Visualizing Waikiki

Integrating GIS into Driving Simulation Scenarios

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Highway Driving Simulator (HDS)

U.S. Department of Transportation
Federal Highway Administration

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OUTLINE

- Background
  - HDS Features
  - HDS Activities Types
  - What GIS is, and Why Do we need it?
- Scenario Elements
  - Roadway geometry, Buildings, Trees, Signs, Signals (Lights + Ped), Traffic, GUI requirements, Data Collection
- GIS Tools
- Questions?

Highway Driving Simulator

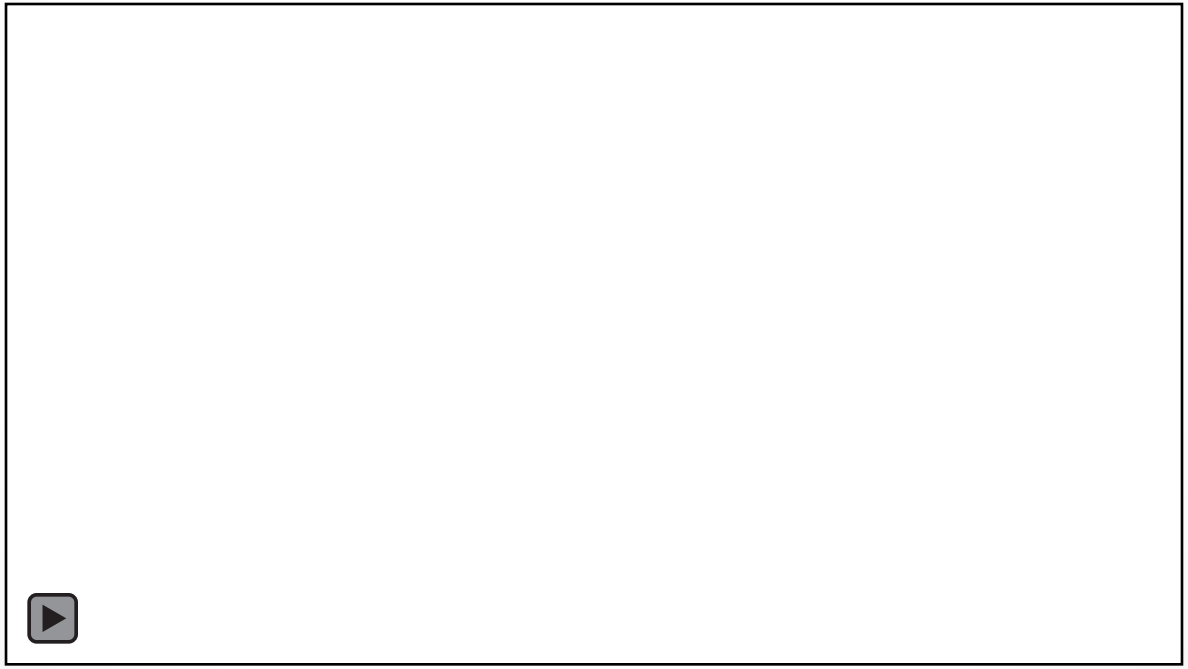
New Car Cab 2013 Ford Fusion December 2015

HDS FEATURES

- The Highway Driving Simulator now has 18 Video Channels covering 200 degrees FOV front overlapping for a full 360 degrees with LCD based rear view mirrors.
- 3x Barco SIM10 4K front projectors, each at 4096x2400 resolution with cylindrical warping, edge blending, Auto-Alignment (Color and intensity)
- Multi-Display Operators Console
- 3 Rear View panels (replacing mirrors) 1024x800 resolution each
- 6 Degrees of Motion platform for Pitch, Roll, Yaw, Heave, Sway and Surge
- Audio rendering of Engine, Road, and Wind sounds independently
- A full data capture and replay capability including EyeTracking

