysis of the existing ortho imagery's color, tone, location, texture, shape, and context.
- Pros
  - Buildings will align with imagery source used for digitizing (radial displacement issue)
- Cons
  - Buildings will not meet map scale accuracy
  - Buildings may not align with future imagery source (radio displacement issue)
  - Does not provide quality polygon geometry
  - Automated methods can not achieve a 98% acceptance rate
  - Inability to detect elevation change
  - Needs significant manual editing



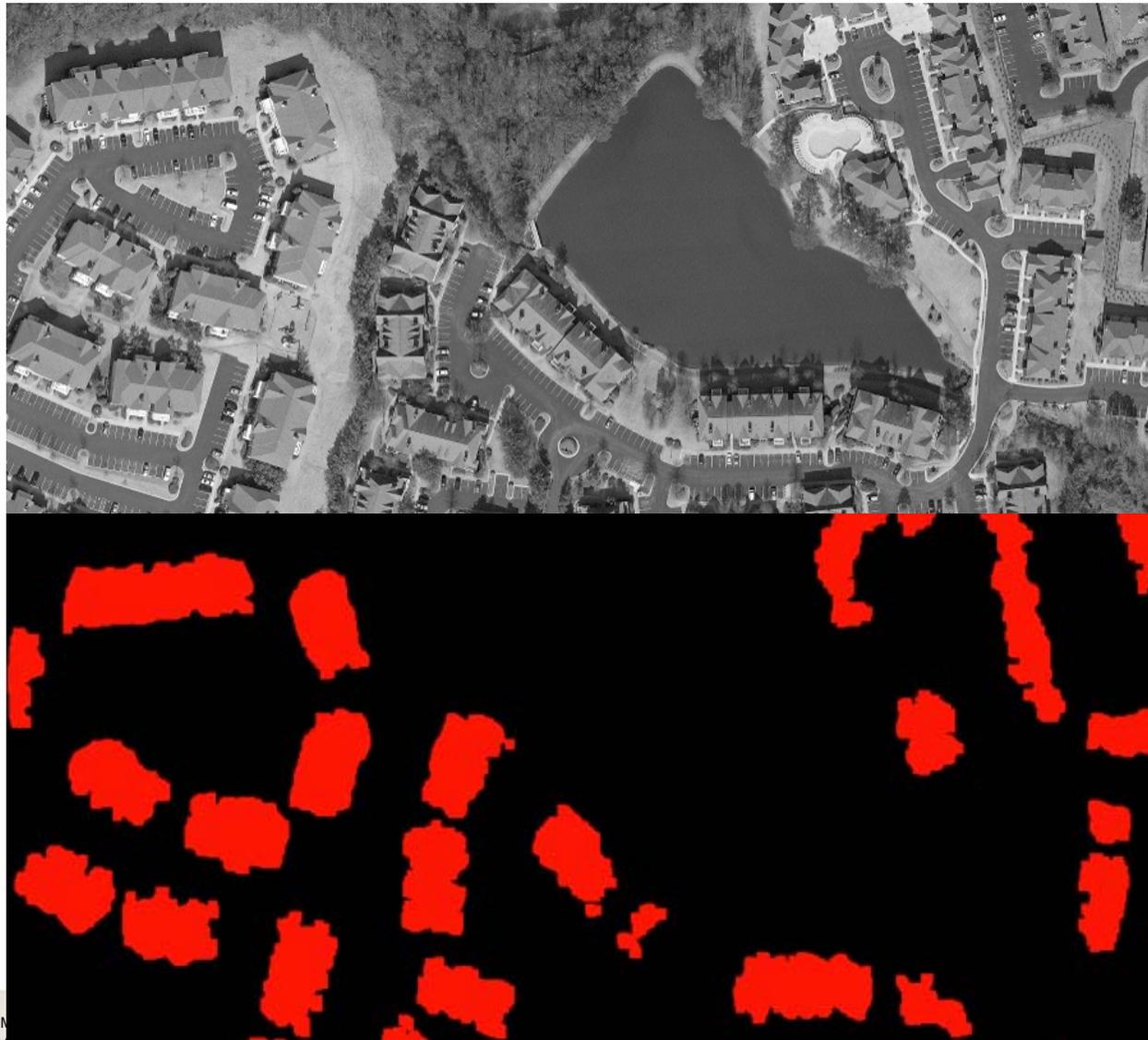
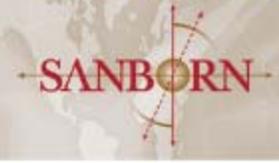
# Simple Building Outline: 2D polygon



