# Geospatial, 3D, Visualization and BIM Convergence

## …at the intersection

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# The plan for today …..

- The emerging AND converging 3D/BIM world
  - How?
    - What are the technology drivers and emerging technologies?
  - Why?
    - Beyond the “way cool” effect why is 3D (and visualization) going to be pervasive ? How does 3D add value to BIM
  - Why not 3D ?
    - What are the impediments?
  - The value and challenge of being in the middle
    - e.g. NIST study - $15.8 billion lost to the lack of interoperability - and this is the tip of the iceberg !

# At the "intersection" of emerging technologies

- Mapping
  - Terrestrial surveying
  - GIS
  - Remote sensing
  - Photogrammetry
    - Aerial, terrestrial and close range
  - LiDAR, terrestrial scanning
  - Sensor fusion
  - Geodesy
- CAD and BIM
- Computer science
  - Machine vision
  - Databases
  - Computer graphics
- Gaming
  - MMOGs ……
    - SecondLife
    - FarCry, Worlds of WarCraft
    - Sony Home
- Construction
- Animation

# … and at the intersection of professions and business silos

- Creators
  - Architecture
  - Civil engineering
  - Mapping/surveying/GIS etc
  - Gaming developers
  - … etc
- Consumers
  - Construction management
  - Emergency management
  - Entertainment
  - Asset management
  - Facilities management
  - City management/planning
  - ….etc

# Multiple fields means …

- **Bad news …**
  - Multiple vocabularies, confusion about terms
    - “polygon (e.g. GIS or CAD) “scale” ….
  - Multiple fundamental world views
    - Confusion and conflict
  - Difficult to change “business as usual” for current players
- **Good news**
  - Opportunities for disintermediation
  - Money to be made and savings to be had ….
  - Entirely new businesses to be created

# Interoperability value chain …

Interoperability

- Ontology
- Semantics
- Standards and specifications

Leads to interoperable systems

- Software
- Databases

Leads to seamless

- Design, construction, operations, maintenance, management

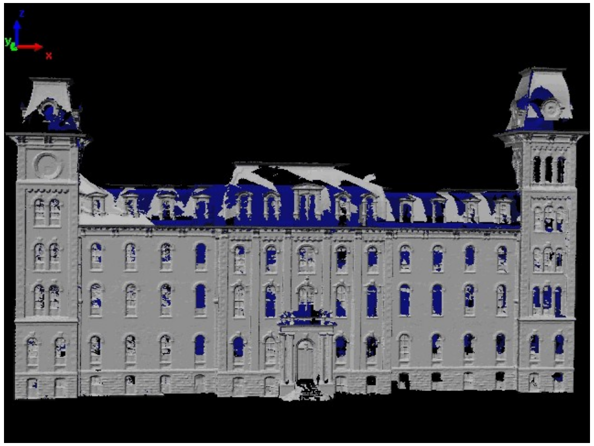
Leads to

- increased efficiency, cost savings, time to objective

# Abstraction

- Mensuration professions move from "real world" to an abstraction of the real world
  - Survey, GIS, photogrammetry, etc..

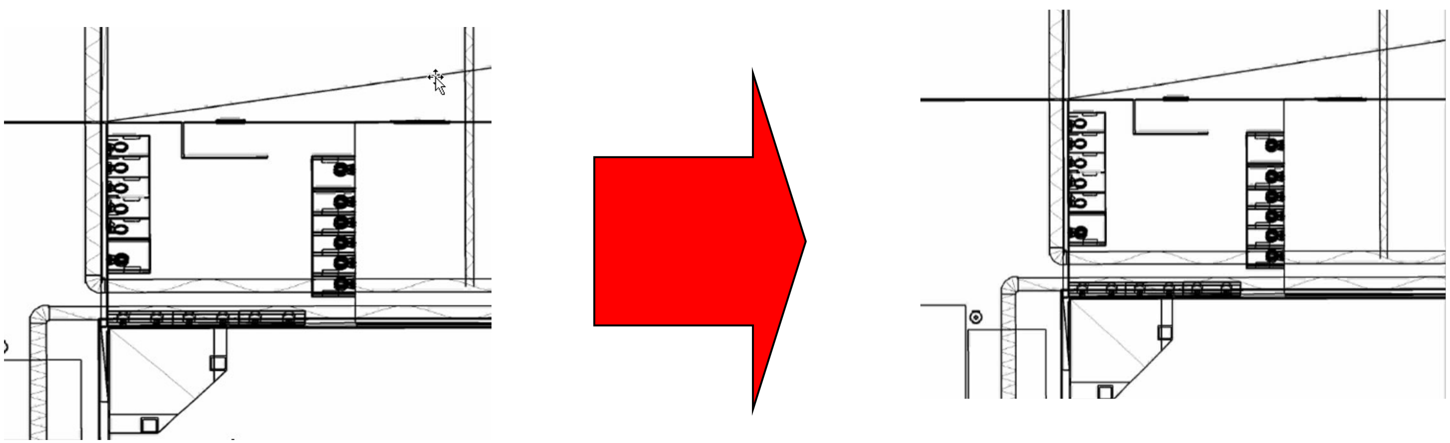
"real world"



"idea"

# In contrast …

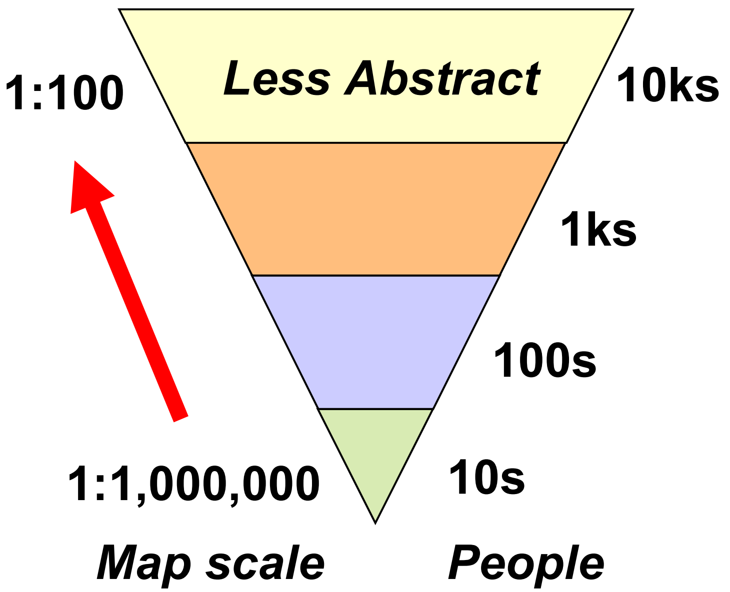
- Design professionals move from the abstract (an idea) to the real world

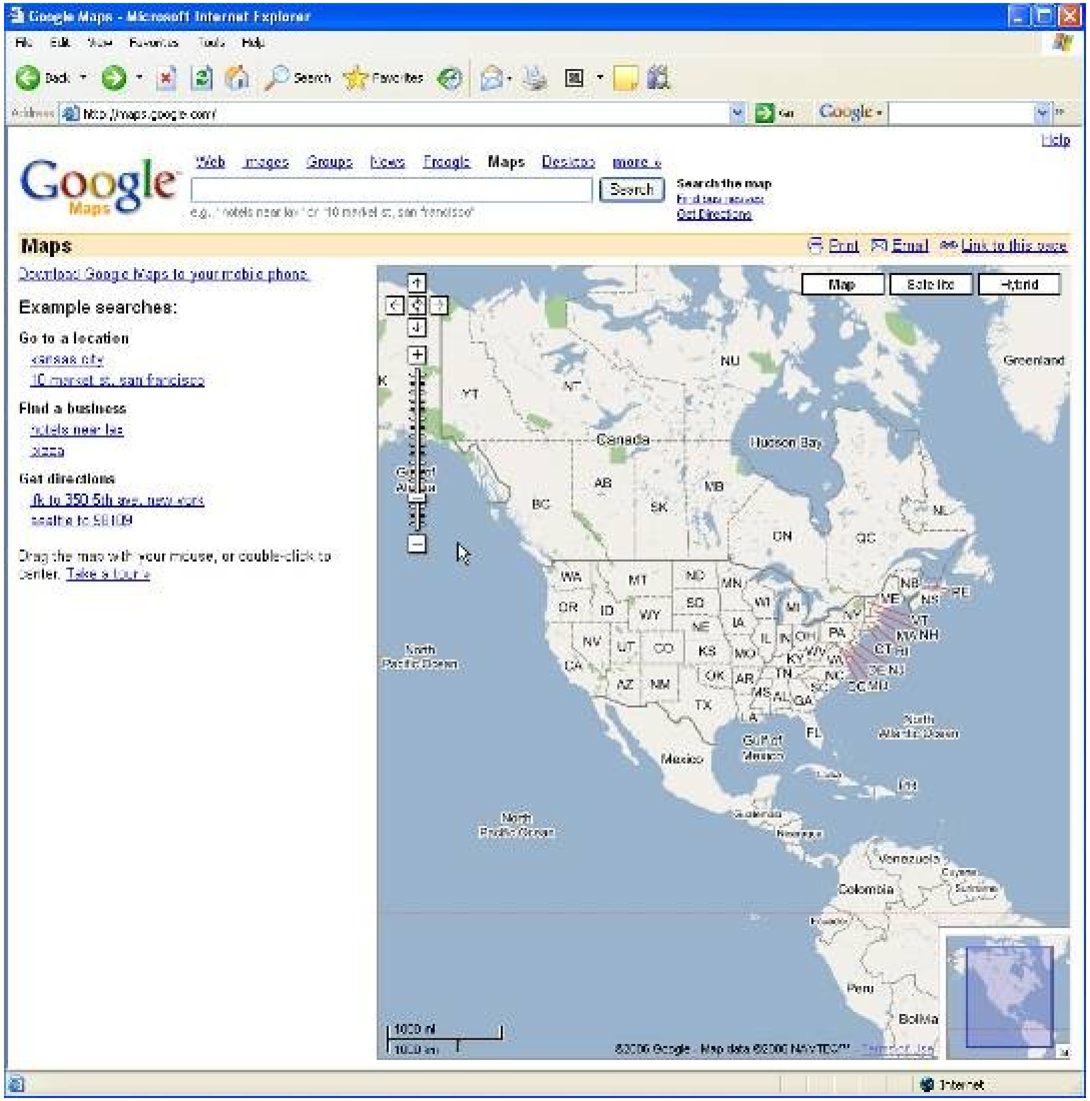


**"idea"** **"real world"**

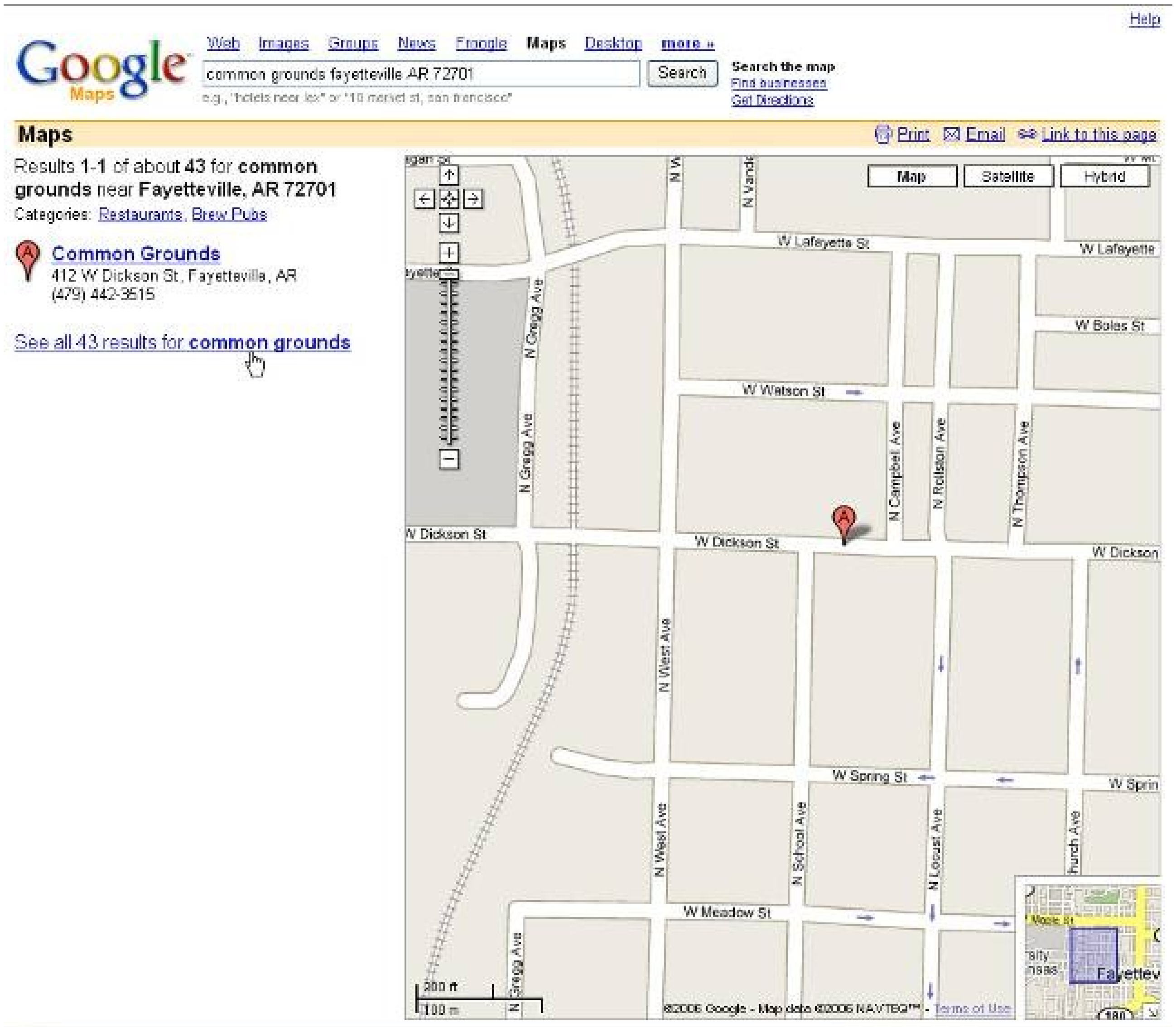
# "Mapping" and abstraction

- Geospatial and mapping professions think in "map scale" (1:12,000)
  - BTW hardly anyone else does!
- The larger the scale the LESS the abstraction
- Conversion from an abstraction to the "real world" is learned
- The less the abstraction the MORE people understand!!!