Operators Console

4K PROJECTORS



HDS Types of Activities

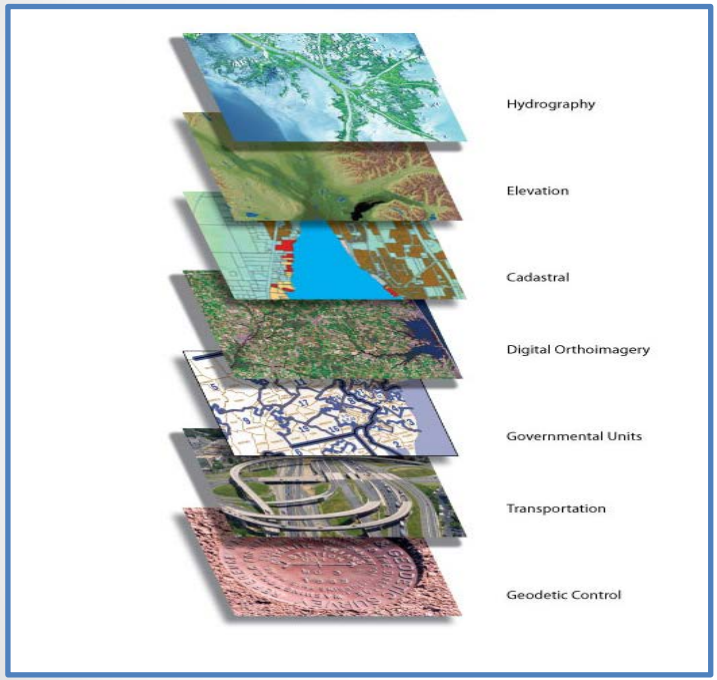
- Visualization projects to demonstrate how new infrastructure will “look” – articulate the benefits of roadway safety investments

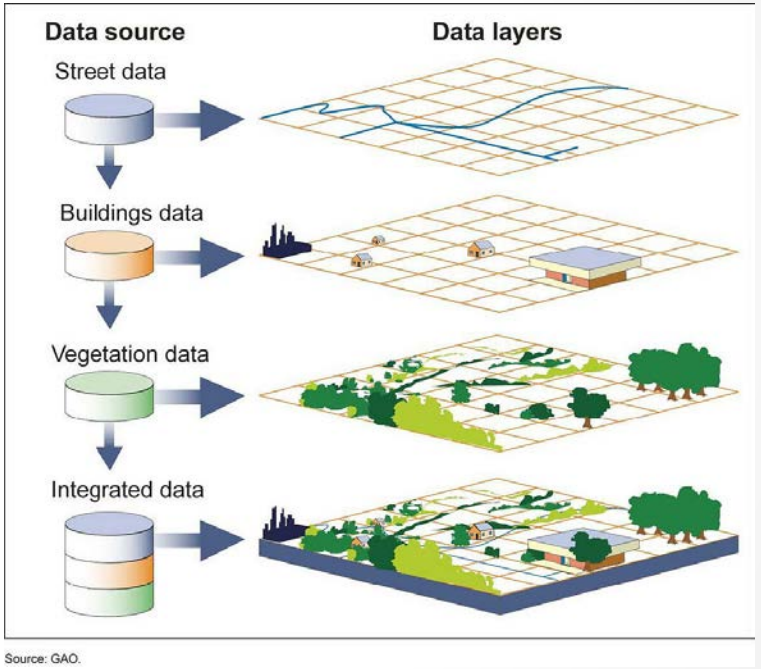
- Behavioral research for safety to understand how the driving environment effects driving performance and what changes can be made to improve safety

What is GIS?

- "A geographic information system (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present spatial or geographic data." Source: Wikipedia
- "GIS lets us visualize, question, analyze, and interpret data to understand relationships, patterns, and trends." Source: esri website
- GIS data and GIS applications have become ubiquitous in everyday use and coverage of many data types are of high quality and accuracy