## Method: 2D Digitizing from Ortho

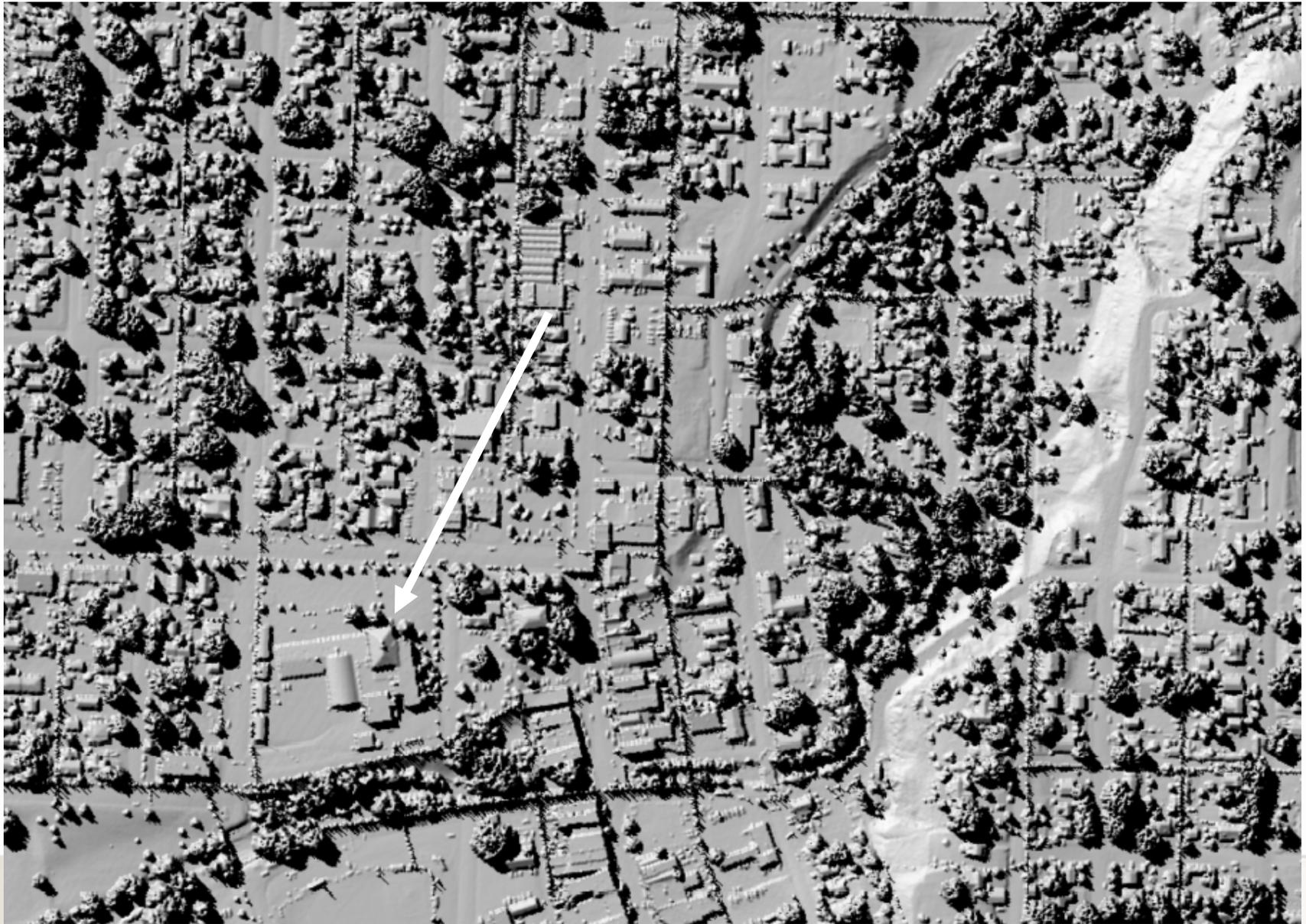
- Methodology: Using the digital ortho imagery a GIS technician can trace the outline of a building based upon the location of the building on the imagery
- Pros
  - Buildings will align with imagery source used for digitizing (radio displacement issue)
  - 10-20% lower cost compared to stereo digitizing
  - Allows for topology corrected vector polygons
- Cons
  - Buildings will not meet map scale accuracy
  - Buildings may not align with future imagery source (radio displacement issue)
  - Delineation of actual outline is much more difficult to distinguish
  - Inability to detect elevation change
  - Needs significant adjustment for right angle