**maps.google.com**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Web Images Groups News Froogle Maps Desktop more »
Google Maps
common grounds fayetteville AR 72701
Search
Search the map
Find businesses
Get Directions
Maps
Print Email Link to this page
Results 1-1 of about 43 for common grounds near Fayetteville, AR 72701
Categories: Restaurants, Brew Pubs
Common Grounds
412 W Dickson St, Fayetteville, AR
(479) 442-3515
See all 43 results for common grounds
Map Satellite Hybrid
W Lafayette St
W Lafayette
W Boles St
W Watson St
N Gregg Ave
N Campbell Ave
N Rollston Ave
N Thompson Ave
W Dickson St
W Dickson St
W Dickson
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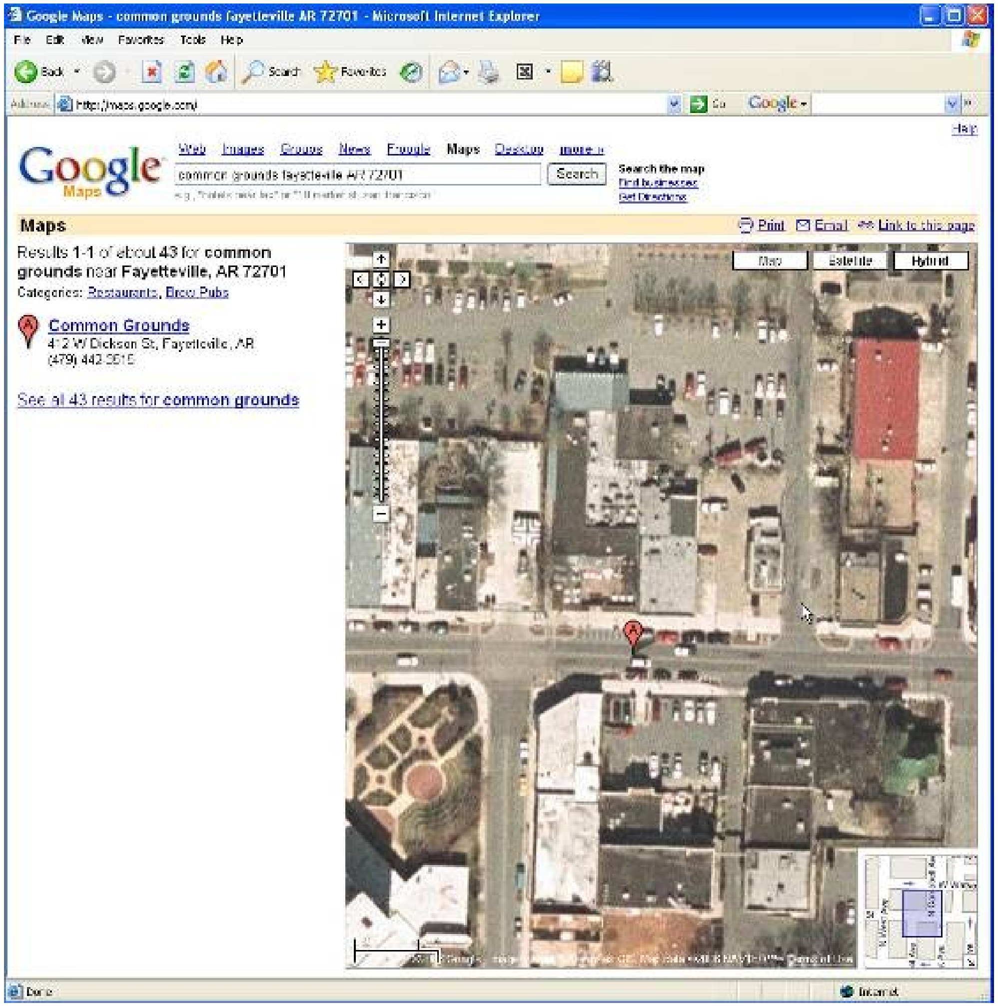
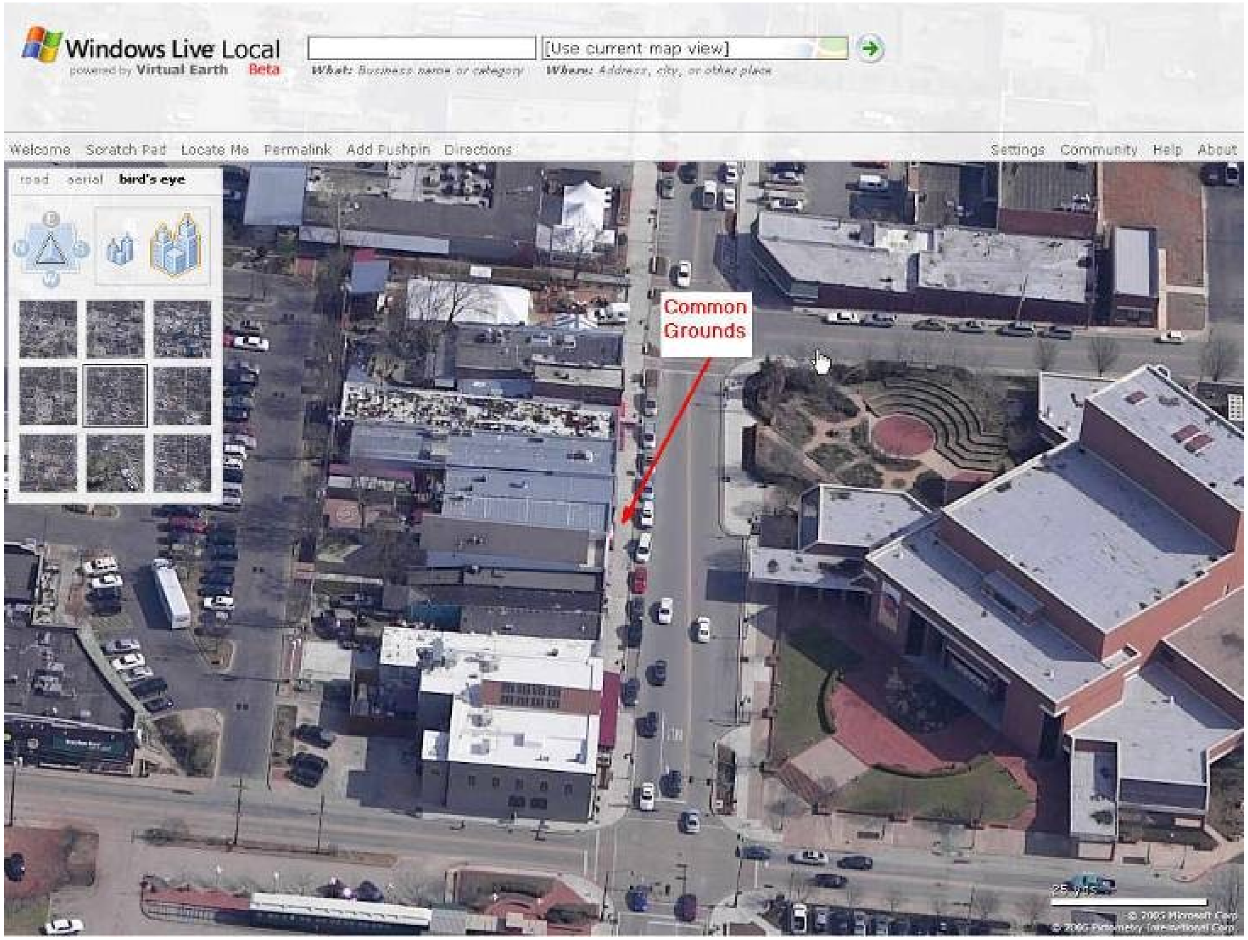
N Locust Ave
W Meadow St
200 ft
100 m
©2006 Google - Map data ©2006 NAVTEQ™ - Terms of Use




***Digital Globe imagery originally acquired by City of Fayetteville***




**Oblique photography**

**Less abstract than orthos…**

**live.local.com**
**Pictometery**

***Picotmetry imagery initially acquired by NW Arkansas Imagery Consortium***

# Verisimilitude vs scale

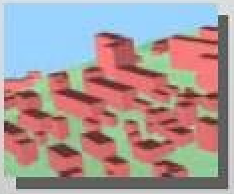
- Verisimilitude - the level of visual reality in a visualization -- “how real is it?”
- No ready relationship between some measure of verisimilitude and the image
- Terms coming into practice
  - Level of detail
  - related to but different from “scale”

# Level of Detail

- Thomas Kolbe and Gerhard Groger
  - Institute for Cartography and Geoinformation Univ. of Bonn
- David Colleen et al Planet 9 ( www.planet9.com)
- Basic concerns in 3D graphics – speed!
  - Number of polygons!
  - Use of texture

## Multi-scale modelling: 5 level of details

- LOD 0 – Regional model
  - 2.5D Digital Terrain Model
- LOD 1 – City / Site model
  - “block model“ w/o roof structures
- LOD 2 – City / Site model
  - textured, differenciated roof structures
- LOD 3 – City / Site model
  - detailed architecture model
- LOD 4 – Interior model
  - “walkable“ architecture models



| Item | DCD0 | DCD1 | DCD2 | DCD3 | DCD4 |
|---|---|---|---|---|---|
| Texture Resolution | 1m. | 50cm. | 25cm. | 10cm. | 5cm. |
| Building Detail | 10m. | 5m. | 1m. | 50cm. | 10cm. |
| Street Detail | Flat | Curbs | Curbs | Curbs | Curbs & Cuts |
| Landscaping Detail | | | | | |
| Trees | Bill-board | x-trees | x-trees | x-trees with Trunk | Poly-gonal |
| Shrubs | | | Scrim | x-Bush | xx |
| Topo Features | | | Slight | xx | xx |
| Pathways | | | Major | All | All w/ Curbs |
| Fountains | | Bill-board | Bill-board with Base | Poly-gonal | Poly-gonal |
| Statues | | Bill-board | Bill-board with Base | Poly-gonal | Poly-gonal |
| Walls & Steps | | Basic | with Ramps | with Ramps | with Steps |
| Street Furniture Detail | | | | | |
| Traffic Signs | | | Yes | Yes | Yes |
| Traffic Signals | | Yes | Yes | Yes | Yes |
| Street Signs | | Gen-eric | Read-able | Read-able | Read-able |
| Waste Receptacles | | | | Yes | Yes |
| Benches | | | | Yes | Yes |

