



Best Practices for Managing Historical Imagery

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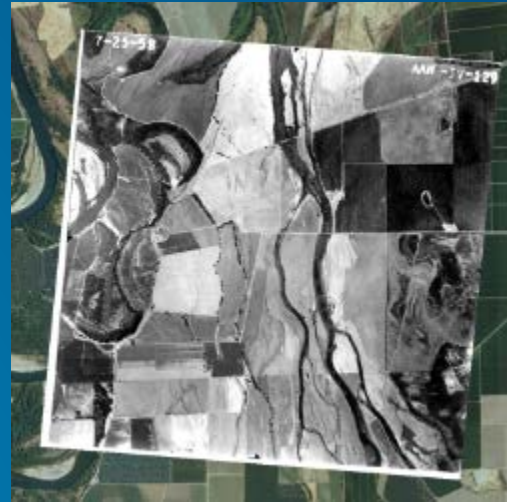
Kumar Dhruv

Objectives

- **Manage & Share Collections of Historic imagery**
- **View & use best imagery**
 - By geography
 - By date, other attributes
- **Initial product is mosaic dataset or image service with approximate georeferencing**
 - Accuracy may be improved, depending on metadata and priority

Historical Imagery

- **Film imagery from archives**
 - Rolls of aerial film (9", other)
 - Panchromatic, True Color, Color IR
 - 1930's – 2000's
- **Value**
 - Water rights
 - Property Boundaries
 - Finding UXO (Europe, WWII)



Data Sources

- Typically scanned by
 - Photogrammetric scanner
 - Table top scanner
- Scan quality sometimes poor
- Often Pan, sometimes color RGB
- Orientation & Metadata
 - None
 - Poor – Just Index Map
 - Good – Digital Index from navigation data (> 1990)
 - Excellent – Output from AT

Simple Workflow (manual, small # of images)

- Scan
- Compile metadata
- Manual georeferencing
 - Details on following slide
- Mosaic Dataset
 - *Raster Dataset* Raster Type
- Optionally Refine Orientation
- Use directly in ArcGIS for Desktop
- Publish as Image Service

Manual Georeferencing - Details

- **Set TIF images to ReadOnly**
- **Use ArcGIS Georeferencing Tool**
 - **Manually measure tie points using imagery base map**
 - **Typically 6 spread out are sufficient**
 - **Use Projective Transform**
 - **Automated tie point may work (if similar base imagery is available)**
- **Use “Update Georeferencing”**
 - **Do NOT rectify and output**

Manual Georeferencing



High Level Workflow (large/multiple projects → automation)

1. Scan
2. Compile metadata, create feature class with approximate photo centers
3. Calculate approximate orientation

Many steps involved; See GP Tools available for download: <http://www.esriurl.com/HistoricalTools>