# 2D Building Models: LiDAR Derived

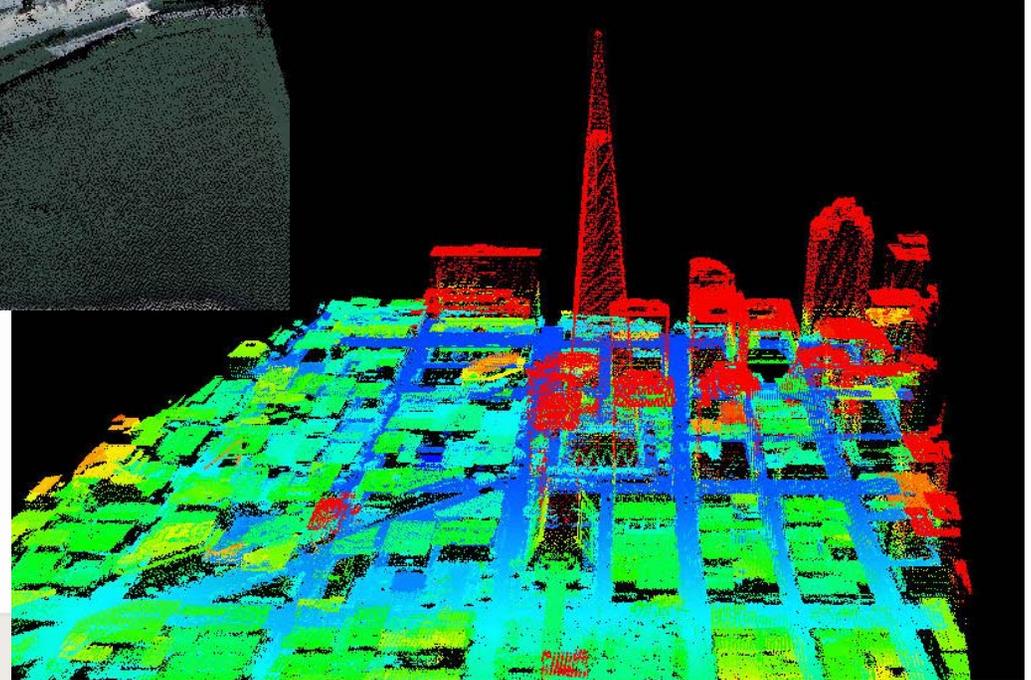
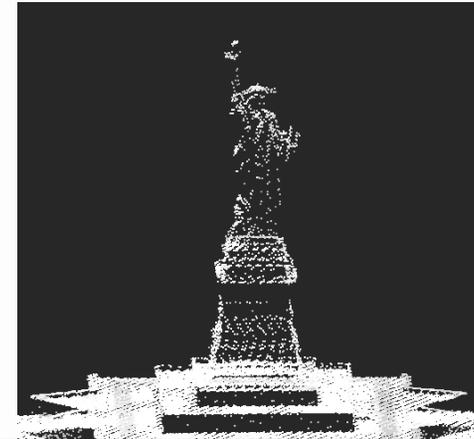
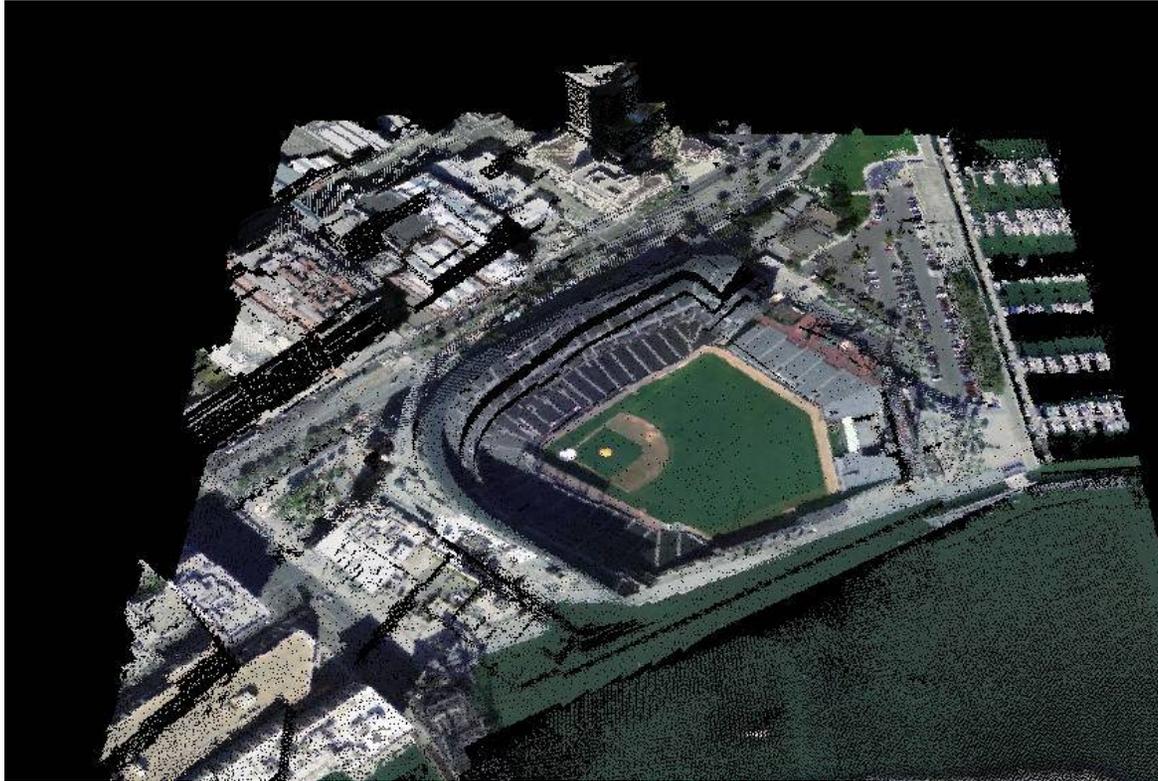


# LiDAR Point Cloud

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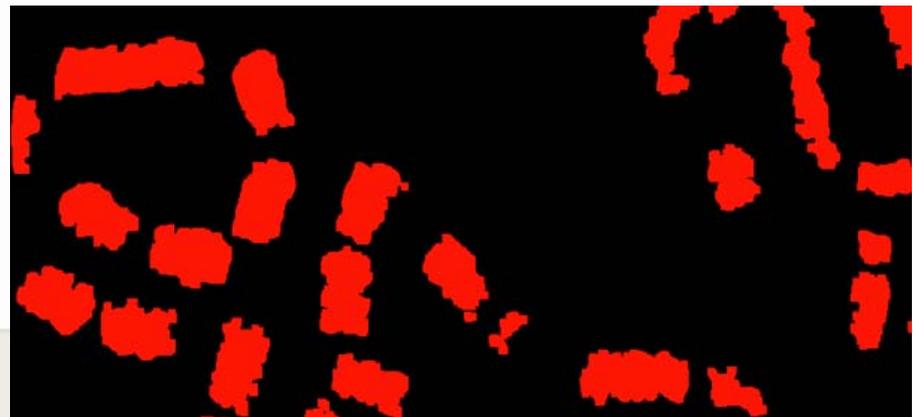
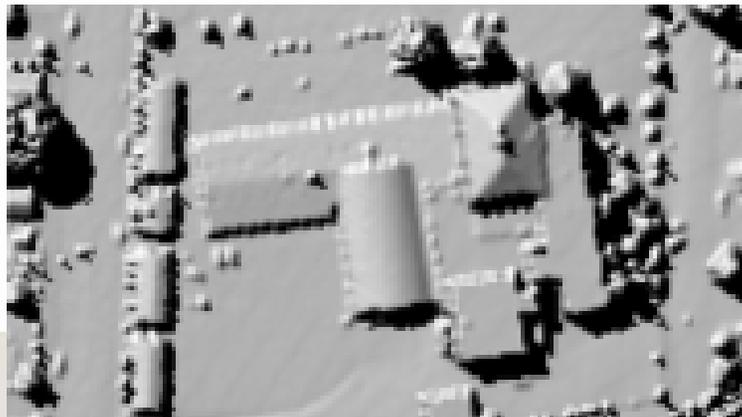
# 3D Building Models: LiDAR Derived