Fig. 11 DCD0 – Virtual Palo Alto ™

Fig. 12 DCD1 – Virtual Washington DC ™

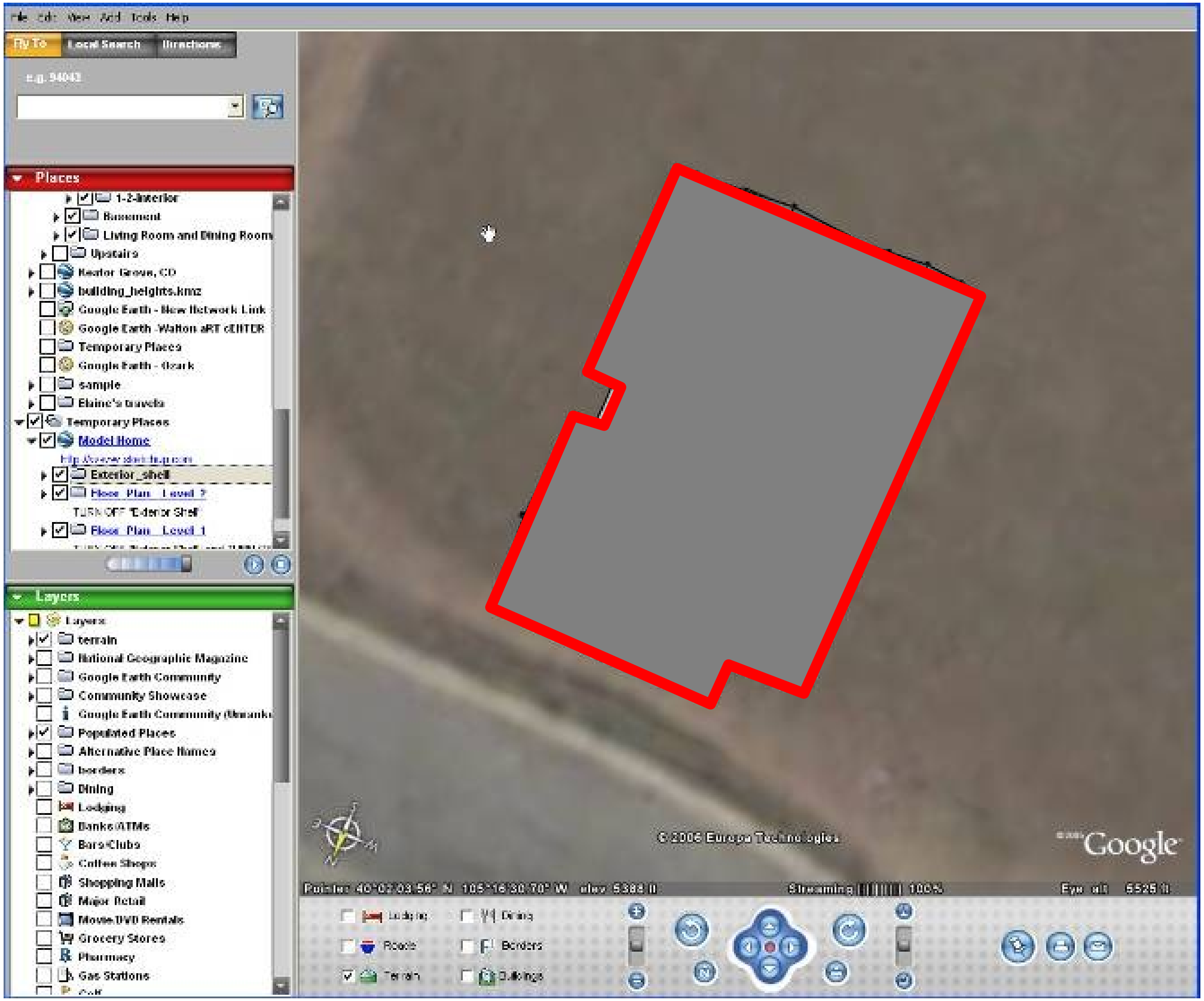
Fig. 13 DCD2 – Virtual San Diego ™

Fig. 14 DCD3 – Virtual San Francisco ®

Fig. 15 DCD4 – Virtual Oakland ™

**BUILDING HIGH RESOLUTION CITY MODELS.... EVOLVING STANDARDS**

David Colleen et al IMAGE 2005 Conference



File Edit View Add Tools Help
Fly To
Local Search
Directions
e.g. 94043
Places
1-2-Interior
Basement
Living Room and Dining Room
Upstairs
building_heights.kmz
Google Earth - New Network Link
Google Earth -Walton aRT cENTER
Temporary Places
Google Earth - Ozark
sample
Elaine's travels
Temporary Places
Model Home
Exterior_shell
Floor_Plan_Level_2
TURN OFF Exterior Shell
Floor_Plan_Level_1
Layers
Layers
terrain
National Geographic Magazine
Google Earth Community
Community Showcase
Populated Places
Alternative Place Names
borders
Dining
Lodging
Banks/ATMs
Bars/Clubs
Coffee Shops
Shopping Malls
Major Retail
Movie/DVD Rentals
Grocery Stores
Pharmacy
Gas Stations
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Google
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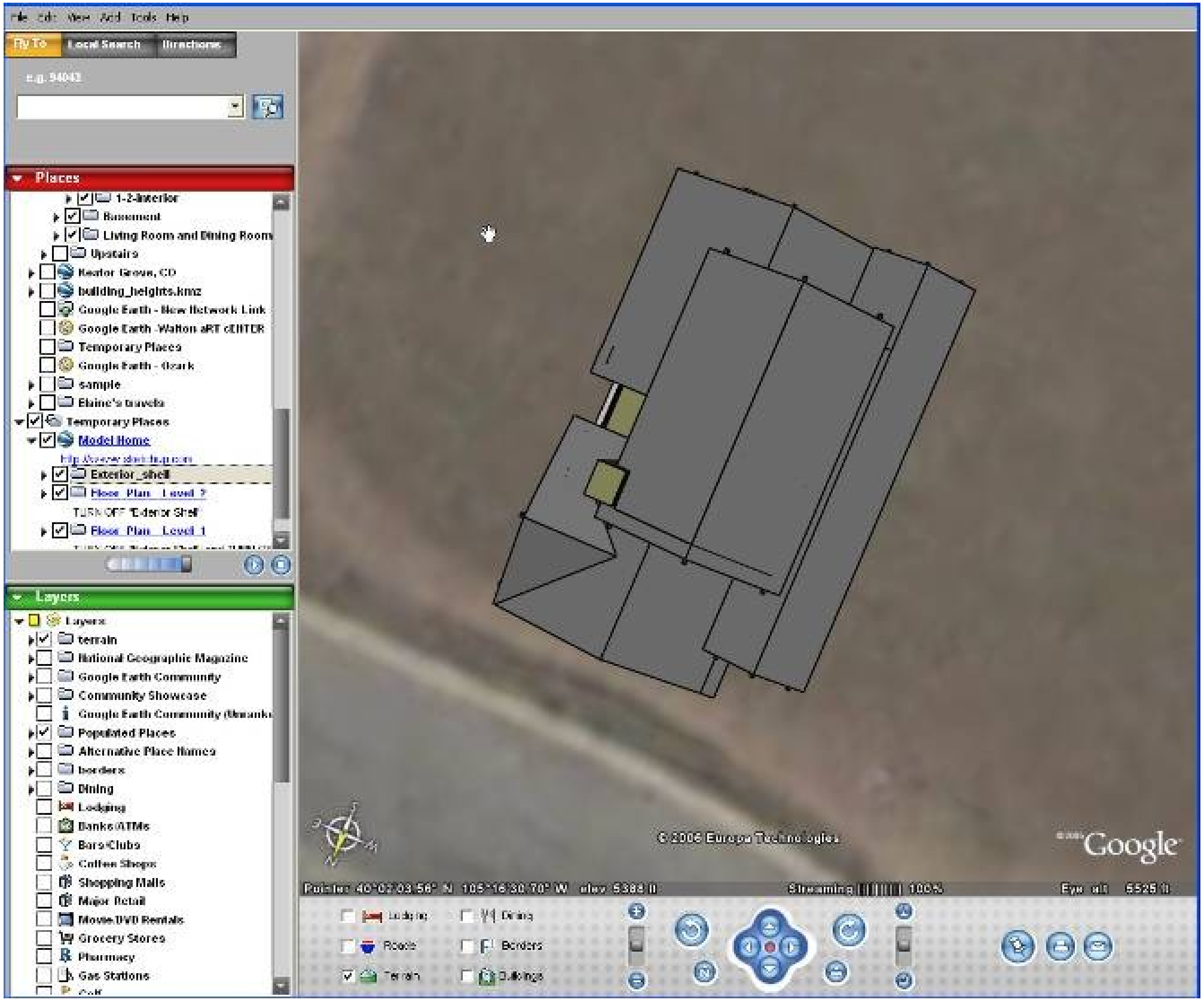
Lodging
Dining
Roads
Borders
Terrain
Buildings


File Edit View Add Tools Help
Fly To
Local Search
Directions
Places
Basement
Living Room and Dining Room
Upstairs
building_heights.kmz
Temporary Places
sample
Model Home
Exterior_shell
Floor Plan Level 2
Floor Plan Level 1
Layers
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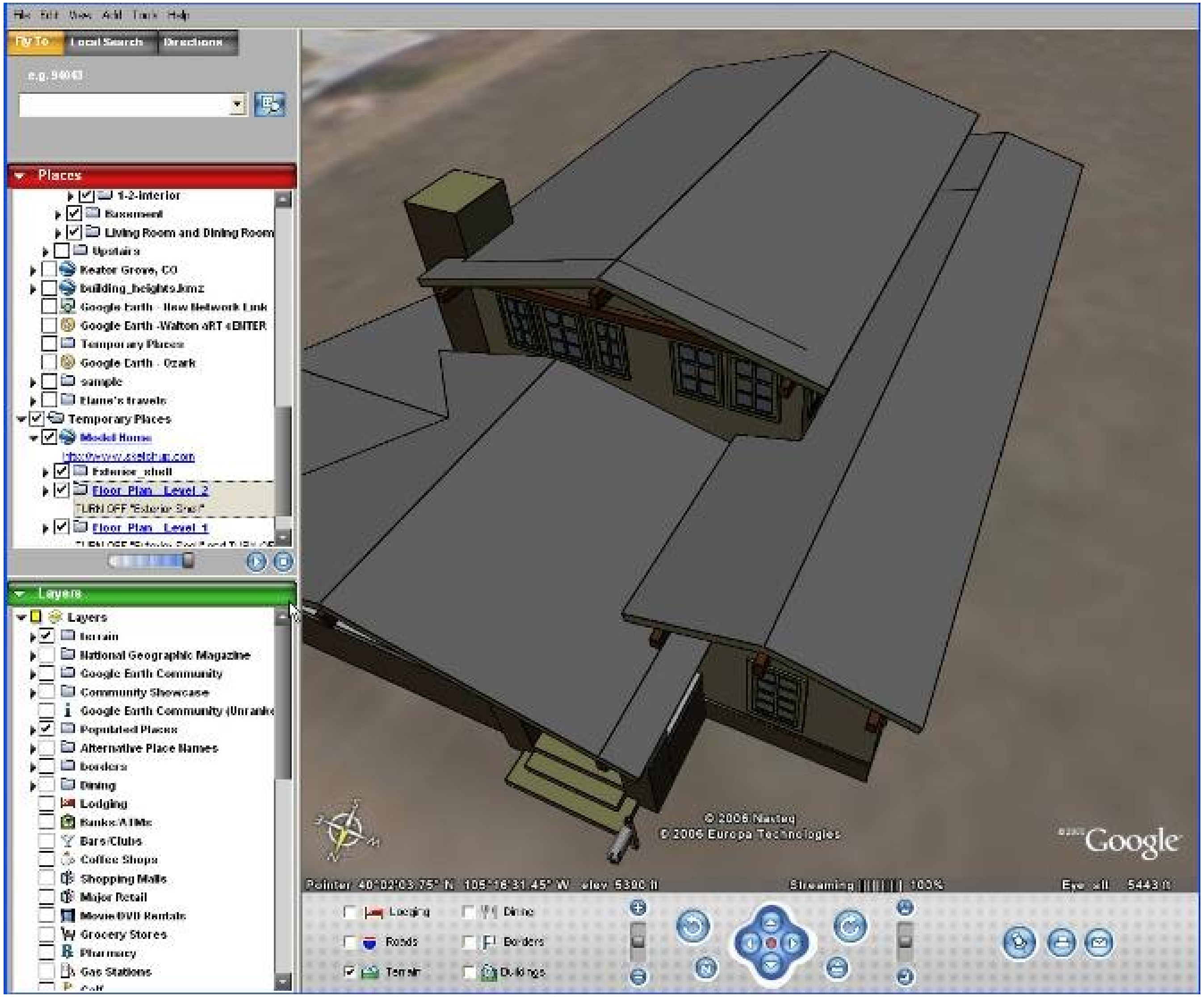
Streaming
100%
Lodging
Dining
Roads
Borders
Terrain
Buildings


**Sketchup to Google Earth**

**www.sketchup.com**



File Edit View Add Tools Help
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Dining
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Grocery Stores
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Google
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Lodging
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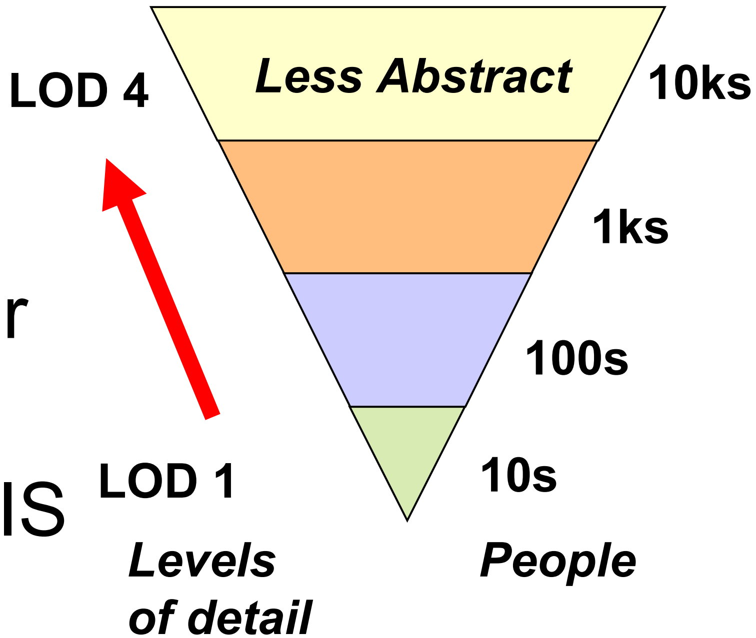
Roads
Borders
Terrain
Buildings

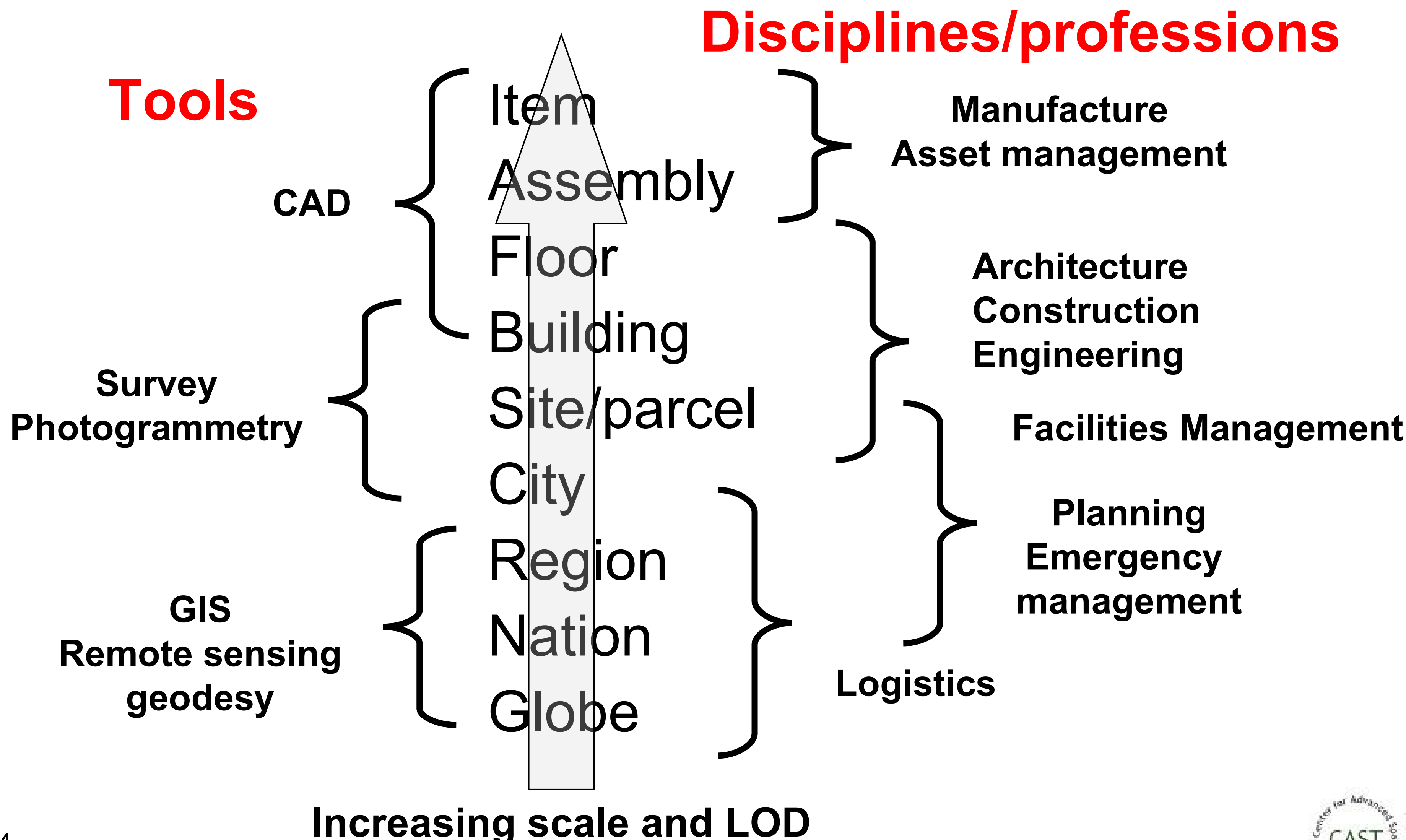
# More LOD = more interest

- Accuracy "versus" verisimilitude
  - Requirement for accuracy contradicts requirement for verisimilitude
  - More polygons (CAD or GIS types)
    - more accuracy
    - less performance