GIS Data Layers

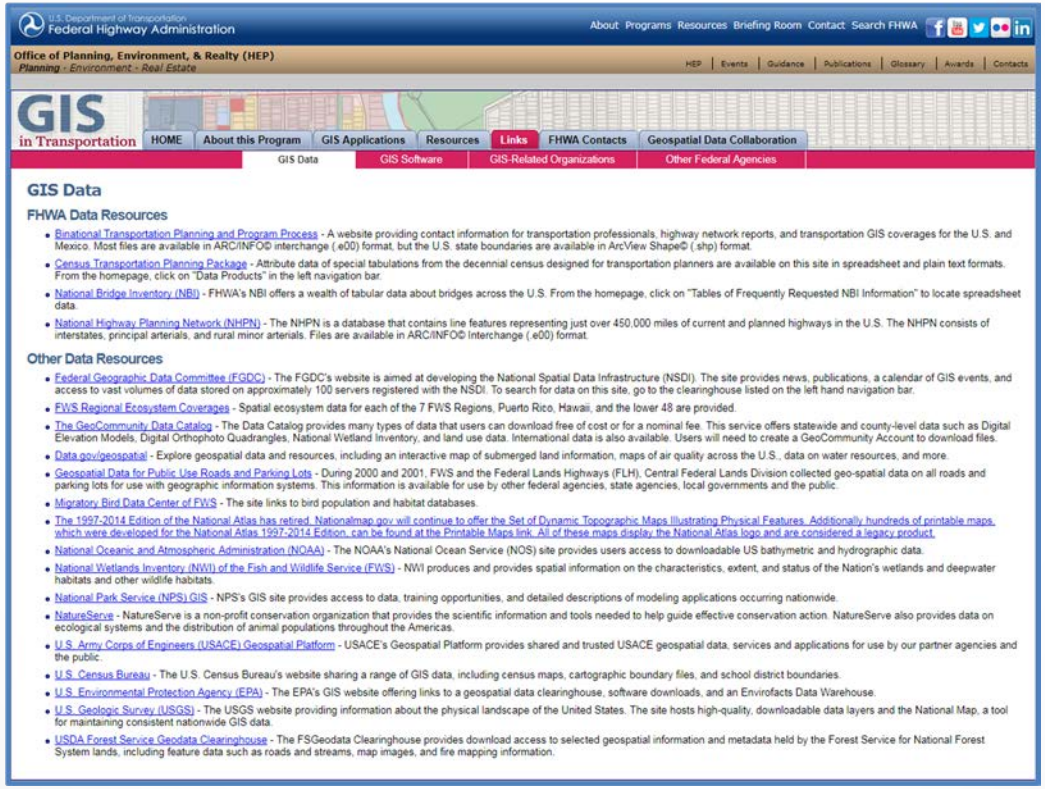




Source: GAO.

GIS Data Resources from FHWA

https://www.gis.fhwa.dot.gov/gisData.asp



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GIS in Transportation

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GIS Data | GIS Software | GIS-Related Organizations | Other Federal Agencies

GIS Data

FHWA Data Resources

- Binational Transportation Planning and Program Process - A website providing contact information for transportation professionals, highway network reports, and transportation GIS coverages for the U.S. and Mexico. Most files are available in ARC/INFO© interchange (.e00) format, but the U.S. state boundaries are available in ArcView Shape© (.shp) format.
- Census Transportation Planning Package - Attribute data of special tabulations from the decennial census designed for transportation planners are available on this site in spreadsheet and plain text formats. From the homepage, click on "Data Products" in the left navigation bar.
- National Bridge Inventory (NBI) - FHWA's NBI offers a wealth of tabular data about bridges across the U.S. From the homepage, click on "Tables of Frequently Requested NBI Information" to locate spreadsheet data.
- National Highway Planning Network (NHPN) - The NHPN is a database that contains line features representing just over 450,000 miles of current and planned highways in the U.S. The NHPN consists of interstates, principal arterials, and rural minor arterials. Files are available in ARC/INFO© Interchange (.e00) format.