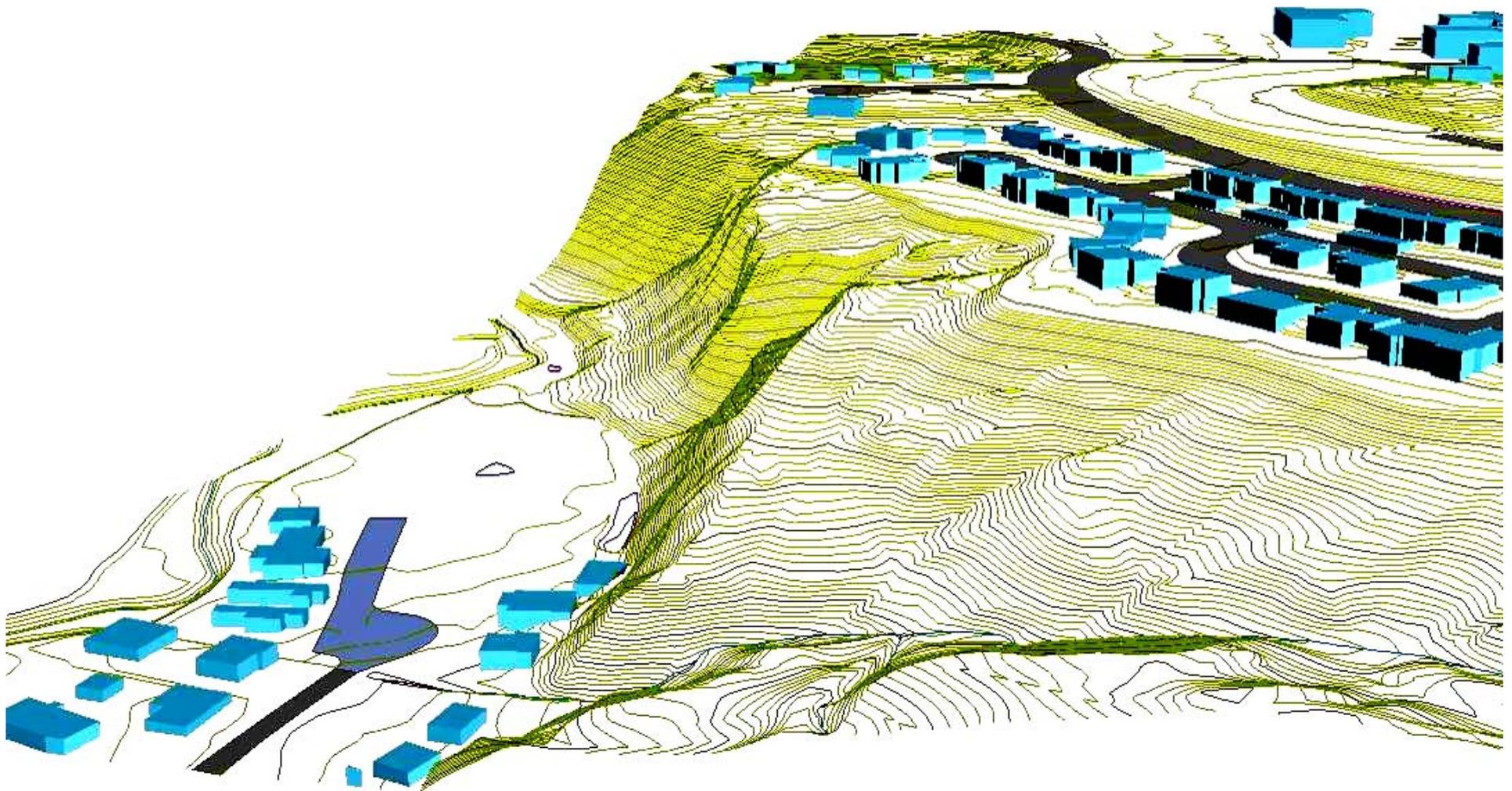
## Method:

# LiDAR Based Automated Extraction

- Methodology: Using the last return data and the “bald earth” surface Sanborn can extract building outlines automatically
- Pros
  - Low Cost (using existing LiDAR)
  - Allows for Elevation Data
  - Will come close to 1”=100’ map scale accuracy
- Cons
  - Mass points do not provide for quality polygon geometry
  - Automated methods can not achieve a 98% acceptance rate

