Guidance for Acquisition of
Oblique Aerial Imagery and Software System

Working Group for Orthophotography Planning,
Statewide Mapping Advisory Committee,
North Carolina Geographic Information Coordinating Council

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NCGICC

The Statewide Mapping Advisory Committee, a standing committee of the North Carolina Geographic Information Coordinating Council, identified a need to create a guidance document for local governments in North Carolina that are considering acquisition of oblique imagery. The Working Group for Orthophotography Planning researched this topic and consulted local governments that purchased oblique imagery. The Committee determined that a statewide set of oblique imagery is not a current business need of state agencies, but understands that oblique imagery is applied by numerous local governments. The Committee is neutral on questions of acquisition of oblique imagery by local governments. The guide is intended to describe current imagery and software systems in support of informed decisions.

1. **Overview**

   a. What is oblique imagery?
   Oblique Imagery is aerial photography that is collected at an angle, usually downward at a 40° to 50° angle to the ground. It contrasts with traditional orthophotos that they are collected looking straight down (nadir) position.

   Oblique imagery may be acquired using various camera system types.

      ▪ A three-view camera system consists of three cameras mounted so that each exposure collects a nadir image and oblique images facing forward and aft.

      ▪ A five-view camera system consists of five cameras mounted so that each exposure collects a nadir image and oblique images facing forward, aft, left, and right. This may be referred to as a "Maltese Cross" configuration.

      ▪ Oblique cameras may use a fixed frame (many examples), pushbroom (e.g., Wehrli) or sweeping imaging, also known as panoramic (e.g., VISIONMAP A3).

   b. What is an oblique imagery system?
   An oblique imagery system pairs the imagery with a software viewing system that allows for navigation, measurements, and image annotation.

   c. How is it used by local governments?
   Oblique imagery is used extensively by local governments to assist in the property value assessment process and in public safety.

   In the property valuation process oblique imagery is useful in determining structure use by allowing views of the various elevations. It also allows views from various perspectives to allow appraisers to determine obscured features. For example, an

oblique image can reveal if a structure is a closed garage or an open car port, with implications for potential damage if located in a flood hazard area (see Figure 1.)

Figure 1. Example of House with Car Port in Ortho Image (what roof on left) with Flood Hazard Zones and Oblique Image (right) Showing Open Sides of Car Port.

In the public safety realm, because oblique images provide a view from each side of a location, dispatchers and first responders have a more complete view of a call location than they do with either orthophotos or street level imagery.

d. Where is it being used?
Oblique imagery has been used by various jurisdictions in North Carolina since 2005. A complete list is not available, but many counties and municipalities have acquired oblique aerial photography at least once, and many jurisdictions have acquired obliques in multiple years. Vendors may share lists of their clients when a jurisdiction expresses interest.

e. How does oblique imagery compare to orthoimagery?
Oblique imagery may be a complement to orthoimagery, but it is not a replacement. Orthoimagery is unsurpassed as a base map with horizontal precision consistent with state specifications. Oblique imagery provides additional perspectives on vertical features. Oblique imagery is not intended for precise measurement of horizontal or vertical distance.

2. **Imagery Basics**

   a. Nadir – An image that has been taken from a camera positioned to look vertically straight down. Traditional orthophotography is produced from near-vertical nadir images. Oblique images contrast to near-vertical nadir images because oblique images are intentionally exposed at an angle between 40° and 50° from nadir.

   b. Look Angle – The angle from the ground to the oblique camera angle, typically 40°to 50° from nadir.

   c. Field of View – This defines how wide an area on the ground that each image covers.

   d. Oblique Frames – Individual oblique images of an area. Oblique and nadir images make up an image library.

   e. Ground Sample Distance – Generally considered the ground pixel size. An image pixel ground sample distance of 2 inches means that each pixel is 2 inches by 2 inches in size.

3. **Software Controls**

   Any image viewing software provided by a vendor should have controls appropriate for manipulating graphically based data. These should include but are not limited to:

   a. Session setup and management tools to control the basic state of the operational session. Usually conveyed as part of a workspace.

   b. Search tools used to locate exact locations such as a street address.

   c. Image navigation tools such as pan, zoom, and revert back to, and the original setting should be available.

   d. Tools to export or extract images that allow a user to use portions of the imagery outside of the vendor software environment.

   e. Image mark-up tools that allow for text and simple graphic annotations to be displayed over the image. These graphics should be geographically aware and able to be saved and retrieved at a later time.

   f. Image measurement tools to include the capability to measure length, height, area, terrain changes, slope, and elevation. Measurements should be consistent throughout the images.

g. Printing capability should include virtual page creation and customization to include graphics or text annotations.

h. The viewing software should also allow for the synchronized display of the coordinated oblique and orthographic imagery at a given location.