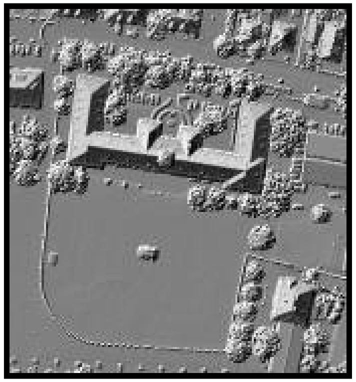


# Design professionals

- Increasing verisimilitude
- Plans that are “understood” but only by limited number of professionals
- 3D visualizations that are understood by many

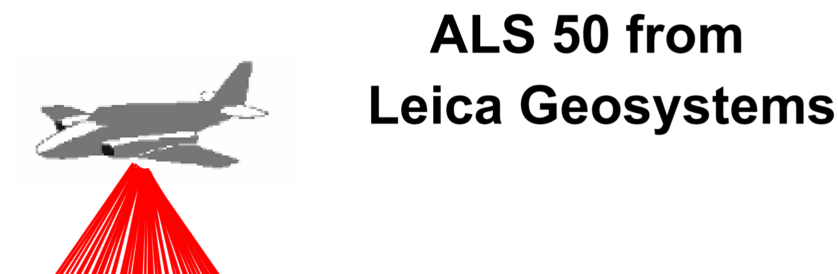
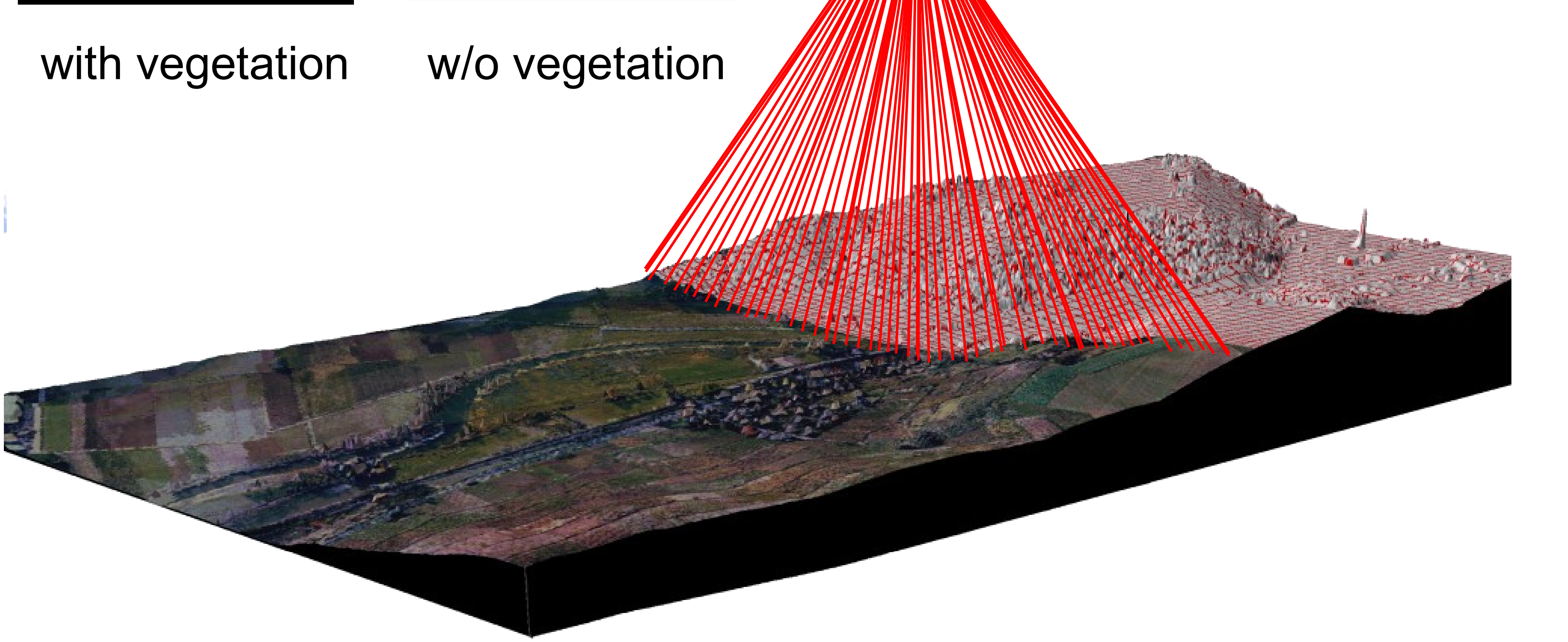

Disciplines/professions
Tools
Item
Assembly
Floor
Building
Site/parcel
City
Region
Nation
Globe
CAD
Survey
Photogrammetry
GIS
Remote sensing
geodesy
Manufacture
Asset management
Architecture
Construction
Engineering
Facilities Management
Planning
Emergency
management
Logistics
Increasing scale and LOD

# Examples of some mensuration methods

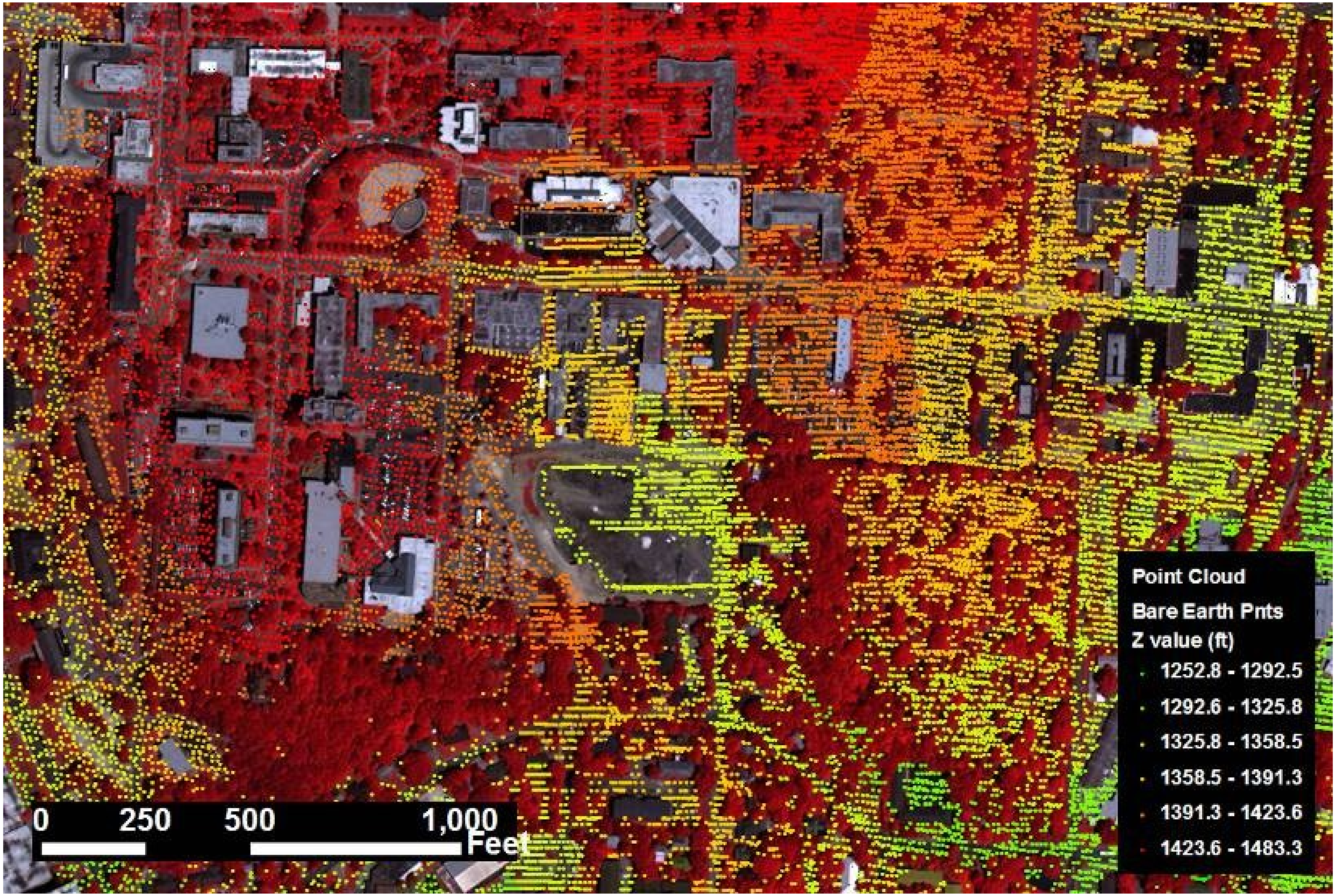


with vegetation

w/o vegetation

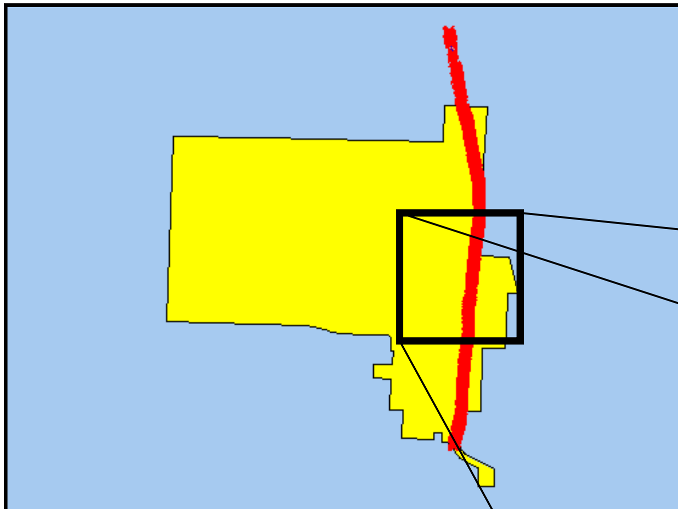

# Airborne Laser Scanning – fast digital terrain data


Point Cloud
Bare Earth Pnts
Z value (ft)
1252.8 - 1292.5
1292.6 - 1325.8
1325.8 - 1358.5
1358.5 - 1391.3
1391.3 - 1423.6
1423.6 - 1483.3
0 250 500 1,000
Feet

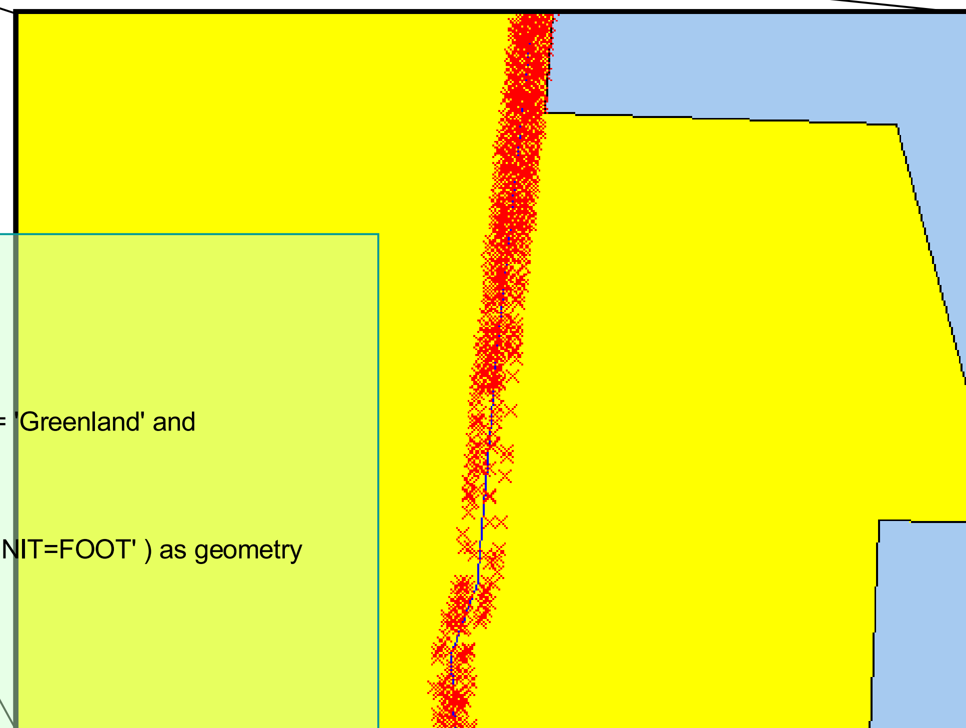
Oracle Center of Excellence in Spatial Data Management

# Manipulating Airborne LIDAR Returns

- Oracle 10g and 11g Spatial (SDO geometries)
- Enable analytical work with raw data (all returns and breaklines)
- Classification aided by existing vector geometry
  - Coordinate system transformations handled in the database
  - All spatial operators available
- Fast retrieval and aggregation based on combination of geometry and attributes
- SDO_NN (*n* nearest neighbors) and SDO_WITHIN_DISTANCE operators enable filtering operations



Extract all “surface” returns within 50ft of all railroad tracks through the city of Greenland, AR from data set of 200 million



```
SELECT a.geometry
  FROM city_limits2003_ahtd a
  WHERE a.city_name = 'Greenland'

SELECT a.geometry
FROM railroads_tig99 a, city_limits2003_ahtd b WHERE b.city_name = 'Greenland' and
SDO_RELATE(a.geometry,b.geometry,
        'mask=ANYINTERACT') = 'TRUE'
SELECT SDO_CS.TRANSFORM(a.geometry,8265) FROM beaver a,
    (SELECT SDO_GEOM.SDO_BUFFER(a.geometry,50.0, 0.0005,  'UNIT=FOOT' ) as geometry
      FROM railroads_tig99 a, city_limits2003_ahtd b
      WHERE b.city_name = 'Greenland' and
SDO_ANYINTERACT(a.geometry,b.geometry) = 'TRUE') b WHERE
SDO_ANYINTERACT(a.geometry,b.geometry) = 'TRUE';
```

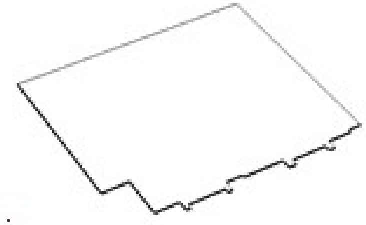
**RETURN COUNT: 4579**


Full return information allows more detailed analysis.

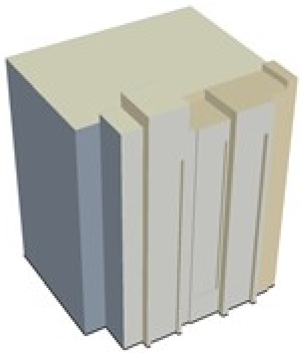
Blue = last returns
Red = first returns

Existing geometries may be used in the classification process.