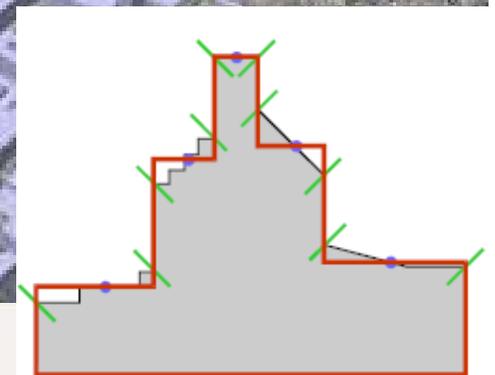
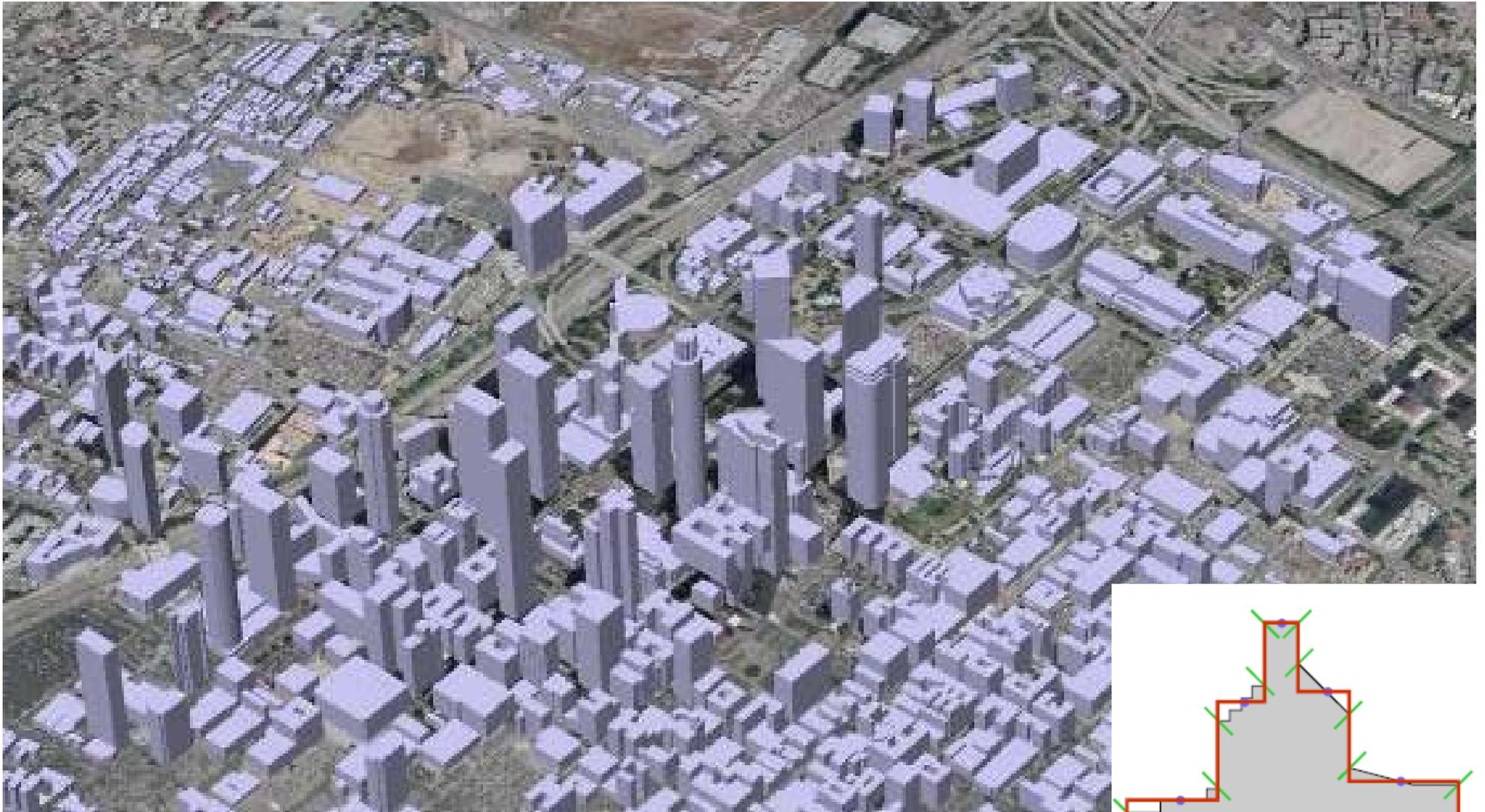