Other Data Resources

- Federal Geographic Data Committee (FGDC) - The FGDC's website is aimed at developing the National Spatial Data Infrastructure (NSDI). The site provides news, publications, a calendar of GIS events, and access to vast volumes of data stored on approximately 100 servers registered with the NSDI. To search for data on this site, go to the clearinghouse listed on the left hand navigation bar.
- FWS Regional Ecosystem Coverages - Spatial ecosystem data for each of the 7 FWS Regions, Puerto Rico, Hawaii, and the lower 48 are provided.
- The GeoCommunity Data Catalog - The Data Catalog provides many types of data that users can download free of cost or for a nominal fee. This service offers statewide and county-level data such as Digital Elevation Models, Digital Orthophoto Quadrangles, National Wetland Inventory, and land use data. International data is also available. Users will need to create a GeoCommunity Account to download files.
- Data.gov/geospatial - Explore geospatial data and resources, including an interactive map of submerged land information, maps of air quality across the U.S., data on water resources, and more.
- Geospatial Data for Public Use Roads and Parking Lots - During 2000 and 2001, FWS and the Federal Lands Highways (FLH), Central Federal Lands Division collected geo-spatial data on all roads and parking lots for use with geographic information systems. This information is available for use by other federal agencies, state agencies, local governments and the public.
- Migratory Bird Data Center of FWS - The site links to bird population and habitat databases.
- The 1997-2014 Edition of the National Atlas has retired. Nationalmap.gov will continue to offer the Set of Dynamic Topographic Maps Illustrating Physical Features. Additionally hundreds of printable maps, which were developed for the National Atlas 1997-2014 Edition, can be found at the Printable Maps link. All of these maps display the National Atlas logo and are considered a legacy product.
- National Oceanic and Atmospheric Administration (NOAA) - The NOAA's National Ocean Service (NOS) site provides users access to downloadable US bathymetric and hydrographic data.
- National Wetlands Inventory (NWI) of the Fish and Wildlife Service (FWS) - NWI produces and provides spatial information on the characteristics, extent, and status of the Nation's wetlands and deepwater habitats and other wildlife habitats.
- National Park Service (NPS) GIS - NPS's GIS site provides access to data, training opportunities, and detailed descriptions of modeling applications occurring nationwide.
- NatureServe - NatureServe is a non-profit conservation organization that provides the scientific information and tools needed to help guide effective conservation action. NatureServe also provides data on ecological systems and the distribution of animal populations throughout the Americas.
- U.S. Army Corps of Engineers (USACE) Geospatial Platform - USACE's Geospatial Platform provides shared and trusted USACE geospatial data, services and applications for use by our partner agencies and the public.
- U.S. Census Bureau - The U.S. Census Bureau's website sharing a range of GIS data, including census maps, cartographic boundary files, and school district boundaries.
- U.S. Environmental Protection Agency (EPA) - The EPA's GIS website offering links to a geospatial data clearinghouse, software downloads, and an Envirofacts Data Warehouse.
- U.S. Geologic Survey (USGS) - The USGS website providing information about the physical landscape of the United States. The site hosts high-quality, downloadable data layers and the National Map, a tool for maintaining consistent nationwide GIS data.
- USDA Forest Service Geodata Clearinghouse - The FSGeodata Clearinghouse provides download access to selected geospatial information and metadata held by the Forest Service for National Forest System lands, including feature data such as roads and streams, map images, and fire mapping information.