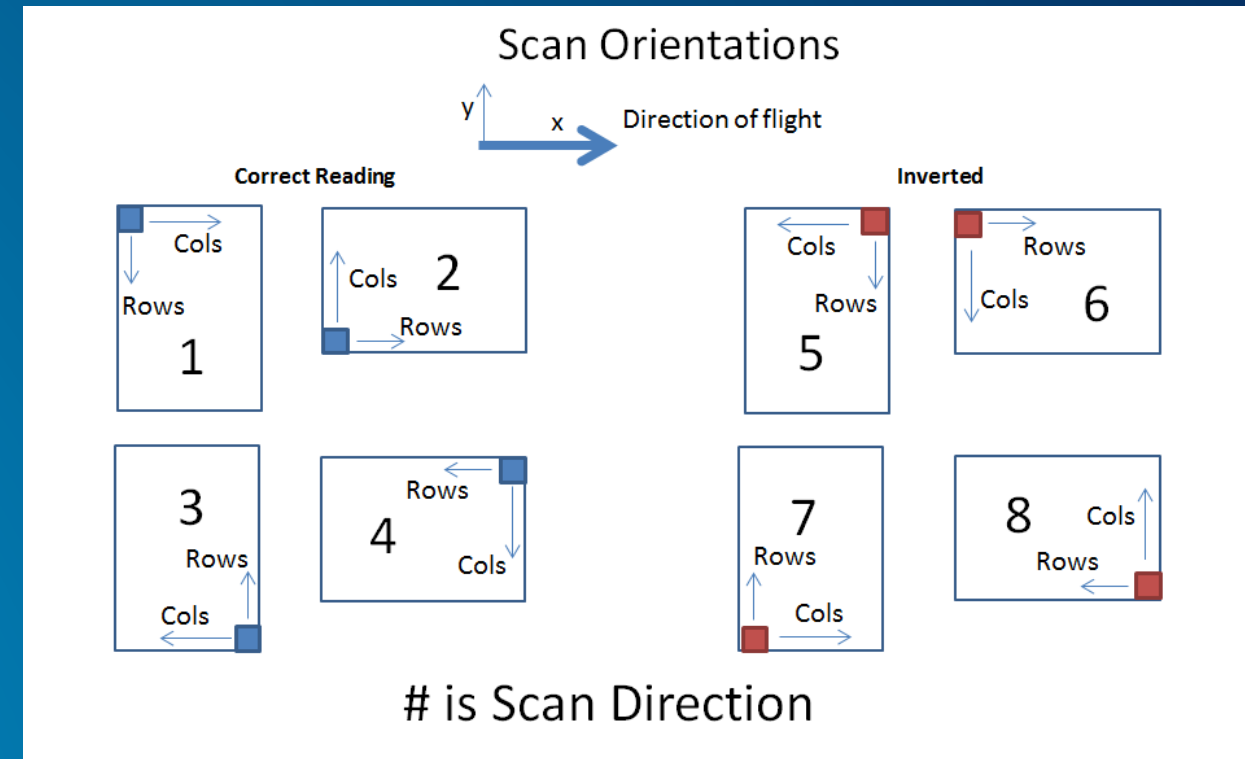
4. Mosaic Dataset

Frame Camera Raster Type

5. Optionally Refine Orientation
6. Use directly in ArcGIS for Desktop and/or Publish as Image Service

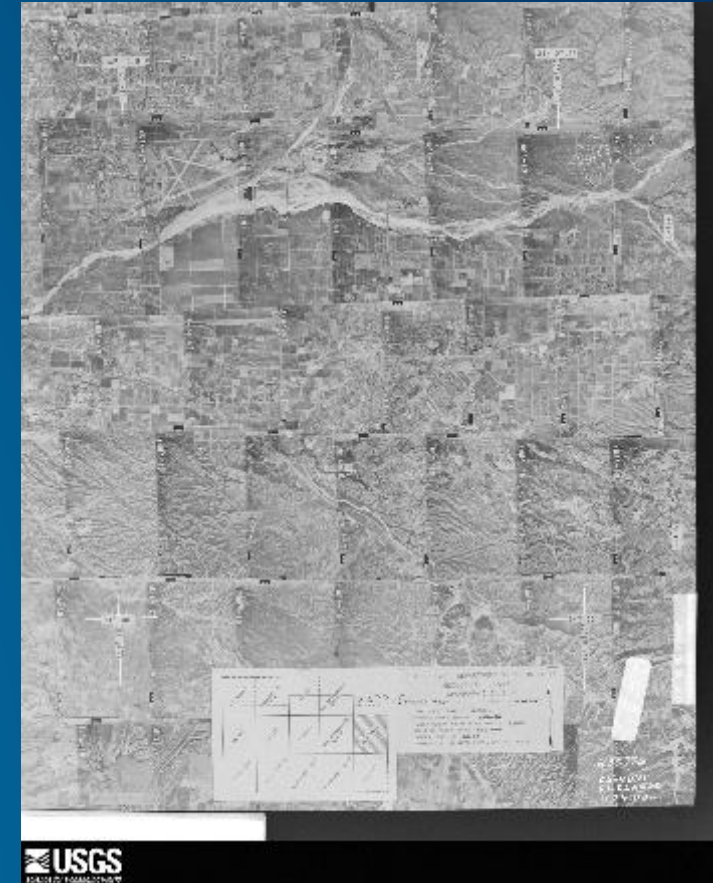
(1) Scanning & Optimum Format

- Scan at about 20 microns
- Record scan direction →
- Optimize Compression
 - TIF with JPEG compression (Q80 ~ 5x)
 - If color use JPEG_YCbCr (Q80 ~ 8x)
- No need to generate statistics
- Generate Pyramids
 - Often Internal (GDALaddo)
- To optimize format use *CopyRaster* or *Raster to Other Format* (Multiple)



(2) Compilation of Metadata & Digitization of Approximate Photo Centers

- **Photo Index or Print Laydown**
 - Digitize locations and frame numbers by run & film number
 - Build feature service → (x,y) point for approximate photo center
 - “How??” will depend on your data. Easiest method typically to:
 - Scan & georeference the Photo Index/Print Laydown
 - Manually create points for photo centers
 - Populate “Key Historic Imagery Parameters” Table (next slide)
- **Film Report**
 - Include other metadata about the flight – date, type of film, etc.