# Simple Building Outline 2D Polygon with Elevation Attribute

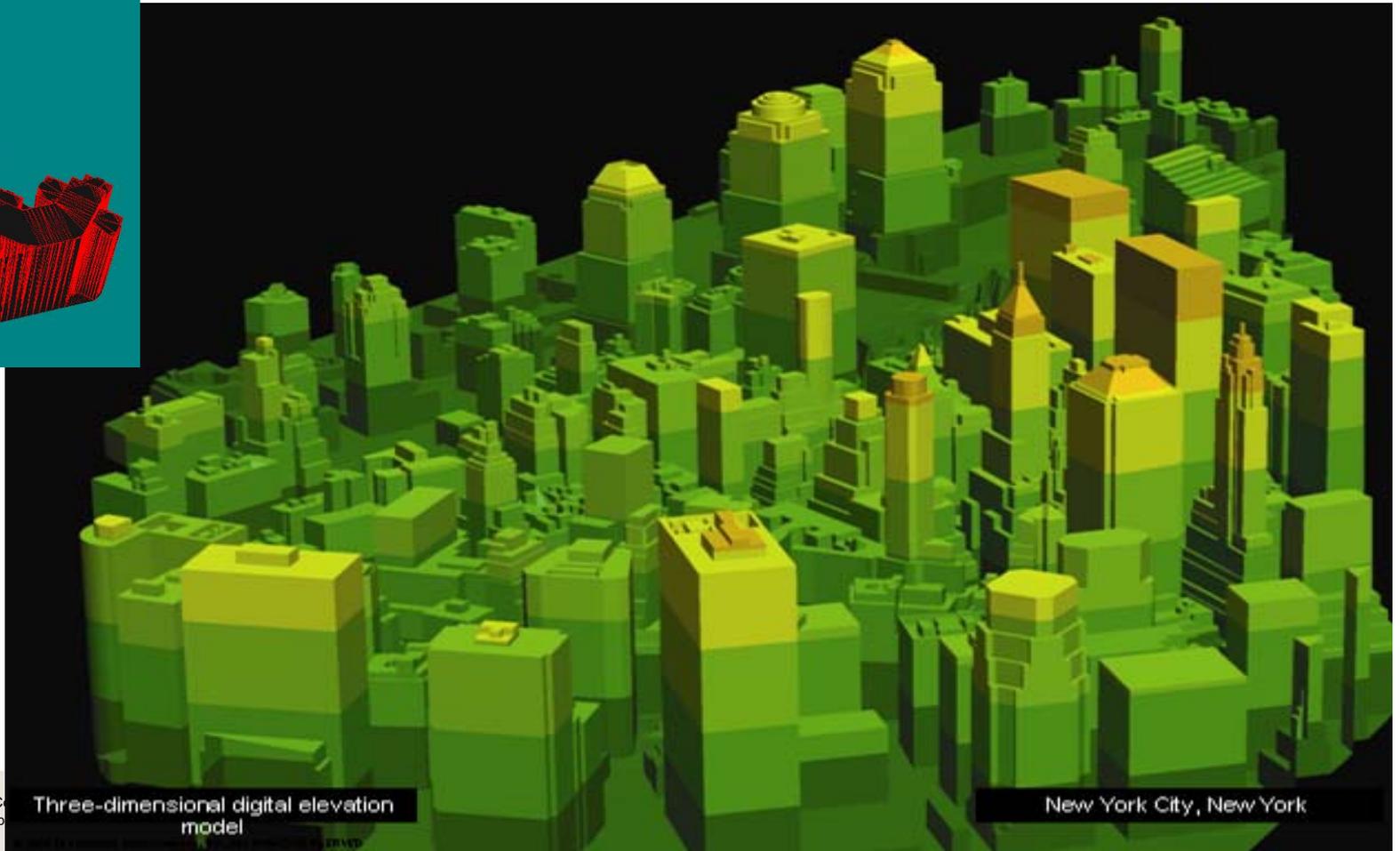
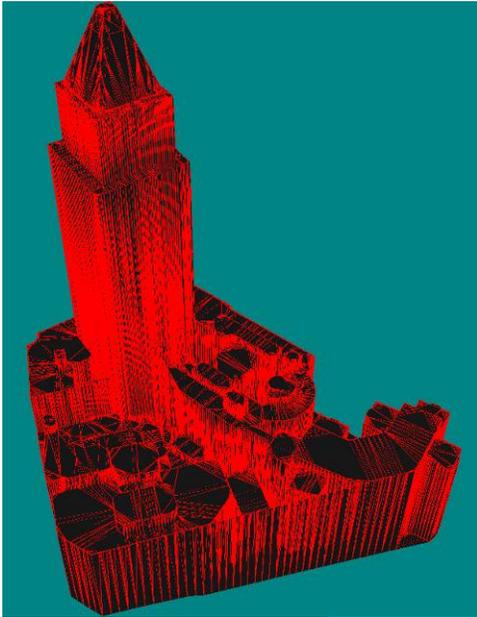


# 3D Building Outline “Block Style”

## Multiple 2D polygons with elevation attribute

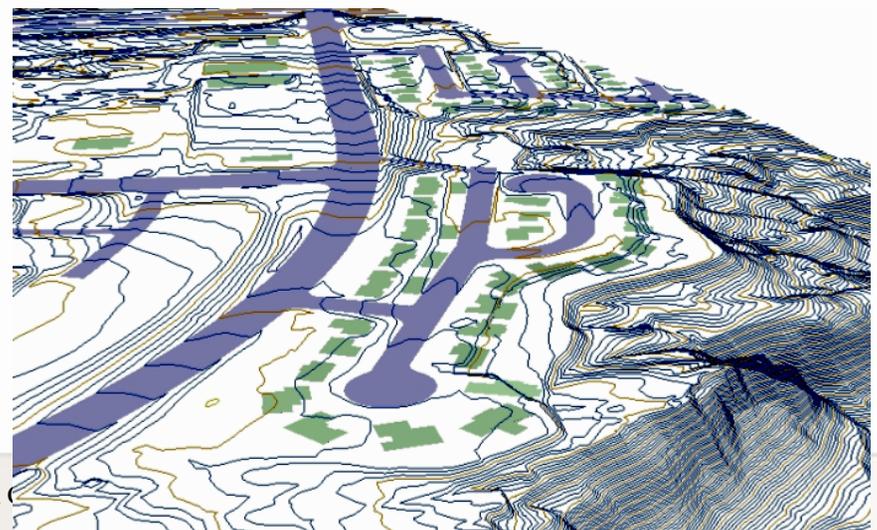


# 3D Building Models (True Architecture): Stereo Image Compiled



# Method: 3D Digitizing from Stereo Imagery

- Methodology: Using the digital stereo imagery a GIS technician can trace the outline of a building based upon the location of the building
- Pros
  - Provides the most accurate method for collection
  - 2008 imagery will allow for 1"=100' map scale accuracy and 1"=200' map scale accuracy (National Forrester)
  - Allows for single point or multi-polygon elevation data
  - Allows for topology corrected vector polygons
- Cons
  - Cost
  - Requires stereo imagery