For example, building heights may be estimated from building returns and surround ground returns.

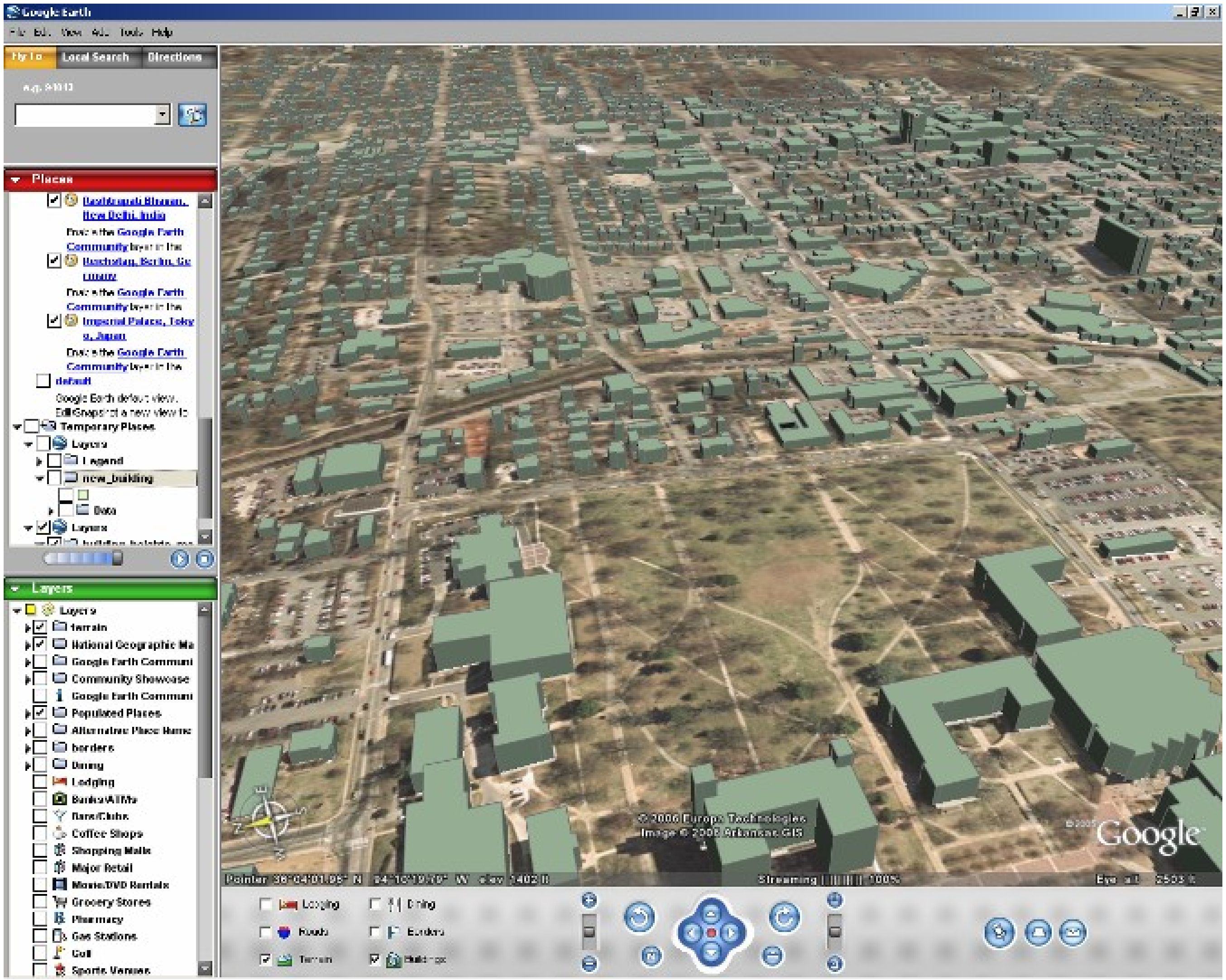


**Start with building foot print from City of Fayetteville GIS**



**Use LiDAR to determine height**

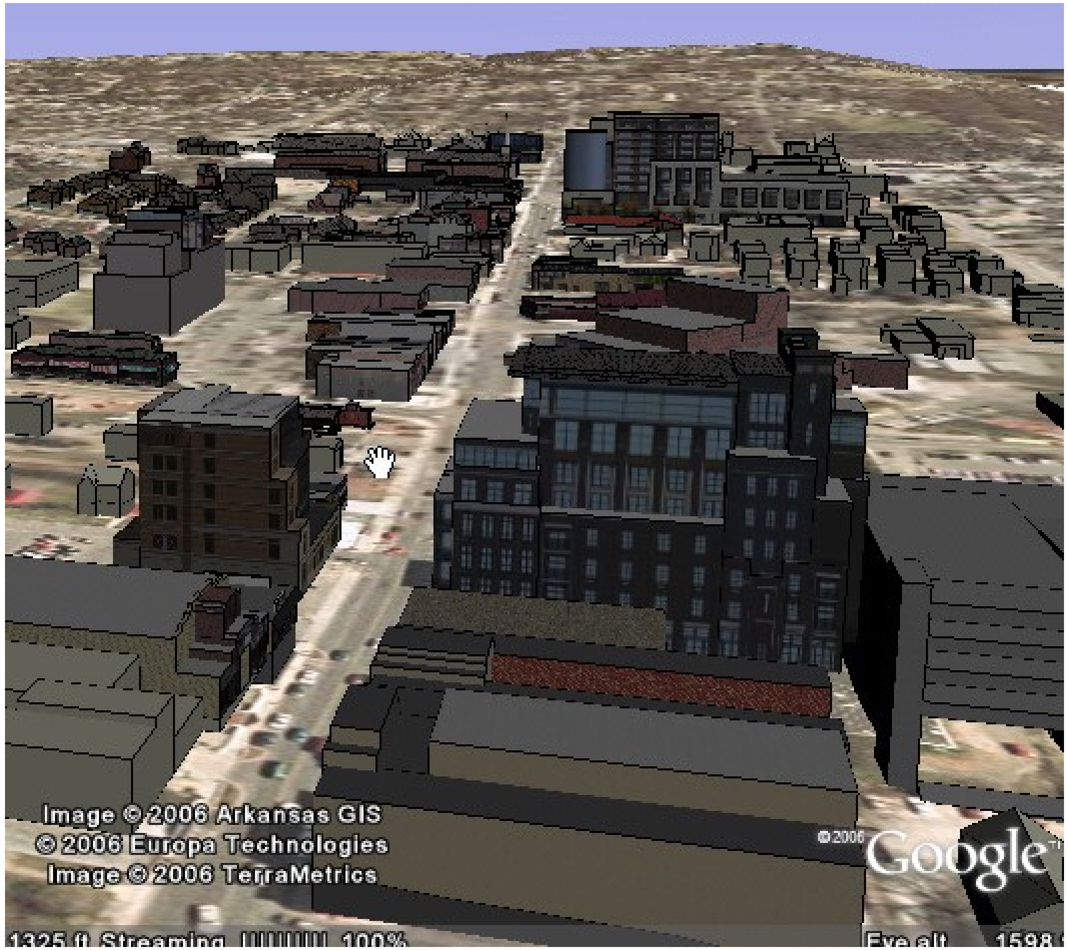
**Apply photo texture to surfaces**




**Sugar cube building masses**

***Derived from LiDAR stored and retrieved from Oracle to GeoMedia SmartStore processed to calculate building heights.***

***LiDAR acquired by NWA Image Consortium***




www.cast.uark.edu/local/cadis_crate_06 and Google Picks!

# Traditional photogrammetry

- New twist in systems and methods
  - old dogs new tricks
- Not just bare earth
- Point clouds,
- Building footprints
- Building shapes

# Leica ADS 40 - Seven bands

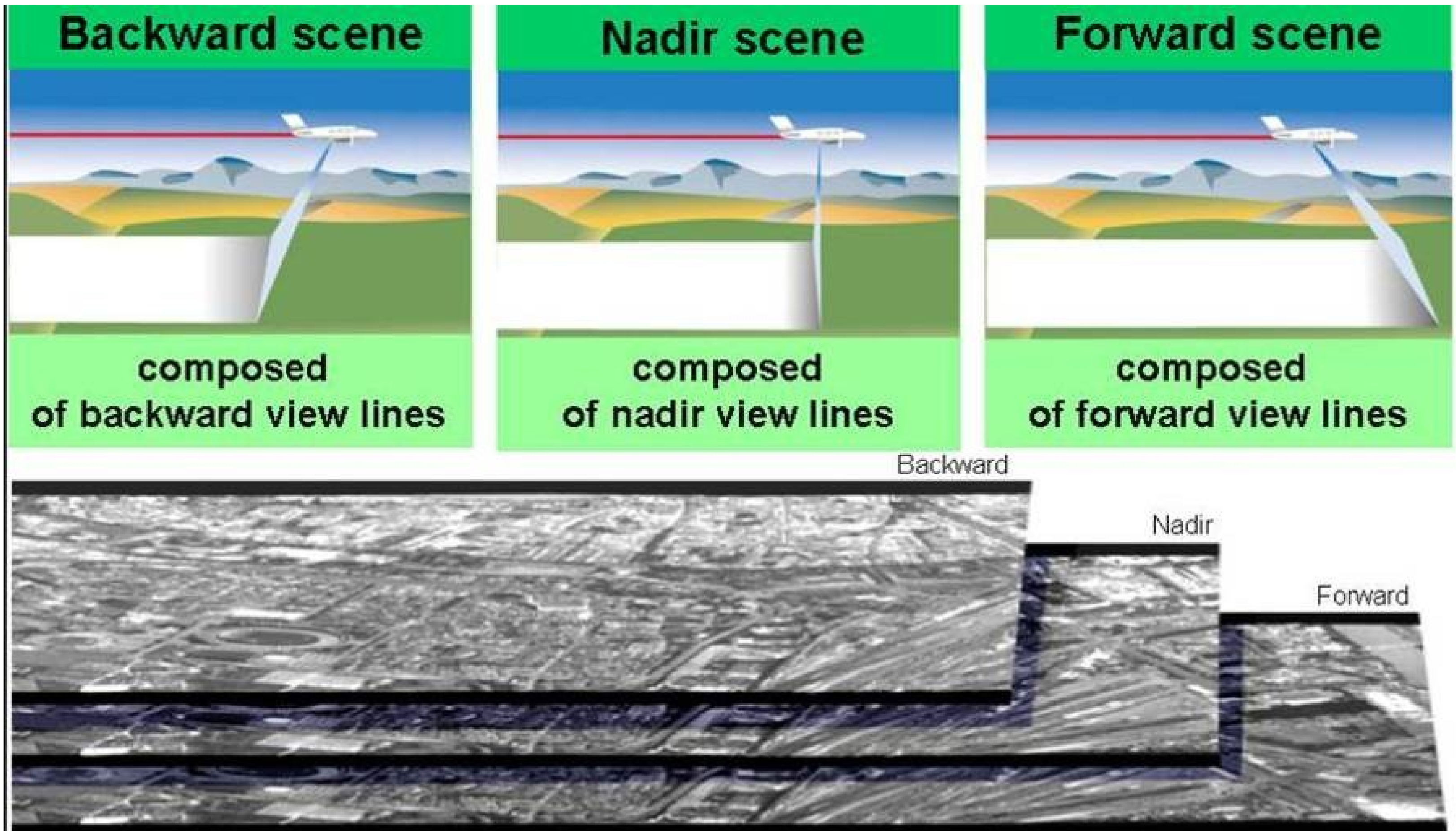
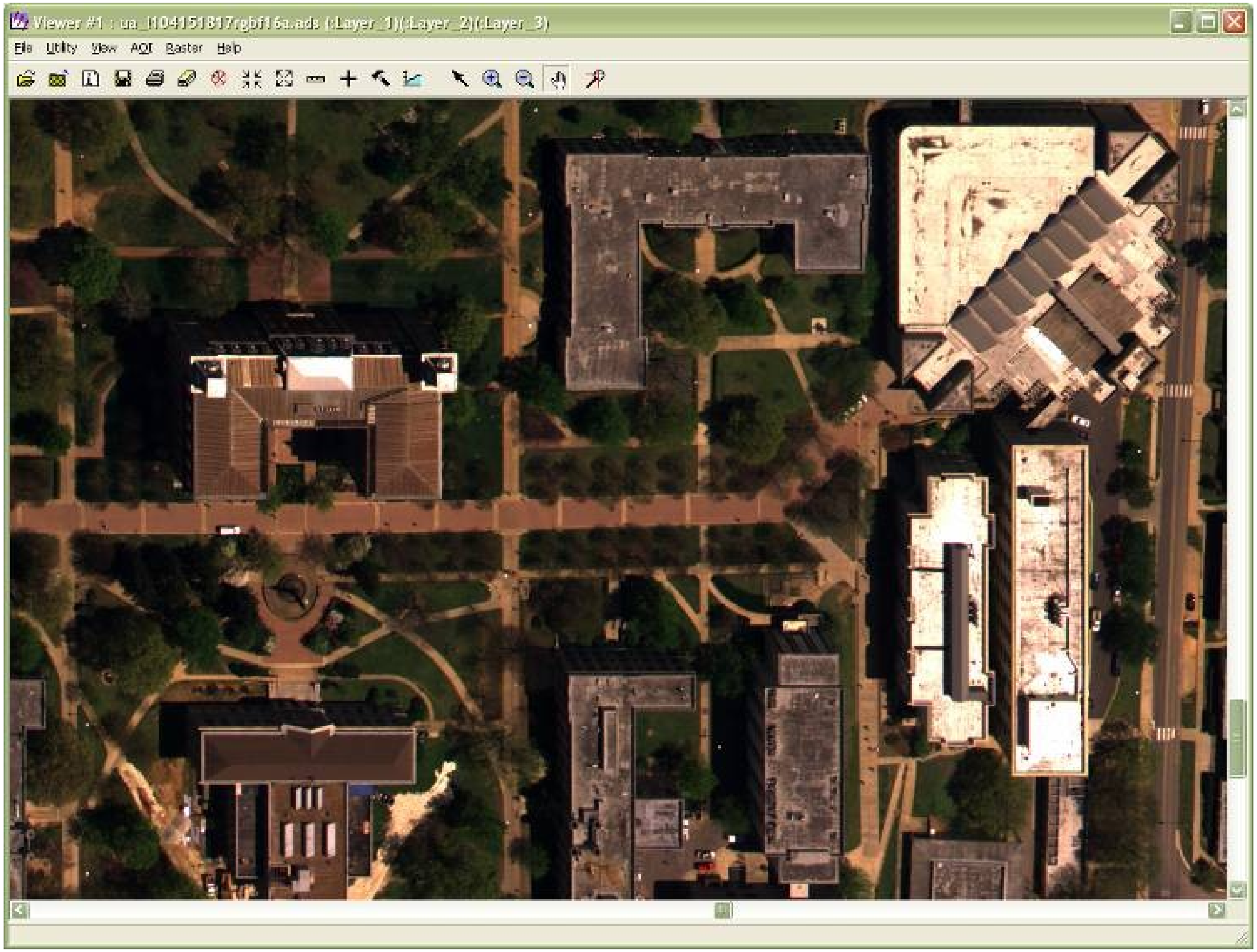