(2) continued: Build “Key Historic Imagery Parameters” Table

For “Historical Imagery.pyt” - Required fields

Approximate X,Y (Geometry)

COG (course over ground) – this will be calculated

‘Raster’ field: path and file name to each scanned file

PhotoScaleF – Scale factor e.g. 5000 for 1:5000

FocalLength - In microns; e.g. 152400 for 6 inch

ScanDirection – per previous diagram

ScanResolution – in microns. If not known, can be estimated as $0.24/\text{Min}(\text{Cols}, \text{Rows})$

FrameSize – in microns e.g. 180000 for 18cm. If undefined then assumed to be 23cm

Frame – As a 4 digit string, e.g. 0023 (not stored as an integer)

Run – As a string

Film – As a string

(2) continued: Build “Key Historic Imagery Parameters” Table

For “Historical Imagery.pyt” - Optional fields

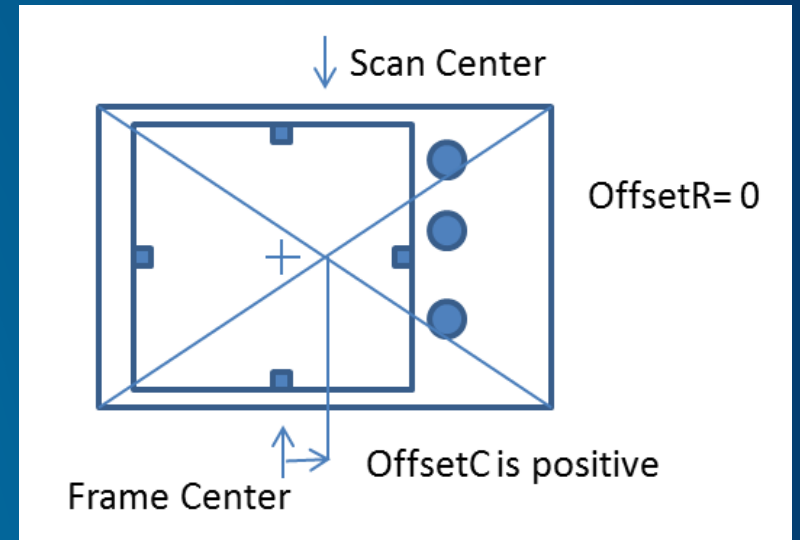
Cols,Rows – Number of Cols and Rows of the image. Will be obtained from Image if not defined

OffsetC, OffsetR - in microns. This is the offset of the camera center from the center of the scan. If undefined then assumed to be 0.

Other parameters optional – from Film Report

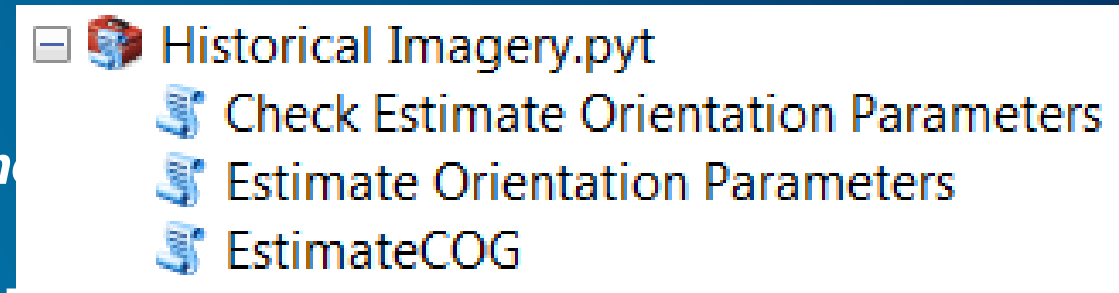
e.g. AcquisitionDate, ScanDate, ScannerModel, FilmType, etc.

Frame Camera Raster Type will add to attribute table



(3) Calculate Approximate Orientation

- Geoprocessing Tools “Historical Imagery.pyt” available for download

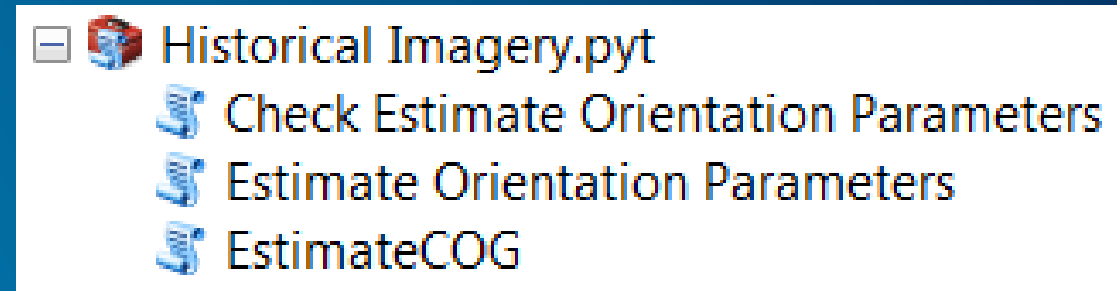


- Will build table(s) required as input to the *Frame Camera Raster Type*
 - *Frame Table and Camera Table* corresponding to Exterior orientation and Interior orientation
 - Can be separate tables, or combined into one
- Details re: *Frame Camera Raster Type* in Demo Theater Thursday @ 12:30
“Best Practices for Managing Aerial and UAS Frame Imagery”