# Editing and Processing for Polygons (QA/QC)



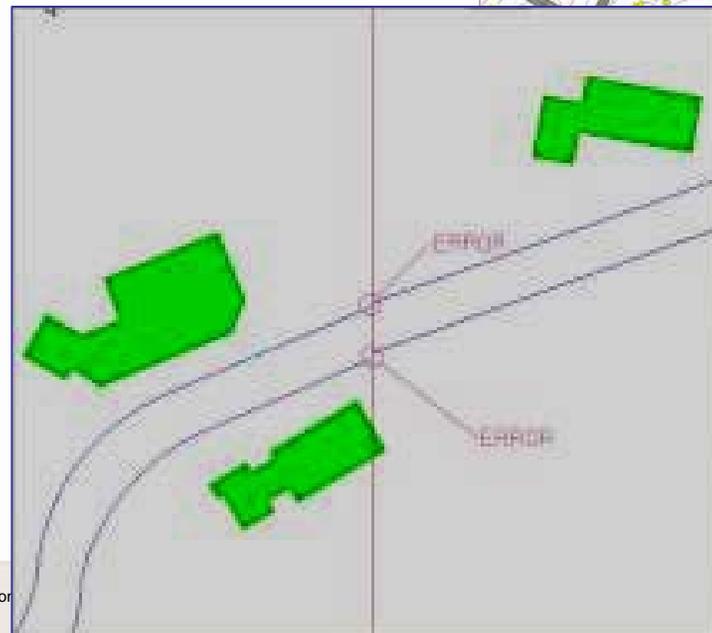
## Automated Topology Vector Checks

- Edge matching
- Point duplication
- Connectivity
- Line quality
- Segmentation
- Point criteria
- Precision
- Line criteria
- Spatial continuity
- Graphic standards



## Other QA/QC Checks

- Attribute domains
- Symbology
- Annotation criteria





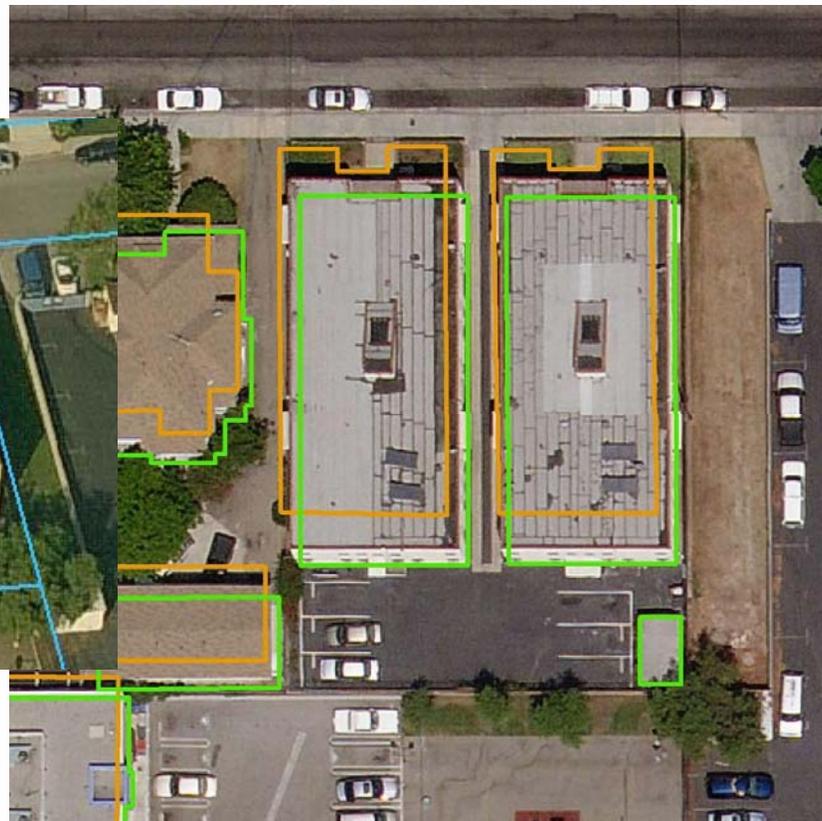
# Building Classification: Photo Identifiable

- Single-Family Building (Residential), Multi-Family Building (Residential)
- Commercial: Building devoted to trade, services, entertainment, cemeteries, and recreational
- Industrial: Building devoted to warehouse, manufacturing, processing, or miscellaneous industrial activity
- Institutional Building: devoted to civic or educational activity
- Mixed Use
- Utility Structures: devoted to transportation, utility or facility housing.
- Mobile Home, Detached Carport, Detached Garage, Out Building
- Tank Canopy (Gas Stations, Banks, RTD Stations)
- Parking Garage (Commercial), Recreational (Parks, Golf Courses)
- Cemetery, Entertainment (Amusement Park, The Coliseum)
- Catwalk or Building Connector, Corridor, Shed, Greenhouse, Under Construction, Uninhabitable, Destroyed, or Demolished, Miscellaneous Structure, Enclosed Courtyard, Non-Building
- Miscellaneous Structures: devoted to an unknown or other use