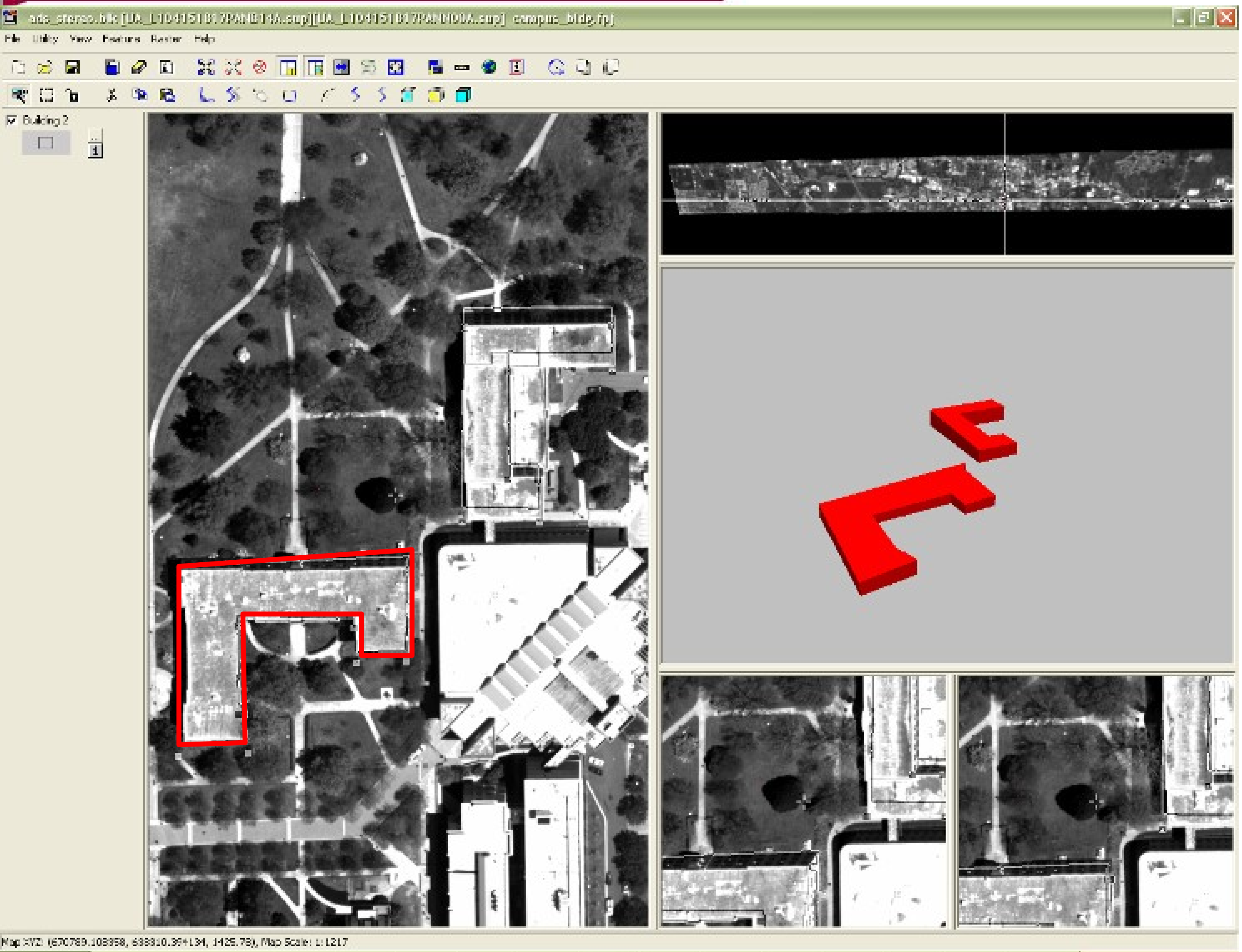

Image courtesy Lieca GIS and Geospatial Imaging




**U of A Campus**

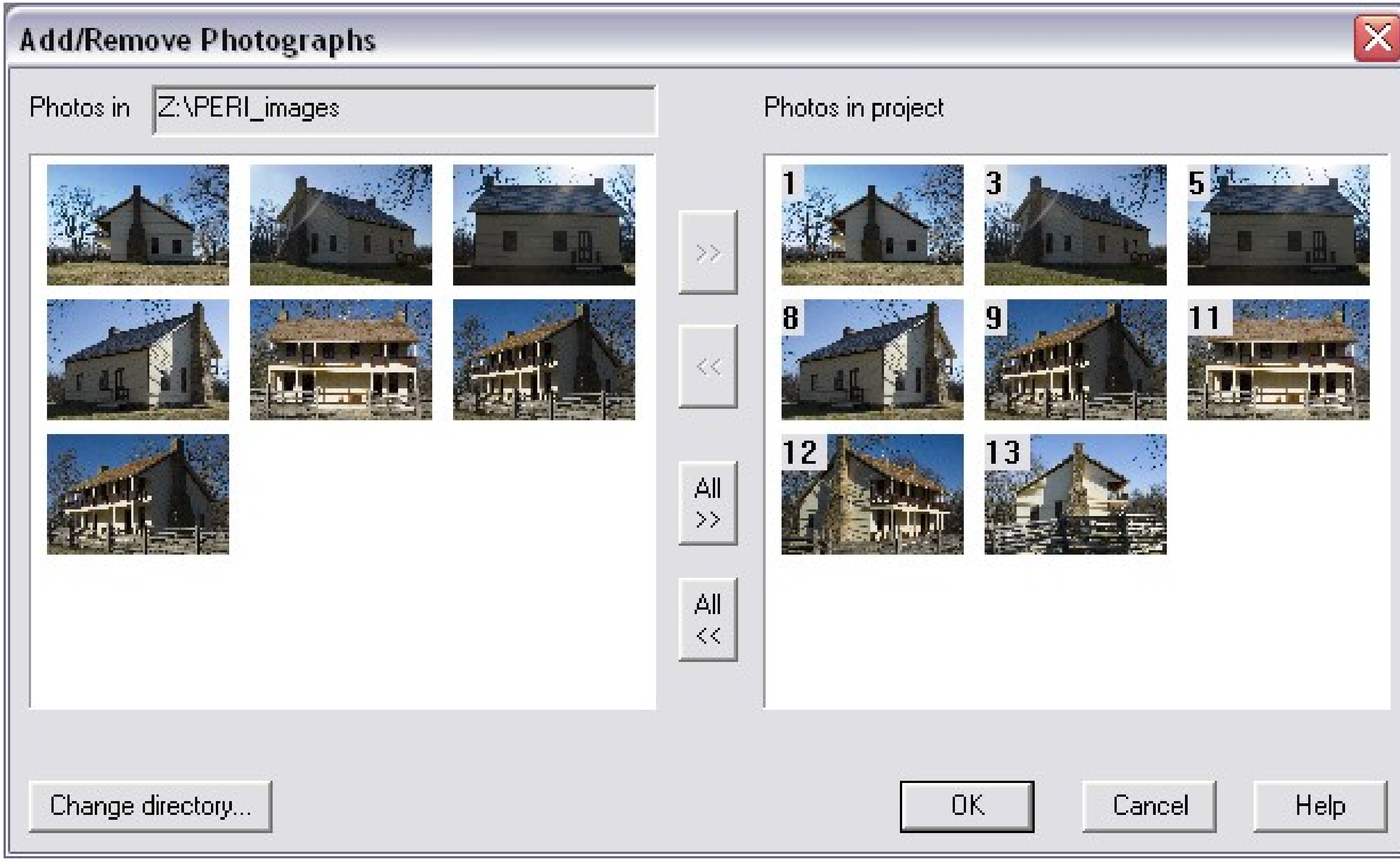
**6 inch pixel RGB also near-IR**

**Acquired by LandAir Mapping**

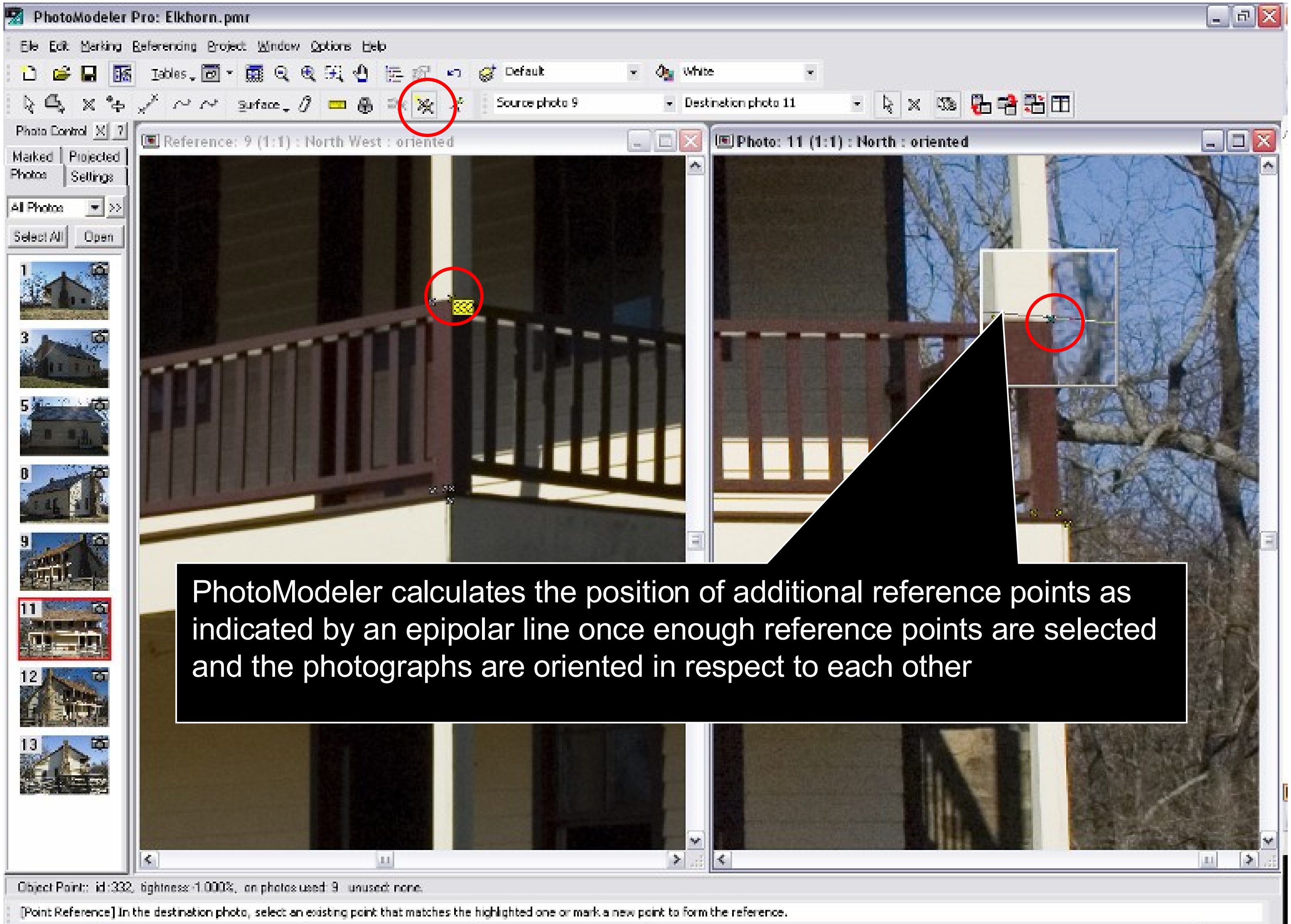


**Processing Via Leica G-Pro, LPS and Stereo Analyst**

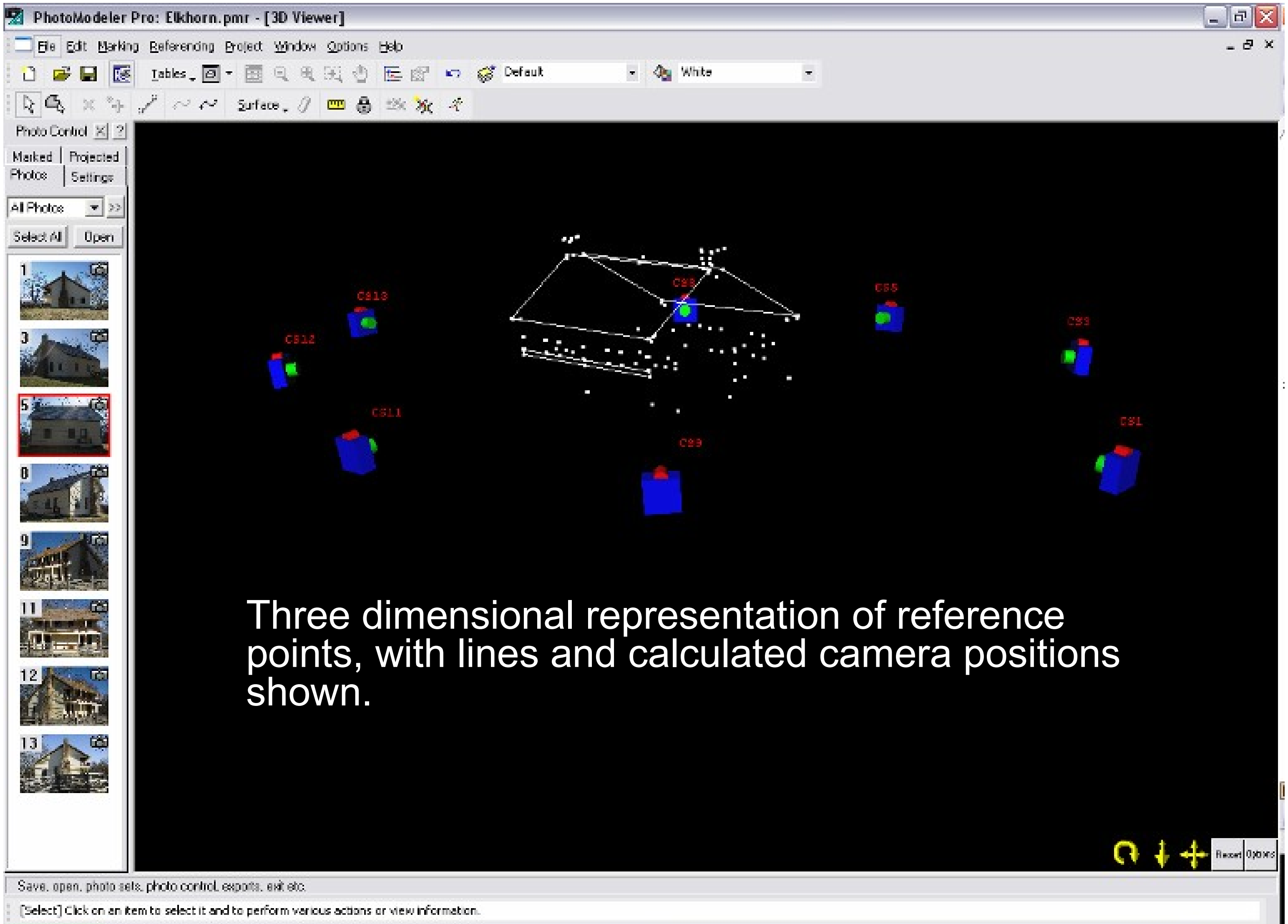
# Adding Images




**PhotoModeler (www.photomodeler.com)**

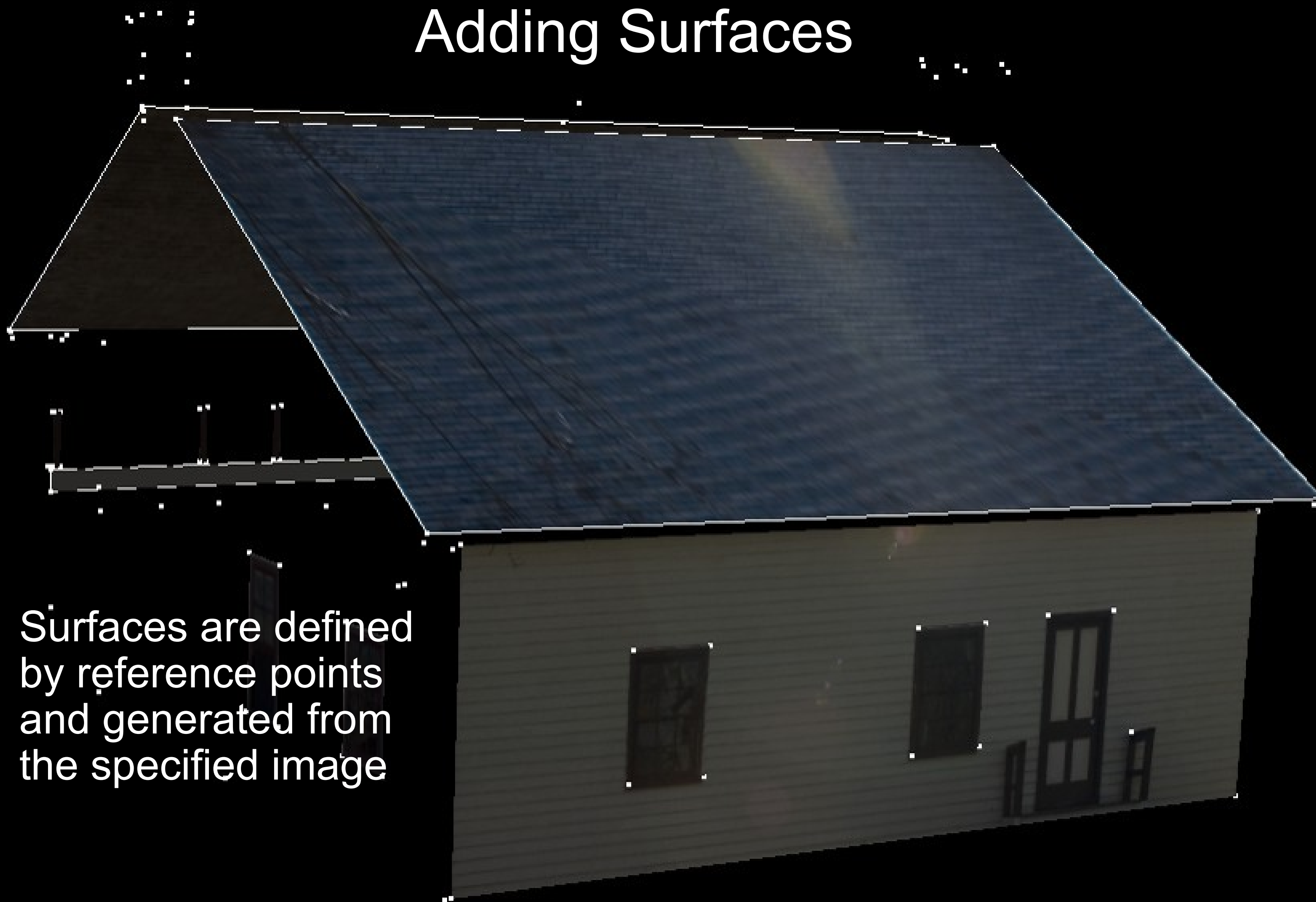



PhotoModeler calculates the position of additional reference points as indicated by an epipolar line once enough reference points are selected and the photographs are oriented in respect to each other

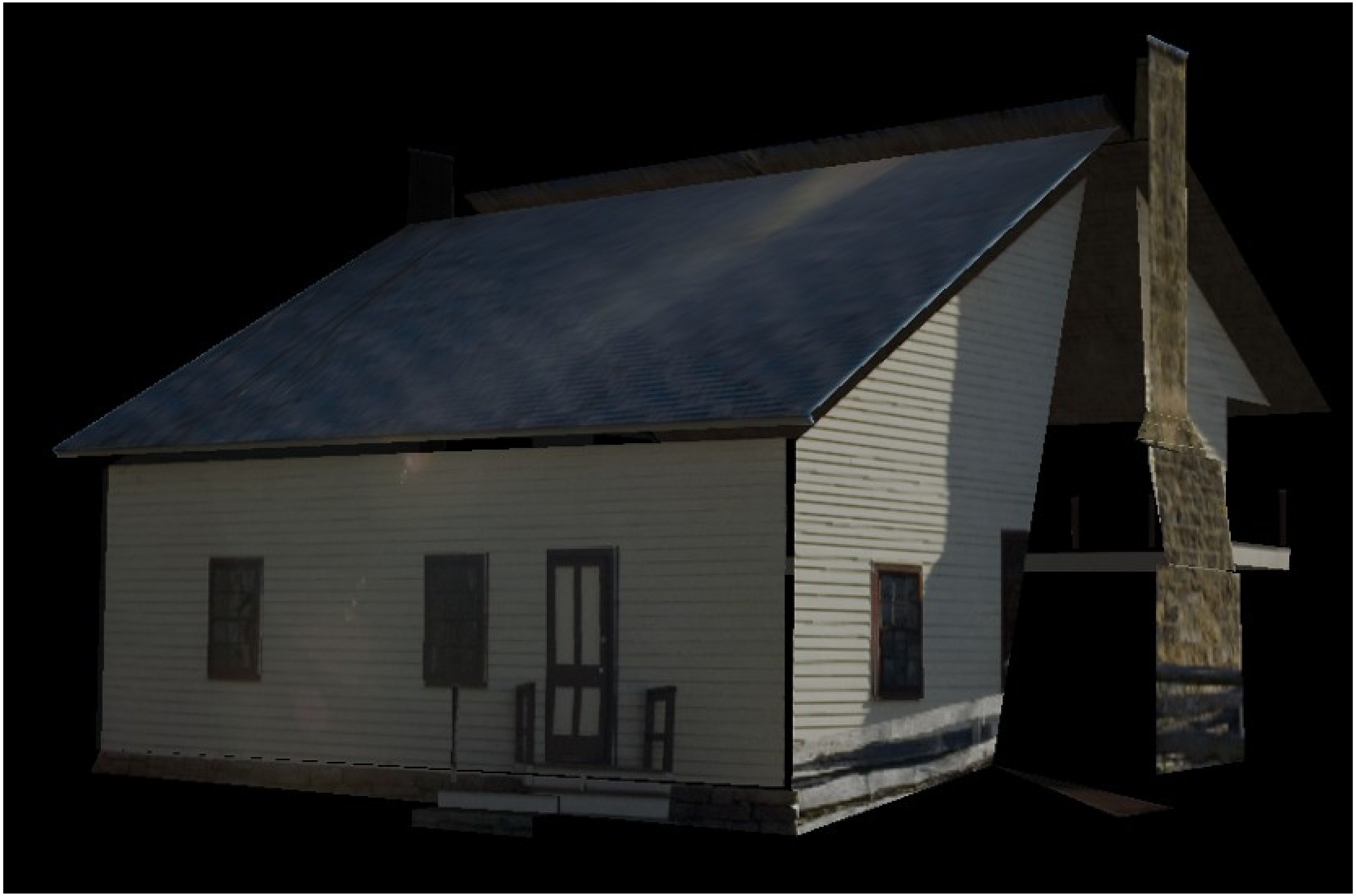