See in ArcGIS Help System:
<http://esriurl.com/FrameSchema>
<http://esriurl.com/CameraSchema>

(3) Continued - Calculate Approximate Orientation

- Run *EstimateCOG* → Input KHIP table
 - This populates COG field
- Run *Check Estimate Orientation Parameters*
 - This verifies required data is populated before beginning a lengthy run
- Run *Estimate Orientation Parameters*
 - This builds single Frame & Camera Table required as input to *Frame Camera Raster Type* (workflow step 4)



(4) Create Mosaic Dataset

- Use *Frame Camera* Raster Type
 - Input Frame+Camera table as input
- Calculate footprints by Geometry, shrink ~200 m, clip to footprints
- Set Mosaic Method = Closest to Center
- Create Overviews

Approximate Orientation using the Frame Camera Raster Type

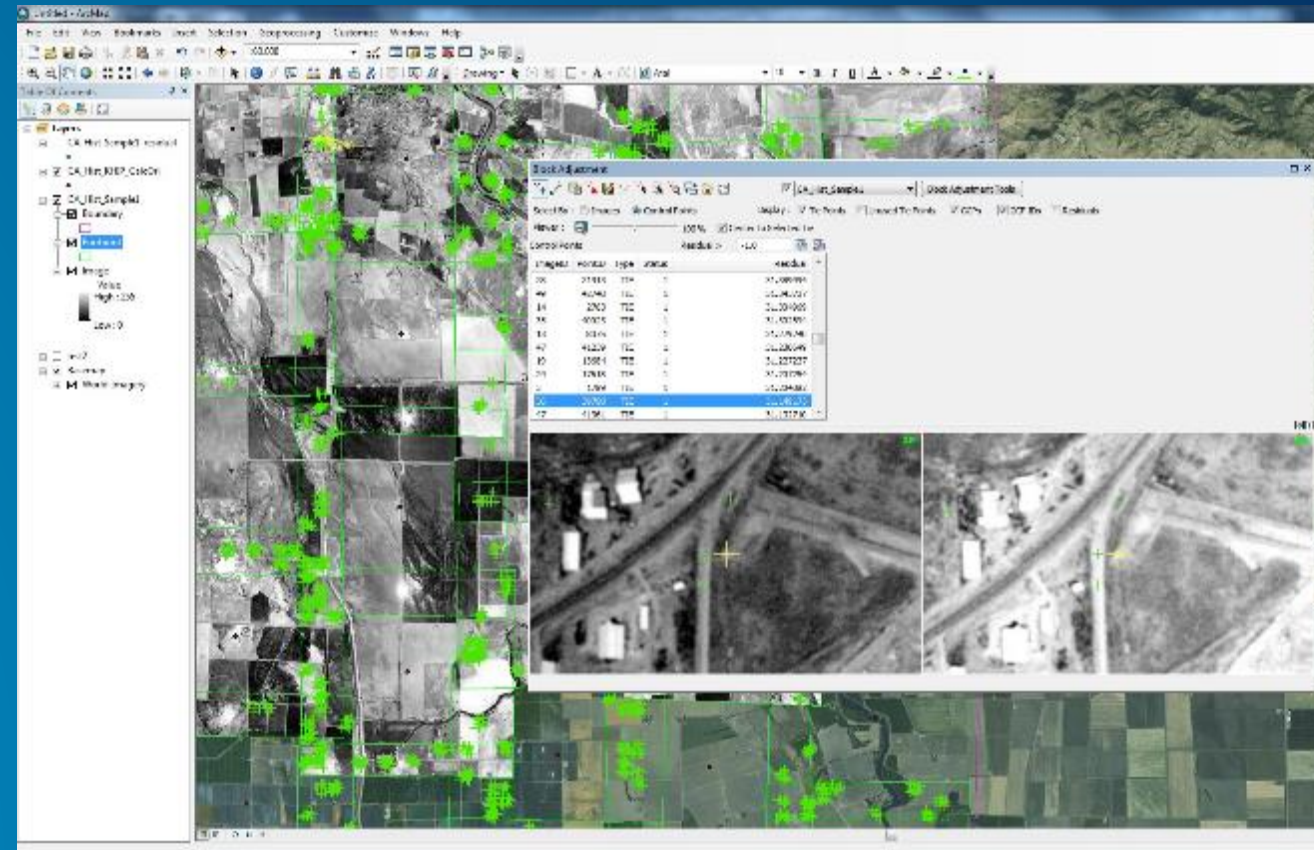


(Workflow step 5 - optional) Block adjustment in ArcGIS

- Calculate tie points between images
- Input ground control points
- Adjust with simple polynomials
- UI for tie point editing

- Details re: *Block Adjustment* -
Demo Theater Thursday @ 12:30

*“Creating high quality mosaics using
Block adjustment in ArcGIS”*



Refine Orientation using Block Adjustment



Publishing (Workflow step 6)

- **As Image Services**
 - **Highest Image Quality (No data loss)**