# Additional Methods for Building Classification Classification: Pictometry Oblique

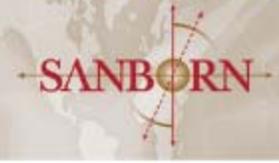


Pictometry Oblique Images



2007 Ortho Imagery  
(LAR-IAC2 Pilot)

# Building Attribution



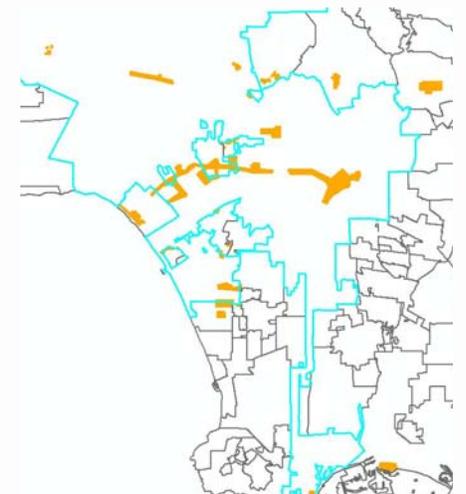
- Object/building id
- Sq. footage (photo identifiable)
- Height of buildings (photo identifiable)
- Number of floors (Derived based upon height)
- Database linkage possibilities
  - Address(es) (linkage to existing geocoded database)
  - APN association with DSO4 attributes table
  - Name of building (City Hall, Museum, Culture Center, etc.)
  - Hazard building
  - Prevailing use (based on classification of buildings)
  - Fire zone
  - Emergency use

# Building Attribution: Database Linkage Issues

- Issues related with adding attributes
  - adding addresses based on integrated processing County address files
  - solving discrepancies among files
  - one building on many parcels
  - multiple building on one parcels
  - legacy addresses not following County rules
  - fragmental addresses (for example: 24 ¼)
  - development of various classifications
- Cooperation with a local firm and County to solve these issues

# Additional Important Issues for Consideration

- All Buildings should have independent BID (building identification number, arbitrary)
- Accepting City's building definition
- Developing update procedures for new and re-developed buildings
- Develop specifications based upon utilization (e.g. zoning regulation, EM routing, solar placement...)
- Schedule of deliveries can be made based upon priorities (incremental delivery areas)
- Identify areas for 3D products



# Building Model Textures



# Building Model Textures



# Recommendations

- Stereo digitizing is more accurate for above ground features (buildings) due to radial displacement (lean)
- Stereo digitizing allows for elevation attribution
- Stereo digitizing allows for True 3D format
- Stereo digitizing allows for a greater percentage of features captured due to hidden areas (caused by building lean)
- Establish Pilot area for ~10,000 buildings to create accurate scope and cost.
- Additional value of base products, Ortho and Oblique imagery can be used by the County or outside vendor to complete quality assessment.



# Project Scope, Budget Estimate and Potential Partners

- La County Project Area Understanding (Source: LA County Estimate)
  - Estimated numbers of building in the LA County: 2,300,000- 3,000,000
  - This is inclusive of “out buildings” (6’ x 6’)
- Approximate Cost Based upon Stereo Digitizing
  - **~\$0.53 per building**
  - Additional fees for classification, attribution and database integration
- Partnership
  - LA County (Contract Mechanism, stereo imagery acquisition and funding)
  - Participants of LAR-IAC2
  - Private/Public Utilities Company (Need data may be able to support with funding)

# 3D Product Cost



3D Products		
Product Level	Description	Estimated Cost (Per Building)
Level 1	Single Polygon with height attribute	\$0.53
Level 2	Multiple polygons with height attribute	\$0.75-\$1.00
Level 3	3D Architectural Form (assumes ~50,000 buildings)	\$1.26 – \$1.75
Level 4	3D Architectural form with generic facade	TBD (low cost)
Level 5	3D Architectural form with library façade	TBD (intermediate)
Level 6	3D Architectural form with image based facade	TBD (most costly)

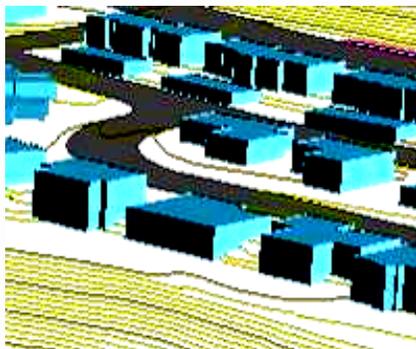


Photo Real Textures

Attribute Based Textures

Generic Textures

# Justification for Building Outlines

*Generally, building polygons would be selected when either visualization needs to take place or when an application is to be used that relies on the building area as a key component. Usually this is some kind of polygon overlay analysis between two sets of polygons (parcels/building, flooded areas/building, vegetation/building, impervious/building, etc).*

## Major Potential Applications

- **County/City Planning** – Provides support for determining setbacks, access, view shed protection, parking requirements, evaluation of FAR, zoning enforcement etc...
- **E911** – Especially for complex urban and suburban routing
- **Taxation** - When put together with parcel and impervious data, specific applications (generally for stormwater) can be built to calculate tax rates based on pervious/impervious area.
- **Risk Analysis** – Buildings can be used with respect to analysis of risk related to fire or flood when combined with other data layers. We have seen these types of analysis recently with respect to wildfire analysis.
- **Utility Planning** – Provide target destination for utility lines
- **Watershed Planning** – Provides data for impervious analysis
- **Visualization** – having a polygon, especially one that is 3D, can help users better visualize the data.

# Testimonials

- Long Beach GIS developed 156,000 building outlines in the late 1980 from stereo pairs.
  - Statement from Long Beach GIS Project Manager, “I do not know any department in our city, which does not use daily building footprints in its GIS operation” September 2007
- Ordnance Survey's national geographic database describes more than 440 million individual features — **such as every house**, road and field. Each year more than a million changes to the British landscape need to be measured and assimilated into this database. This equates to 5,000 changes every day, and it requires efficient planning and control.



# Questions?