Three dimensional representation of reference points, with lines and calculated camera positions shown.

# Adding Surfaces

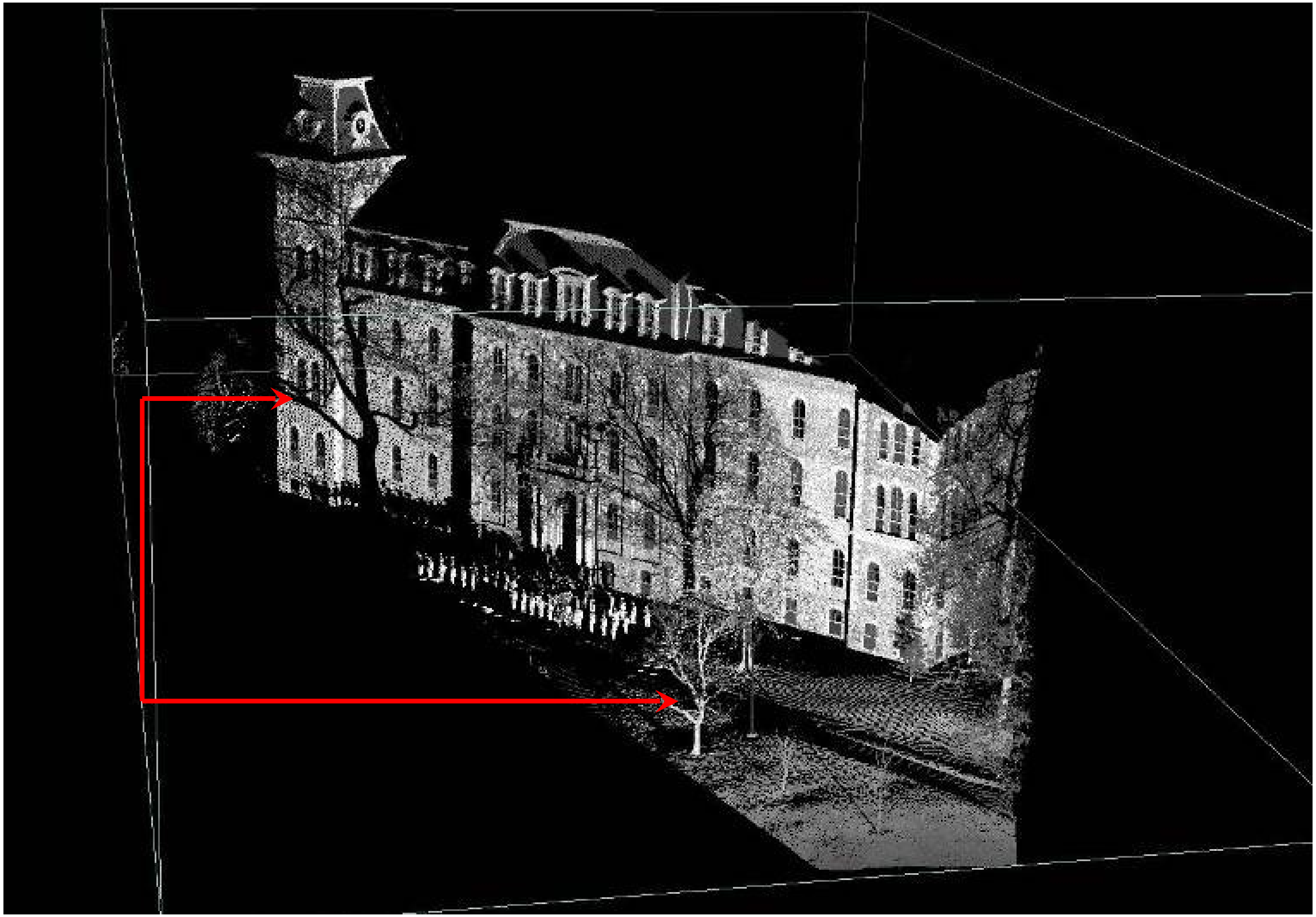


Surfaces are defined by reference points and generated from the specified image



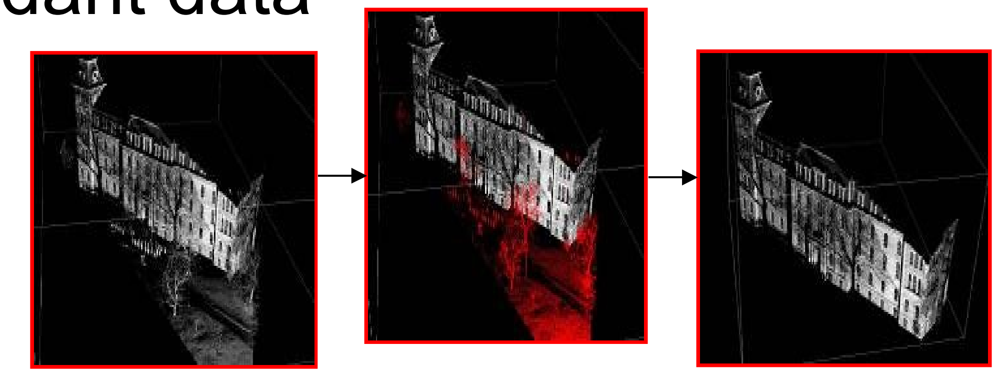
# Terrestrial Laser Scanners

- Optech ILRIS 3D
  - A *long-range,* TOF scanner
  - Typical working range: 10 - 350 meters
    - Capable to 850 meters +
  - Modeling accuracy: published 3 - 5 millimeters
    - Achieving 6 mm -- currently being tested further
  - X, Y, Z, I (laser intensity)
- Minolta-Konica Vivid 9i
  - A close range triangulation scanner
  - Typical working range: 0.6-2.5 m
  - Modeling accuracy: published 0.05mm
  - X, Y, Z, R, G, B
- Data compatible with many applications