4. Refresh – How Often?

Similar to traditional orthophotography, jurisdictions may schedule re-flights based on the growth rate of the particular jurisdiction. Updates may be annual where construction is widespread. Refreshing imagery may be coordinated to be available for scheduled real property revaluation. Be aware that some vendors offer cost savings for multiple year flights. These multi-year contracts can also be designed to provide a balanced budget amount over the contract years.

5. Platforms

a. Vendors
Vendors number in the dozens nationally and internationally. Companies that provide custom oblique imagery and supporting software include but are not limited to Geospan, ControlCam, and Ofek Multivision. The list below represents the companies that have been known to market their products in North Carolina, but there may be other service providers.

- Fugro Earthdata (www.fugroearthdata.com) – Fugro EarthData offers the PanoramiX Oblique Mapping system. Their system includes 104° field of view oblique imagery. The PX Mapper software is available for viewing the imagery and is provided in desktop and browser-based versions. PX Mapper is Esri ArcGIS compatible.

- EagleView Pictometry (www.eagleview.com) - Pictometry Intelligent Images is the imagery component of the Pictometry System. These images are captured using a five-camera system that includes the nadir and cardinal direction views. Pictometry images can be viewed using a variety of the vendor's software products that include both browser-based and desktop tools. They are viewed using a suite of software products called CONNECT. The imagery collected by Pictometry is licensed to the client and is delivered in proprietary file formats.

- Sanborn (www.sanborn.com) – The Sanborn Oblique Imagery Solution uses a five-camera system that captures the nadir and cardinal directions. They also provide a browser-based viewer called the Oblique Analyst and an extension that operates within the Esri ArcGIS Desktop platform. The imagery collected by Sanborn is the property of the client and is delivered in non-proprietary file formats.

- Woolpert (www.woolpert.com) – Woolpert does not currently offer an oblique-based product but are developing a system. Woolpert had previously offered the SmartView product that used "pushbroom" camera technology.

b. Software Options
- Desktop – Several vendors provide desktop-based software solutions used to interact with their oblique imagery. These products generally allow for the import of GIS-based data sets.

- Desktop Extensions – Several vendors provide software extensions that allow for interaction with oblique imagery from within an Esri ArcGIS Desktop session.

- Browser-based – The browser-based platform is where most of the newer products can be found for oblique image viewing. The primary viewing products for each vendor are migrating to this operational environment and towards serving their images though a cloud architecture.

- Server – This type of delivery involves a software system that manages the image library and delivers (serves) images to client software. These servers can be hosted by the vendor or locally by the client.

- Image Library – This will generally be a self-contained imagery folder with an indexing database used to retrieve the appropriate images.

6. ASPRS and Standards

The American Society for Photogrammetry and Remote Sensing (ASPRS) has created the PDAD Oblique Aerial Imagery Committee with the goal of creating an oblique standards document. The document is in development and is expected to be released for comments to the ASPRS during the spring of 2015.

7. Procurement

Oblique Aerial Photogrammetry is considered a surveying service under state law (N.C.G.S. § 143-64.31) and as such, procurement should be pursued through the Request for Qualifications process (see for example http://canons.sog.unc.edu/?p=2565 for more information).

8. Miscellaneous

Image Mosaics – Oblique images cannot be merged into a seamless mosaic the way traditional orthophoto images can. This is due to the fact that each oblique is trapezoidal in shape and the same features are photographed from a different perspective in each exposure. Each image will have a distinct edge and transitioning to