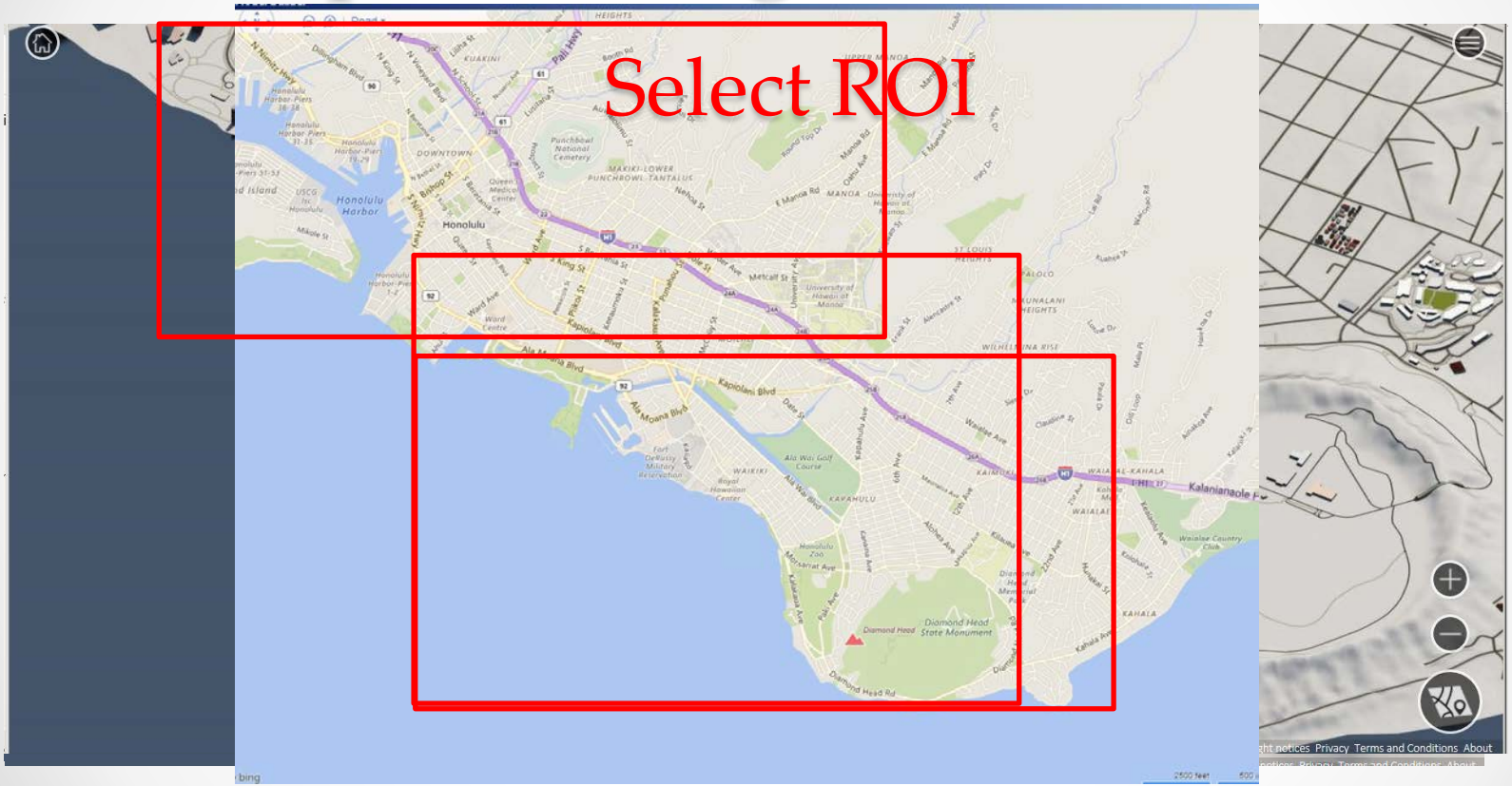
Using GIS in Simulation & Visualization

- What Data can we get from GIS?
  - Elevation Data
  - Street Data (Open Roads compliant)
  - Vegetation Data (Parks, specific trees along streets, vegetation level)
  - Building Data (Based on footprint, stories, style, use procedural generation rules)
  - Some city based “furniture”
- Advantages of GIS
  - Modelling existing “Real World” locations
  - Fit CAD Designs to “Real world” locations
  - For Public Understanding and Involvement (Hey That’s my House!)
  - Comparisons of Real World Data matching Simulator Data
  - Many Cities and communities are generating the GIS Database layers for us
- Challenges
  - Real-Time simulation must run fast at over 60 fps
  - Many GIS end products are for either proprietary or geared for presentation only (images / videos)
  - Only certain file formats can be used in 3D model environment

GIS Modeling Tools

- **Google Earth ™**
  - Not fully GIS, but more of a viewer (data layers restricted and defined by developer)
  - Elevation Data
  - Imagery (satellite and aerial)
  - Map Based Data
  - Street View, 360 images based on location along major roads and some foot paths
  - Some Building Data from larger cities
- **ArcGIS ™**
  - Full GIS Database
  - Actual Database Engine
  - Requires expert knowledge to use
- **Esris CityEngine ™**
  - Easy to use Interface
  - Parametric based scripting to generate large areas quickly
  - Includes all GIS data layers from ArcGIS
- **Autodesk Infraworks 360 ™**
  - More Gear to Infrastructure Design Engineers and Quickly Generating Data Visualizations
  - Also allows for scripting interpolation of data layers
  - Large number of Export formats geared toward 3D Modeling