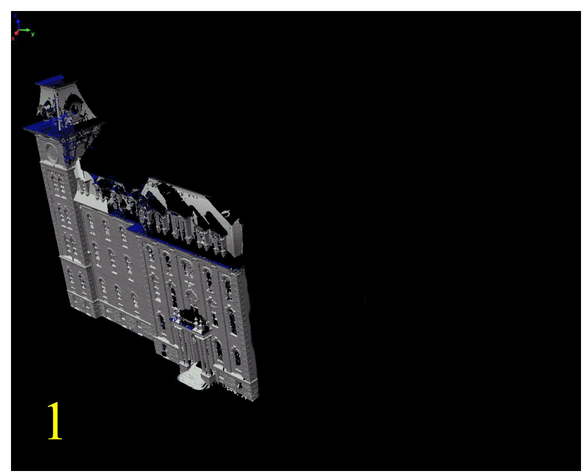


# Typical Steps in Data processing

- **Step 1:** Clean scanner data to remove unwanted or redundant data



- **Step 2:** Align Scans



# Data resolution

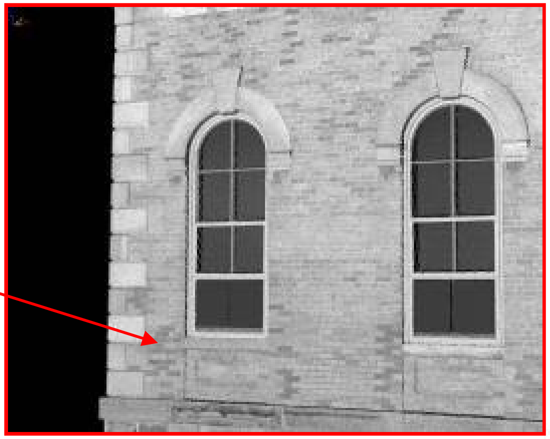
* Notice the different level of architectural detail displayed in the data sets of varied resolutions

**Old Main Data**

**1 cm data**
Scan time: 9 minutes
File Size: 10mb

**2 cm data**
Scan time: 2.5 minutes
File Size: 2mb

**5 mm data**
Scan time: 34.5 minutes
File Size: 44mb



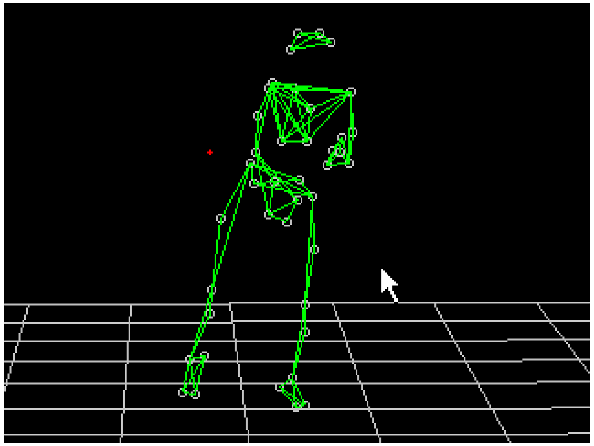
Note the detail of individual bricks in the 5mm dataset

# Machine vision and image segmentation

# 3D design options

- Visualization systems
  - Landscape and nature
    - Virtual Nature Studio, World Construction Set, Vue5, etc.
  - Buildings and structures
    - Bentley, AutoDesk, SketchUp, ArchiCAD etc…
- Animation
  - SoftImage XSI, Maya, Studio 3D Max, Alias, etc…
- Game Engines
  - FarCry, Unreal, Torque, RenderWare many others
- Massive Multiplayer On-line games (MMOGS)

Motion Capture
(aka “real time” photogrammetry)



***Many, many movies***

BusinessWeek online

MAY 1, 2006

COVER STORY

## My Virtual Life

**A journey into a place in cyberspace where thousands of people have imaginary lives. Some even make a good living. Big advertisers are taking notice**

As I step onto the polished wood floor of the peaceful Chinese country house, a fountain gurgles softly and a light breeze stirs the scarlet curtain in a doorway. Clad in a stylish blue-and-purple dress, Anshe Chung waves me to a low seat at a table set with bowls of white rice and cups of green tea. I'm here to ask her about her booming land development business, which she has built from nothing two years ago to an operation of 17 people around the world today. As we chat, her story sounds like a classic tale of entrepreneurship.

Except I've left out one small detail. Chung's land, her beautifully appointed home, the steam rising from the teacups

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# Massive Multi-player On-line Games

## e.g. Second Life

# Critical role of interoperable data base

IMHO – An **essential** element of a successful within-enterprise strategy will be using a **database** that:

Natively manages:
- Non-spatial enterprise data
  - Asset information etc,
  - BIM attributes
  - other
- Spatial vector (aka GIS) data
- Imagery, texture raster data
- Point cloud and LiDAR
- CAD
- Network
- Geocoding

- Supports OGC specs
  - WFS. WMS etc.
- Supports topological operations
  - 2D and **3D**
- Supports 3d indexing
- Supports view frustum access
- Examples
  - Oracle 11g Spatial (all except 3d topological operators)
  - MySQL4.x (many but not 3d)
  - PostGIS 1.2 (many but not 3d)

# Key interoperability initiatives and tools

COLLADA JetStream

**IFC/OmniClass** Industry foundation classes

**aecXML**

**CityGML**

**LandXML**

**OGC (multiple)**

**KML**

Item
Assembly
Floor
Building
Site/parcel
City
Region
Nation
Globe

**X3D/VRML**

**NBIMS**

- **SDSFIE** Spatial Data Standard for Facilities Infrastructure and Environment
- **LAS** LiDAR

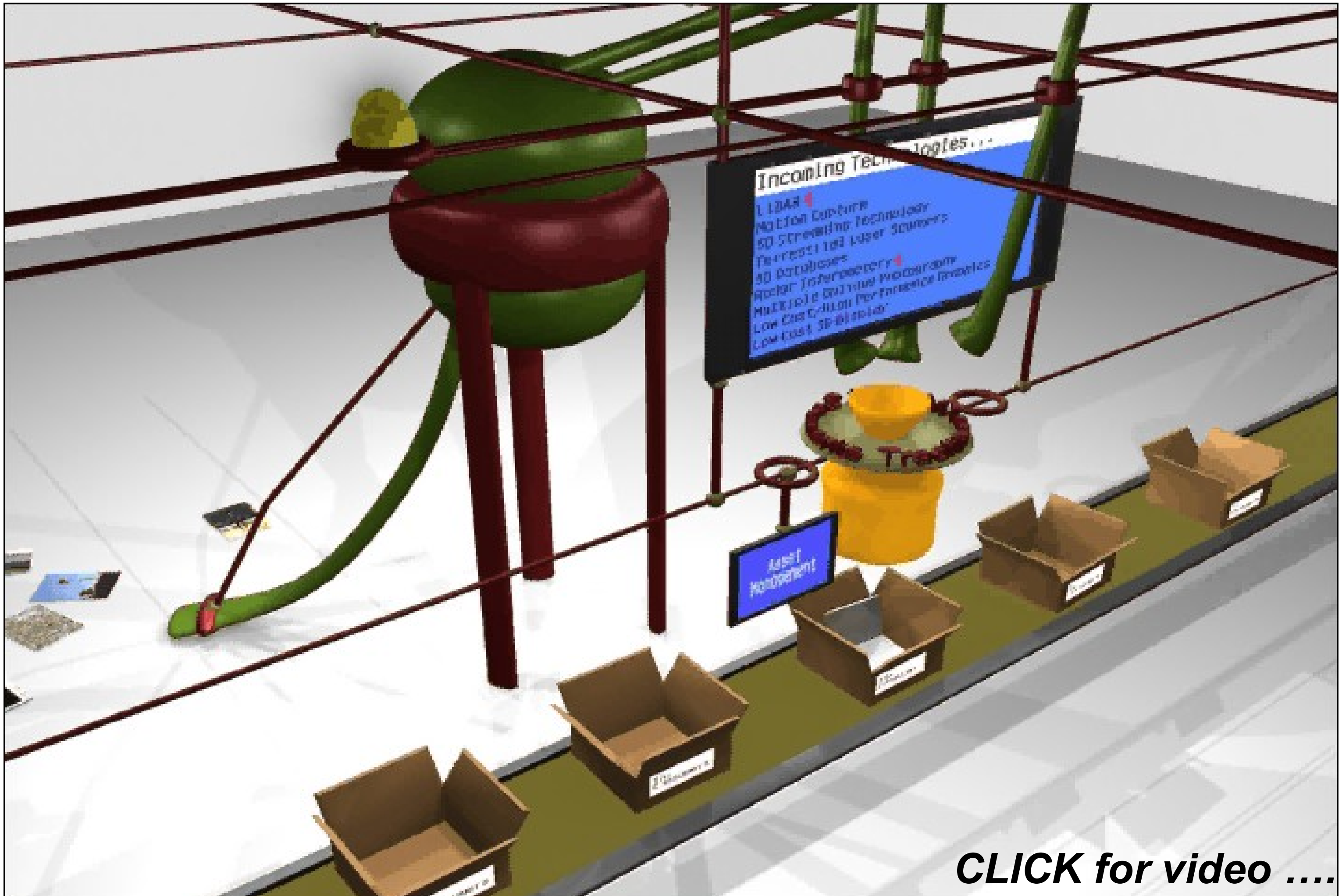
**DISDI** Defense Installation Spatial Data Infrastructure

# It’s exciting but not all is well…

- Interface of multiple disciplines, cultures, ideas….
  - Machine vision, photogrammetry, “traditional GIS,” gaming …
- No single field is capable
- Isolation (esp. in US) in silos
  - Machine vision researchers not familiar w/ photogrammetry
  - etc…..

# US educational systems is **not** designed to prepare students for this brave new world

- Multi-departmental fragmentation is common
  - Machine vision = computer science department
  - Geospatial explorers = geography department
  - Photogrammetry/survey = civil engineering
  - CAD = architecture
  - etc.
- European and Canada (some integration)
  - Geomatics
  - Geoinformation
- Also – a lack of training in standards and interoperability requirements




**CLICK for video ….**

magic_final3.avi

# Info on standards/specification efforts

**OGC (multiple)**

- **Simple Features, Coverages, Web Mapping, Web Features, etc. www.opengis.org**

**aecXML**

- Specifications for information interoperability that deal with AEC-including design, construction and life-cycle applications-are included in the aecXML structure. *www.iai-na.org/technical/faqs.php*.

**LandXML**

- LandXML is an industry-driven XML format intended to facilitate the exchange of data during land planning, land survey and civil-engineering processes*www.landxml.org*

**LAS**

- For LIDAR data, the American Society of Photogrammetry and Remote Sensing-approved LAS format provides for exchange of this critical data type. Information on LAS can be found at *www.lasformat.org* Work at NIST on terrestrial scanners is underway

**CityGML**

- CityGML is a comprehensive, multi-scale specification for “city” data that are directly relevant to any 3-D efforts. More detail on this effort can be found at *www.citygml.org*

**SDSFIE**

- The Spatial Data Standard for Facilities Infrastructure and Environment (SDSFIE) is an ANSI standard, *https://tsc.wes.army.mil/products/TSSDS-TSFMS/tssds/projects/sds/default.asp*.

DISDI

- Defense Installation Spatial Data Infrastructure http://www.acq.osd.mil/ie/bei/disdi.htm

**OWS 4**

- The current Open Web Services 4 initiative, for example, has a specific component that focuses on CAD/GIS and 3-D interoperability. For more on this, visit the Web at *www.opengeospatial.org/initiatives/?iid=199#cad*.

NBIMS

- National Building Information Modeling Standard

IFC/OmniClass

- Industry foundation classes

Featured:

- GeoStor v 4.00
- Satellite Duck Tracking System
- NWA Imagery Viewer
- Animation at the U of A

Center for Advanced Spatial Technologies

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The Center for Advanced Spatial Technologies (CAST) focuses on research, education, outreach, and applications (both on campus and web-based) in geospatial analysis and modeling, enterprise spatial databases, remote sensing, digital photogrammetry and geospatial interoperability. Much of CAST's research efforts involve new approaches to spatial data and the development of new methodologies for analysis of these data.

Information on the following topics can be found using the links on the left.

- Research
- Outreach
- Geospatial Solutions/Data Distribution
- Educational Service – University and K-12
- Facilities
- Collaborators
- Centers of Excellence

CAST is an administrative unit of the J. William Fulbright College of Arts and Sciences but serves the entire campus community including the Dale Bumpers College of Agricultural, Food and Life Sciences, the Sam M. Walton College of Business, the College of Engineering and the School of Architecture in the common goal of introducing and making geospatial technologies available to a wide variety of researchers and professionals and to furthering the field through basic and applied research. Cooperative programs developed by CAST are designed to bring together the benefits of academic research and development, the resources of state and federal agencies and the private sector to provide the state and region with effective spatial technologies, trained practitioners, and low-cost digital data.

CAST serves both the university and the K-12 community through its emphasis on high quality university courses in geographic information systems (GIS), photogrammetry, geospatial analysis, global positioning systems (GPS), and related technologies; providing facilities and software and hardware. CAST is actively involved in extensive research efforts, through multiple grants totaling more than $1 million awarded each year. The research efforts compliment and greatly benefit the educational and public service focus by allowing staff and students to stay on the leading edge of emerging technologies as well as providing opportunity for economic development through the Center's business incubator efforts.

The Center has built strong and enduring relationships with the private sector including industry leaders such as Definiens Imaging, eSpatial Systems, ESRI, Intergraph Corporation, IONIC Software, Leica GGM, Oracle Corporation, PCI Geomatics, Safe Software, Skyline Software, Sun Microsystems, and Trimble Navigation Ltd.

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Thanks to:
Snow Winters
Jack Cothren
Angie Payne
Malcolm Williamson
CAST Staff
NWA Regional Planning
NWA Regional Image Consortium
UA Facilities Management
Software and data providers



**More on 3D at: http://www.geoplace.com**