an adjoining image will present an entirely new perspective on the area of interest. The screen images below show adjacent oblique images (Figure 2). Notice the difference in how the outlined building is displayed. This effect is normal, and while it can be confusing, it also shows an additional perspective of the building.
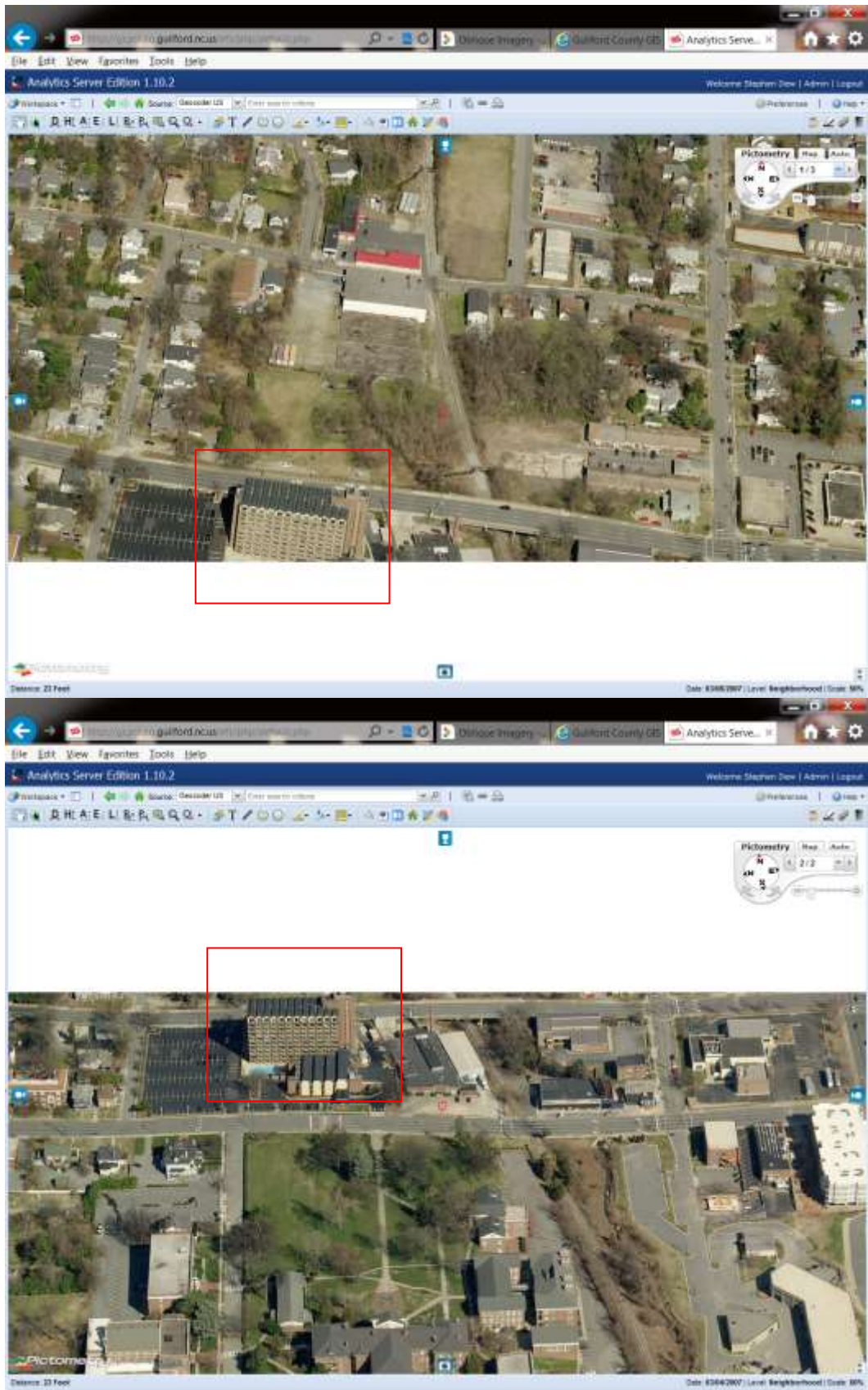
Figure 2. Example of Different Representations of a Building

Image Ownership – Some vendors retain ownership of their imagery and the client is only licensing access to it.

Image Format – Some vendors use proprietary image formats but have the capability for specific images to be exported for use outside of the oblique viewing software environment.

Image Storage Consideration – While many vendors are moving towards storing the oblique imagery within a Cloud architecture, it is still common practice keep an image library locally. Be aware that an oblique imagery system can potentially contain well over 100,000 individual images.

Technical Note on photogrammetry – To rectify oblique images, a photogrammetry technique would be to determine what plane to rectify to, then apply a 3D model that includes ground and structure data. This data could be visualized in a 3D colorized point cloud environment, but that is more in the realm of computer vision and 3D modeling technology, which is being integrated with traditional photogrammetric math models. With the advent of small unmanned aerial systems (UAS), this technology may become commonplace in the photogrammetric and surveying community.

9. **Resources**

GIM International is a magazine for geomatics that featured a comprehensive two-part series on current oblique imaging systems. See Issue 4, Volume 28, April 2014 and Issue 5, Volume 28, May 2014. www.giminternational.com

Vendor websites include but may not be limited to the following.

EagleView Pictometry www.eagleview.com

Fugro Earthdata www.fugroearthdata.com

Sanborn www.sanborn.com

Woolpert www.woolpert.com

Geospan www.geospan.com

ControlCam www.controlcam.com

Ofek Multivision http://www.ofek-air.com/

For more information, visit the website of the NC Geographic Information Coordinating Council www.ncgicc.org