Examples Using InfraWorks 360

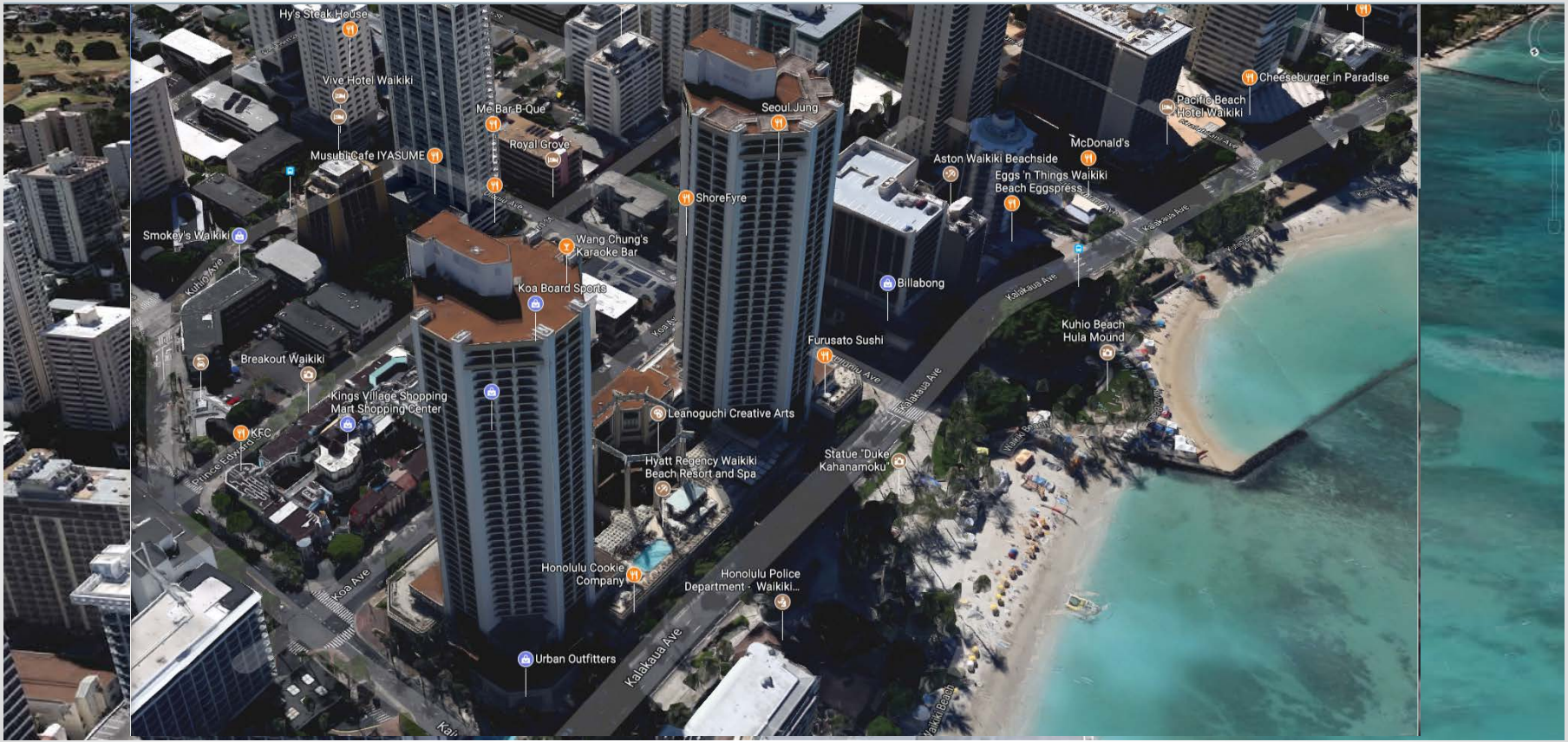



Jason Williams
Conceptual View
master
Textured / Shaded Views
Jason Williams
Engineering View
master