 - **Provide Metadata**
 - **Access to All Overlapping data**
 - **Clip to Footprints**

- **As Raster Tile Cache (*not* generally recommended)**
 - **Generate in Desktop or Server**
 - **Publish through Server or to ArcGIS Online**
 - **Provides Static Backdrop**

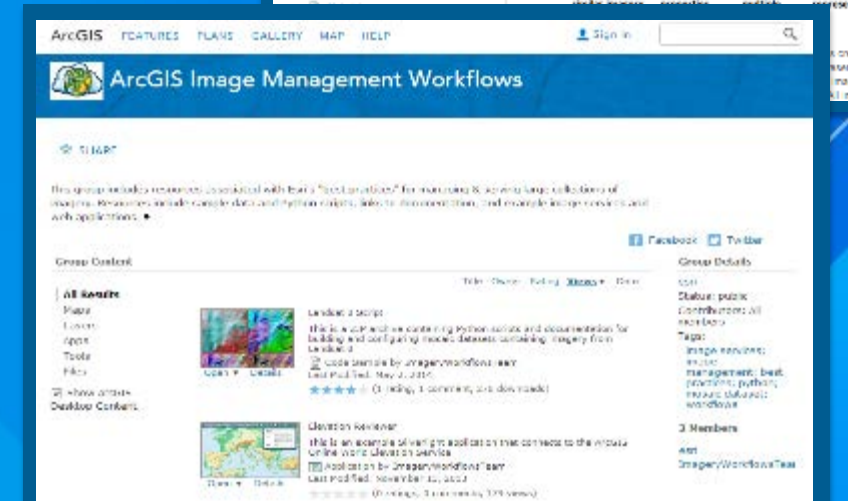
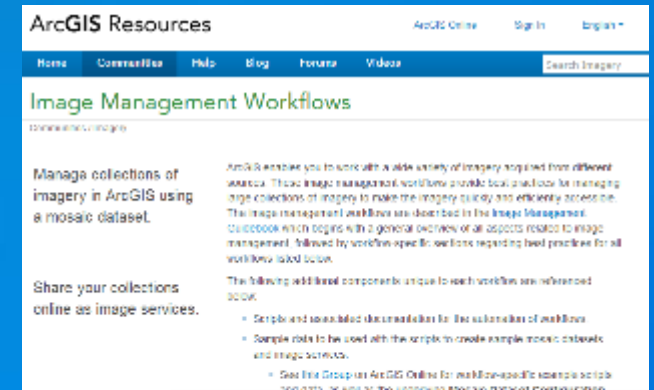
Highest Accuracy - Use Aerial Triangulation (Workflow step 3)

- Best for large collections (e.g. PCI HAP, Trimble Match AT)
- Aerial Triangulation (AT) & Block Adjustment
 - Best estimates of interior and exterior orientation parameters
- Uses best available DEM
- Outputs following parameters
 - Key Properties - ImageID,FocalLength
 - Exterior Orientation - X,Y,Z,Omega,Phi,Kappa
 - Interior Orientation - A0,A1,A2,B0,B1,B2
- Use *Frame Camera* Raster Type
- Link in other metadata

Image Management Workflows

Best Practice Workflows for Image Management

- **Resource Center landing page** <http://esriurl.com/6005>
- **Guidebook in Help System** <http://esriurl.com/6007>
- **ArcGIS Online Group** <http://esriurl.com/6539>
 - Downloadable scripts & sample data
- **Historical Imagery Toolbox:** <http://esriurl.com/Historical>
- **Recorded webinar:** <http://esriurl.com/LTSImgMgmt>
- **Source code on GitHub**





Understanding our world.