Google Earth

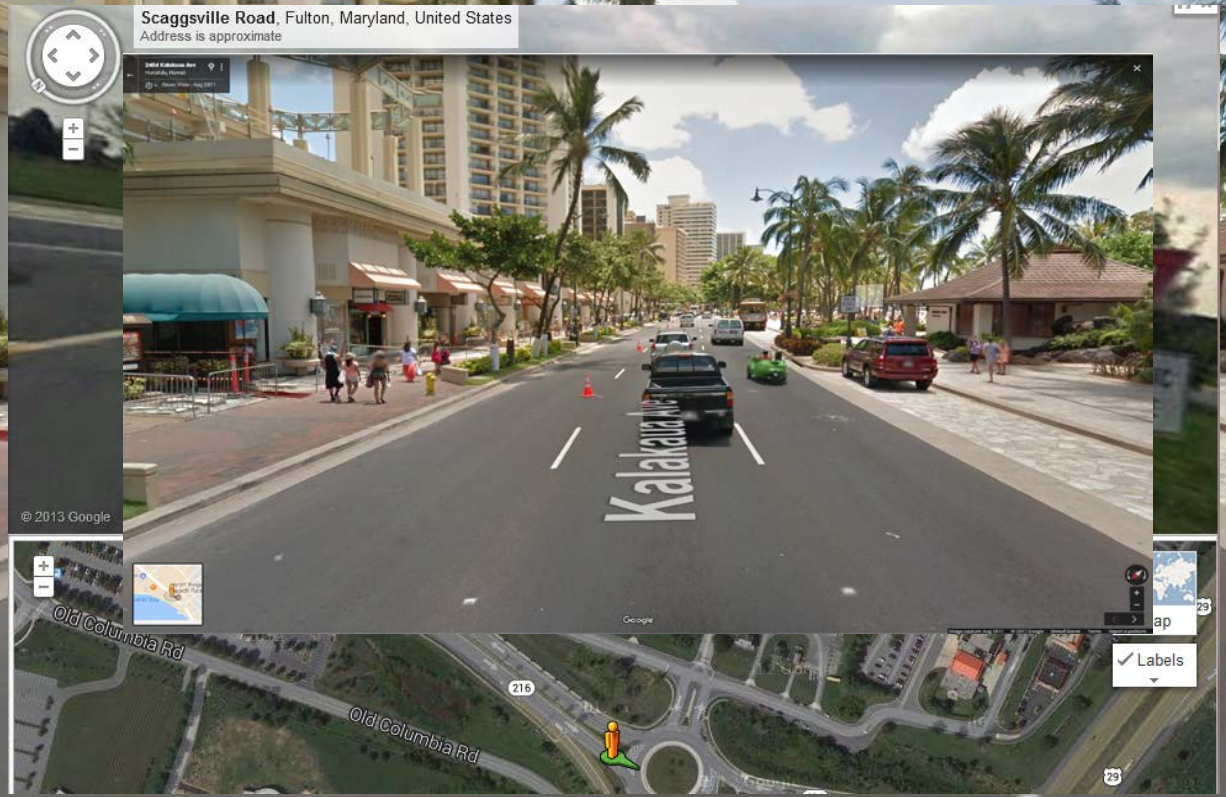
- Advantages
  - More true representation with data
    - Buildings are vetted by Google and not just generated
    - Constant corrections fixes are added
  - Includes 3D point cloud data for some vegetation / Tree layers
  - Imagery and Elevation Data is fairly high resolution
  - Data source and resolution is defined
  - Tightly integrated with Street View
- Disadvantages
  - Much of the data can't be easily exported (other than elevation and imagery)
  - Does not work directly with other GIS data bases

Google Earth Buildings



Trees

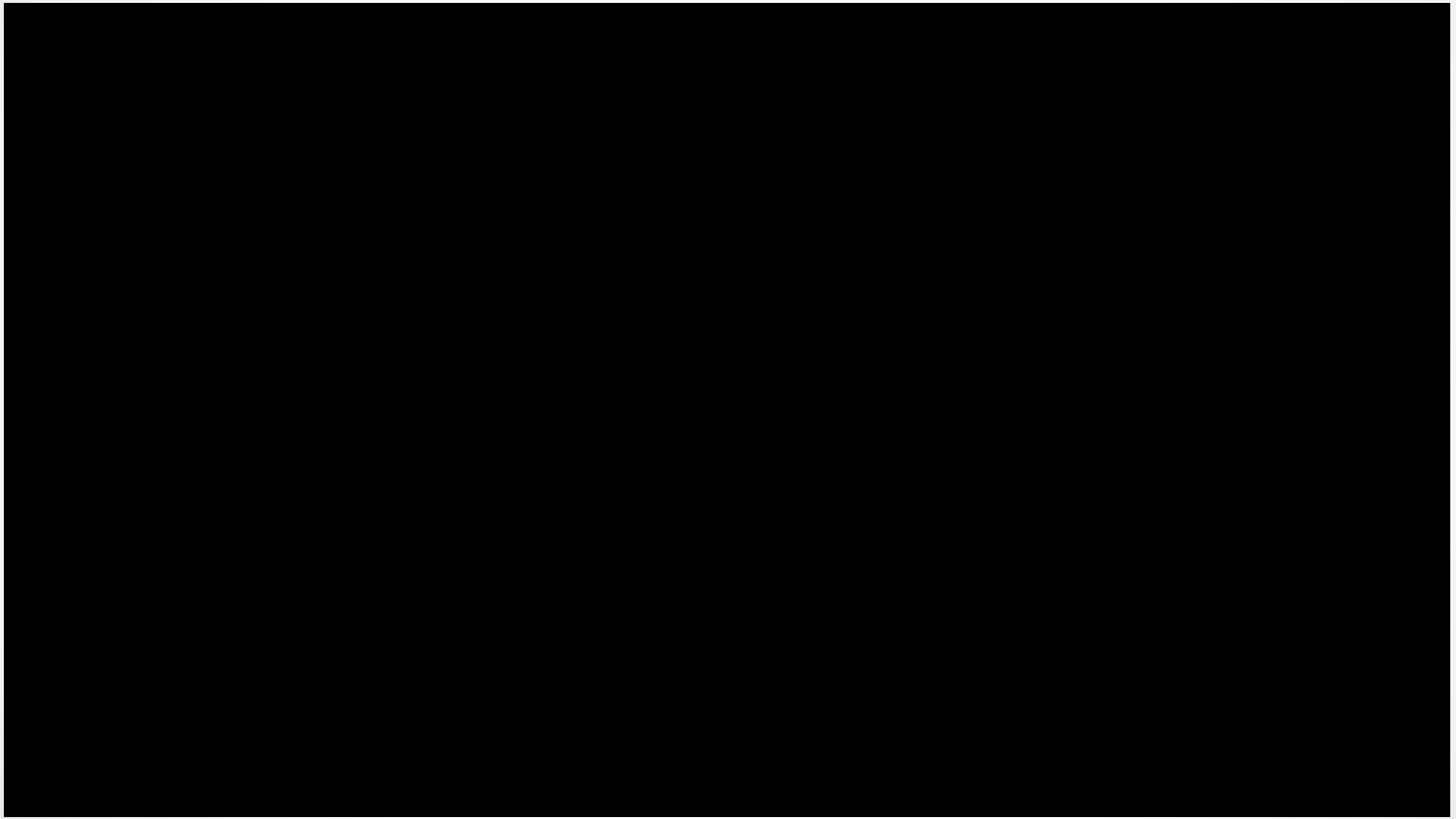
Google Street View



Procedural Solutions

- Can quickly build model based on parameter lookups and substitutions
- For example, using just the foot print, the number of floors and an architectural style, we can approximate many buildings
- Trees and Street Furniture can also be built procedural
- ESRI City Engine may be best if doing allot or procedural modeling.

Waikiki - Video



Challenges

- InfraWorks and ESRI City Engine data is not precise
- Need to make changes based on Google Street View or own surveys
- Point data is still hard to work with
- Level of expertise requirements are high for all the applications and engineering areas (Takes a while to learn)
- Large data sizes can be “clunky” to work with
- Need to control Level of Detail (LOD) switching for real-time, few good tools exist to automatically generate LOD in the GIS world
- Tools are always evolving

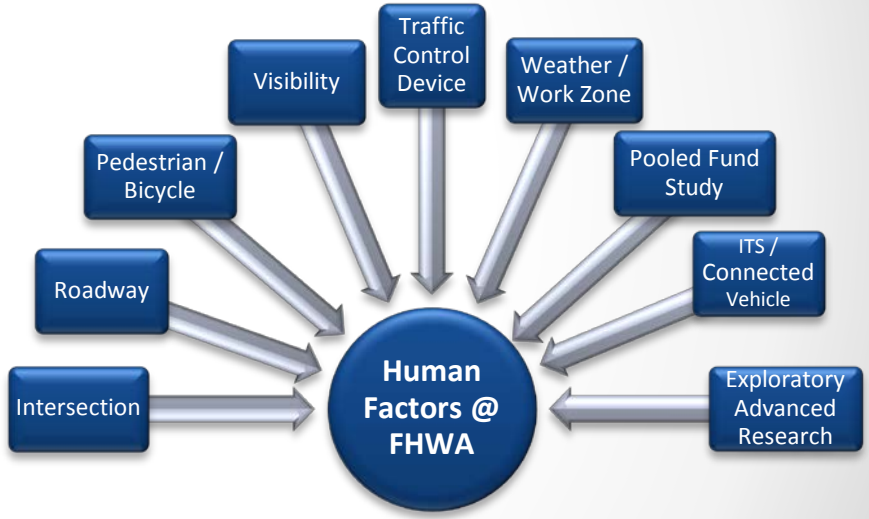
ONLINE RESOURCES

Federal Highway Administration

Office of Safety Research and Development

Human Factors Program

http://www.fhwa.dot.gov/research/tfhrc/labs/humanfactors/



Questions?

THANK YOU!